PART G

ASSESSMENT OF EFFECTS ON THE ENVIRONMENT

12.1 Introduction and summary of effects on the environment

12.1.1 Overview

Overview

The assessment of effects on the environment for the Project has identified a wide range of actual and potential positive and adverse effects on the environment.

The most significant positive effects of the Project relate to travel, transport and economics during operations. These effects include reduced congestion, improved journey times for vehicles, freight and public transport, improved connectivity for pedestrians and cyclists, and enabling improved economic efficiencies as a result of transport improvements. Other significant positive effects include an improved noise environment for residents adjacent to SH1, rehabilitation of the coastal edge and improved quality of stormwater discharges into the Māngere Inlet.

During construction there will be temporary adverse effects, including loss of habitat, potential sedimentation of waterways and the Māngere Inlet, noise and traffic from construction activities, business disruption and human health risks from working on contaminated land.

The Project will have some permanent adverse effects. Most notably these impacts are on outstanding natural features, loss of intertidal habitat and impacts on rare flora.

12.1.1.1 Introduction

This section provides a summary of the actual and potential effects of the construction, operation and maintenance of the Project, as assessed in the remainder of the sections in this Part. The summary provides an overview of the effects associated with the Project and identifies whether they are positive or adverse and the scale they are likely to occur at (i.e. local, regional or national).

Active avoidance of adverse effects has been the first principle for the design of the structures and road alignment. Where avoidance has not been possible, mitigation measures have been proposed. Details of mitigation still required is addressed in more detail in subsequent sections and will be reflected in the conditions for the project.

12.1.1.2 Structure of the assessment

The remainder of the sections in Part G describe the assessment undertaken in the key topic areas. For convenience, each assessment topic is described in a separate section. The topic sections, and the relevant supporting technical reports, are set out in Table 12-1.

Table 12-1: Effects on the environment assessment topics

AEE Section	Topic	Relevant technical report/supporting information
12.2	Traffic and transport effects	TR 1: Traffic and Transportation Assessment
12.3	Economic effects	Report 3: Economic Assessment
12.4	Property, land use and business disruption	-
12.5	Network Utilities	-

AEE Section	Topic	Relevant technical report/supporting information
12.6	Values of importance to Tangata Whenua/Mana Whenua	-
12.7	Heritage – Built	TR 2: Built Heritage Assessment
12.7	Heritage - Archaeology	TR 3: Archaeological Assessment
12.8	Heritage – Geological	TR 4: Geological Heritage Assessment
12.9	Trees	TR 5: Arboricultural Assessment TR 5: Archaeological Supplementary Assessment
12.10	Landscape and Visual	TR 6: Landscape and Visual Impact Assessment TR 6: Landscape and Visual Impact Supplementary Assessment Supporting information: Urban and Landscape Design Framework
12.11	Noise and vibration	TR 7: Traffic Noise and Vibration Assessment TR 8: Construction Noise and Vibration Assessment TR 8: Construction Noise and Vibration Supplementary Assessment
12.12	Air quality	TR 9: Air Quality Assessment
12.13	Construction traffic	TR 10: Construction Traffic Impact Assessment TR 10: Construction Traffic Impact Supplementary Assessment
12.14	Social Impact	TR 11: Social Impact Assessment TR 11: Social Impact Supplementary Assessment
12.15	Earthworks and vegetation removal	TR 12: Stormwater Assessment TR 15: Ecological Impact
12.16	Groundwater	TR 13: Groundwater Assessment
12.17	Ground settlement	TR 14: Assessment of Settlement Effects
12.18	Contaminated land	TR 17: Contaminated Land Assessment
12.19	Coastal Processes	TR 15: Coastal Processes Assessment
12.20	Ecology	TR 16: Ecological Impact Assessment TR 16: Ecological Impact Supplementary Assessment
12.21	Stormwater	TR 12: Stormwater Assessment TR 12: Stormwater Supplementary Assessment

The technical reports supporting the assessments are contained in *Volume 3: Supporting Technical and Assessment Reports*.

12.1.2 Summary of Effects

The actual and potential effects of the construction, operation and maintenance of the Project are summarised in Table 12-2. This table provides a summary of the positive and adverse actual and potential effects of the Project, and in many cases there are opportunities or measures that can be taken to minimise or mitigate the adverse effects identified.

Table 12-2: Summary of effects relating to the NoRs

Table Key: Construction / Temporary Effects | Operational / Permanent Effects

Actual or potential effect	Positive	Adverse	Local, regional or national level effect(s)
Traffic and Transport Effects			
Increased construction traffic movements from both staff vehicles and heavier vehicles are likely to have adverse amenity and safety effects on local roads – including for pedestrians and cyclists – and may cause damage to road surfaces.		ü	Local, regional
Disruption on the local road and state highway network.		ü	Local, regional
Changes of intersections, road alignments and bus stop locations.		ü	Local
Closure of walking and cycling routes.		ü	Local
Property access closure or restrictions		ü	Local
Significant travel time reductions for vehicles, freight and buses.	ü		Local, regional
Increased average speeds.	ü		Local, regional
Improved travel time reliability for vehicles, freight and buses.	ü		Local, regional
Generally reduced traffic on local roads.	ü		Local, regional
Higher quality and more facilities for walking and cycling – including safety for cyclists.	ü		Local
Providing separate 'commuter' and recreational cycle/walk routes.	ü		Local
Steady growth in use of pedestrian and cyclist facilities.	ü		Local, regional
Connecting existing shared paths to proposed paths and key destinations.	ü		Local, regional
Access to properties generally improved by reduced traffic and reduced flows.	ü		Local
Ability to accommodate on street parking demand with reduced parking spaces in local roads.	ü		Local
Economic effects			
Increased spend during construction.	ü		Local, regional
Business disruption in addition to property access changes.		ü	Local, regional
Increased flexibility for businesses to maintain and enhance productivity through improved accessibility.	ü		Local, regional
Improvements in travel time and journey time reliability will reduce delivery costs, attract new businesses and enhance business efficiency.	ü		Local, regional
Land Use, business disruption and property effects			
Temporary occupation of property for construction purposes, including construction site compounds.		ü	Local
Integration with known local projects.	ü		Local
Changed access to some properties.	ü	ü	Local

Table Key: Construction / Temporary Effects | Operational / Permanent Effects

Actual or potential effect	Positive	Adverse	Local, regional or national level effect(s)
Permanent acquisition of private residential and business property for the construction and operation of the Project – some full sites and some part sites. This affects both land owners and lessees.		ü	Local
Occupation of Southdown Freight Terminal.		ü	
Network Utilities			
Potential to cause unplanned physical damage or disruption to network utility assets or other transport infrastructure.		ü	Local, regional, national
Some utilities need to be relocated.		ü	
Improved accessibility to port land.	ü		
Cultural / Tangata Whenua			
Potential discovery or destruction of artefacts of importance to Mana Whenua.	ü	ü	Local
Effects on traditional mahinga kai, including terrestrial vegetation and, potentially, marine species.		ü	Local, regional
Reinforcement of two of the historic portages in the area.	ü		Local, regional
Improved quality of discharges from the Onehunga catchment into the Māngere Inlet in the long term, assisting to enhance the mauri of the Manukau Harbour and enabling kaitiaki role.	ü		Local, regional
Responds to key cultural interests through ongoing partnership with the Mana Whenua of the area.	ü		Local, regional, national
Works on sites of value to Mana Whenua.		ü	Local
Replacement of Ōtāhuhu culvert with a bridge structure	ü		Local
Heritage – Built			
Improved access including for walking and cycling to the Aotea Sea Scouts Hall.	ü		Local
Reduced historic context of Aotea Sea Scouts Hall.		ü	Local
Reduced historic context of Waikaraka Park and weakened relationship with Māngere Inlet.		ü	Local
Heritage – Archaeology			
Discovery of artefacts during construction.	ü	ü	Local
Potential destruction of artefacts during construction.		ü	Local
Heritage – Geological			
Enhanced legibility of volcanic features, including interpretive signage and material.	ü		Regional
Changes to the valued features of ONF(s) and volcanic features.		ü	Regional
Trees			
Works in the dripline of trees		ü	Local
Planting of new trees.	ü		Local

Table Key: Construction / Temporary Effects | Operational / Permanent Effects

Actual or potential effect	Positive	Adverse	Local, regional or national level effect(s)
Landscape and Visual			
Visible construction works and construction yards.		ü	Local
Improved amenity of the coastal edge with open space for informal recreation purposes including new wetland planting, new public walking and cycling shared paths.	ü		Local, regional
Enriched amenity for Anns Creek through weed clearance and replanting.	ü		Local
Natural character of the coastal edge will be rehabilitated, including through reflecting the historic landforms.	ü		Local, regional
Noticeable changes to the outlook from some properties and public areas.	ü	ü	Local
Noise walls.	ü	ü	Local
Reduced legibility and natural character of Te Hōpua.		ü	Local
Loss of sea views from the Waikaraka Cemetery.		ü	Local
Noise and Vibration			
Nuisance and disturbance to close neighbours.		ü	Local
Changed noise environment for residential properties due to replaced / installed barriers on SH1.	ü	ü	Local
Air quality			
Localised dust impact.		ü	Local
Potential odour or hazardous air pollutants release from working in landfills.		ü	Local
Discharges from concrete batching.		ü	
Emissions from construction machinery.		ü	Local
Reduced congestion and therefore improved air quality.	ü		Local
Social Impact			
Disruption to recreational users of walking and cycling facilities, including at and along the foreshore.		ü	Local
General disruption to local communities (residents, businesses, visitors) as a result of construction activities including diversions, change in access, noise, and large numbers of construction workers.		ü	Local
Exposure to disturbed contaminated soils therefore risk to human health (predominantly for workers).		ü	Local
Temporary occupation of Waikaraka Park.		ü	Local
Disruption to emergency service routes.		ü	Local
Closure / diversion of important walking and cycling routes for commuters and recreational users.		ü	Local, regional
Loss of passing trade from local road diversions.		ü	Local

Table Key: Construction / Temporary Effects | Operational / Permanent Effects

Actual or potential effect	Positive	Adverse	Local, regional or national level effect(s)
Loss of passing trade from diversions and changes to access.		ü	Local
Potential reduction in crime resulting from more people in the area and passive surveillance.	ü		Local
Increase in trade for local businesses from in-flow of construction workers.	ü		Local
Enhanced public accessibility to the coastal environment and coastal edge.	ü		Local, regional
Improved amenity and impacts for businesses from reduced traffic volumes on Neilson Street.	ü		Local, regional
Improved Princes Street Interchange.	ü		Local, regional
Reduced traffic and improved connections to Onehunga Town Centre. Improved amenity in Onehunga Town Centre as a result.	ü		Local, regional
Integration with local projects such as Greenways in Ōtāhuhu.	ü		Local
Reinstatement of Waikaraka Park south occupied during contributing to the development by Auckland Council of recreational facilities.	ü		Local
Loss of amenity and tranquillity in the Waikaraka Cemetery.		ü	Local
Reduction in amenity for residents and activities where land is partially taken.		ü	Local
Loss of community services from full land requirement (e.g. businesses on Sylvia Park Road).		ü	Local
Reduction in passing trade on Onehunga Harbour Road due to separation of through and local traffic.		ü	Local
Loss of affordable residential houses in Mt Wellington / Ōtāhuhu area and limited choice for relocation due to wider housing pressures.		ü	Local
Loss of social housing and perceived lack of alternatives.		ü	Local

Table 12-3: Summary of effects relating primarily to the resource consents

Table key:	Construction / Temporary Effects	Operational / Permanent Effects

Actual or potential effect	Positive	Adverse	Local, regional or national level effect(s)
Earthworks and vegetation removal			
Discharge of sediment into the surrounding environment.		ü	Local, regional
Groundwater and settlement effects			
Raised groundwater levels		ü	Local
Improved long term quality of groundwater through management of leachate in some cases.	ü		Local, regional
Ground settlement			
Settlement effects on buildings, utilities and transport networks		ü	Local , regional
Works in contaminated land			
Discharge of contaminants from historic landfills to the receiving environment.		ü	Local, regional
Increased risk to human health and terrestrial / aquatic life from disturbance of contaminated land.		ü	Local
Risk to human health (largely for workers) from disturbance of asbestos, methane gas and other contaminants.		ü	Local
Remediation of contaminated sites directly within the Project footprint.	ü		Local
Improved long term management of contamination and reduced exposure for humans and ecology along the foreshore through containment.	ü		Local
Coastal Processes			
Changes to coastal environment during construction from temporary works, including dredging.		ü	Local, regional
Changes to access to the coastal environment – may require exclusion of the public.		ü	Local
Minor changes to coastal processes within the Māngere Inlet resulting from the loss of tidal prism.		ü	Local
Enhanced resilience, protection from stormwater inundation and provision of protection from sea level rise, enhancing the usability of many properties in the Onehunga area.	ü		Local, regional
Ecology – Marine Environment			
Loss of intertidal habitat by occupation of CMA.		ü	Local, regional, national
Fragmentation of habitats.		ü	Local, regional
Removal of vegetation.		ü	Local, regional
Disturbance of habitats.		ü	Local, regional
Increased habitat diversity.	ü		Local, regional
Reduced contaminant load discharged to the CMA.	ü		Local, regional

Table key: Construction / Temporary Effects | Operational / Permanent Effects

Actual or potential effect	Positive	Adverse	Local, regional or national level effect(s)
Ecology – Avifauna			
Removal of intertidal habitat which is foraging ground for sea and shore bird species.		ü	Local, regional, national
Increased habitat diversity.	ü		Local, regional
Reduced contaminant load discharged into the CMA.	ü		Local, regional
Cumulative loss of habitat		ü	Local, regional
Ecology – Terrestrial			
Removal of vegetation.		ü	National
Fragmentation of habitats.		ü	Local, regional
Increased weeds.		ü	Local, regional
Ecology – Freshwater			
Reduced habitat due to reclamation of streambeds.		ü	
Increased habitat diversity through creation of new habitats in the form of stormwater wetlands.	ü		Local, regional
Reduced contaminant load discharged to streams.	ü		Local, regional
Loss of habitat.		ü	Local, regional
Stormwater and impermeable surfaces			
Increased risk of sediment and contaminant discharges to the Māngere Inlet.		ü	Local
Increased stormwater discharge to the CMA.		ü	Local
Potential mobilization of sediments in coastal waters.		ü	Local
Improved quality of stormwater discharges to Māngere Inlet from the local Onehunga and Penrose Catchment.	ü		Local, regional, national
Reduced contaminant levels in run off entering the Māngere Inlet from roads and the surrounding urban area as a result of treatment being provided in some areas where none is currently present.	ü		Local, regional, national
Improved stormwater quality from new treatment for parts of SH1 that currently have no treatment.	ü		Local, regional
Potential opportunity to provide for some treatment of contaminated discharges.	ü		Local, regional

12.2 Traffic and transport

Overview

The Project will deliver significant positive traffic and transport effects (i.e. benefits) for Auckland, namely:

- Significant improvements in consistency and reliability of travel times for trips accessing the strategic network (i.e. SH1 and SH20) from Onehunga-Penrose business area. The access times become much more consistent and reliable across the day which will allow improved and more flexible journey and logistics planning for businesses;
- Improvements to journey times to key locations over a wider area (e.g. to/from the airport and Highbrook);
- Improved accessibility to businesses in the Onehunga-Penrose area by the provision of new access roads;
- Reduced traffic flows using local roads which improves amenity for residents. Resilience in the local road network by taking pressure off the Neilson Street corridor, having alternative access points and providing a link between the two State highways in case of an emergency event or closure;
- Improved accessibility for pedestrians and cyclists between Māngere, Onehunga and Sylvia Park Town Centrevia high –quality, direct and dedicated facilities. Improved access to Ōtāhuhu East by safer walking and cycling facilities, reduced impact of motorway queues and new accessibility to the adjacent Panama community;
- Safer walking and cycling facilities; and
- Improved travel time reliability for buses accessing Onehunga Town Centre from SH20 and on other local bus routes.

These benefits are important for local business activities, the movement of road-based freight and for local communities who will experience improved and more reliable journey times. Less traffic on local roads means safer, quieter streets for the people who live there.

There will be a reduction in community severance in the Ōtāhuhu area as a result of a safer and shorter routes for pedestrians and cyclists.

These benefits would not be achieved without the Project.

12.2.1 Introduction

This section presents the findings of the assessment undertaken to determine the actual and potential effects of the Project on operational traffic and transport following construction. This includes predicted changes in travel times, traffic flows, active transport (pedestrian and cycling), public transport (bus and train), property access and parking. Details of the existing environment, methods and findings of transport investigations are contained in *Technical Report 1: Traffic and Transport Assessment* contained in Volume 3.

12.2.2 Existing traffic and transport environment

The description of existing traffic and transport environment is included in *Technical Report 1: Traffic and Transport* in Volume 3.

In summary, the five key existing transport issues currently affecting the Project area were identified as:

1. Unreliable and inconsistent journey times, including significant variability in travel times between businesses in the Onehunga-Penrose area and SH1 and SH20;
2. Unreliable and inconsistent bus journey times between SH20 and Onehunga Town Centre;
3. Conflict between through and local access traffic on Neilson Street, Church Street and Great South Road;
4. Use of residential streets to access the industrial hub due to congested strategic connections; and
5. Walking and cycling routes with connectivity, severance and amenity problems.

12.2.3 Methodology for assessing effects

The Traffic and Transport Assessment (refer to *Technical Report 1: Traffic and Transport Assessment*) was developed in accordance with Auckland Transport's *Integrated Transport Assessment Guidelines* (2015) and the Transport Agency's *Integrated Transport Assessment Guidelines* (2010).

The methodology for assessing the operational effects of the Project on the transport environment included modelling, qualitative assessment, data collection and future forecasting, observations and surveys (car parking, trips, walking and cycling). An integral part of the methodology has been altering or incorporating changes to the design of the Project to avoid or reduce any adverse transport impacts and considering feedback from stakeholders. Wherever possible the design of the Project has sought to minimise land requirements, impacts on parking and access and ensuring the Project does not preclude future transport projects.

Modelling is one of the techniques used and the following three models were used for assessing effects on travel times, travel reliability and traffic flows:

6. A Strategic Demand model (referred to as ART3)[57] that relates land use (such as population and employment) to travel patterns at a strategic, region-wide level;
7. A Project model (SATURN) which considered a smaller geographical area to the strategic model. The extent of the model was from Mt Albert Road in the north to Manukau City Centre in the south. This model loads vehicle trip patterns onto the road network to investigate traffic effects at a more detailed level; and
8. Design / operational models which use micro-simulation and intersection packages to look at traffic operation in even greater detail within the Project area.

The models have been appropriately calibrated, validated and peer reviewed.

The transport environment is constantly changing as a result of new transport initiatives coming on-line, land use changes and changes in network performance. Assessment of the Project against the existing (2016) environment is therefore not considered appropriate. Instead, key parts of the assessment have used transport models to simulate the following future scenarios for comparison purposes:

[57] The ART3 model is owned and operated by the Joint Modelling Application Centre which is a collaboration between Auckland Council, Auckland Transport and the Transport Agency.

- Future network with and without the Project in 2026; and
- Future network with and without the Project in 2036.

The modelling year 2026 has been used as it is shortly after the EWL is anticipated to open and aligns with the Regional models. The year 2036 is used as longer term forecast and is approximately 10 years after the Project is expected to open.

The assessment has been based on travel modes and issues, rather than the geographical Project sectors used in other assessments. This is because transport movements generally traverse multiple sectors with interactions between them, depending on the activities and travel conditions.

12.2.3.1 Without Project scenario

The Without Project modelled scenario represents a future scenario for 2026 without the Project in place. This has been developed to provide a baseline against which the effects of the Project can then be assessed. This scenario recognises that a number of other transportation projects are likely to be progressed, and development will continue to occur in the period to 2026, irrespective of the Project.

The Without Project scenario includes the land use changes forecast by Auckland Council (including from the AUP (OP)[58]). Transport projects that have not yet been constructed (and have not been consented), but are expected to be completed by 2026 regardless of whether the Project goes ahead are included in the Without Project scenario. These include:

- The Waterview Connection Project, including the upgrades to SH20 south of the Waterview tunnel;
- Auckland accelerated projects (Southern Corridor Improvements, Northern Corridor Improvements, AMETI and SH20A to Airport (Kirkbride Road grade separation));
- Auckland City Rail Link; and
- Upgrades to SH20 (Queenstown Road to Neilson Street), local widening of Neilson Street currently under construction as separate works (see *Section 6.7.6.2: EWL SH20 Capacity Improvements: Neilson Street to Queenstown Road* for further discussion).

12.2.3.2 With Project scenario

The With Project modelled scenario is the same as the Without Project scenario detailed above but also includes the Project.

Modelling results are set out in *Technical Report 1: Traffic and Transport Assessment* contained in Volume 3.

12.2.3.3 Effects based assessment methods

To assist in assessing effects, the models have been used to provide quantitative forecasts of the four scenarios. The key assumptions that have been used in the modelling include:

- Medium level population forecasts consistent with those developed for the Auckland Plan;
- Committed or likely regional projects;

[58] Forecasts based on the Proposed Auckland Unitary Plan, dated 30 September 2013. The results of the zoning in the Decisions Version (released 19 August 2016) are similar.

- Behavioural responses to non-price travel demand management measures that reduce car usage and increase public transport, walking and cycling; and
- Committed local projects such as the widening of SH20 south of Maioro Street and between Queenstown Road and Neilson Street, and four laning of Neilson Street between Alfred Street and MetroPort.

The full modelling results are contained in *Technical Report 1: Traffic and Transport Assessment* in *Volume 3: Technical Reports*.

In summary, the results indicate that in the Without Project scenario, the already-congested conditions experienced when accessing the Onehunga-Penrose area from both SH20 and SH1 are expected to get significantly worse due to regional and local traffic growth. This additional congestion causes time delays and significant variability in travel times, affecting vehicles both commuter and commercial (including buses) and freight.

12.2.4 Assessment of operational traffic and transport effects

There will be significant positive operational traffic and transport effects as a result of the Project. Reduced congestion on local roads will be achieved, resulting in faster and more reliable travel times for vehicles, freight and public transport. The Project improves accessibility to SH20 and SH1 from the Onehunga-Penrose area for vehicles, provides improvements to cycling and walking facilities and improves journey time reliability for buses between SH20 and Onehunga Town Centre. These predicted effects and effects on parking, access and safety performance are set out below.

12.2.4.1 Travel times, travel time reliability and traffic flows

a. **Predicted travel times**

Significant travel time savings are anticipated for freight (and other vehicles) from the Onehunga-Penrose industrial area accessing the State highway network. From the intersection of Captain Springs Road and Neilson Street (being a representative location in the industrial area) the following travel time savings are predicted in 2036 with the Project:

- Reductions accessing SH20 north of up to 4.1 minutes (43%[59]);
- Reductions accessing SH20 south of up to 6.5 minutes (48 %);
- Reductions accessing SH1 north of up to 6.3 minutes (37%); and
- Reductions accessing SH1 south of up to 18 minutes (68 %).

The time savings vary for each movement and time period. These values are the maximum savings identified and reference should be made to *Technical Report 1: Traffic and Transport Assessment* for the detailed assessment.

The most significant savings are those to and from SH1 south, due to the new link and access ramps. The works include extra lanes on SH1 south to Ōtāhuhu meaning this improvement will be able to accommodate the additional traffic that is generated on SH1 as a result of the Project. Substantial travel time savings are predicted to and from SH20 heading south and will significantly reduce congestion at Onehunga, specifically along Onehunga Mall, Onehunga Harbour Road and Neilson Street. The travel time savings to and from SH20 north are lower as this movement typically is not as highly congested.

[59] The changes are taken from comparing the Without Project scenario to the With Project scenario.

Similarly, the savings to SH1 north are lower, as the access points are directly into the Church Street corridor and this corridor remains influenced by congestion on SH1 north.

When expressed in changes in average speed, these improvements include:

- Increases from 25kph to 60kphto/from SH1 south; and
- Increases from 36kph to 52kph to/from SH20 south.

The travel time savings vary across the day with peak periods experiencing the greatest improvements. The local traffic expected to benefit from these access movements is estimated to include:

- Some 32,000 vehicles per day accessing SH20 north;
- Some 40,000 vehicles per day accessing SH20 south;
- Some 45,000 vehicles per day benefiting from improvements on Church Street, including those accessing SH1 north; and
- Some 20,000 vehicles per day accessing SH1 south.

In addition to local benefits, wider travel time savings as a result of the Project have been identified. The Project is expected to improve journeys between the wider Auckland isthmus and Manukau areas. The travel time implications on the wider area include:

- Up to nine minutes between SH20 and Highbrook;
- Up to four minutes between Onehunga and Auckland Airport;
- Some three minutes between Royal Oak and Auckland Airport;
- Over three minutes between SH1 and Auckland Airport;
- 14 minutes between MetroPort and Highbrook; and
- Over three minutes between Pakuranga and Onehunga.

Almost all of the representative movements have savings, which range up to 14 minutes. The movements with the biggest savings relate to those to or from MetroPort and Highbrook. A good level of savings is also predicted to other locations, including to or from Royal Oak, Pakuranga and Ōtāhuhu. The few forecast increases in travel time are predicted to be small (up to 2.5 minutes, <11%[60]). There is a slight increase in travel times predicted from Highbrook to the airport (12% in the PM peak). This is due to the increase in southbound traffic on SH1 and downstream constraints elsewhere on the network.

Overall, this indicates that the Project is expected to improve journeys over a much wider area than just the Onehunga-Penrose area.

b. **Travel time consistency**

Consistency of travel times across the day has been used as a measure of journey time reliability to reflect the manufacturing and logistics activity in the Onehunga-Penrose area. In addition to reductions in average travel times, there will be a significant reduction in the range of travel times experienced across the day and by direction of travel. This is most notable for trips accessing SH1 south where the range reduces from over 12 minutes to under two minutes. Whilst there will still be variability in travel times through peak periods it is expected to be significantly improved with much greater consistency across the time of day and direction of travel.

[60] Percentage reduction is compared to the Without Project scenario.

The significantly improved consistency across the movements, directions and times of day are expected to allow improved and more flexible journey and logistics planning for businesses in this area. This is expected to assist increased freight and economic efficiency for this area.

When the Project is in place, modelling predicts that travel times on SH1 and SH20, for vehicles not accessing the Onehunga-Penrose area, stay the same or experience marginal improvements. This shows that the extra capacity provided on SH1 (as part of the Project) and on SH20 (as separate works), means that the extra EWL flows can be accommodated without a detrimental impact on the travel along SH1 and SH20.

c. **Changes in daily traffic flow – local network**

The general pattern of changes in daily flow suggest that traffic will move from the adjacent corridor to the EWL, with large reductions in flow, and therefore reduction in congestion, seen on Neilson Street and Church Street. There is a decrease in flows on other routes, including residential areas, therefore improving conditions and accessibility for residents.

Flows expected on the Main Alignment range from 33, 700-48, 500 vehicles per day which is similar to the flows in the existing Neilson Street/Church Street corridor. This level of flow requires a general configuration of four lanes.

Changes in daily flows on EWL and in the adjacent corridors are illustrated on Figure 12-1 to Figure 12-3. Where there has been a decrease in the daily flow, the figure illustrates this in green; an increase in flow is illustrated in red. The line thickness denotes the relative change in flow where a wider line is a greater change and a thinner line is a smaller change. The changes are discussed in more detail in the paragraphs that follow.

Figure 12-1: Changes in daily flow in the adjacent corridor (west)

Notable from the figure above is a significant diversion of traffic to EWL and the on/off-ramps connecting to EWL. The new extension of Galway Street results in more traffic on Galway Street, south of Neilson Street. Generally the remaining roads in the area have lower daily flows, with Onehunga Mall (south of Neilson Street), Onehunga Harbour Road and Neilson Street having the biggest change. The traffic on Onehunga Mall (south of Neilson Street) is expected to reduce significantly (81-84 %) with the flows on Onehunga Harbour Road predicted to reduce by nearly 100% (only a few hundred per day) without the wharf redevelopment. The traffic flows on Neilson Street (Selwyn Street to Onehunga Mall) are also expected to reduce substantially (38-40 %).

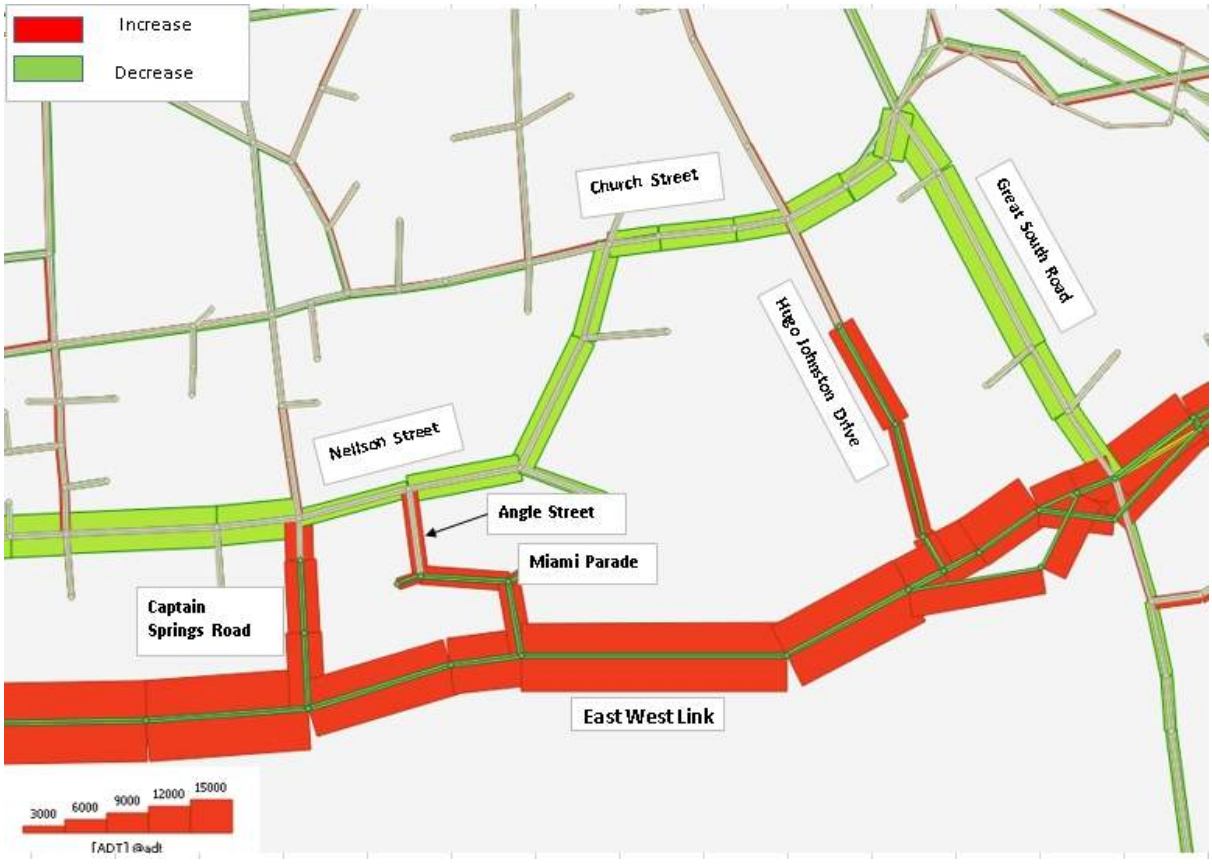
Some 55% of the total current traffic and 64% of the existing freight movements are expected to be removed from the Neilson Street/Onehunga Mall intersection. This reduction in flow allows improved pedestrian and cycling facilities, improved amenity, and reduced traffic severance between Onehunga, the foreshore and Old Māngere Bridge.

There will also be a significant reduction on Gloucester Park Road (south) due to the provision of the new on ramp to SH20 from the EWL.

There will be increases in traffic on Selwyn Street due to the closure of Gloucester Park Road (north). However, Selwyn Street is a 4-lane road which can accommodate the predicted level of traffic flows.

An increase in traffic is expected on Victoria Street (north of Neilson Street). However, the increase of 2,000 vpd should not create a material adverse impact. Further, the presence of the rail crossing on Victoria Street and the predicted increase in traffic flows will only result in a minor increase to queue lengths during a train crossing and these are not expected to queue back to the Neilson Street intersection.

Figure 12-2: Changes in daily flow in the adjacent corridor (central) 2026



Notable from Figure 12.2 is a significant diversion of traffic to EWL and along the connecting roads (Captain Springs Road and Hugo Johnston Drive) between EWL and Neilson Street. This figure also shows Neilson Street, Church Street and Great South Road have much lower traffic flows.

There will be a significant increase in traffic (a 371% increase) on Captain Springs Road south of Neilson Street. This is because it becomes the major connection between the EWL and Neilson Street, taking on an arterial road function. It will be widened to four lanes to accommodate this change in function and traffic flow.

There is an increase in traffic flow predicted at the northern end of Hugo Johnston Drive, as it provides an additional connection between the EWL and Church Street and O'Rorke Road. The extra through traffic attracted to the route is partially mitigated by a proportion of traffic from activities on Hugo Johnston Drive now being able to exit south to the EWL rather than having to exit to the north. This means that there will be a small increase at the northern end, but the southern end will get noticeably busier with the introduction of through traffic. Hugo Johnston Drive will retain its current two lane and tree-lined form.

The flows on Neilson Street (near MetroPort) are expected to reduce significantly which will ease the ability to access Neilson Street from properties and side roads. An increase in flows is expected on Miami Parade and Angle Street and these flows can be accommodated. The flows on Great South Road are expected to reduce, including a 36-37% reduction at Southdown Lane.

Combining the flows on EWL Main Alignment and Neilson Street (east of Galway Street) there are predicted to be some 60,000 vpd travelling along the corridor; increasing towards 80,000 vpd when combined with the Church Street corridor.

Figure 12-3: Changes in daily flow in the adjacent corridor (east) 2026

Notable in Figure 12.3 is a large increase in traffic on Sylvia Park Road (west of the new motorway ramps), and an increase along SH1. Local roads around Princes Street benefit from reduced traffic.

The flows on Sylvia Park Road are expected to increase significantly (29-34%) west of the new motorway ramps, but only marginally at the eastern end (1-5%). Sylvia Park Road is proposed to be widened to four lanes to accommodate the increased flow and to integrate with the new ramps.

There will be an increase in daily flow on SH1 by approximately 10-11% with the new ramps and increased capacity on SH1. The additional lanes on SH1 avoid potential adverse effects on the travel times along SH1.

The flows on the western end of Vestey Drive are expected to increase significantly (41%) by approximately 3,000 vehicles per day in 2026. Vestey Drive will be able to accommodate the predicted increase in vehicles and will not need to be upgraded. However, it is recommended that the destination of Māngere is included on any existing or future road signage located on Mount Wellington Highway which directs motorists to perform a right turn into Sylvia Park Road, rather than using Vestey Drive. Reductions are expected on the arterial north-south routes of Great South Road (8-11% reduction) and Mount Wellington Highway (7-11% reduction), as traffic is diverted to SH1 (a 10-11% increase).

In Ōtāhuhu, the improved capacity and access to SH1 is expected to reduce vehicles currently diverting through the local network. Therefore significant reductions in traffic on Avenue Road (46-47%) and Princes Street (9-11%) are predicted. Together over 4,700 vehicles per day are expected to be removed from these two roads.

d. **Changes in daily traffic flow - Wider Network**

Key changes including improved network capacity and connectivity is predicted to reduce through traffic on residential streets north and west of Onehunga. Reductions in east-west traffic in Penrose including a 12-21% reduction in traffic on Mt Smart Road and other reductions in streets within Penrose. The flows on SH1 north of the South Eastern Arterial are not expected to materially change. Flows south on SH1 south of EWL are expected to increase, however SH1 is being widened between the EWL ramps and Princes Street to accommodate these changes. An increase on SH20 is expected north of Neilson Street however the flows on Manukau Harbour Crossing are not expected to materially change.

e. **Effects on Residential Amenity**

Reductions in traffic are predicted in residential areas in both 2026 and 2036, thus improving network conditions for residents on streets such as:

- Campbell Road;
- Mt Albert Road;
- Mt Smart Road;
- Avenue Road;
- Trenwith Street; and
- Frank Grey Place (north of Trenwith Street).

f. **Community and Business Accessibility**

The significant reduction in traffic around Neilson Street and Onehunga Mall will provide amenity benefits and improve the environment of the road, allowing a high quality pedestrian and cycling facility to be provided. This will significantly improve accessibility to Onehunga Town Centre from the south.

Current high volumes of traffic on Neilson Street can mean it is difficult to turn into or out of local driveways and side roads resulting in people taking ‘chances’ pulling into small gaps and in some cases leading to crashes. Without the Project, traffic demands will increase, potentially further exacerbating the problem of motorists pulling into very small gaps. The reduction in traffic on Neilson Street with the Project will significantly reduce the wait times from local roads and driveways improving accessibility to local businesses.

g. **Corridor Operational Analysis**

Level of service is a consistent measure used across transport projects to understand how a road is currently performing and how it is predicted to perform. Level of service assesses the waiting time at intersections and the speed of flowing traffic which helps to inform design. The level of service for intersections is defined by the seconds of delay experienced. For vehicles (including freight) on the EWL all intersections perform at or better than the Project design target of Level of Service D (33-55 seconds delay at intersections). For pedestrians at signalised intersections the majority of crossing points will be Level of Service D or better (30-40 seconds delay).

For traffic travelling along EWL the average speed will meet or better the recommended targets of Level of Service B during interpeak periods and C at peak periods.

h. **Impact on State Highway Network**

When the Project is in place the travel times on SH1 and SH20 routes will be similar to the Without Project scenario, or in some cases experience some improvement. The improvements are due to the proposed motorway widening on SH1 (to be undertaken as part of the Project) and the EWL Main Alignment allowing some diversion of traffic away from the southern parts of SH20. This demonstrates that the widening on SH1 will allow the proposed ramps and associated traffic increases to be accommodated without significantly impacting on through traffic on SH1. Similarly on SH20, the auxiliary lanes proposed between Neilson Street and Queenstown Road (a separate project being implemented by the Transport Agency in late 2016), will mean that the extra flows from the improved Neilson Street Interchange can be accommodated without adverse impact on SH20.

12.2.4.2 Effects on parking, access and roads with increased traffic

a. **Access**

Access to some properties and streets are likely to change as a result of the Project.

There are some properties on Gloucester Park Road, Onehunga Mall, Onehunga Harbour Road and Sylvia Park Road that will require a longer route to gain access to them. However, potential adverse effects are all mitigated by the reduced congestion and significantly improved access to SH1, SH20 (and the local roads) due to the Project.

Access to Orpheus Drive will be via a low volume local road rather than the current high volume motorway access road. This will be more compatible with its recreational function.

Access to businesses on Galway Street (north of Neilson Street), will have reduced accessibility due to the banned turns proposed from Neilson Street at Galway Street. The proposed reinstatement of the right turn into Onehunga Mall will mitigate the impact on accessibility.

Access to 781 Great South Road is currently restricted to left-in and left-out only, however these constraints can be removed due to the significant reduction in traffic flows at that location. This will significantly enhance access to and from the site, especially for access to the EWL.

Vehicles exiting Pacific Rise onto Sylvia Park Road are anticipated to become easier with the widened intersection form. The staggered movement allows traffic lanes to be crossed in succession rather than all at once.

Access to Sylvia Park Town Centre for Hillside Road residents will be significantly improved by reinstating the right turn from Hillside Road into Panama Road. The route will be shorter and quicker and has a positive connectivity impact for this community.

The upgraded interchange at Princes Street is expected to better manage motorway queuing, and allow non-motorway traffic to move around any residual queues. This is expected to significantly improve the quality and resilience of access to this community.

b. **Parking**

The removal of approximately 15 parking spaces on the southern side of Onehunga Harbour Road cul-de-sac (opposite The Landing) can be mitigated by replacing these spaces in the redundant portion of Onehunga Harbour Road to the west of the Airport Harbour View Motel. There is also opportunity for these car parking spaces to be replaced on the newly realigned Onehunga Harbour Road which will be lightly trafficked with the Project in place.

On Galway Street (south of Neilson Street) approximately 30 on-street parking spaces will be removed. It is anticipated that the demand for the spaces can be provided off-street as the businesses on Galway

Street were observed during surveys to have extensive off-street parking. A clearway on one side of Galway Street will be considered to mitigate the loss of on-street parking.

With the Project in place there will be an overall net gain of 10 on-street parking spaces on Captain Springs Road due to the conversion of the current private road portion into public road. There will be a temporary loss of 38 on-street parking spaces for short periods of time in the morning and evening peaks with the implementation of a clearway. Demand during these periods will exceed supply, however parking for 42 cars on the western (Waikaraka Park) side of the road will be available at all times during the day and should adequately remedy the temporary shortfall.

The Project will involve the removal of approximately 40 car parking spaces on Hugo Johnston Drive but there will still be sufficient on-street parking capacity for existing users. The on-street parking spaces available will be towards the southern end of Hugo Johnston Drive which may mean some people have to walk further. To mitigate this potential personal safety impact, upgrades to existing street lighting will be considered during detailed design if required in consultation with Auckland Transport. However, the through traffic and enhanced recreational cycling facilities is expected to increase parking demand. Therefore additional parking is proposed at the southern end.

On Sylvia Park Road, 150 existing on-street parking spaces will be removed but will not have a significant impact on parking as the spaces are currently significantly under-utilised with only a 6% occupancy rate. The removal of the majority of the businesses on the southern side will mean that the associated demand will also be removed as all observed cars during surveys were parked on the southern side.

At 1016 Great South Road, approximately eight car parking spaces are likely to be removed. It was assessed that the demand for on-site parking for this site can still be accommodated with the reduced number of spaces.

There will be a loss of approximately 40 car parking spaces associated with the rear units at 20 Sylvia Park Road. An appropriate number of parking spaces, as determined by the AUP (OP) parking provisions or relevant resource consents, will be provided for the remaining rear units.

There are other locations where a small amount of on-street parking will be lost, however this can be absorbed into existing nearby streets. A full discussion of these locations is contained in *Technical Report 1: Traffic and Transport Assessment* in Volume 3.

12.2.4.3 Walking and Cycling Effects

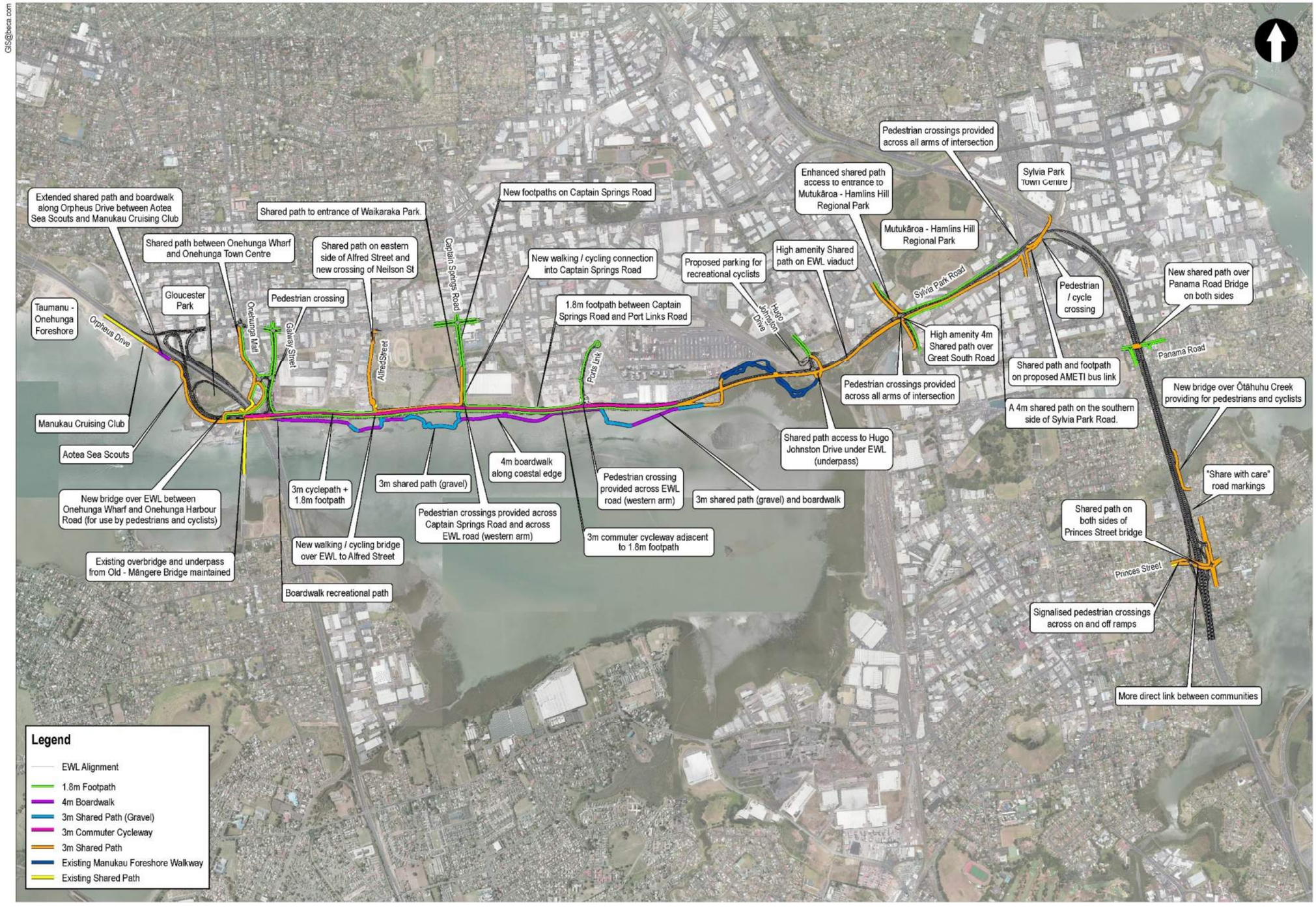
The Project will have significant positive impacts on pedestrians and cyclists and will provide approximately 24km of new cycling and walking facilities.

The Project will improve safety and accessibility for cycling and walking between Māngere Bridge, Onehunga Town Centre and Sylvia Park Town Centre by providing a direct continuous link and connecting key destinations. The proposed direct route between Māngere Bridge and Sylvia Park Town Centre will be approximately 1.6km shorter than the current route. This includes a high amenity elevated shared path over Great South Road removing the need for pedestrians and cyclists to make three separate at-grade crossing movements. One new connection on Captain Springs Road and one enhanced connection on Alfred Street will also improve accessibility and connectivity between the Māngere foreshore and Onehunga. A new pedestrian and cyclist connection across Ōtāhuhu Creek between Princes Street and Panama Road communities and will improve local connections between the two currently segregated communities.

Auckland Transport has identified roads that are intended to accommodate cycleways in the future. A number of these roads are predicted to have reductions in flow of traffic with the Project in place in 2026 (e.g. Onehunga Mall, Church Street and Princes Street in Onehunga). This will have a positive impact on cyclists. All facilities have been designed to safely accommodate the number of cyclists and pedestrians that are predicted to use the facilities, particularly on weekends.

Overall, the Project will have significant benefits for pedestrians and cyclists. The proposed improvements are illustrated on Figure 12-4 and described in Sections (a) to (d) that follow.

Figure 12-4: Overview of proposed walking and cycling facilities as part of the Project



a. **Sector 1**

Between the Aotea Sea Scouts Hall and the Manukau Cruising Club on Orpheus Drive there will be improvements to connectivity and accessibility from the new 3m off-road shared path which connects between the existing Manukau Foreshore Walkway and the Old Māngere Bridge.

There will be significantly improved connectivity for pedestrians and cyclists between Old Māngere Bridge, Onehunga Wharf and key destinations such as Onehunga Town Centre and Onehunga train station. A new link will close the existing network gap between the cul-de-sac at the end of Onehunga Mall and the Onehunga Town Centre and Onehunga train station.

The shared path will be high amenity, separated from traffic by a kerb and adjacent to a low trafficked environment, particularly on Onehunga Harbour Road and Onehunga Mall where traffic volumes will reduce significantly (up to 84 %) with the Project in place.

b. **Sectors 2 and 6**

From Old Māngere Bridge along the foreshore there will be significant connectivity and accessibility improvements through the provision of new high amenity pedestrian and cycling facilities on both sides of the new road. This includes shared paths, boardwalks, commuter cycle lanes and footpaths.

There will be new and enhanced connections between the foreshore and the Onehunga community via a new link at Captain Springs Road and enhanced connections along Alfred Street and with recreational spaces (e.g. Waikaraka Park). Proposed overbridges, underpasses (new and existing) and new at grade signalised intersections will allow pedestrians to cross the new road safely, contributing to high amenity and improved connectivity.

The high amenity facilities provide opportunities for the natural surroundings of the Māngere Inlet to be enjoyed by pedestrians and cyclists. Recreational users and high speed commuters will be separated. Passive surveillance from the new road will improve personal safety. Frequent connections between the boardwalk and the facilities adjacent to the road are provided.

c. **Sectors 3 and 4**

There will be a significant improvement in connectivity for pedestrians and cyclists in Sectors 3 and 4 due to the proposed off-road high amenity route between the end of the existing Manukau Foreshore Walkway at Hugo Johnston Drive and Sylvia Park Town Centre. This will link key destinations of Mutukāroa-Hamlins Hill Regional Park and Sylvia Park Town Centre and close this significant network gap. This sector completes the route between Māngere Bridge and Sylvia Park Town Centre.

This sector includes a 4m high amenity elevated shared path adjacent to the road structure, a proportion of which passes over Great South Road, and continues on the southern side of Sylvia Park Road to approximately 13 Sylvia Park Road. From this point the shared path will remain slightly above the road grade of Mount Wellington Highway until connecting with Sylvia Park Town Centre. The elevated portion over Great South Road will have considerable benefits for pedestrians and cyclists (east-west movements) as they will not have to use the three at grade crossings on the southern arm of Great South Road.

The severance between Anns Creek and Sylvia Park Town Centre will be significantly reduced with a new, high amenity and very direct shared path which is approximately 1.6km shorter than the existing indirect, mainly on-road route. A significant proportion of the shared path will be elevated.

d. **Sector 5**

At Panama Road the shared path on both sides of the replacement Panama Road bridge and a short length of Hillside Road will improve connectivity for cyclists as there are currently no facilities for these

road users. The 3m shared path will be off-road, separated from traffic which is a significant improvement from the existing narrow footpath on the bridge catering only for pedestrians.

The new pedestrian and cycling connection over Ōtāhuhu Creek removes the severance for the local communities on either side of the Creek. This will significantly improve connectivity as it will link the Princes Street and Panama Road communities. This will address an existing potential safety risk of children walking along SH1.

At Princes Street, a reconfigured interchange will provide a controlled crossing point across SH1 Princes Street off-ramp and the provision of a large refuge for waiting pedestrians across the SH1 Princes Street on-ramps which will improve safety significantly. A high amenity 3m shared path will significantly improve connectivity and safety for cyclists as there are currently no facilities. More direct and shorter routes across SH1, along with a significantly wider footpath on the bridge, will improve connectivity between the two communities.

e. **Estimate of usage**

Growth predictions have only been undertaken for the main Manukau Foreshore Walkway. Predictions are highly challenging to develop due to the significant variability in usage and because many people would currently be dissuaded from walking and cycling due to the limited infrastructure, high traffic and limited passive surveillance. The key features of the existing use of the walkway include low commuter usage and very high recreational use, including people with families.

Notwithstanding the challenges in predicting likely usage, steady growth across the network for the five years after opening is anticipated. It is estimated that with the Project, the usage would be similar to the upper Dominion Road cycleway or the North West cycleway near Te Atatu. Significant growth in commuter travel in this part of Auckland does not seem feasible without the increased connectivity offered by this Project.

12.2.4.4 Public transport effects

There will be significant improvements to journey time reliability and time savings for buses in the Project area as a result of reduced congestion on local roads. Faster travel times are predicted for the key public transport route of northbound buses accessing Onehunga Town Centre from SH20 with savings of up to five minutes compared to the Without Project scenario. The travel time savings will benefit between 2,400 and 6,300 passengers per day in the future (2036). The main changes to the road network impact bus routes 380, 313 and 309 (on the new bus network) travelling between Māngere and Onehunga Town Centre via SH20. These impacts are:

- Northbound Buses: A revised route via a realigned SH20 Neilson Street off-ramp, EWL off-ramp, Galway Street and Galway Link Road to connect with Onehunga Mall. Buses will no longer use Onehunga Harbour Road to access the Town Centre; and
- Southbound Buses: Existing southbound on-ramps to be slightly realigned. The existing T2 lane at Gloucester Park Road and SH20 on-ramp will be converted to bus-only and will connect directly into the existing bus lanes on SH20.

Without the Project, congestion will cause bus travel times to increase between now and 2036, but with the Project in place, travel times entering Onehunga are shown to be lower (by up to 5 minutes), and remain consistent throughout the day. This results in more resilient and reliable bus services. The travel times for buses during peak times are predicted to be consistent with those for the inter peak, thus indicating a higher level of reliability not impacted by congestion.

The improvements for travel time reliability will also benefit passengers by making it easier to make onward rail and bus connections. It is anticipated that passengers accessing the Onehunga train station via bus services will experience an increase in reliability to the overall journey into the CBD or other rail station.

Reduced travel times will result in significant cumulative time savings for public transport users. Given more reliable journeys are predicted with the Project, efficient service scheduling and timetables can be developed.

In addition to the positive impacts for bus passengers accessing Onehunga Town Centre, the Project will provide benefits for other bus routes. Significant journey time savings on eight other bus routes are predicted in 2026 with the Project in place. This includes a predicted seven minute saving on southbound Crosstown 8 bus in the morning peak in 2026 with the Project in place compared to without the Project.

School bus routes are expected to gain potential travel time and safety benefits where they travel through roads with predicted reductions in traffic flows and congestion.

The Project will not impact any existing bus stops. The two future bus stops planned by Auckland Transport for Great South Road can be accommodated by the Project design.

The Project does not preclude a future mass transit connection to the Auckland Airport. Auckland Transport has advised that the current preference is for an elevated route over Neilson Street and the EWL as it crosses the Manukau Harbour. The design of EWL and its connection to Galway Street has sought to provide flexibility for future decisions on the mass transit link. This has included provision of an at grade intersection of Galway Street and the EWL.

The Project also integrates with Auckland Transport's proposed AMETI bus link at Sylvia Park.

Overall, the Project will have a highly positive impact on public transport in the local area particularly for buses travelling northbound between SH20 and the Onehunga Town Centre with significant (5 minute) journey time savings for between 4,500 and 6,300 passengers in the future. The Project will also have a positive impact on eight bus routes in the wider area with significant travel time saving benefits. The Project does not preclude further future bus or the rail plans to the airport.

12.2.4.5 Effects on safety performance

A high crash rate was not identified as a major problem in this area. However, the predicted reductions in traffic flow on the wider network are expected to result in some reduction in road crashes in those areas. Significant reductions would be expected on adjacent roads such as Neilson Street, Church Street, Great South Road, Onehunga Mall and Princes Street in Onehunga. Smaller-scale reductions would be expected in the wider network, such as on Favona Road, Campbell Road, Mt Smart Road and Mt Albert Road.

In relation to the new roads, consideration of safety has been a critical part of the design process. This has included use of design standards, Safety in Design workshops and independent Safety Audits at various stages of the design development. Issues raised in the Safety Audit have been considered and the design revised or confirmed as appropriate. Overall, it is considered that the new facilities are expected to appropriately address safety issues in their design, with crash rates likely to be lower than those on existing local roads. This is due to the specific design features, including limited direct property access, appropriate lane and shoulder widths, raised median islands and an appropriate arterial road environment.

The analysis of recent recorded crashes described earlier showed few recorded crashes for cyclists and pedestrians, except on Neilson Street where a serious and fatal cyclist crash was recorded.

The proposed pedestrian and cyclist facilities and connections were informed by a desire-line analysis that identified the routes and movements that were considered critical to incorporate.

Generally, the Project is considered to enhance pedestrian and cyclist safety in a range of ways:

- Providing an extensive network of off-road/separated facilities connecting key communities and destinations;

- Safe crossing facilities of the route and at existing roads;
- Reductions of truck and traffic flows on a range of local streets which could be used by cyclists; and
- Providing a strong east-west link along the foreshore (connecting with north-south access routes), that would reduce the need or desire for cyclists to use Neilson Street, which would continue to have high levels of truck movements.

12.2.5 Measures to avoid, remedy or mitigate potential adverse effects on traffic and transport

12.2.5.1 Approach to mitigation

The general approach to potential adverse operational traffic effects has been to design the Project to avoid or remedy adverse effects where practicable. Residual effects that have not been mitigated by the initial design phase are outlined below. It is anticipated all the operational traffic effects can be mitigated through the detailed design phases of the Project such that there will be minimal adverse effects.

12.2.5.2 Particular areas for mitigation

Specific areas for mitigation to be included either in the design or subsequent agreements with stakeholders are as follows:

- Replace car parking that is removed outside The Landing;
- Provision of clearways on Captain Springs Road and consideration on Galway Street to allow for off-peak parking;
- Removal of some parking on Hugo Johnston Drive along with the consideration of upgraded street lighting (if required);
- Provision of a u-turn facility and additional parking at the southern end of Hugo Johnston Drive;
- Explore the potential to allow internal access arrangements to 8 Sylvia Park via 1 Pacific Rise;
- Reinstatement of right turn onto Onehunga Mall from Neilson Street;
- Inclusion of Māngere as a destination into any existing or any future highway signage on Mount Wellington Highway directing motorists to perform a right turn into Sylvia Park Road rather than using Vestey Drive;
- Ongoing engagement with Auckland Transport to enable delivery of the shared path at the eastern end of the EWL main alignment in conjunction with Auckland Transport and extends through to the Sylvia Park Town Centre boundary;
- Ongoing engagement with Auckland Transport during detailed design development of the type of walking and cycling infrastructure, including both the form and connections; and
- Implementation of deign objectives and ongoing engagement with Auckland Transport for the design of specific locations where the Project interfaces with the existing local road network. This includes the design of Hugo Johnston Drive, Captain Springs Road, Pacific Rise intersection to accommodate u-turns and the re-instatement of the right turn from Hillside Road and at 781 Great South Road.

12.3 Economic effects

Overview

The Project will deliver significant benefits to the local and regional economies. During construction, these include employment opportunities for local contractors and the supply of construction materials. Once the Project is completed, it will enable faster and more reliable travel times and reduced congestion, resulting in economic efficiencies that support businesses for growth and less congestion for motorists.

12.3.1 Introduction

This section presents the findings of investigations undertaken to determine the high level actual and potential economic effects from the construction and operation of the Project. The economic assessment is based on census data and interviews with businesses in the Project area.

Effects on individual properties and businesses are assessed in *Section 12.4: Assessment of property, land use and business disruption effects* of this AEE.

12.3.2 Existing Economic Environment

The existing economic environment for the Project is discussed in *Section 2.0: Background*, *Section 11.0: Description of the existing environment* and also in *Report 3: Economic Assessment* in *Volume 3*.

The assessment shows the biggest changes to the current economic issues are likely to result from:

- Increasing growth in transport, warehousing and distribution which will lead to an increase in freight trips to, from and within the Project area;
- Increasing employment within the Project area, which will lead to increased pressure on the transport system at peak hours as commuting trips increase;
- Specific pressures on the transport network as a result of local economic growth, e.g. the consequences of greater movements of heavy vehicles in and around Penrose and Onehunga; and
- Freight volumes, which are strongly driven by regional population growth rather than local employment growth and are expected to increase as a consequence of regional population and economic growth.

12.3.3 Assessment of economic effects during construction

The period of construction will have a positive impact on the local and regional economy. The Project is anticipated to take approximately five to seven years to build and at its peak would employ 300 to 500 people. The presence of construction teams will likely increase spending at some local businesses including local food outlets. In addition some local suppliers will benefit from the manufacture and provision of construction materials. There will be adverse impacts on specific businesses and properties, which are discussed in further detail in *Section 12.4: Assessment of property, land use and business disruption effects* of this AEE.

12.3.4 Assessment of economic effects from operation

There will be positive economic effects from the ongoing operation of the Project. These effects are of local, regional and national significance and are set out in further detail in *Section 3.4: The outcomes to be delivered by the Project* of this AEE.

In summary the benefits will facilitate economic growth in the area through:

- Lower delivery costs from improved travel times;
- Increased accessibility both locally and regionally for vehicles, pedestrians and cyclists;
- Attracting new businesses due to increased local amenity, safety and reduced congestion;
- Improved accessibility from better travel times and reliability for buses;
- Increased land values; and
- Greater propensity for higher value-added industrial activities.

Overall, travel demand within and through the area will increase as Auckland's population and transport pressures increase. The Project will help enable growth in the area and absorb the impacts of growth in travel demand by providing capacity to keep pace with growth and deliver economic benefits for Auckland.

The significance of the Southdown Freight Terminal as a key link between regional supply chains will grow. Northland, Auckland, Waikato and the Bay of Plenty together produce more than 50% of New Zealand's GDP today. Increased economic interaction between these regions through the establishment and strengthening of supply chains will continue to drive economic growth in the upper North Island and throughout the country. Based on engagement during the Project, it is understood that there is likely to be an increase in the volume of freight going through MetroPort and the rail associated facility, with longer trains and additional services needed to service increased demand for goods.

More rail freight[61] will lead to an increase in short distance road freight trips in the Project area. Without increased road capacity, this will result in congestion and travel time delays, compromising economic efficiency. The Project will enable improved road capacity by reducing congestion on local roads and thereby improving rail freight accessibility within and beyond the area. This will contribute to increased economic efficiency and growth.

The State highway networks are the backbone of the regional and freight economy. The Project will add a new strategic road to the State highway network, helping to manage anticipated growth.

For local businesses, economic advantages of the area include the central location to the main industrial area, proximity to customers and suppliers and proximity to good transport links. For businesses, the comparative advantages of the location have increased with business growth. However, this growth has resulted in increased congestion on the road network. By addressing congestion, the Project will continue to support the principal economic function of the Onehunga-Penrose industrial hub. The zoning of the area has recently been confirmed in the AUP (OP) for industrial purposes, providing industrial and commercial land to support Auckland's growth.

In response to existing congestion, local businesses have identified three operational adaptations that they currently consider necessary:

- Adjusting patterns of operation to avoid the worst peak periods;
- Undertaking longer deliveries in the early morning when congestion is lower and doing shorter local movements in the middle of the day; and
- Increasing resources (vehicles and staff) to meet transport needs.

These necessary adaptations affect business efficiency. The Project will reduce congestion, deliver more reliable travel times and higher quality freight routes, which will have direct economic benefits on the businesses currently experiencing these issues. Improved freight times are likely to reduce handling

[61] This is anticipated from growth, not as a direct result of the Project.

costs. The Project will also assist business to meet customer expectations, especially for businesses relying on time-critical deliveries.

12.4 Assessment of property, land use and business disruption effects

Overview

The Project traverses business and commercial areas around the Onehunga Town Centre in the west; through industrial and business areas of Penrose, Mt Wellington and Te Papapa and through dominantly residential areas in Ōtāhuhu and parts of Mt Wellington. This section provides an assessment of the effects of the Project on land uses, property and business activity during both construction and operation of the Project.

Construction effects

The Project is a significant construction project. The Project design has minimised and/or avoided a number of potential business disruption effects, however there are potentially significant impacts to businesses and existing land uses arising from construction activities. Measures will need to be implemented during construction to minimise or mitigate these potential impacts.

Construction activities will require establishment of construction yards, haul routes, temporary road works (including closures) and traffic management through construction. Key disruption effects include:

- Restrictions in access to businesses during construction, disrupting the ability for businesses to undertake operations. These potential adverse effects can be appropriately managed by involving potentially affected businesses in the preparation of construction traffic management plans and construction management.
- Changes to accessways and loss of visibility for businesses reliant on 'passing trade' and pedestrian access for their operation. These potential effects can be appropriately managed through consideration of temporary signage and other information to direct and inform those business users of access arrangements, and to consult with businesses on specific access requirements.
- Disruptions to business operations sensitive to noise and vibration, for construction works generating these impacts. Given the industrial nature of many areas of the Project, this impact is considered minor and can be appropriately managed through liaison with key businesses.

Some businesses are likely to experience positive effects during construction due to increased economic activity from the influx of construction workers to the area. This benefit is likely to be experienced by service industries and construction businesses.

In addition to effects on business land, the Project will affect open spaces and residential properties. Open spaces will be adversely affected during construction but will be appropriately reinstated or replaced such that the long term effects will be positive.

Operational (permanent) effects

The improved accessibility and travel time reliability will provide significant positive business operation effects, improving efficiency for business operations notably supply chain and distribution activities. These infrastructure improvements provided by the Project are identified in the Auckland Plan as a key enabler to improving GDP per capita in Auckland.

Reduced traffic volumes and the separation of local business traffic from 'through traffic' will provide significant benefits for the commercial, residential and retail activities existing and proposed in the Onehunga Town Centre. This will facilitate opportunities for the planned growth of this centre to be realised. This is considered a positive effect of the Project.

Direct land requirements will impact a number of businesses within the overall Project area. The alignment design has specifically sought to minimise or avoid adverse business effects.

Notwithstanding this, the following potential business disruption effects have been identified:

- Closure (temporary or permanent) or relocation of businesses. PWA processes are available to address these matters. Mitigation measures proposed to address the residual business disruption impacts include early engagement with these businesses to enable business relocation (as appropriate) and
- Reconfiguration of business operations on sites where partial land acquisition is required, to enable business continuity where land requirement will either impact on specific business operations or on site manoeuvring. PWA processes are available to address this. Mitigation measures to address residual potential adverse 'business disruption' effects include early engagement to enable effective planning and implementation of these works.

12.4.1 Introduction

There is a general pattern of land use change along the Project, as described in *Section 11.0: Description of the existing environment* of this AEE. The alignment traverses business and commercial areas around the Onehunga Town Centre in the west; through industrial and business areas of Penrose, Mt Wellington and Te Papapa, and through predominantly residential areas along the Project in Ōtāhuhu (adjacent to SH1). This section provides an assessment of the effects of the Project on land uses, property and business activity during both construction and operation of the Project. This section should be read in conjunction with *Section 12.14: Social Effects* of this AEE which addresses impacts on recreation, community and residential resources.

For those properties where land is required either permanently or for construction, the acquisition or lease of land will be undertaken by the Crown through the PWA process. The PWA establishes acquisition and compensation processes for this required land and as such, this specific matter is not considered further in this AEE.

This section assesses the effects of direct property impact, land use change and business disruption. Social effects of land use acquisition on residential properties and reserves, are addressed in *Section 12.14: Social Effects* of this AEE and contained in *Technical Report 11: Social Impact Assessment* in *Volume 3: Technical Reports*.

12.4.2 Overview of property effects and business disruption

Impacts on land use and property arise from three broad categories of physical impact. Each of these physical impacts give rise to different business disruption and land use effects during construction and operation activities. The categories of impact include the following:

- Effects arising from the direct physical impact of land. Key variables which influence the significance of the land use or business disruption effects include whether:
    - The whole site or only part of a site is required;
    - Building or service removal / relocation is required;
    - The required land is from the front or rear of the site (frontage land is often of greater significance); and
    - The land includes accessways or other services / utilities integral to the site.

- Effects on a property or land use arising from direct physical impact on adjoining land where this impacts on an easement or other property right (such as a right of way). The land use and business disruption impacts derive from loss or changes to accessways or site servicing. This category of impact also considers impacts to the operation of utilities over existing land uses (e.g. if a designation across land is affected this may have consequential impacts on the land uses and activities on a site); and
- Properties within proximity to the Project. In these cases, adjoining activities and land uses are impacted by effects resulting from the Project. This includes construction and operation effects. A number of these effects are considered elsewhere in this report (e.g. noise and vibration effects) and changes to the use (e.g. traffic volume), or operation of existing roads (e.g. accesses) or other network utilities. This section specifically considers the impact of these changes on the operation/activities of those properties/land uses, in particular impacts on the operation of businesses.

The Project footprint is shown on *Plan Set 3: Road Alignment* in *Volume 2* and a schedule of all the land required by the Project is attached to the NoRs.

12.4.3 Project context of property impacts and business disruption

The Project is located within the commercial and industrial suburbs of Onehunga, Penrose and Mt Wellington and then follows SH1 through the residential areas of Mt Wellington and Ōtāhuhu. Typical business activities can be broadly defined over these suburbs as:

- In the Onehunga area, businesses include a range of service and retail operations, including automotive servicing, building and business supplies and retail and food service businesses. A number of these businesses are small to medium sized enterprises with up to 10 full time employees.
- In the Southdown/Penrose area, there is a greater mix of heavy industrial activities and businesses, including construction, supply chain logistics, and manufacturing activities that involve discharges to air typical of a heavy industry zone. A number of these businesses are larger enterprises (e.g. Car Haulaways, Downer (parent company of Green Vision Recycling Ltd), and OI Glass).
- In the Mt Wellington area, there is a mix of industrial and business activities, including business park (e.g. at Hugo Johnston Drive), manufacturing (e.g. on Great South Road and Sylvia Park Road), service businesses and food processing and distribution. Throughout this area there are a range of small, medium and large businesses.

Open spaces in the Project area provide a mix of formal and informal recreation opportunities. Key open spaces of note are:

- Gloucester Park North;
- Gloucester Park South;
- Waikaraka Park;
- Waikaraka Cemetery;
- Manukau Foreshore Walkway (east and west);
- Ōtāhuhu Marginal Strip; and
- Bedingfield Memorial Park.

12.4.4 Design philosophy to minimising property, land use and business disruption impacts

The Project philosophy has been to avoid and minimise potential adverse impacts on businesses and business disruption through alignment and Project design, where this is practicable. This has included specific consideration of the potential business disruption impacts in the assessment of alternatives for alignment options as discussed in *Section 8.0: Consideration of Alternatives* of this AEE.

There are a number of examples where this process has enabled potential effects to be avoided or has minimised potential effects. For example:

- In early phases of the corridor options assessment (as discussed in *Section 8.0: Consideration of Alternatives* of this AEE), corridor selection considered routes that bisected industrial zoned areas and considered the potential for such severance to undermine the viability of residual land blocks.
- The assessment of alignment options considered the significance of land required and resulting business disruption, particularly where the Project could impact on the viability or operation of major / significant business activities in the area. This issue was considered in the development of alignment designs for the ramps to SH1 (e.g. impacts on business operations including Tip Top and the major activities at Turners & Growers).
- The development of the Preferred Alignment sought to avoid significant disruption impacts to land use and business activities where these issues were raised by landowners in engagement (see *Section 9.0: Engagement* of this AEE). For example, design was undertaken to reduce impacts on business manufacturing operations at Great South Road / Sylvia Park Road and for vehicle access and manoeuvring for distribution to businesses on Captain Springs Road.
- The use of open space or 'low utilised' land for construction yards. For example, the undeveloped areas of Onehunga Wharf, the southern Waikaraka Park area, Gloucester Park South and the vacant land at Hugo Johnston Drive and 'undeveloped' (vacant or low use) business land areas adjoining SH1.
- The investigating of alternative options for stormwater treatment such as proprietary devices where land requirement would have potentially adverse impacts on business operations.

12.4.5 Quantifying the land impacts for property and business disruption effects

The Project requires land from a number of existing land uses (broadly defined by zones). The total Project footprint is 128.9ha which includes approximately 104.5ha of land (including existing areas associated with SH1). The land includes the following zoned land for the AUP (OP):

- 17ha of existing road (excluding State highway);
- 2.7ha of residential land across 62 properties – these impacts are largely in Sector 5 (comprising purchase of 14 properties in full and predominantly impacts on the rear of sites adjoining the existing SH1). The resulting "impact" on owners, residents and the local community of this request for residential land is discussed in *Section 12.14: Social effects* of this AEE;
- 12.5ha of Open Space Zoned Land – the impacts on open space will be greater for construction (see comments in Section 12.4.4 above) than for the permanent physical works. Major areas of impact include Gloucester Park, the Manukau Foreshore Walkway, the undeveloped southern area of Waikaraka Park and some reserve areas where mitigation works are proposed. The resulting "impact" of these acquisitions are discussed in *Section 12.14: Social effects* of this AEE;
- 40.7ha of business and industrial land affecting approximately 40 businesses[62], of which:
  - Approximately 20 business sites are required to be purchased in full (such that the business operations on these sites will be required to relocate or be reconfigured). Two of these sites are undeveloped with one at Hugo Johnston Drive and one at Mt Wellington;
  - Land requirements will impact on the existing operation of a number of businesses, including:
    - On buildings and site operations on businesses;

[62] Some sites have multiple tenants and businesses operating on site.

- On sites with specific locational requirements, including the Advanced Flight heliport operation which has specific Civil Aviation Authority requirements that prescribe operations;
- On site accesses and site servicing which have the potential to impact on business operations (e.g. for remaining businesses on Gloucester Park Road, Captain Springs Road, and Sylvia Park Road); and
- On amenity and open space areas of sites which have the potential to impact on either development plans for business operations or on the amenity use/enjoyment of these sites.

For those properties where land is required either permanently or for construction, the acquisition of land rights, including leases, will be undertaken by the Crown through the PWA process. The PWA addresses the issues of compensation for this required land, including business loss and relocation. As such, this specific matter is not considered further in this AEE, but rather the effects focus on the potential for the Project to disrupt business and land use activities.

While it has not been raised as a particular concern during consultation with affected landowners, actual and potential (including perceived) effects on property values is not a relevant consideration under the RMA.

12.4.6 Permanent full acquisition

All property owners whose land is directly affected have been informed and are aware of the potential for land or property rights to be required. Meetings with business owners and lessees, as well as group forums with representatives from the business community, were undertaken at several stages throughout Project development. An overview of this engagement is summarised in *Section 9.0: Engagement* and in *Section 12.14: Social Effects* of this AEE.

The full acquisition of operational business land required for the Project will result in business disruption impacts. These effects range from business closure to business relocation, and will depend on the circumstances of the business owner and the particular economic circumstances of the business impacted. As noted previously the PWA addresses issues of compensation for this required land.

The types of businesses that will be impacted by full acquisition can generally be categorised as follows:

- There are a number of small businesses, particularly on Sylvia Park Road. These businesses include a mix of retail, service and trade businesses. While relocation may be significant for some of these individual businesses, they are generally considered relatively ‘mobile’ or location flexible, and the relocation of these businesses is not considered to have an adverse impact on surrounding business activities (e.g. alternative businesses or relocation of the business will not significantly disrupt other activities);
- There are some medium sized business operations. The proximity of these businesses to transport networks, the CBD and residential areas (in the case of the storage business in Onehunga) are considered important factors to these businesses. Notwithstanding this, the businesses affected are not considered ‘location’ or resource dependent. As such, relocation of these businesses or reliance on alternative similar businesses in the wider area was considered probable for surrounding business activities (in the context of wider business disruption impacts); and
- A business operation that is location-specific. This is the Advanced Flight heliport at Southdown where specific Civil Aviation Authority requirements inform its operations. In particular, it is understood that flight paths over an operational State highway in this location are unlikely to be able meet specified requirements in this instance. Liaison with the owner and operator of this business is ongoing to seek to determine the best means to avoid this impact. Options considered to address the effects on the operation of the heliport have included locating the road alignment to the north of the heliport buildings, and relocating the heliport to a new location.

Mitigation measures proposed to address the residual business disruption impacts include early engagement with these businesses to enable best opportunities for business relocation where such mitigation is considered the best practicable option under the provisions of the PWA. This engagement process is discussed further in *Section 12.14: Social Effects* of this AEE.

The only open space that will be fully and permanently required for the works is the Manukau Foreshore Walkway. The land currently occupied by the walkway is required to enable the construction and permanent works of the Project along the Māngere Inlet foreshore. This will affect the community's ability to access the coast and use this recreational facility during construction as discussed in *Section 12.14: Social Effects* of this AEE. This loss of open space will be replaced by recreation walkways and boardwalks as part of the new foreshore.

12.4.7 Partial property acquisition and business disruption

In addition to full acquisition, there are a number of business sites where a portion of land is required. As noted above, the Project has sought to avoid business disruption to the greatest extent practicable.

The land acquisition process under the PWA compensates an affected landowner for the loss of the land required for the Project and any loss in value of the diminished balance of the land.

- Land requirements that will impact on buildings and site operations of businesses:
  - On the Turners & Growers site at Mt Wellington, two buildings are affected and this will have operational impacts for the wider fresh produce processing at the site. These impacts are considered potentially significant and specific mitigation measures are proposed to address these effects. These include ongoing liaison and site planning with the businesses operating on the Turners & Growers site.
  - The land required from the Southdown Co-generation Plant. Although this plant is being mothballed, the existing physical resources on this site are considered to be strategically significant and provide resilience for the Auckland electricity network. While the new road does not avoid this site, the design has sought to maintain opportunities for future use of the key physical assets on this site.
  - Land is required from 20 Sylvia Park Road which comprises two blocks of commercial units, one fronting Sylvia Park Road and the other located to the rear of the site. All of the front units and one rear unit will require removal. These businesses will require relocation. Discussions on mitigation options with the land owner are ongoing.
  - The land required from a business at George Bourke Drive may impact on truck circulation, where the building or access around part of the building which may require that part of the building be either acquired or modified. Discussions on mitigation options with this land owner are ongoing.
  - The acquisition of land from business sites (e.g. on Captain Springs Road, Gloucester Park Road, Great South Road and Miami Parade) where the land area itself is used for storage or stockpiling of materials or resources, which will mean that the reduction in site size will impact the operation of the site. Acknowledging that this impact has a PWA process in respect of the 'business loss' arising from this land requirement, there is considered to be minor or less than minor additional business disruption effects.
- Land requirements that will impact on site accesses and site servicing, which have the potential to impact business operations. These impacts include:
  - Requirements from sites that impact accessways, vehicle manoeuvring areas or works on roads that will impact accessways to adjoining businesses on Gloucester Park Road, Neilson Street, Captain Springs Road, Hugo Johnston Drive, Great South Road, Sylvia Park Road, Pacific Rise, and Monahan Road. Early engagement with landowners and businesses to plan for access and vehicle manoeuvring during detailed design and construction planning will appropriately manage these effects.

- Site accesses for both 19 and 20 Sylvia Park Road will be affected by limiting the range of movements, reducing and/or relocating the number of access points. 20 Sylvia Park Road will be limited to left turn movements. A number of on site parking spaces will be required and will be replaced for the remaining rear units. The main access point for 19 Sylvia Park Road will be removed and replaced via two separate driveways. Right turns into this site will be restricted; vehicles traveling form the east will be required to travel approximately an additional 1km to enter the site. Overall any inconvenience experienced by the altered access arrangements from the Project will be minimal when taking into account journey time savings and direct access onto the EWL. Engagement with landowners and businesses is ongoing.
- Land requirements that will impact on amenity and open space areas of sites, which have the potential to impact on either development plans for business operations or on the use or enjoyment of these sites.
- Land required temporarily for construction activities at Monahan Road and Carbine Road are considered to potentially impact on open space areas on these sites. No specific adverse effects have been identified for the businesses operating on these sites regarding these impacts. However, the proposal to reduce the final designation to the extent practicable following construction activities will enable any effects in this regard to be addressed.
- Specific consideration has been given to the legibility of the Tip Top building adjacent to SH1. While the Project will alter the experience of this building signage it is not considered to be an adverse effect as the building will remain visible to users of the road network.

In addition to business impacts, some open spaces require partial property acquisition. These include land at Gloucester Park North, Gloucester Park South, Bedingfield Memorial Park and South Waikaraka Park (a planned future park). Land is required to enable the construction and in some cases permanent works of the Project and for the health and safety of the community. The indicative construction methodology will be confirmed once a construction contractor is engaged, however indicative timeframes for construction have been provided in *Section 7.4: Anticipated construction programme* of this AEE. These range from approximately two years near Bedingfield Memorial Park to 3 years at Waikaraka Park.

The land required has been minimised as far as practicable to avoid effects on the active recreation areas and maintain public access where practicable. It is intended that the designation will be reduced in area as much as possible following construction. In addition, for Gloucester Park North and Waikaraka Park, a reinstatement plan is proposed to enable construction yard decommissioning to facilitate future recreational open space activities. Social effects of this land requirement are discussed in detail in *Section 12.14: Social Effects* of this AEE.

12.4.8 Temporary property and business disruption for construction

Some of the directly impacted land will only be required temporarily for construction of the Project and is not required in the long term for permanent works. Land areas that may not be required in the long term include:

- Construction yards and laydown areas; and
- Construction access routes.

Wherever practicable, these proposed activities have been sited on vacant or low developed land, (e.g. the currently undeveloped southern part of Waikaraka Park on Captain Springs Road, the undeveloped business land at Hugo Johnston Drive and similarly on Carbine Road). This approach has avoided potential business disruption impacts in other areas of the Project. *Section 12.14: Social Effects* of this AEE proposes mitigation in respect of the impacts on open space during construction.

On completion of construction, the Transport Agency will review the designation, and uplift those parts that are no longer required for roading purposes (see Section 5.1.6 of this AEE for further discussion). This will enable the future use and development of these sites.

During construction, changes to accessways and loss of visibility for businesses reliant on passing trade and pedestrian access for their operation is a potential adverse effect. This is considered particularly

relevant for service businesses, (e.g. in the Onehunga Town Centre, Onehunga Harbour Road (hotel and restaurant) and on Sylvia Park Road), where construction of the Project is likely to require modifications and temporary closures on the existing road network. The scale of impact to businesses will depend on the nature of the business and the scale and duration of works, but is expected to range from minor to significant. These potential effects can be managed through use of temporary signage and other information to direct and inform of accesses, and consultation with businesses on specific access requirements for their business.

12.4.9 Planning approvals for businesses

The Project affects a number of sites operating under existing planning approvals, including existing designations and resource consents such as land use consents, air discharges, water takes and discharge consents. Implications on existing resource consents will be identified on a case-by-case basis with those existing consent holders.

Existing designations that are affected by the Project are addressed in *Section 11.0: Description of the existing environment* of this AEE.

12.4.10 Positive business and property effects

Some businesses are likely to experience positive effects during construction, as a result of increased economic activity from the influx of construction workers to the area. This benefit is likely to be experienced by service industries (e.g. restaurants, cafés and convenience retail outlets) and construction businesses (e.g. demolition processing, supplies etc.).

The improved accessibility and travel time reliability both for users of the EWL and for traffic using existing local roads in the Project area will provide significant positive business operation effects and improve efficiency for business operations (supply chain and distribution). This benefit will be particularly significant for the logistics and supply businesses (e.g. fresh produce and processing in Mt Wellington; logistics and distribution in Southdown). The infrastructure improvements provided by the Project (e.g. improving accessibility) are identified in the Auckland Plan as a key enabler to improving GDP per capita in Auckland. These effects are significantly positive for business operations.

Reduced traffic volumes and the separation of local business traffic from through traffic on Neilson Street and Great South Road will provide significant benefits for the commercial, residential and retail activities proposed in the Onehunga Town Centre and in the wider context of Great South Road. In particular, the increased capacity in the roads will facilitate opportunities for the planned growth (as provided for in the AUP (OP)) to be realised. This is considered a positive business and land use effect of the Project. Properties are likely to experience enhanced locational attributes as a result of improved connectivity to the road network.

12.4.11 Methodology to avoid or mitigate adverse effects

Meetings were held with all landowners whose land was initially identified as affected by the Project. The purpose of these meetings was twofold, first to inform the landowner about the Project and the potential land required and second, to gain an understanding of how the site is currently used (e.g. the nature of businesses operating on site), the operational needs of each site and the potential effects that could arise as a result of land requirement. This engagement has enabled understanding of the composition and function of residential sites and local businesses within the Project area.

Where engagement signalled there was likely to be a significant impact on the use of residential land, opportunities to amend the construction methodology or design to reduce effects were considered. For example, the construction methodology for noise walls along SH1 was altered from undertaking construction from the property side to the motorway side where practicable.

Where engagement signalled there was likely to be a significant impact on the ongoing viability of a business, the Project team sought to modify the design and extent of land required on those properties as far as possible. Changes made to the design in response to potential effects has included:

- Redesign (vertically or horizontally) of bridges, viaducts and ramps, including locations of piers;
- Alterations to existing property accesses (discussed in more detail in *Section 12.2: Traffic and transport* of this AEE);
- Creation of new access points; and
- Relocation (if required).

Mitigation measures for business disruption during construction include:

- To address impacts of construction works disrupting the ability for businesses to undertake operations, particularly for those businesses reliant on regular movement of goods to the sites, these businesses will be involved in the preparation of construction traffic management planning and construction management, relevant to the local works areas.
- To address impacts associated with changes to business access and the loss of visibility for businesses reliant on passing trade and pedestrian access during construction, consideration will be given to temporary signage and other information to direct and inform those business users of access, and to consult with businesses on specific access requirements.
- In addition to the specific measures proposed for managing noise and vibration during construction, it is proposed that business operations sensitive to noise and vibration be managed through liaison with key businesses (e.g. the glass bottle logistics business).

In numerous circumstances it has not been possible to avoid entire or partial land requirement from businesses or residential properties. In these situations the acquisition of land will be completed in accordance with the provisions of the PWA. Section 60 of the PWA provides for fair and reasonable compensation to be paid to the affected owners.

Where avoidance has not been possible, mitigation measures are proposed which will assist to alleviate effects during operations such as early engagement with these businesses to enable business planning in response to the works and where required to facilitate business relocation (as appropriate).

12.4.12 Summary

There will be moderate to significant site-specific adverse effects on some individual businesses across the Project. Overall, the Project provides greater accessibility and reliability to a market in which transportation cost is a large component. This will be a significant positive impact for business activity in the area. However, to deliver the Project, a number of specific businesses and sites require either full or partial land acquisition and others will experience disruption during construction.

Potentially significant adverse effects on business continuity have largely been avoided by Project design. In addition to this, the residual potential adverse effects arising from land acquisition and business disruption can be mitigated through ongoing liaison and involvement of business in construction management, construction traffic management and for affected service businesses, through specific planning for temporary signage and way-finding to support business continuity during the construction period.

12.5 Network utilities

Overview

There are a large number of existing infrastructure networks throughout the Project area ranging from local service connections to regionally significant rail, water, electricity and gas transmission infrastructure. Given the scale of the Project, effects on network utility infrastructure are anticipated and include impacts from temporarily or permanently relocating existing network utilities and from construction activities.

The Project team has engaged with network utility operators to identify the relocation and/or protection of network utilities and to develop appropriate measures to manage adverse effects on network utilities during the construction and operation of the Project. There are well-established procedures across the industry for the relocation and/or protection of network utilities arising from construction activities.

Potential operational adverse effects on network utilities have been avoided through design of the Project and any adverse effects during construction can be managed through appropriate measures.

12.5.1 Introduction

The Project is located in an urban area and therefore it contains a large number of existing infrastructure networks[63] including transmission lines, a high pressure gas pipeline and rail lines. The Project will have both direct and indirect impacts on existing infrastructure networks including:

- Effects associated with temporarily or permanently relocating existing network utilities for the construction and operation of the Project; and
- Effects on network utilities from construction of the Project including from dust, ground settlement, and the accidental striking of services.

The relocation and/or protection of network infrastructure is a normal part of construction for a project of this scale. There are well-established procedures across the industry associated with the relocation and/or protection of network utilities. The Project team has engaged with network utility operators to identify where relocation and/or protection is required during construction and operation of the Project. Any adverse effects can be appropriately managed either by providing protection or by relocating the utility. Where practicable, the necessary mitigation works will be undertaken as enabling works to the main Project construction works.

Some of the existing infrastructure networks in the Project area are designated. Further details about these existing designations are contained in *Section 11.0: Description of the Existing Environment* of this AEE.

12.5.2 Existing environment - network utilities

The existing network utilities along the Project are summarised in Table 12-4.

[63] This section of the AEE addresses Network Utilities with the exception of roads which are addressed in Section 12.2 of this AEE.

Table 12-4: Existing network utilities

Network utility	Operator	Details	Affected by the Project?
Transmission lines	Transpower NZ Limited	MNG-ROS A 110kV line PEN-ROS A 110kV line HEN-OTA A 220kV line	Yes No Yes
Electricity distribution lines – overhead and underground	Vector	Local lines throughout the Project.	Yes
High pressure gas transmission	First Gas	Westfield-Hillsborough high pressure gas pipeline between Neilson Street Interchange and Anns Creek. The Oaonui-Southdown high pressure gas pipeline (400 line) between Anns Creek and Mt Wellington Highway.	Yes No
Gas distribution lines	Vector	Local gas distribution lines throughout the Project.	Yes
Water supply mains	Watercare Services Limited	Hunua 4 bulk watermain under the Manukau Harbour Crossing, Onehunga Mall and Galway Street. Hunua 1 in Great South Road. Hunua 3 Sylvia Park bulk watermain within Sylvia Park Road.	No No No
Water distribution and wastewater	Watercare	Water supply and wastewater lines throughout the Project.	Yes
Telecommunications	Spark, Chorus, Vodafone, Vector Communications, FX Networks	Cables throughout the Project. Cellular communication masts at Great South Road Intersection and Frank Grey Place.	Yes No
Stormwater	Auckland Council	Stormwater lines and outfalls throughout the Project.	Yes
Landfill leachate interception system	Auckland Council	Pikes Point closed landfill interception system (see Figure 12-21).	Yes
Rail network	KiwiRail	Onehunga Branch Railway Line Southdown Freight terminal North Auckland Railway Line	Yes Yes Yes

These utilities are shown on the utilities relocation drawings in *Plan Set 12: Utilities Relocation* in *Volume 2*.

12.5.3 Assessment of effects on network utilities

12.5.3.1 Electricity transmission

There are three transmission lines within the Project area which are owned and operated by Transpower. These are:

- The Māngere - Mt Roskill A (MNG-ROS A) 110kv line located in Sector 1;

- The Penrose - Mt Roskill A (PEN-ROS A) 110kv line located in Sector 1; and
- The Henderson - Ōtāhuhu A (HEN-OTA A) 220kv line located in Sectors 1, 3, 4 and 5.

The HEN-OTA A line is one of only two transmission lines providing power transmission to Northland.

In Sector 1, the PEN-ROS A 110kV line passes close to the Neilson Street Interchange at Towers 20, 21 and 23 (refer to *Plan Set 3: Road Alignment* in Volume 2 for tower locations and extent of works). The road alignment will curve around the base of these towers to avoid relocation and/or modification of the towers. To avoid adverse effects during construction, Transpower has requested protection in the form of barriers and guardrails around the towers.

The HEN-OTA A 220kV line crosses SH20 just south of Neilson Street. Tower 31 is positioned between the EWL/SH20 southbound on-ramp and the EWL/Neilson Street overbridge. The foundation will be protected which means that the tower and lines can remain unmodified. The other towers of the HEN-OTA A are located clear of the alignment.

The MNG-ROS A 110kV line crosses SH20 just southeast of the Onehunga Bay Reserve footbridge and continues southbound through the Onehunga Bay Reserve and back across SH20 near the Manukau Cruising Club. The proposed alignment has been designed to achieve the Transpower 10m vertical clearance for roads carrying more than 30,000 vehicles a day at this location.

In Sector 3, the alignment will not cross under the HEN-OTA A 220kV line, however the new Hugo Johnston Road link will cross between Tower 20 and the gantry structure at the Southdown Co-generation Plant. This meets the Transpower clearance requirements and will not require modification. At the Great South Road intersection Tower 18 of the HEN-OTA A 220kV line, located at the eastern end of the properties at 20 to 24 Sylvia Park Road will require relocation and replacement. The tower may be replaced with one or two monopole structures.

In Sector 4, the HEN-OTA A 220kV line runs along the northern side of Sylvia Park Road. The northbound off-ramp will pass through the foundation edge of Tower 14 and therefore the tower will need to be relocated and replaced. The tower will be replaced by a monopole structure to minimise the footprint of the new structure and thereby reduce the physical impact on the adjacent property at 6-8 Monahan Road.

Tower 15 will remain within its current footprint however it will require raising to provide an 11m vertical clearance plus construction clearance over the northbound SH1 off-ramp. Towers 16, 17 and 18 along Sylvia Park Road are expected to be unaffected as the northern kerbline of Sylvia Park Road will remain in approximately the same position as currently. The remaining towers through this sector, Towers 12 and 13, will not meet the clearance requirement of Transpower. Dispensation is currently being sought to leave the towers in their current location provided the necessary foundation strengthening and/or temporary prop structures are installed to support these structures during construction of the Project.

In Sector 5, the HEN-OTA A 220kV line runs along the eastern side of SH1 to the southern extent of the Project at the Princes Street. Assessment of vertical clearances for the length of line shows that the vertical offset from the widened carriageway does not meet the minimum clearance requirements. Dispensation is currently being sought from Transpower for the clearances.

Construction in proximity to Transpower assets could give rise to the following potential effects on transmission lines if not appropriately managed:

- Blocking maintenance access to support structures;
- Dust from construction causing arcing of lines;
- Machinery working in proximity to lines increasing the risk of electrical hazard if lines are struck; and
- Earthworks undermining support structures.

These effects can be managed through the refinement of the design and construction methodology in consultation with Transpower, and the implementation of specific measures during construction as agreed with Transpower.

All adverse effects on existing electricity transmission infrastructure can be avoided through design or adequately mitigated through systematic construction sequencing and interim diversions where required to ensure security of supply through the construction of the Project.

12.5.3.2 Local electricity distribution

Throughout the Project area, there are a number of above and below ground local electricity distribution assets owned and operated by Vector.

Within Sector 1, there are low and medium voltage underground cables along both sides of Galway Street which terminate before the Project. There are low and medium voltage power lines running down the western side of Gloucester Park Road and passing under SH20. These lines will not be affected by the Project.

On the southern side of SH20, the lines go overhead and run along the northern berm of Onehunga Harbour Road servicing the Onehunga Wharf area before returning underground prior to tying in with the Māngere Bridge ground mounted substation. This section of Vector overhead line will need to be undergrounded. There are also a number of above and below ground connections along Onehunga Harbour Road and Onehunga Mall that will need to be relocated/undergrounded.

Within Sector 3, there is a series of sub-transmission oil filled cables in Great South Road as well as low and medium voltage underground cables. These can be maintained in their current location provided that acceptable cover is maintained or suitable concrete protection is provided.

Within Sector 4, there is a series of low and medium voltage underground cables along both the northern and southern sides of Sylvia Park Road. The overhead lines will be undergrounded into the northern berm, while the remaining underground electrical ducts along the southern berm will be abandoned as they will no longer be required.

Within Sector 5, there is a series of low and medium voltage underground ducts crossing the Panama Road Bridge. These will need to be relocated onto the new structure.

The relocation/undergrounding of the electricity distribution lines and cables will be undertaken in such a way (either before works commence or suitably scheduled during construction), to minimise effects on these services during construction.

Discussions have been held with Vector in regards to the relocation/undergrounding of electricity distribution lines and cables surrounding the Neilson Street Interchange and Vector has provided approval in principle.

12.5.3.3 Gas transmission

The First Gas Westfield-Hillsborough high pressure gas pipeline crosses SH20 near the Neilson Street Interchange and continues parallel to SH20 until it reaches the Manukau Harbour. From here it continues along the foreshore in Sector 2 and then onto the Southdown Co-generation Plant in Sector 3. From Sector 3 it continues eastbound, passing under the rail corridor and Great South Road, then runs parallel to Sylvia Park Road. First Gas has identified the continuity of gas supply to the region as critical. Any works requiring the relocation or realignment of the gas pipeline will be carefully co-ordinated with the Project works so an ongoing connection is maintained at all times.

Within Sector 1, the typical cover for the high pressure gas pipeline is 1m and therefore the pipeline can be retained in its current location. Where construction of the new Neilson Street Interchange ramps pass over the existing pipeline it will be suitably capped with concrete protection and relocated out of the

carriageway where it runs parallel to SH20. This is expected to be completed in stages subject to the live connections required along this pipeline.

At the south eastern edge of the Neilson Street Interchange, the pipeline passes over the old Galway Street Landfill and some relatively soft existing ground. The construction of the new road embankment may result in ground settlement following construction which has the potential to affect the pipeline, and therefore this section of the gas pipeline (and the adjoining section within Sector 2) will be relocated to a new route within competent material on the northern side of the proposed embankment. The relocation of the line will minimise potential effects on the gas pipeline and enable ongoing unrestricted access for operations and maintenance.

Within Sector 2, the construction of the road embankment will require the relocation of high pressure gas pipeline line between the Neilson Street Interchange and the Southdown Co-Generation Plant. This will be relocated during construction to sit within the new embankment. Approximately 3-4 stages of relocation will be required to maintain operation of the existing pipeline. This will be managed to meet the requirements of First Gas for permanent and temporary construction loading.

Within Sector 3, the high pressure gas pipeline line will be crossed perpendicularly by the Anns Creek viaducts. The bridge piers of this viaduct will be spaced to meet the requirements of the existing First Gas protection easement are met, whilst avoid significant ecological and geological features (refer to Sections 12.8 and 16.23). Existing above ground gas infrastructure in this area (e.g. mainline valve) will need to be relocated because it cannot be placed under the new road structures.

Within Sector 4, the Project will pass over two existing eastbound gas pipelines along the northern side of Sylvia Park Road. The ramp piers have been spaced to provide the First Gas minimum clearance for the existing pipelines.

Within Sector 5, a bulk gas supply main has an existing concrete encased crossing of SH1 north of Panama Road. This will be extended to protect the supply main.

The proposed realignment and protection works have been discussed with First Gas and no issues are anticipated. The proposed Network Utilities Management Plan (NUMP) (as detailed in *Section 13.1: The Project Delivery Framework* of this AEE) will set out the process to be followed for First Gas and the Transport Agency to work together during the detailed design and construction phases of the Project to manage potential adverse effects on the gas transmission network.

12.5.3.4 Gas distribution

There are a number of Vector low to medium pressure local gas distribution lines located throughout the Project area.

Relocation of local gas distribution lines will be required along Onehunga Harbour Road, Onehunga Mall and Sylvia Park Road. The steel gas main on southern side of Sylvia Park Road will be removed were existing buildings are removed to facilitate the works. Where these assets are present within existing carriageway, concrete capping will be the primary treatment to minimise disruption to supply.

The Project team has been in discussion with Vector regarding its assets and is confident that a design solution can be found at locations where the proposed road alignment will impact gas distribution lines. Any required protection or realignment of the pipelines will be co-ordinated with the works for the Project as far as practicable, within the framework established through the NUMP as detailed in *Section 13.1: The Project Delivery Framework* of this AEE. All potential adverse effects on gas distribution infrastructure can be adequately managed.

12.5.3.5 Water supply

Within Sector 1, the Hunua 4 bulk watermain is suspended on the Manukau Harbour Crossing and then runs underground up Onehunga Mall and adjacent to and across the Galway Street rail corridor. The

pipeline has a typical existing ground cover of approximately 3m shallowing to 1m under the rail corridor. As the EWL will pass under the Hunua 4 bulk watermain (beyond pier 1 of the existing bridge), no further works to protect or divert it during construction are required. Outside of the Interchange, the pipeline is at a depth where no impact is anticipated during construction or operation.

Within Sector 3, there are a number of significant assets running along Great South Road including the Hunua 3 bulk watermain, the Sylvia Park 700mm bulk watermain and the twin 1700mm wastewater siphon crossing Sylvia Park Road immediately to the west of the intersection with Great South Road. The valve chamber for the junction between Hunua 3 and Sylvia Park bulk watermain will require relocation out of the carriageway, which will involve temporary and then permanent diversion.

Within Sector 4, the 700mm Sylvia Park bulk wholesale watermain continues the length of Sylvia Park Road. As the Sylvia Park Road bulk watermain is located sufficiently to the north of the proposed ramps, it will not require relocation.

The Sylvia Park bulk wholesale watermain is at a depth of 1.7m beneath Sylvia Park Road and therefore will not require protection as part of the construction works. The Hunua 3 Bulk watermain runs along the western side of Mt Wellington Highway with a valve chamber positioned on Sylvia Park Road. The Sylvia Park ramp bridge piles have been positioned to avoid impacts on the pipeline and the valve chamber however consideration will need to be given during construction to the placement of machinery in relation to the assets.

The Hunua 1 bulk watermain continues east towards and beneath SH1 at a depth of 1.7m beneath Sylvia Park Road and therefore will not require protection or relocation as part of construction. This pipeline will be protected during bridge construction to minimise potential effects. The spacing of piers for the SH1 ramps has been increased to avoid having to relocate the Watercare bulk line valve chamber linking the Sylvia Park Watermain and Hunua 1.

Discussions have been held with Watercare and no particular issues are anticipated with any realignment of these services during construction of the Project. The NUMP, as detailed in *Section 13.1: The Project Delivery Framework* of this AEE, will set out the process to be followed for construction in the vicinity of existing utilities. Adhering to the procedures and measures set out in the NUMP will facilitate the management of effects such that any potential adverse effects on water supply infrastructure will be appropriately managed.

12.5.3.6 Water distribution and wastewater

Within Sector 3 and Sector 4, the water distribution pipe located on the southern side of Sylvia Park Road will be decommissioned where the pipeline is no longer required to service properties intended to be removed as part of the Project. The scour valve associated with the twin wastewater siphons located just south of the Sylvia Park Road crossing will be located within the new carriageway and a culvert/accessway will be provided to allow Watercare ongoing access.

Within Sector 5, there are two water mains that cross the Panama Road Overbridge and a 150mm watermain crossing the Princes Street Overbridge. This infrastructure will be relocated on to the new structures. An existing abandoned watermain crossing the Panama Road Overbridge will be removed as it is no longer required.

Discussions have been held with Watercare and no particular issues are anticipated with any minor realignment of these services during construction of the Project.

12.5.3.7 Telecommunications and telephone

Chorus, Vodafone, Vector Communications and FX Networks have telecommunications infrastructure throughout the Project area. Telecommunication cables throughout the Project area will need to be temporarily and then permanently relocated where they are affected by construction activities and the final alignment. Remaining services will require minor protection works where the ducts cross the Project.

The Project team has consulted with Chorus, Vodafone, Vector Communications and FX Networks to identify a preferred process for the protection of these assets. These solutions will be incorporated into the design of the Project and protection and/or permanent realignment of lines will be undertaken in conjunction with construction of the Project. The proposed road embankment and structures in Sectors 2 and 3 will include ducts that can be used in the future for new telecommunication cables.

There are two Spark cellular towers, one located at the south-eastern corner of Great South Road/Sylvia Park Road Intersection (Sector 4) and the other on the northwest corner of Frank Grey Place and Princes Street (Sector 5) in Ōtāhuhu. Both towers may require relocation and the Project team is in discussions with Spark regarding the appropriate locations for these towers.

No particular issues are anticipated with any minor realignment of telecommunications infrastructure and any adverse effects will be appropriately mitigated.

12.5.3.8 Stormwater

Within Sector 1, the existing stormwater infrastructure within the Neilson Street Interchange will need to be modified due to the increased impermeable catchment from the interchange ramps and overbridges.

Within Sector 2, the existing stormwater will be diverted as part of the construction of the new stormwater treatment system within the foreshore.

Within Sector 3, the Anns Creek culverts passing under Great South Road will be modified to service the new stormwater treatment system south of the EWL.

Within Sector 4, the Anns Creek stormwater infrastructure will be modified along the southern side of Sylvia Park Road to construct the new stormwater treatment system.

Within Sector 5, the existing motorway drainage system will need to be protected and/or modified as part of the widening works to facilitate the carriageway drainage and treatment.

Overall, the proposed stormwater treatment wetlands are located and designed to tie in with the existing network. Any adverse effects on stormwater infrastructure will be appropriately mitigated through relocation of the existing infrastructure as part of the Project.

12.5.3.9 Landfill leachate interception system

Auckland Council operates a leachate interception system for the Pikes Point closed landfill. This system intercepts groundwater from the closed landfill area and conveys it to the Watercare trade waste system for treatment. The system is discussed in further detail in *Section* 12.16*: Groundwater*.

Construction of the EWL in Sector 2 will directly impact the leachate interception system. The system will therefore be replaced and relocated as part of the works. The Project team has engaged with Auckland Council regarding the design, construction and operation of the relocated leachate interception system. This engagement will continue during the detailed design and construction of this system. Once constructed, the replacement leachate interception system will be transferred to Auckland Council for ongoing operation and maintenance.

12.5.3.10 Rail Network

Adjacent to Sector 1 is the Onehunga Branch Line and Onehunga Rail Station. The proposed works in Sector 1 will improve pedestrian and cycle access to the station through improved crossing facilities at the Neilson Street-Onehunga Mall intersection and the provision off road facilities connecting from the foreshore along Onehunga Harbour Road and Onehunga Mall.

The Southdown Freight Terminal travels north to west through Anns Creek in Sector 3. The Anns Creek viaduct has been designed to minimise operational effects on the ongoing use of the Freight Terminal

and to avoid preclusion of potential future expansion and development of the site. As a result of engagement with KiwiRail, the design across Southdown Freight Terminal was revised from a skewed design to a perpendicular alignment to minimise potential adverse effects. In addition the location of the viaduct piers was designed in consultation with KiwiRail. During construction, all works will comply with rail safety requirements which will be detailed in the CEMP (see *Section 13.1: The Project Delivery Framework* for further discussion) but may require rail protection and/or periods of blocked lines. Ongoing liaison will occur with KiwiRail to minimise effects on rail operations.

The alterations to the Great South Road intersection require the widening of the rail overbridge to the south of the intersection. During operations there will be no effects on the operation of the rail line. The bridge widening will be staged to enable ongoing operations of Great South Road, as well as the rail line. During construction appropriate rail safety requirements will be implemented and ongoing engagement will occur with KiwiRail to minimise effects on their operations.

In Sector 4 along Sylvia Park Road, the Project has been designed to entirely avoid the rail corridor during construction and operation of the Project. The Project ramps' connection to SH1 will pass over the rail corridor. The operation of the Project will not affect the ongoing operation of this rail corridor. During construction appropriate rail safety requirements will be implemented and ongoing engagement will occur with KiwiRail to minimise effects on rail operations.

12.5.4 Measures to avoid, remedy or mitigate potential adverse effects on network utilities

The general design philosophy adopted for the Project has been to avoid potential adverse effects on existing network utilities, wherever practicable. However, not all potential impacts can be avoided due to the large scale of the Project and the considerable number of network utilities located within the Project area.

Areas where the Project will or may potentially result in adverse effects on utilities have been identified. Consultation with the relevant network utility provider has been undertaken and through this process, concept solutions for each utility have been discussed, and where possible, developed and incorporated into design.

These solutions typically involve one or more of the following approaches:

- Providing increased protection for the utility so that its operation is not adversely affected by the Project;
- Providing access to the utility so that its operation and maintenance is not adversely affected by the Project;
- Relocating or realigning part of the network utility to avoid or mitigate potential adverse effects; and
- Other specific measures (e.g. dust management) to address potential physical adverse effects.

Consultation with affected operators will continue during detailed design to ensure that any relocation, diversion or protection of network utilities will meet the requirements of the operators. Specific agreements will be developed with each affected network utility operator for detailed design and construction.

Specific measures are proposed during design and construction of some network utilities as discussed earlier in this section. These are summarised in Table 12-5.

Table 12-5: Specific measures for network utilities

Utility	Potential effects	Proposed measures to mitigate effects
Transmission lines	Dust during construction. Vibration during construction. Machinery strike. Access to assets during construction and on completion of the Project.	Manage construction activities near transmission assets. Relocate or increase the height of towers in consultation with Transpower. Ongoing liaison with Transpower to confirm specific measures for each location. Achieve clearances specified by the New Zealand Code of Practice for Electrical Safe Distances.
Electricity distribution lines – overhead and underground	Continuity of supply during construction. Conflict with final alignment. Machinery strike during construction.	Manage construction activities near lines. Underground some lines.
High pressure gas transmission	Continuity of supply during construction. Conflict with final alignment. Machinery strike during construction. Differential settlement from construction	Relocate pipeline where necessary in consultation with First Gas. Monitor settlement during construction. Protect pipe during construction.
Gas distribution lines	Continuity of supply during construction. Conflict with final alignment. Machinery strike during construction.	Manage construction activities near lines.
Water supply mains	Continuity of supply during construction. Conflict with final alignment. Machinery strike during construction.	Manage construction activities near pipes.
Water distribution and wastewater	Continuity of supply during construction. Conflict with final alignment. Machinery strike during construction.	Manage construction activities near pipes.
Telecommunications	Continuity of supply during construction. Conflict with final alignment. Machinery strike during construction.	Relocate cables/ducts and telecommunication towers where necessary in consultation with utility operator. Manage construction activities near lines.
Stormwater	Disruption to operation during construction. Machinery strike during construction.	Manage construction activities near pipes
Landfill leachate interception system	Damage during construction. Ongoing operation during construction.	Undertake detail design in consultation with Auckland Council. Manage construction activities.
Rail network	Disruption to operation during construction. Conflict with final alignment.	Undertake detailed design in consultation with KiwiRail. Manage construction activities near rail lines.

The process for engaging with network utility operators and for the Transport Agency's contractors undertaking the works in conjunction with the network utility operator's own contractors will be set out in the NUMP. This will include specific agreements made with network utility operators during the detailed

design phase of the Project. Further details of the NUMP is contained in *Section 13.1: The Project Delivery Framework* of this AEE.

Overall, any operational adverse effects on network utilities have been avoided through design of the Project including planned relocation of utilities where required. Any adverse effects during construction can be appropriately managed through the measures outlined in this section.

12.6 Effects on values of importance to Mana Whenua

Overview

The Project traverses an area rich in Māori history. Mana Whenua have identified that, from the early 1840s to the present time, the development of Auckland has erased the visibility and legibility of their cultural landscape elements. As such, the exercise of kaitiakitanga and expression of the rich historical tapestry of the area has been limited. The Project is recognised both as having potential adverse impacts on values important to Mana Whenua and equally it provides a significant opportunities. The main opportunities are for the application of a design approach which reflects the principles of partnership through Te Tiriti o Waitangi through cultural landscape design and for the management of stormwater prior to discharging into the CMA. The acknowledgement of the Treaty and the approach that has been taken in assessing and delivering the Project with Mana Whenua is discussed further in *Section 15.1: Statutory Analysis of this AEE*.

Opportunities to acknowledge Mana Whenua cultural values through the concept design for the Project are described in *Section 6.0: Design of the Project* of this AEE. In particular, the Project has avoided or minimised physical impact on known cultural sites where practicable, provided a 'containment bund' to establish a physical barrier between the Māngere Inlet and historic landfills, and incorporates landscape design features to establish a more naturalised coastal edge inclusive of additional stormwater treatment to improve overall environmental outcomes for the Manukau Harbour in this area.

The cultural values report completed to support the AEE reflects the collaborative working process established for the Project. The process of engagement, Project option assessment and collaborative hui is a key component of acknowledging and respecting the mana of the Iwi/hapū involved.

When recognising the values of Mana Whenua, there is a need to consider the environment holistically. This has been reflected in the approach to engagement with Mana Whenua and in the approach to address the potential effects of the Project.

In respect of the physical works, the Project traverses a range of landscapes, values and significant sites and areas of value to Mana Whenua. These include:

- The cultural landscape, which includes historic areas through to current settlement, trade, economic prosperity and occupation that extend across the whole area;
- The water bodies of the Manukau Harbour and Tāmaki, which themselves have mana. The mauri of these water bodies is also significant; and
- Specific sites and features which both reflect the wider cultural landscape and are significant as their own entity. These include the Ōtāhuhu and Kāretu portages between Māngere Inlet and the east. It also includes other identified features and unique elements of the maunga landscape such as Te Hōpua, the pahoehoe lava flows, and the puna (springs) (e.g. in Onehunga). Other sites of settlement and occupation are also significant and include pā (such as Mutukāroa-Hamlins Hill), and urupā.

Mana Whenua and the Project team have identified the potential for the above values to be impacted both during construction and in the operation of the Project, both in terms of the physical works and in the way such works are undertaken.

In response to the ongoing engagement with Mana Whenua, the following Project design features and proposed measures to manage construction and operation works have been identified:

- The Project design has sought to avoid areas of significance value to Mana Whenua, such as Te Hōpua, Mutukāroa-Hamlins Hill and the Ōtāhuhu portage;

- A 'containment bund' or physical barrier between the Pikes Point landfills and the Māngere Inlet is expected to reduce the tidal flow of water (and potential leachate contamination) into the Māngere Inlet;
- The treatment of stormwater and leachate discharges from all proposed and some existing road surfaces and from the Onehunga-Penrose catchment will further improve water quality of discharges to the Māngere Inlet and Tāmaki estuary environment, seeking to enhance the mauri of these water bodies and as such acknowledge and restore the mana of these environments;
- To maintain and enhance active engagement and the principle of partnership with Mana Whenua, to respect and acknowledge their relationship to the environment and provide for an ongoing active role during the Project construction;
- To acknowledge and reflect the identified values of Mana Whenua in the physical environment, Te Aranga Principles have been core to the design. This is reflected and set out in the ULDF with processes for ongoing design inputs to key features of the Project;
- The full bridging of Ōtāhuhu Creek (including removal of the existing culverts on SH1) in acknowledgement of the significance of this historic portage. This measure also acknowledges and provides a positive response to the impacts on the wāhi tapu area of Te Apunga o Tainui, which are unable to be avoided by the Project design;
- Where potential adverse effects are unable to be avoided, additional measures have been proposed for the management and monitoring of works to recognise the significant wāhi tapu values. As such, specific protocols are proposed for undertaking works in culturally significant areas, particularly between SH1 and Ōtāhuhu Creek in acknowledgement of the sensitive sites in this area;
- Where existing infrastructure and land use results in significant impacts on the Kāretu portage, this Project proposes design and additional measures to appropriately recognise and remember this valued area (e.g. through signage, structure design and landscaping to provide for the legibility of this historic link at Sylvia Park Road); and
- To identify opportunities for Mana Whenua to provide for their social, economic and cultural wellbeing and for Mana Whenua to exercise kaitiaki over their taonga throughout construction and implementation of the Project. This is provided through ongoing discussions between the Transport Agency, Mana Whenua governance representatives and through the development of protocols in the procurement process.

12.6.1 Introduction

This section presents our understanding of the cultural values and issues of significance to Mana Whenua[64] in respect of the Project. This section draws from our engagement with Mana Whenua and inputs provided Mana Whenua during Project development[65]. A summary of the engagement with Mana Whenua is provided in *Section 9.7.3* of this AEE.

In developing the Project, recognition has been given to both the relationship of Tangata Whenua to their lands, culture and traditions in this area and the commitment to partnership between Mana Whenua and the Transport Agency (as representative of the Crown) founded through Te Tiriti o Waitangi. The acknowledgement of the Treaty and the approach that has been taken in assessing and delivering the Project with Mana Whenua is discussed further in respect of the approach to and process of engagement

[64] Mana Whenua is a term used to describe Māori who have tribal links to Tāmaki Makaurau. Mana Whenua interests are represented by tribal authorities of iwi and hapū

[65] *Part E: Engagement* provides further detail on the engagement undertaken with Mana Whenua.

(see *Section 9.0: Engagement* of this AEE). Furthermore, it is recognised that the Treaty Settlements process provides important context to the Project. The settlements recognise the importance of the relationship of Mana Whenua to the environment of the Project area and the intergenerational responsibility of Mana Whenua to preserve, protect, manage and utilise the taonga of this area. This recognition is afforded in existing settlements[66] and in the outstanding claims, which include specific redress for the Manukau Harbour (provided for in the Tāmaki Settlement Collective) and the Wai 8 Claim.

While there are outstanding claims under other avenues, there are currently no recognised customary marine title groups under section 85 of the MACA Act. Therefore, there are no planning documents prepared by a customary marine title group that would be relevant under clause 3(c) of Schedule 4 of the RMA. Regarding Te Kawerau ā Maki Claims Settlement Act 2015, parts of the Project are within the Coastal Statutory Acknowledgement Area shown on map OTS-106-14[67]. The statutory acknowledgement in the Settlement Act contains obligations for consent authorities, the Environment Court and HNZPT. For example, consent authorities must have regard to the statutory acknowledgement when deciding, under section 95E of the RMA, whether the trustees are affected persons in relation to the activity. Regarding this Project, the Transport Agency has acknowledged that Te Kawerau ā Maki are Mana Whenua (along with other Iwi) and further that they have a role as Treaty Partner. The Transport Agency has engaged and consulted with Mana Whenua (including Te Kawerau ā Maki) and has involved them in the development of the Project as described in *Section 6.0: Description of the Project* of this AEE.

The Mana Whenua groups listed in Table 12-6 have been involved in the Project.

Table 12-6: Mana Whenua of the Project (Iwi and Hapū)

Mana Whenua	Organisation
Te Akitai Waiohua	Te Akitai Waiohua Iwi Authority
Ngāti Te Ata Waiohua	Te Ara Rangatu o Te Iwi o Ngāti Te Ata Waiohua
Ngāti Paoa	Ngāti Paoa Trust
Ngāti Maru Rūnanga	Te Runanga a Ngāti Maru
Te Kawerau a Maki	Te Kawarau a Maki Tribal Trust
Ngāti Tai Ki Tāmaki	Ngāi Tai Ki Tāmaki Tribal Trust
Ngāti Whatua Ōrākei	Ngāti Whatua Ōrākei Trust
Ngāti Whatua	Te Rūnanga o Ngāti Whatua
Te Ahi Waru	Makaurau Marae
Ngāti Tamaoho	Ngāti Tamaoho Trust

The cultural values assessed and reported in this AEE should be considered in the full context of the collaborative working process established for this Project. The process of engagement, of Project option assessment and of collaborative hui is a key component of acknowledging and respecting the mana of the Iwi / hapū involved and the principles of Te Tiriti o Waitangi (defining the relationship of the Crown and Mana Whenua). The approach is considered a key element in acknowledging the relationship of Mana Whenua to the environment in which the Project is located and impacts upon.

[66] Ngāti Whātua Ōrakei Claims Settlement Act 2012, Te Kawerau ā Maki Claims Settlement Act 2015 and the Tāmaki Settlement Collective, 2012.

[67] Office of Treaty Settlement plan reference.

12.6.2 Existing environment

12.6.2.1 Māori history and heritage

There is an acknowledgement that there are many different interpretations and histories from Mana Whenua about the land in the Project area. A brief summary of the accepted Māori history amongst Mana Whenua is set out below.

Onehunga dates from the earliest time of occupation by the older tribes of Tāmaki such as Te Waiohua and Te Kawarau a Maki. By 1100AD, the Ōtāhuhu portage linking the Māngere Inlet with the Tāmaki River was already in use. Onehunga saw the arrival of the Great Fleet's Tainui Waka into the Project area via the Kāretu and Ōtāhuhu portages (in 1350AD). From this time onwards successive tribes gained territory on the isthmus by marriage and through allegiances warfare. Further specific commentary on the whakapapa for Mana Whenua to this area is provided in the Maori Values Assessment reports prepared by Mana Whenua on this project. The Project team acknowledge this whakapapa.

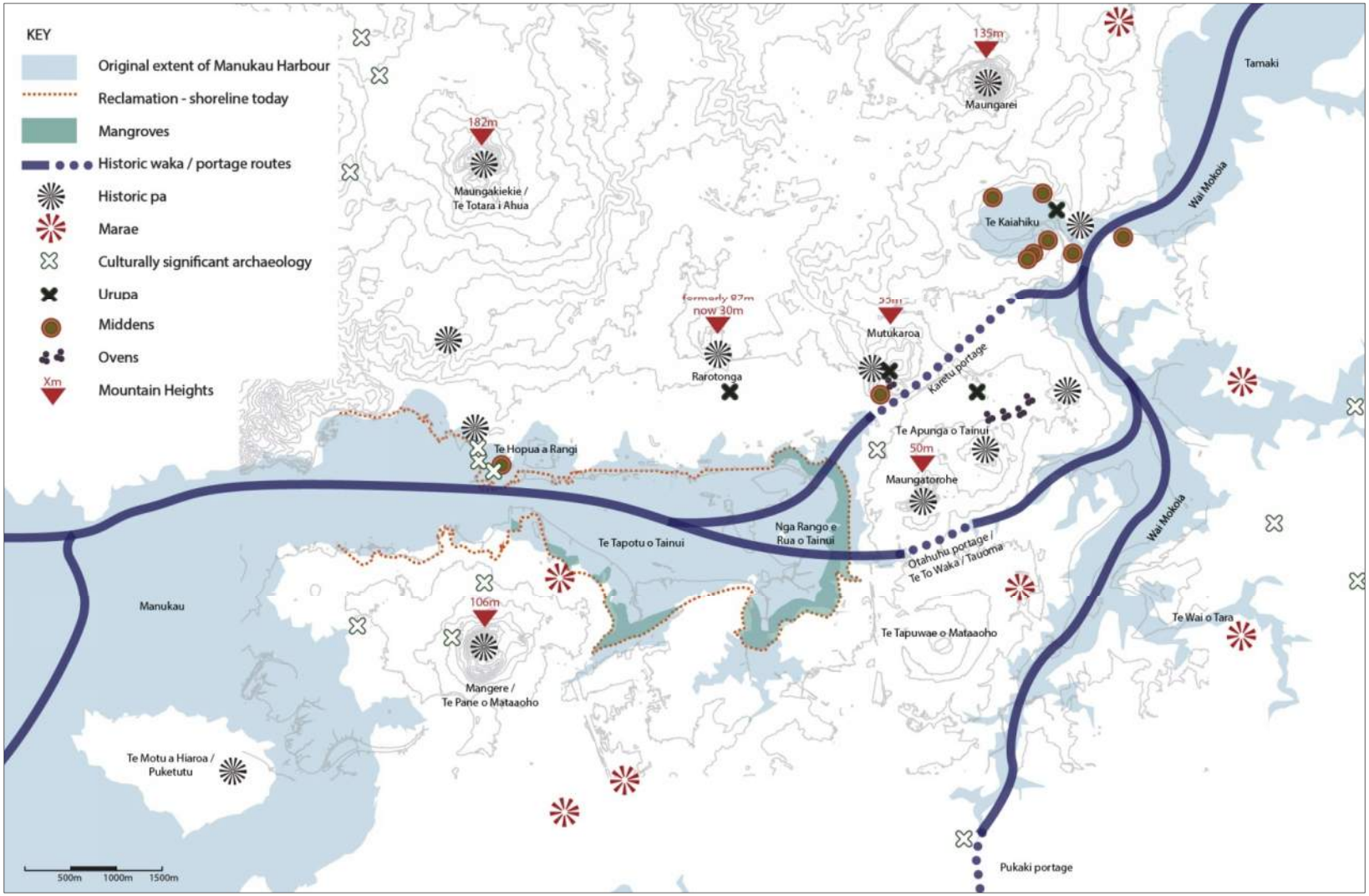
Historically, Onehunga was a desirable location for many reasons. Its location adjacent to the Māngere Inlet (once a rich source of food); proximity to strategic portages connecting the Manukau Harbour, Tāmaki River and Māngere Inlet; and its role as an important place of trade and commerce. The abundant natural resources of the foreshore and hinterland were an important resource, sustainably harvested by successive generations of tribal groups.

12.6.2.2 Cultural Landscape

Mana Whenua place particular importance on the cultural values of the Manukau Harbour as it has been a place of sustenance, commerce, transport and communication for hundreds of years. The harbour also has specific significance as a food basket for kai moana, strategic importance for east west movements both for waka and Māori people up to the present day and its contribution to the economic prosperity of Mana Whenua over time (e.g. with their involvement in the flax mills and for trade with Pakeha as the city of Auckland established). The soils in the Onehunga area have been important in the past as crops have flourished and provided an important resource for iwi and hapū.

During engagement with Mana Whenua, many shared their histories and stories, identifying connections to significant places within the Project area and broader region. The whole area is recognised as a cultural landscape, by the long history of occupation, settlement, trade and activity in the area. Within this landscape, specific sites and significant features are identified. These are shown on and discussed briefly below.

Figure 12-5: General location of culturally significant landscapes and sites



Te Waimokoia (Māngere Inlet)

The Te Waimokia is identified as a taonga. Notable features identified within the inlet include:

- The portages between the Manukau and Tāmaki harbours that extend from the reaches of the inlet, including the Ōtāhuhu and Kāretu portages;
- The small island Nga Rango Erua o Tainui, the final resting place of the skids used to haul the great waka Tainui across the Ōtāhuhu portage around 1300; and
- All coastline and riverbanks/marine and freshwater areas including Anns Creek.

Nga Tapuwae o Mataho

Several maunga form the backdrop and landscape setting of the Project (Te Pane o Mataaoho (Māngere Mountain), Maungakiekie (One Tree Hill), Maungarei (Mt Wellington), and Rarotonga (Mt Smart)). There are also features within the Project. In the immediate area features include:

- Te Hōpua ā Rangi, the basin of Rangi (the wife of the first Waiohua paramount chief Huakaiwaka), the tuff ring formally open to the Manukau Harbour but filled in 1930's and now bisected by SH20;
- Pahoehoe lava flows at Pikes Point and west of Alfred Street;
- Ōtāhuhu/Maungatorohe (Mt Richmond); and
- Views to maunga, including Māngere to the south and Maungakiekie in the north.

Several other significant maunga have been quarried out of the landscape, including Maungataketake (Mt Ellett), Te Ihu a Mataoho, Pukeiti / Puketaapapa (Otuataua Historic Reserve), Te Motu a Hiaroa (Puketutu Island), and Waitomokia (Mt Gabriel).

Portages

Waka portages were vital for east west trade and supported a strategic network of pā from the far north to the South Island (noted also in respect of the Māngere Inlet above). Those within the Project area are:

- The Kāretu portage linking Anns Creek with Kāretu, south of the Panmure Basin. The portage is located alongside Mutukāroa-Hamlins Hill;
- The Ōtāhuhu (Tauoma/Te To Waka) portage which was in use by 1100AD and was the most important in the area because of its location, gradient and length: it was the narrowest point between east and west coasts of New Zealand, sloping gently for less than 1km from the Tāmaki River to the Manukau Harbour; and
- The Pukaki portage, while outside the immediate Project area, formed part of the linked waterway routes.

Ancestral Pā

The ancestral pā in the area include:

- Mutukāroa-Hamlins Hill: a strategic site for the Kāretu portage, with many houses and storage pits among the cultivated slopes;
- Rarotonga: to the north of the Project area but whose cultural sites reach down towards the Māngere Inlet;
- Ōtāhuhu /Maungatorohe: just north of the Ōtāhuhu portage routes and closely associated with the portage;
- Mauinaina and Mokoia, fortified pā at the mouth of the Panmure basin positioned to control movement on the Tāmaki River;

- At Ihumatao on or around the volcanic cones of Te Ihu o Mataaoho/the nose of Mataaoho, and at Te Pane o Mataaoho; and
- Maungakiekie, dominating the centre of the isthmus between the harbours and one of the largest and most significant pā sites in the history of the area.

Te Apunga o Tainui

Within the cultural landscape, the area referred to as Te Apunga o Tainui is an area of specific heritage and history, initially for Māori settlement (referring to the arrival of the Tainui waka) and subsequently as the colonial military camp area (McLennan Hills). This area is geographically defined by the current landmark areas from Mt Wellington to the Ōtāhuhu Creek. Further information on the archaeological remnants and record of this area are provided in *Technical Report 3: Archaeological Assessment* in Volume 3. Mana Whenua have specific ancestral association with this area and on the basis of this, identify the area as wāhi tapu. This significance is formally acknowledged (in part) by the recorded and protected urupa to the west of SH1 in this area.

12.6.3 Consideration of cultural effects and management responses

Mana Whenua and the Project team have identified the potential for the above values to be impacted both during construction and in the operation of the Project, both in terms of the physical works and in terms of the way such works are undertaken (particularly for the latter in respect of the metaphysical effects on mauri and tapu of the environment and specific sites). The process of identifying the potential effects of the Project, and development of options to avoid, remedy and mitigate these effects is an iterative process. This section addresses both in an integrated manner.

12.6.3.1 Project benefits

An integral component of the consideration of the cultural effects of the Project is acknowledgement of the existence and importance of the residential and business activity of Auckland (as the country's major urban area). Economic activity in Auckland provides for the social and economic wellbeing of its residents, including Mana Whenua, mataawaka and other residents. In this regard, it is recognised that the EWL, as a Project to support the economic functioning of Auckland, will have benefits to the wider community including Mana Whenua.

There is potential for ongoing opportunities during construction and operation of the Project for Mana Whenua and mataawaka to provide for their social and economic wellbeing (and as a result cultural wellbeing). Acknowledgement of these opportunities is provided through ongoing discussions between the Transport Agency and Mana Whenua governance representatives and through the development of protocols and considerations for outcomes assessed in the procurement process. These opportunities are being explored in the partnership and collaboration arrangements discussed below.

12.6.3.2 Partnership and collaboration

Mana Whenua have acknowledged the ongoing journey that has been taken in building a relationship of collaboration on the Project and in the delivery of other transport projects. A core element of appropriately addressing the potential effects of the Project on cultural values is acknowledging and establishing enduring relationships between iwi/hapū and the Transport Agency at a consistent level across the various phases of a project.

In acknowledgement of this, the Transport Agency has established a number of levels of engagement and collaboration for this (and wider) Projects. These include:

- Project development between the Project team and Mana Whenua (which has informed the design, option evaluation, assessment and mitigation process to date); and
- Measures set out for the subsequent detailed design, during construction and operational processes (e.g. future contractors) (discussed further below).

The Transport Agency is also progressing wider levels of engagement between the Agency and Mana Whenua, for governance and leadership.

12.6.3.3 Alignment Design

The Project team has sought to recognise and acknowledge Mana Whenua cultural values in identification and design of the Project. In particular, alignment options and designs have sought to avoid potential adverse effects on cultural values. Examples of this approach include:

- A design which avoids impacts on the physical remnants and exposed lava of Te Hōpua. Design considerations include avoiding / minimising cutting into or through the tuff ring, avoiding significant geological areas and avoiding works that would require covering exposed lava flows in the CMA (e.g. to the west of the tuff ring in the Onehunga area);
- The proposed alignment avoids the mapped area of Mutukāroa-Hamlins Hill. Options that may have impacted on this feature, and designs that had the potential to require land from the reserve at Mutukāroa-Hamlins Hill (along Sylvia Park Road) were dismissed earlier in the options assessment process;
- A design which does not intrude on existing and protected views to valued maunga, including Māngere and Maungakiekie;
- Avoiding corridor options that would have increased the extent of impact on Te Apunga o Tainui (at Panama Road), in particular this refers to an option that provided a more easterly connection for the EWL at SH1, but also more recently an alignment and construction design for the ramps connecting the EWL with SH1 at Mt Wellington;
- Investigating alignment options through the Anns Creek area, that have sought to avoid impacts on outstanding and/or significant geological features (acknowledging there are some impacts on ecological features in this area that are not avoided); and
- Selecting the design option that removes the existing culvert obstruction of the Ōtāhuhu portage on SH1 and replaces them with a bridge. This provides opportunity to recognise the culturally significant Ōtāhuhu portage (discussed below).

In addition, in acknowledgement of certain adverse cultural effects of the Project and the opportunities that are afforded by the Project, the following alignment designs have also been developed:

- The provision for full bridging of Ōtāhuhu Creek acknowledges the significance of this historic portage. Recognition of the portage feature in design of the structures of this bridge will provide further opportunities to positively recognise this significant feature;
- The issue of reclamation of the CMA is significant for Mana Whenua, representing the permanent displacement of this taonga with land. Mana Whenua generally consider reclamation an untenable environmental impact. The extra-ordinary conditions of the northern coastal edge of the Māngere Inlet (which include extensive areas of landfill), the impacts of water discharging from land to the Harbour and the modification of the coastal edge in this area have all been considered in the identification of the opportunities provided by the Project. The design of the foreshore reclamation of EWL, provides for:
  - The construction methodology on the foreshore which includes the removal of materials from parts of the closed landfills along the Māngere Inlet and establishment of a ‘contamination containment bund’ or barrier between these landfills and the harbour. This is expected to reduce the tidal flow of water (and potential leachate contamination) between the Māngere Inlet and these landfills to recognise and enhance the mauri of the coastal environment;
  - The establishment of new areas to manage existing stormwater discharges from the wider Onehunga area (addressing activities which are currently degrading the mauri of the Māngere Inlet and as a result the wider Manukau Harbour);

- Restoration and rehabilitation of natural character / natural form of the Manukau Harbour edge to contribute to the restoration of mana to this area of the Māngere Inlet; and
- Carefully balancing the extent of reclamation from the Māngere Inlet; seeking to minimise the extent of reclamation while still achieving the contamination containment, water quality and restoration outcomes of the Project.

12.6.3.4 Te Aranga Principles

Te Aranga Principles are delivered through the design of the EWL, as set out in the ULDF. Embedded within the ULDF are processes for ongoing design inputs by Mana Whenua to key features of the Project. The ULDF will guide the ongoing development of the Project, focusing on design and integration of the Project into the surrounding environment, particularly both the urban areas of Onehunga and the coastal environment of the Māngere Inlet.

Key specific examples of measures from the ULDF which demonstrate the ongoing input of the Te Aranga principles in the delivery of the Project include:

- The concepts for recognition and acknowledgement of Te Hōpua and the commitment to contribution of Mana Whenua in the establishment of artworks in this area;
- The themes for and ongoing role of Mana Whenua input into the design and interpretive signage of the foreshore and in the Anns Creek area to acknowledge the value of this environment to Mana Whenua;
- The recognition of the Kāretu portage – the Project follows the alignment of the Kāretu Portage alongside Mutukāroa-Hamlins Hill for about 1km and offers an opportunity to improve awareness and legibility of the cultural values of this area. Specific measures proposed to appropriately recognise and remember this valued area include signage and interpretative information on the portage area, structure design and in particular the design beneath the viaduct structures through Anns Creek, as well as landscaping to provide for the legibility of this historic link at Sylvia Park Road; and
- The Ōtāhuhu portage – to recognise the portage in design of the bridge structure, including opportunity for passage beneath the bridge to maintain connectivity down the waterway.

In all cases, the application of the design principles is proposed to be undertaken in a process of ongoing consultation / engagement with Mana Whenua, to recognise wider values of kaitiaki and ahi kā.[68]

12.6.3.5 Effects on the mauri of the Māngere Inlet and waterbodies

A number of sections in this AEE consider the effects of sediment discharges to the CMA and the resulting impacts on ecological values (e.g. Sections 12.15, 12.20 and 12.21). Collectively, these assessments provide information for the assessment of the overall health or mauri of the Māngere Inlet and other water bodies impacted by the Project (including the Tāmaki Estuary). Mana Whenua input during construction and operation will both maintain opportunities for the effects on the mauri of the Māngere Inlet to be considered going forward and further contribute to recognising cultural values in respect of kaitiaki, ahi kā and rangatiratanga (governance and self-determination) in respect of this taonga.

[68] (noun) burning fires of occupation, continuous occupation – title to land through occupation by a group, generally over a long period of time.

12.6.3.6 Works on or in vicinity of culturally significant areas

Construction of the Project will require land disturbance activities that could have adverse effects on some of the following areas of cultural significance:

- Te Hōpua tuff ring;
- Pahoehoe lava flows in and around Anns Creek;
- Ōtāhuhu and Kāretu Portages;
- The culturally significant area between SH1 Mt Wellington and Panama including Te Apunga o Tainui; and
- The CMA.

The potential works in these areas include activities such as:

- Minor earthworks on the external and internal slopes of Te Hōpua tuff ring;
- Disturbance to the CMA (including coastal processes and marine habitats) during construction of the foreshore and structures in the CMA;
- Temporary erosion and sediment control ponds to manage sediment discharges during construction activities; or
- Restrictions on access during construction works, such as closure of access on the Ōtāhuhu Portage during construction of the proposed bridges (noting access is already constrained by the existing culverts on SH1).

To respond to the potential cultural effects on Mana Whenua values, protocols for Mana Whenua engagement throughout construction are proposed.

12.6.3.7 Archaeological Effects and Accidental discovery of artefacts

The archaeological assessment is contained in *Section 12.7.2: Archaeology* and *Technical Report 3: Archaeological Assessment* of *Volume 3* and it should be read in conjunction with this assessment. There are several sites of cultural significance and wāhi tapu within the Project area (discussed above). Construction of the Project will require earthworks and disturbance of ground surfaces in and around these known areas of previous Māori occupation. The works have the potential to disturb or uncover, previously unknown heritage artefacts of cultural significance. To minimise any potential impacts to these artefacts, specific tikanga protocols will be established for undertaking works in this area. This is in addition to the proposed accidental discovery protocols and Archaeological Authority to be sought for the Project. The specific tikanga protocols, and the more general accidental discovery protocols, will be prepared in consultation with Mana Whenua in advance of construction, and will be implemented during construction to ensure appropriate procedures are followed.

12.6.4 Operation and Monitoring of Project Outcomes

The principles of partnership and collaboration are proposed to extend through the operation of the Project and through monitoring and management planning will confirm the expected outcomes. This will include (but is not limited to):

- Participation of Mana Whenua in the review of monitoring reports for water quality and discharges to the CMA, reporting on ecological outcomes from the Project and in the development of any necessary contingency or response plans (e.g. if monitoring triggers are reached). This on-going role in the operation and management of the environmental outcomes of the Project recognises the kaitiaki role of Mana Whenua in this environment and provides an opportunity for the Maori world view and cultural values to be reflected in the development of any contingency or action plans prepared in response to monitoring outcomes.

- Opportunity for cultural monitoring processes are to be offered to Mana Whenua. Cultural monitoring will provide Mana Whenua an opportunity to identify and articulate the values and perspectives of the Māngere Inlet / Manukau Harbour and project environment that are significant to them. The monitoring will enable them to understand the environmental-cultural changes experienced in the Project area during construction and through to implementation, from a Maori perspective.

12.6.5 Summary of project measures to address cultural effects

The construction and operational effects of the Project on water bodies and areas of cultural significance are of particular concern to Mana Whenua. The measures to avoid, remedy or mitigate these effects are summarised below.

12.6.5.1 Construction

Mitigation and management measures that will be implemented during further project development to minimise adverse effects on cultural values and to recognise the relationship of Mana Whenua to the environment, are incorporated into various sections of this AEE including:

- Protocols for engagement and ongoing input from Mana Whenua in detailed design of the Project and during construction;
- Specific protocols and Te Aranga principles for the design of:
  - Structures at Te Hōpua;
  - Structures and elements of the foreshore design;
  - Structures in the Kāretu portage; and
  - The aesthetic treatment of the bridge and provision for public access beneath the bridge at Ōtāhuhu Creek.
- Protocols for recognition of Mana Whenua and the cultural significance of the landscape in which the Project sits (e.g. undertaking blessings for construction works);
- Protocols for cultural monitoring in significant sensitive sites (e.g. earthworks in the area of Te Apunga o Tainui, works in the vicinity of the historic coastline and works at Te Hōpua);
- An accidental discovery protocol for the Project will be developed and agreed with Mana Whenua and HNZPT. Further discussion of the accidental discovery protocol is contained in *Section 13.1: The Project delivery framework* of this AEE; and
- Sourcing of locally grown natives for proposed landscaping.

12.6.5.2 Operation

The following measures are proposed during the operation of the Project:

- Participation of Mana Whenua in the review of monitoring reports for water quality and discharges to the CMA, reporting on ecological outcomes from the Project and in the development of any necessary contingency or response plans (e.g. if monitoring triggers are reached); and
- The opportunity for cultural monitoring processes are to be offered to Mana Whenua (e.g. water quality).

12.7 Archaeology and built heritage

Overview

The Project is located in an area highly modified by urban development and reclamation. This has resulted in the destruction and damage of a number of recorded archaeological sites and probably also unknown or unrecorded archaeological remains or sites. Notwithstanding this, there are a number of archaeological sites recorded within, and in proximity to, the Project area. The works associated with the Project have been assessed as likely to have a moderate effect on previously recorded and unrecorded archaeology provided that works comply with mitigation measures or conditions.

Construction of the Project, and particularly earthworks, has the potential to affect archaeological sites and for unknown archaeological sites to be encountered. An application(s) for an archaeological authority will be submitted to HNZPT prior to the construction works commencing. The methods to record, analyse and monitor archaeological sites will be defined in that application and implemented in accordance with any conditions of the HNZPT authority during construction to appropriately manage the potential adverse effects on archaeology.

The Project sits in close proximity to a number of built heritage features. While these features will not be directly physically affected by the Project, construction has the potential to affect the heritage values and context and the structural integrity of these buildings. These effects include construction vibration and ground settlement, which can be appropriately managed during construction. Operational effects include limiting views and access to some built heritage places and are assessed to have minor to moderate effects on scheduled and listed built heritage places.

12.7.1 Introduction

This section outlines the actual and potential effects of the Project on archaeology and built heritage.

There are a number of archaeological sites recorded within and in proximity to the Project area. The actual and potential effects on archaeological sites for the Project comprise damage to or destruction of archaeological or heritage material. An archaeological assessment including a detailed description of the existing archaeological environment is provided in *Technical Report 3: Archaeological Assessment* in Volume 3.

The Project also sits in close proximity to a number of built heritage features. Potential adverse effects on built heritage include visual amenity, limited access and damage to the structural integrity of the built heritage features as a result of construction vibration and ground settlement. A built heritage assessment including descriptions of built heritage features is provided in *Technical Report 2: Built Heritage Assessment* in Volume 3.

This section does not provide an assessment of Māori cultural values. That assessment is contained in *Section 12.6: Effects on values of importance to Mana Whenua* of this AEE.

12.7.2 Archaeology

The methodology used to assess the archaeological environment along and within the vicinity of the Project alignment has involved both a desktop and field assessment.

12.7.2.1 Existing Archaeological Environment

Within the wider Project area, there are numerous archaeological sites recorded by the New Zealand Archaeological Association (NZAA) and other records such as Cultural Heritage Inventory (CHI) records. These include sites of Māori origin, including former settlement sites, middens, pits/terraces, burial sites

and sites of Colonial era origin, including sea walls, sawmills and infrastructure. The recorded sites in proximity to the alignment are summarised in Table 12-7 and illustrated in Figure 12-6.

These sites are of limited archaeological value and significance because the majority have been damaged or destroyed by urban development and previous State highway construction.

There is also the potential for unknown archaeological sites to exist within the Project area. However, given the extent of land modification it is not possible to fully assess the extent and values of such sites prior to works.

Table 12-7: Recorded Archaeological Sites

Sector	Location relative to EWL	NZAA Site Number	CHI number	Site Type/Description	Condition
1	Within the EWL alignment	R11/99	6826	Settlement/Pa	Destroyed
1	Located on the southern edge of Te Hōpua	R11/352	5837	Midden Oven	Area has been extensively modified
1	Within the EWL alignment	R11/2743	N/A	Transport Communication	Archaeological remains
3	Located at Anns Creek	R11/1635	10107	Industrial Water Supply	Archaeological remains
4	Adjacent to Project (will not be affected)	R11/142	1176	Mutukāroa-Hamlins Hill Pit/Terrace/Settlement site	Archaeological remains
4	Within 60m of the Project	R11/1394	N/A	Pit/Terrace	Totally destroyed and built over by factories.
4	Within 60m of the Project	R11/898	1165	Pit/terrace	Site under commercial development
5	Within 100m west of Project	R11/10	N/A	Te Apunga o Tainui McLennan Hills (Pits/Terraces)	Destroyed by quarrying. Surrounding areas may have archaeological remnants.

Figure 12-6: NZAA Archsite recorded sites

In addition to the NZAA recorded sites in Table 12-7, there are other CHI sites adjacent to the site that contribute to archaeological values. These include amongst others the Onehunga Wharf (CHI 467) and the Old Māngere Bridge (CHI 659) and seawalls.

12.7.2.2 Assessment of effects on archaeology

The actual and potential effects on archaeology from the Project relate to the potential destruction, modification or damage of archaeological sites arising from the construction works. The archaeological effects of the Project will be limited to the footprint of the physical works.

The majority of the NZAA and CHI archaeological records are located outside the Project footprint and as a result will not be affected. Scheduled archaeological sites will not be affected. There is a midden record (R11/352 and CHI 5837) on the southern side of Te Hōpua. The NZAA detail record suggests this has largely been destroyed as a result of previous development, however associated unrecorded archaeological material may be encountered during works.

Remains of historic Onehunga Port infrastructure may also be affected in this area (CHI 467 and 469, and remains of R11/2743, being the Onehunga branch line rail embankment to the port).

There is the potential that unknown archaeological remains are encountered during construction. Accidental discovery protocols can set out the procedures to be followed should archaeological remains be encountered during construction.

The HNZPT Act provides for the identification, protection, preservation, and conservation of the historical and cultural heritage of New Zealand. The HNZPT Act defines an archaeological site as a place or structure associated with pre-1900 human activity and where there may be evidence relating to the history of New Zealand. It is unlawful for any person to modify or destroy, or cause to be modified or destroyed, the whole or any part of an archaeological site without the prior authority of HNZPT. An application(s) for an archaeological authority will be submitted to HNZPT prior to the construction works commencing.

Overall, as the Project is located in a highly modified area, including on areas of reclaimed fill, and known sites are identified as being largely destroyed, archaeological effects cannot be assessed with certainty but are expected to be minor, with the possible exception of the southern part of Te Hōpua, where a variety of archaeological material may be encountered during deeper works which may extend to the original seabed.

12.7.2.3 Measures to avoid, remedy or mitigate potential adverse effects on archaeological sites

The following measures are proposed to mitigate the potential adverse effects on archaeological sites:

- The Project team will continue to liaise with Mana Whenua, HNZPT, and Auckland Council Heritage staff with regard to developing a framework for management of Historic Heritage values during construction, in accordance with conditions of any HNZPT Archaeological Authority, and to identify opportunities for interpretive and commemorative material for any archaeological discoveries;
- For areas identified as having greater potential for archaeological discoveries, an Archaeological Authority(s) will be sought from HNZPT under the HNZPT Act; and
- For other areas of the Project, the Transport Agency Accidental Archaeological Discovery Protocol and AUP (OP) accidental discovery protocols (with input from Mana Whenua) will be applied, to ensure appropriate steps are taken in the event of archaeological discoveries.

The Project team has liaised with HNZPT during the preparation of the Application and this liaison will continue during subsequent stages of the Project.

The mitigation measures, methods and protocols set out above will appropriately manage the potential adverse effects of encountering archaeological or heritage material.

12.7.3 Built Heritage

The built heritage assessment has been undertaken for extent of the Project and the areas extending approximately 50-100m out from the boundary of the proposed works. The built heritage features have been assessed in two broad groups:

- Listed and scheduled historic heritage buildings and structures; and
- Other built heritage not listed or scheduled, but identified on Auckland Council's CHI and/or buildings or structures that contribute to the character of the area.

12.7.3.1 Existing Environment

The Project area has a rich history of European settlement as discussed in *Section 10.0* of this AEE. Within the area assessed a number of built heritage features have been identified. A complete list of these features has been included in *Technical Report 2: Built Heritage Assessment* in Volume 3. Table 12-8 summarises the key and/or listed built heritage features that may be impacted by the Project.

Table 12-8: Built Heritage within the Project area

Historic Heritage Feature	Address	Cultural Heritage Index No.	AUP (OP) ID	HNZPT Listing
Aotea Sea Scouts Hall	1 Orpheus Drive, Onehunga	100	2598 (Category A)	N/A
The Landing (former Manukau Tavern)	2 Onehunga Harbour Road, Onehunga	2861	2610 (Category B)	N/A
Shaldrick Building	50 Onehunga Mall	19951	2617 (Category B)	N/A
Waikaraka Park Stone Walls and Cemetery	175-243 Neilson Street	3219	1755 (Category B)	N/A
Onehunga Wharf	55 Onehunga Harbour Road, Onehunga	20036	2736 (Category B)	-

In addition to the built heritage features outlined below, the wider area contains scheduled and/or listed built heritage places and areas identified as having character and/or heritage values. This includes the Onehunga Town Centre and the character streets in Onehunga which are identified as special character areas. There are other buildings and structures in the Project area that are included in Auckland Council's CHI, or may have value in terms of contributing to the character of the area such as sea walls and the Onehunga Wharf remains.

Aotea Sea Scouts Hall

The Aotea Sea Scouts Hall (former Manukau Yacht and Motor Boat Club) is accessed via Orpheus Drive and Onehunga Harbour Road and is a significant and highly visible landmark and an aesthetically pleasing building.

The Aotea Sea Scouts Hall has high historic values, being one of the oldest boating club buildings in New Zealand.

The building has significant architectural values and has high cultural and social significance due to its contribution to the social and cultural life of Onehunga. The existing SH20 and Neilson Street Interchange have disconnected the Aotea Sea Scout Hall from the Onehunga Town Centre to some extent.

Other built features in the vicinity of the Aotea Sea Scouts Hall include the stone sea wall and Onehunga Wharf remains.

Figure 12-7: Aotea Sea Scouts Hall

The Landing

The Landing (former Manukau Tavern) is Onehunga's only remaining 19th century hotel in operation and has been in continuous use for its original purpose since its construction in 1879. The building has considerable historical significance due to its associations with people and organisations significant to the early settlement of Onehunga.

The building has moderate context significance due to the contribution it makes to the wider historical and cultural context, and proximity to Onehunga Wharf.

Figure 12-8: The Landing, Onehunga

Shaldrick Building

The Shaldrick Building, located at 50 Onehunga Mall, was built around 1880. The building is significant as it is the only remaining 19th century residential building at the southern end of the Onehunga Mall area.

The building has been assessed to have considerable local historical significance due to its connection to William Shaldrick, a prominent Onehunga resident and businessman.

Figure 12-9: Shaldrick House, Onehunga

Onehunga Wharf

The Onehunga Wharf, constructed in 1924, retains early cargo structures and a sea wall. The Onehunga Wharf has considerable local significance for its role as a hub for coastal shipping. For a period during the 1960s it was the largest coastal shipping port on the west coast of New Zealand. The port closed to international shipping in 1990, operating solely as a coastal port handling a wide range of cargoes to and from other New Zealand ports.

Waikaraka Park

Waikaraka Park was set aside for public use in 1881 for use as a recreation ground, rifle range and public cemetery. The Park has significant social and cultural significance due to its historical social contribution to Onehunga and the wider Auckland. The heritage features within Waikaraka Park are:

- The War Veterans Memorial dedicated to soldiers and service people, unveiled in April 1917;
- Stone walls surrounding Waikaraka Park;
- Stone caretakers cottages located in the north-eastern corner of the Park; and
- Built heritage features associated with the speedway in the north western corner of the site.

Figure 12-10 illustrates the historic heritage features within the Park.

Figure 12-10 : Waikaraka Park features

Key features

A Cemetery

B 1930s Grandstand

C Ticket Booth

D 1948 Toilet Block

E 1942 Caretakers cottage

F 1930s/40s toilet block

G Sports Fields

Note: Yellow (items A-G) represents places of historic interest and are included in the evaluation. Blue (H-K) indicates places excluded from the evaluation as these are modern service buildings providing toilets, changing rooms, sportsfield services and motorspeedway services. Red indicates the overall extent of Waikaraka Park and Cemetery.

12.7.3.2 Assessment of construction effects on built heritage

None of the built heritage features identified will be directly physically affected by the construction works for the Project. Construction will however have the potential to have indirect adverse effects associated with ground settlement and construction vibration.

The assessment of ground settlement effects set out in *Section 12.17: Ground Settlement* identifies that ground settlement associated with the Project will largely be generated by consolidation or compression of the ground from construction fill. Ground settlement beyond the immediate Project footprint is calculated to typically be in the range of 0-10mm (which is low). Adverse effects of settlement in this range, combined with the separation distances to the heritage buildings means that the potential effects on the structural integrity of heritage buildings and structures are assessed as negligible (see *Section 12.17: Ground Settlement* for further discussion).

The assessment of construction vibration is set out in *Section 12.11: Noise and vibration* of this AEE. That assessment identifies that the majority of heritage buildings and structures within the Project area are at a distance where the risk of building damage from construction vibration will be negligible. The Aotea Sea Scouts Hall and The Landing buildings are located in close proximity to the area of construction works (within 10m of the alignment), however, the adverse effects from construction vibration at this distance is still assessed as negligible (see *Section 12.17: Ground Settlement* for further discussion). Buildings may receive perceptible vibration when use of heavy machinery is being used. Low vibration methods of construction will be used wherever practicable to reduce vibration in the vicinity of sensitive land uses.

Vibration monitoring will be used to confirm that vibration intensive works occurring in proximity to heritage features are appropriately managed within the limits set out in *Section 12.11: Noise and vibration* of this AEE. Pre and post construction condition surveys will be undertaken for the Aotea Sea Scouts Hall and The Landing to record and monitor any potential structural damage as a result of construction.

Overall, the potential construction effects on built heritage will be negligible due to the distance of heritage features from the construction extents and the implementation of mitigation measures and monitoring.

12.7.3.3 Assessment of permanent works on built heritage

The Project will not result in the destruction of, or any physical damage to, any heritage features. The ongoing physical presence and operation of the Project has the potential to have an adverse effect on heritage values and visual amenity however, the Project also will have positive effects on some built heritage places within the Project area.

The operational vibration effects of the Project are assessed in *Section 12.11: Noise and vibration* of this AEE. This indicates that as this will be a newly constructed road, it is highly unlikely that there will be any adverse traffic noise and vibration effects on heritage buildings and structures within the Project area. Therefore, no adverse effect is anticipated from traffic noise and vibration on the physical form of heritage buildings and structures.

Adjacent to the Aotea Sea Scout Hall will be the realigned Orpheus Drive, the SH20 on-ramp and the connection to the SH20 overbridge. This will restrict views towards the building from the Neilson Street off-ramp, limiting opportunities to appreciate the main façade. Additionally, the Project will affect the usability of the club by the Aotea Sea Scouts who, during consultation, have identified concerns with safety for children, loss of access to Gloucester Park South and reduced context including views to and from Onehunga Town Centre. The Project will however have a positive effect on the context and improve local accessibility by changing Onehunga Harbour Road/Orpheus Drive to local road connection with walking and cycling facilities. Overall the Project will have permanent cumulative adverse effects on the Aotea Sea Scouts Hall, however this can be partly mitigated through the incorporation of appropriate landscaping. The positive effects of the Project described above will also contribute to minimising the impact of the adverse effects.

The reconfiguration of the Neilson Street Interchange and the establishment of the EWL within Sector 1, will physically and visually change the relationship of The Landing with the surrounding area and further isolate the Onehunga Wharf. Lowering the EWL in a trench adjacent to the Onehunga Wharf the proposed local road connection to Orpheus Drive and Onehunga Wharf, and the improved pedestrian and cycleway facilities, will contribute to mitigating this effect.

The establishment of a road directly adjacent to the southern end of Waikaraka Park and Cemetery will change its context and weaken its historic relationship with the Māngere Inlet. The key concerns for Auckland Council as land owner relate to construction (including noise, dust etc.), however overall Auckland Council is supportive of the operation and the future opportunities to enable active sports fields to be developed.

Discussions with HNZPT identified that amenity of the Cemetery is a particular concern. Potential adverse visual effects will be mitigated through urban design and landscaping on the cemetery side of the road to maintain a “green” outlook. A wider area is available for planting at the western extent of the cemetery. None of the Pohutukawa trees along the Cemetery access road will be affected by the Project. The landscape plans in Plan Set 4: Landscape show this proposed planting for this area.

The Project may have a positive effect on the northern end of Waikaraka Park due to the reduction in traffic volumes along Neilson Street. The widening of the Neilson Street / Captain Springs Road intersection will impact on the context of the northern end of Waikaraka Park however the effect of this will not be significant. The stone walls of Waikaraka Park are not affected by the Project.

12.7.3.4 Measures to avoid, remedy or mitigate potential adverse effects on Built Heritage

To manage the potential adverse effects of construction on historic heritage, vibration monitoring will be undertaken during vibration intensive construction works in proximity to heritage features. The monitoring will confirm the vibration levels experienced and allow construction methodologies to be altered in response to elevated vibration levels.

Building condition surveys of the Aotea Sea Scouts Hall and The Landing will be undertaken prior to works commencing to confirm the condition, context and physical features of the buildings. This information will be included in the CEMP. Post construction, a condition survey will be undertaken to record any potential structural damage as a result of the Project construction and any damage will be rectified in consultation with the building owner.

Landscaping and urban design elements, such as shared paths will reduce further isolation of the buildings and maintain connectivity with the wider environment. These elements are indicated on the drawings contained in *Plan Set 4: Landscape* in Volume 3 and the *ULDF* in Volume 4.

12.8 Assessment of geological heritage effects

Overview

There are several geological features located within the Project area – the Te Hōpua tuff crater, remnant lava features along the Māngere Inlet foreshore and pahoehoe lava flows within Anns Creek. All of these features have been compromised to varying degrees by urban development and their value as examples of volcanic features has been reduced as a consequence.

The Project will result in negligible adverse effects on Te Hōpua as a result of cut and fill required on and in proximity to the remaining tuff features. The new road largely avoids effects on the other remnants of lava flows located along the northern foreshore of the Māngere Inlet and in Anns Creek. In addition, the Project will have positive effects on the geological features along the Māngere Inlet foreshore.

The Project provides the opportunity to enhance knowledge of Auckland's volcanic heritage, and to improve the understanding of, and public access to, these features.

12.8.1 Introduction

This section presents the actual and potential effects of the Project on geological heritage. A detailed description of the existing geological heritage environment and the accompanying assessment of effects on geological heritage are provided in *Technical Report 4: Geological Heritage Assessment* in Volume 3.

The assessment of geological heritage describes the volcanic features in the Project area, explains how previous modification has affected the condition, identifies the values of the features and assesses the effects of the Project on the features. It identifies mitigation measures that can address potential effects.

The AUP (OP)[69] focuses on avoiding the adverse effects of inappropriate subdivision, use and development on the natural characteristics and qualities that contribute to an Outstanding Natural Features' (ONFs) values but also ensuring that any development of infrastructure is consistent with the protection of those values. The AUP (OP) lists the factors (or values) that were used to identify a natural feature as an ONF, and it also contains a description of the site and a classification of the site type. The AUP (OP) does not however list the geological qualities or characteristics that contribute to a classification for a particular ONF.

Technical Report 4: Geological Heritage Assessment identifies the qualities and characteristics of the ONFs, taking into account relevant information in the AUP (OP) including the factors that were used to identify the ONFs and the current state of those ONFs. The assessment then assesses the Project's potential adverse effects on those geological characteristics and qualities and consequently the values of the ONFs.

12.8.2 Existing Environment

Volcanoes are a distinctive feature in the Auckland landscape. Within a 20km radius of the CBD there are some 50 named volcanic vents which form the area referred to as the Auckland Volcanic Field. The Auckland Volcanic Field is geologically interesting due to its visual prominence and young age.

[69] Policy D10.3.3 of the AUP (OP).

The volcanic features within the Project area include:

- Te Hōpua (an ONF);
- Remnant basalt outcrops along the Māngere Inlet foreshore; and
- Pahoehoe lava flow remnants in Anns Creek (part of an ONF).

Technical Report 4: Geological Heritage Assessment contains plans showing the mapped extent of the ONFs at Te Hōpua and Anns Creek.

Te Hōpua and the remnant foreshore lava outcrops at Victoria Street and Pikes Point have been assessed to have limited geological heritage value in comparison to other features of the Auckland Volcanic Field. The Anns Creek Estuary flows are significant and the lava features within the Anns Creek East area are rare, not of themselves but because of the flora growing on them. Each of the volcanic features within the Project area are described further below.

12.8.2.1 Te Hōpua

Te Hōpua is a small volcano in the southern part of the Auckland Volcanic Field. In its original form, it was a roughly circular volcanic crater, enclosed by a raised tuff which was highest on the northern and north eastern sides, and lowest on the western side. It was the product of one of Auckland's smaller eruptions. When the sea-level rose, the tuff ring was breached on the south-western side and a shallow tidal lagoon was formed and marine and organic muds deposited within. The lagoon has been further filled with urban refuse and fill; and currently the crater floor exists as Gloucester Park with SH20 bisecting the crater. Due to the level of modification and the development of buildings, particularly on the eastern and northern sides, it is not easily identifiable as a volcanic feature with only limited outcrops of the tuff forming the ring remaining, largely on the northern side.

Figure 12-11: Aerial image of Te Hōpua and the western end of the Māngere Inlet foreshore
(looking north west across Onehunga with SH20 visible to the left)

In its current state, Te Hōpua has been assessed to have little value as a volcanic feature characteristic of the Auckland Volcanic Field – despite being referenced in statutory planning documents as an ONF. The AUP (OP) has categorised Te Hōpua as a Type B site. The AUP (OP) states that Type B sites are smaller more fragile landforms or other features that could be damaged or destroyed by relatively small-scale land disturbance or constructions. Te Hōpua has only limited outcrops of tuff remaining.

12.8.2.2 Lava Flow Outcrops

Prior to historic reclamation in Māngere Inlet, the original coastline comprised lava flow lobes emanating from Maungakiekie/One Tree Hill, Rarotonga/Mt Smart and Maungarei/Mt Wellington volcanoes. Due to past reclamation and land development, the lava flows have been largely destroyed.

There are remnants of the lava flows along the Māngere Inlet foreshore in the vicinity of Victoria Street, Pikes Point and within the Anns Creek Estuary, West and East areas. Along the Māngere Inlet foreshore, the remaining lava outcrops are not assessed to have any significant volcanic heritage value. In Anns Creek East the existing features are not particularly significant from a geomorphic perspective as the textures are mainly obliterated by weathering. In the Anns Creek Estuary area, within the Māngere Inlet, there is an area of uneven cooling textures representing one of the few examples of pahoehoe surfaces on basalt lava in Auckland. Small areas of mangrove scrub are likely to include unmodified lava flows and outcrops which have remained intact.

Figure 12-12: Aerial image of Māngere Inlet looking south east
(the triangular Pikes Point remnant lava flow is visible along the foreshore with Anns Creek to the upper left)

Figure 12-13: Aerial image of Anns Creek looking northwest
(the Southdown spur of the railway line is visible in the centre)

The distinctive “folded” pahoehoe lava flows within Anns Creek are annotated as an ONF in the AUP (OP). These are also categorised as a site Type B.

12.8.3 Effects on Volcanic Heritage

12.8.3.1 Te Hōpua

The Project works in proximity to Te Hōpua include minor earthworks on the western and south western edge, the establishment of an embankment on the north western edge and minor excavation on the southern margin of the tuff ring on the eastern side of The Landing. The tuff ring has been extensively modified, and the majority of the works will be on the already breached southern side or will not directly impact the tuff ring. The works will have a minor effect on the form of the outer slopes of the tuff ring.

The proposed works for the northbound off-ramp of SH20 will involve earthworks following the line of the existing off-ramp and across land that is filled and so will have no impact on the form of the tuff ring.

Along the southern extent of the tuff ring, a cut trench will excavate landfill material and below sea level will encounter tuff deposits. This area has been extensively excavated by current developments. The tuff deposits are located below sea level and earthworks in this location will have no impact on the form of the tuff ring.

The Project has minimised impacts on Te Hōpua, as far as practicable, by staying within existing modified areas and, where possible, within the Transport Agency existing designation. Given the significant level of modification that has already occurred, and the comparably smaller degree of additional cut that will occur as part of the Project, adverse effects of the Project on Te Hōpua’s geological heritage values are assessed to be negligible.

12.8.3.2 Lava flow outcrops

a. **Foreshore outcrops**

The foreshore along the northern side of the Māngere Inlet is made up of the distal ends of lava flows from Maungakiekie/One Tree Hill and Rarotonga/Mt Smart volcanoes. The new road along the northern foreshore of Māngere Inlet has avoided volcanic features as far as practicable by largely avoiding the Pikes Point remnant. The volcanic features along the foreshore have been assessed as being of low geological heritage value, and adverse effects on these features have been largely avoided through Project design.

The proposed boardwalk in the Inlet will cross the remnant flows at Pikes Point and opposite the end of Victoria Street. These outcrops have little volcanic heritage value. The proposed walking and cycling connection along the foreshore, landscaping and signage with interpretive material will have positive impact for visibility and legibility of the features.

b. **Anns Creek lava flows**

The lava flows from Rarotonga/Mt Smart and Maungarei/Mt Wellington volcanics have largely been destroyed by the development of roads, rail and industrial buildings in the area. Within relatively small areas of mangrove scrub there are remnant patches of lava outcrop illustrating surface lava features.

The viaducts and associated construction access have been carefully located within the Anns Creek Estuary to avoid most of the ONF areas. The proposed construction methodology includes placing any temporary staging on the southern side of the bridge structure. This will avoid the most sensitive parts of the ONF and will minimise effects on the small areas that the bridge structure will overlap.

The Project construction works and the establishment of bridge piers through the Anns Creek East area have the potential to adversely affect these remnant lava flows. During design, the careful siting of viaduct

piers has sought to avoid the lava flow outcrops as far as practicable. The proposed construction methodology seeks to disturb the lava features within Anns Creek as little as possible.

The Project includes landscaping and ecological restoration planting along the foreshore. This will enhance this area and provide an opportunity to link the geological heritage features of Anns Creek with Te Hōpua.

12.8.4 Measures to avoid, remedy or mitigate effects on volcanic features

The volcanic features within the Project area have been assessed to have low value within the Auckland Volcanic Field as they have been largely destroyed or modified by land development and reclamation. The Project will have some adverse effects on these features through the addition of new infrastructure within the Te Hōpua tuff ring and new infrastructure in Anns Creek.

At the same time, the Project presents an opportunity to realise positive effects by emphasising and landmarking these features and enhancing the general knowledge about these features.

The key avoidance and mitigation measures include:

- Enhancement of the park within Te Hōpua tuff crater to include interpretative material explaining its geological history and scientific values;
- Improving the link between Gloucester Park and the proposed pathway that runs along Māngere Inlet to the east. This path is largely on lava flows from Maungakiekie/One Tree Hill and Rarotonga/Mt Smart. The path enables the lava outcrops within the Māngere Inlet to be viewed and appreciated and presents an opportunity to develop a volcanic heritage walk;
- Establishing interpretive signage in Te Hōpua and at Anns Creek which provides educational opportunities and enhances knowledge of Auckland's volcanic field;
- Increasing access to Anns Creek; and
- Avoiding damage to lava flows during construction by excluding areas from the construction footprint and identifying a pier exclusion area within Anns Creek East. These will ensure that adverse effects are avoided on the most sensitive parts of the ONF. The exclusion areas are shown on the construction drawings contained in *Plan Set 11: Construction Activities*.

12.8.5 Conclusion

The Project will be built on, and in proximity to, volcanic features that are part of the Auckland Volcanic Field. This includes Te Hōpua and remnant lava flows of Maungakiekie/One Tree Hill, Rarotonga/Mt Smart and Maungarei/Mt Wellington volcanoes along the northern Māngere Inlet foreshore and in Anns Creek. These features have been extensively modified by various forms of development and their value as examples of volcanic features has been reduced (greatly for Te Hōpua, moderately for Anns Creek West and only a little for Anns Creek East) as a consequence. The further impact as a result of the Project will be minor. Additionally, the Project presents the opportunity to enhance recognition and knowledge of volcanic features which will have a positive effect on volcanic heritage overall.

12.9 Arboricultural effects

Overview

There are a number of trees within and in proximity to the Project area that contribute to the amenity and quality of the urban environment. There are no scheduled notable trees within the Project designation. The Project will require the removal of the majority of trees located within the construction footprint. The removal of these trees is unavoidable and will be mitigated through the landscape replanting that will be undertaken post construction.

The Project also has the potential to adversely affect trees that will be retained. Tree protection measures will avoid and minimise potential adverse effects on these trees.

12.9.1 Introduction

This section identifies and describes the trees with some amenity value within and in proximity to the Project area that are potentially affected by the Project works, assesses the effect of the Project on these trees and outlines measures to avoid, remedy and mitigate potential adverse effects.

The majority of the trees located within the Project footprint will need to be removed for construction of the Project. As a result, this assessment focuses on the potential effects on trees located adjacent to the Project footprint (e.g. due to works in the dripline or a need for pruning).

This section has been informed by *Technical Report 5: Arboricultural Assessment* in Volume 3.

12.9.2 Existing Environment

There are no scheduled notable trees under the AUP (OP) within the Project footprint although there are some within close proximity. . There are a number of unscheduled trees that have been assessed as having amenity or heritage value. There are also a number of trees located in the Project area that are in generally good health and form. The trees and groups of trees which contribute to the amenity and the urban environment in and in proximity to the Project area are outlined in Table 12-9. *Technical Report 5: Arboricultural Assessment* in Volume 3 provides a full schedule of the significant amenity trees that may be affected by the Project.

Table 12-9: Trees with significant amenity value in proximity to the Project

Location	Tree Description
Sector 1	• Pōhutukawa trees located on Onehunga Harbour Road opposite the Aotea Sea Scouts Hall to be removed. • Large Holm Oak on Onehunga Harbour Road to be removed. • Trees within Gloucester Park to be removed.
Sector 2	• Pōhutukawa trees lining the southern boundary of Waikaraka Park to be retained.
Sector 3	• No significant amenity trees identified.
Sector 4	• Trees along Clemow Drive to be retained
Sector 5	• Groups of trees at the Princes Street Interchange to be removed. • Street trees along Princes Street and Frank Grey Place to be removed. • Trees within Bedingfield Memorial Park to be removed.

Location	Tree Description
Sector 6	• Street trees along Alfred Street, Captain Springs Road and the northern end of Neilson Street to be removed. • Pōhutukawa tree in Waikaraka Park on the corner of Captain Springs Road and Neilson Street to be retained.

12.9.3 Assessment of effects on trees to be retained

It has been assumed that all trees within the Project footprint will require removal. The removal of these trees is unavoidable due to the scale of the works.

The majority of these trees are not species of notable value and have been used in mass planting to provide screening or used for landscaping. There are however a number of trees that provide significant amenity value as outlined in Table 12-9.

The Project will involve works in proximity to a number of trees on adjacent sites that will be retained (including several scheduled trees). Construction will include works in the dripline of trees and some trees may require trimming to enable construction activities to occur. If not appropriately managed, these activities have the potential to adversely affect the health of these trees.

12.9.4 Measures to avoid, remedy and mitigate

Tree protection measures will be implemented during construction to avoid and minimise the potential effects on trees to be retained (and on nearby scheduled notable trees). These measures will be developed by an arborist. This will include details of the trees affected and the works affecting them, specific tree protection methodologies, tree transplant feasibility (where applicable), tree removal and replacement planting.

Arboricultural assessments will be undertaken prior to construction commencing to confirm the characteristics of trees and to assess if any existing trees are worthy of retention and the protection measures for amenity trees adjacent to the works. If trees are identified within the Project footprint that may potentially be retained, an arborist will be consulted in order to determine if retention is appropriate. This will include consideration of the location of the trees relative to the works, assessment of tree health and long term viability and if alternatives to retaining the trees such as tree replacement is more appropriate. If retention is determined appropriate, specific protection measures will be implemented throughout the construction works, so that tree health is not adversely affected.

The removal of trees within the construction footprint will be mitigated through the replanting that will be undertaken after construction. Urban and Landscape Design Plans will be developed as set out in *Section 13.1.4* of this AEE. These plans will include replacing significant amenity trees with replacement trees of suitable/comparable species and size.

12.9.5 Conclusion

Overall, the implementation of appropriate tree protection measures during construction will avoid and minimise adverse effects on tree health of these trees to be retained or in close proximity to the Project footprint. The replanting proposed after construction in accordance with a landscape plan will appropriately mitigate the effects of the removal of amenity trees.

12.10 Landscape and visual

Overview

The Project is largely located in an active commercial and industrial urban environment where natural features have been heavily modified in the past. There is potential for the Project to have adverse effects on the natural character of the coastal environment, on natural features including identified ONF, as well visual effects on the natural and urban landscape. However, these effects will be experienced within that highly modified commercial and industrial context.

While the Project has potential to add further to adverse effects such as visual dominance of transport infrastructure, severance of the urban area from the coast, and reclamation of Māngere Inlet, the Project also has greater potential to help reverse some of the adverse effects of historical development and to positively contribute to restoration of the landscape. In particular, the EWL provides a catalyst to help restore and rehabilitate Māngere Inlet. The Project will improve water quality, naturalise the shoreline and enhance access to and along the inlet. There will be substantial positive visual and landscape effects for the community experiencing enhanced amenity and accessibility to the coastal environment, with a focus on active transport modes and recreational outcomes taking people into, and enabling an improved experience with the coastal environment. A new coastal path will enable the public to engage with a re-naturalised landscaped shoreline. This reverses many years of the Māngere Inlet being treated as an 'industrial backyard' and will assist to rehabilitate the image and mana of the inlet. The Project will also help rehabilitate Ōtāhuhu Creek as a culturally important natural waterway.

This is the strategy that lies behind the ULDF and measures incorporated in the Project design. A number of general and specific measures are proposed to address the potential adverse landscape and visual effects resulting from the construction and also operation of the Project.

Overall, the adverse landscape and visual effects will be appropriately mitigated and there will be substantial positive effects.

12.10.1 Introduction

This section presents the findings of assessments undertaken to determine the actual and potential landscape and visual effects of the Project. This includes consideration of effects on the natural and urban landscape, natural character of the coastal environment, natural features including ONF and visual effects. It encompasses matters relating to natural and urban landscape, natural character and visual effects. This assessment is supported by *Technical Report 6: Landscape and Visual Impact Assessment* in Volume 3.

12.10.2 Assessment methodology

The assessment of landscape and visual effects uses the definition of 'landscape' contained in the *New Zealand Institute of Landscape Architects Best Practice Note 10*[70] which defines landscape as "*the cumulative expression of natural and cultural features, patterns and processes in a geographical area, including human perceptions and associations*".

Within each Project sector, effects were assessed in terms of the natural landscape, urban landscape, natural character values, and visual effects. The effects identified and assessed included:

- Effects on natural character of the coastal environment;

[70] *Best Practice Note: Landscape Assessment and Sustainable Management 10.1*, 2010.

- Effects on biophysical landscape processes including water quality and ecological health of the inlet (relying on input from other disciplines);
- Effects on landscape features, including those identified as ONFs;
- Effects on urban form and features, including the connection between Onehunga and Manukau Harbour;
- Effects on aesthetic qualities of the landscape as a whole (such as the aesthetic qualities of Māngere Inlet, the gateway experience to Auckland on SH20);
- Visual amenity from public and private places, taking into account the places from where the works will be visible, sensitivity of audience, prominence and amenity of the Project (taking into account properties adjoining the works, and public places such as Waikaraka Cemetery, Mutukāroa-Hamlins Hill);
- Effects on landscape use and activities, including amenity of and access to the coastal edge; and
- Effects on associative factors such as historical themes (Kāretu portage, Onehunga's relationship with harbour).

Photo simulations have been prepared from key representative public viewpoints within the Project area. The photo simulations are contained as *Plan Set 13: Photo Simulations* in Volume 2.

The assessment relies on the findings of other assessments with regards to biophysical aspects including: ecology (see *Section 12.20: Ecology*); heritage (see *Section 12.7: Archaeology and built heritage*); volcanic heritage (see *Section 12.8: Geological heritage)*; and coastal processes (see *Section 12.19: Coastal processes*).

The assessment also takes into account the relevant statutory provision including the NZCPS and the AUP (OP) Decisions Version. The following AUP (OP) overlays are relevant to landscape matters in the Project area:

- Three ONF are identified in the vicinity of the EWL: "Hōpua explosion crater and tuff exposure", "Southdown pahoehoe lava flows including Anns Creek" and "Hamlins Hills sandstone ridges and rhyolitic tuff";
- Significant Ecological Areas that cover Anns Creek, the remnant lava flow outcrops adjacent to Pikes Point, and a small salt marsh area in Te Hōpua crater; and
- A volcanic cone view shaft to Maungakiekie / One Tree Hill that passes over the intersection of the Project and Galway Street.

12.10.3 Existing Environment – Issues identification

A consistent theme of the area traversed by the Project is the extent to which the natural and urban landscape had been treated as an industrial backyard and dumping ground. It is the location of such activities as refuse landfill, noxious industries, and large scale transport infrastructure. The way in which the area has been perceived and managed in recent history is markedly at odds with its importance and centrality in earlier times. Themes of that earlier landscape include:

- The strategic role of the area for the east west Kāretu and Ōtāhuhu portages, and for the north south Ōtāhuhu land bridge;
- The centrality of Māngere Inlet within a landscape encircled by volcanic features; and
- Onehunga's position as the main town and port on the Manukau Harbour.

The existing landscape and visual context for each sector is summarised below.

The natural landscape in Sector 1 revolves around Te Hōpua volcanic explosion crater and tuff ring which is a pivot between Onehunga Town Centre and Onehunga Wharf. Te Hōpua is identified as an ONF in

the AUP (OP). It is relatively small and has a low tuff rim, the highest part being in the north east corner nearest Onehunga Town Centre and the lowest part in the south west corner where it was breached by the Manukau Harbour to create the former lagoon. The natural landform has been substantially buried and modified through landfill reclamation, urban development and state highway construction. This historical development has resulted in modification of the tuff ring's physical landform and reduction of its legibility. The area is characterised by industrial buildings and transport infrastructure, and poor connectivity between Onehunga and the port and harbour.

There is a distinct contrast between the fine-scale urban development pattern of Onehunga and the coarse scale of the Te Pāpapa and Southdown industrial backdrop.

Within Sector 2, the Māngere Inlet is the central element of landscape upstream of the Manukau Harbour Crossing and includes the surrounding volcanic cones and urban backdrop. The main natural landmark is the inlet itself, characterised by its channels and tidal mudflats.

The northern shoreline of Māngere Inlet was formerly an intricate and deeply indented shoreline of basalt lava flows and tidal inlets. However, the shoreline was straightened and constructed as a sea wall, and the inlets infilled with refuse and other landfill. Such activities buried all previous features of the northern shoreline except from two small distal (outer) remnants of lava flows that remain beyond the rip rap sea wall. Despite the modifications, Māngere Inlet itself is still essentially a natural feature. It is dominated by the tidal processes, and is characterised by the natural channels and shoals and such transient features as the wading birds.

With the exception of Waikaraka Cemetery, the backdrop to the shoreline has been developed for industry. Historical development reclamation of the former harbour bed, burying of the lava shoreline features, discharge of contaminants to the harbour, dominance of the character by industrial activities, and severance of Onehunga from the Māngere Inlet. The area has been degraded physically and perceptually. It could also be said that the Māngere Inlet was invested with a poor image.

There are also two small remnants of the former tidal inlets. A small remnant saltmarsh is located immediately east of Te Hōpua crater. It is confined on its landward side by the edge of a landfill and reclamation, has a sea wall on its outer edge, and is crossed by the walkway/cycleway on a structure. Miami Stream is a small remnant of the much larger inlet that formerly occupied the west side of Pikes Point. Most of the inlet was reclaimed by landfill, leaving a narrow section alongside Miami Parade.

The existing esplanade reserve and Manukau Foreshore Walkway has a somewhat isolated character, hidden away behind industrial sites. While the industrial backdrop has low amenity, the path does afford an attractive outlook over the tidal inlet to the backdrop volcanic cones of Māngere and Ōtāhuhu/Mt Richmond.

In Sector 3, Anns Creek is the last natural remnant of the Māngere Inlet northern shoreline, although it is nevertheless modified. Anns Creek was formerly part of a much more extensive swampy area that flanked the south east side of Mutukāroa-Hamlins Hill and which was part of the Kāretu portage.

Anns Creek has a subtle assemblage of natural features, including areas of pāhoehoe lava classified as an ONF, an associated distinctive vegetation community, and a salt-to-fresh water sequence. Anns Creek is also partitioned into five parts by rail causeways, is infested with weeds, and the backdrop includes a rail marshalling yard, inland port, container storage and large industry.

Sector 4 includes the prominent natural landmark of Mutukāroa-Hamlins Hill, and culturally important former route of the Kāretu portage. The area is otherwise characterised by industrial activities, transport infrastructure and high voltage transmission line.

EWL will skirt the toe of Mutukāroa-Hamlins Hill and trace part of the historical Kāretu portage that formerly extended from the head of Anns Creek. The portage was via the swampy ground between Anns Creek and Kāretu, an inlet on the Tāmaki River. It will share a corridor with Sylvia Park Road, KiwiRail (Eastern Line), and the Ōtāhuhu-Onehunga transmission line.

Mutukāroa-Hamlins Hill is a prominent landmark rising above the surrounding urban development and encircled by key transport routes. It has cultural history associated with its former occupation as a settlement overlooking the Kāretu portage. The wide views from the summit ridge in particular include a view down the Māngere Inlet in the direction of the Manukau Heads. There has been some encroachment onto the flanks of the hill such as the South East Arterial along the north east side of the hill and the Pacific Rise office park in the south east corner.

Sector 5 comprises the existing SH1 corridor between Tip Top corner and the Princes Street Interchange. The land adjoining the corridor is partly industrial and largely residential.

In Sector 5, Ōtāhuhu Creek is the significant natural landscape feature. It is a main tributary of the Tāmaki River and culturally important as part of the Ōtāhuhu portage. Prior to Pākehā settlement, the Ōtāhuhu isthmus held the portages linking the Tāmaki River/Waitematā and the Manukau. At a broader context, the isthmus held the water-borne route between Northland and Waikato. Currently the creek is constricted by the existing SH1 causeway, incidental spoil dumped on the creek margins, and weeds which infest the banks. The Ōtāhuhu Creek in the vicinity of the Project has low-moderate natural character.

SH1 is flanked by housing on both sides. In some instances houses are quite close to the state highway. An exception is industrial uses adjacent to SH1 just south of the Ōtāhuhu Creek crossing.

Figure 12-14: View of remnant lava flows at Pikes Point

Figure 12-15: Anns Creek coastal edge

A number of landscape features in the Project area have been identified as having cultural significance; these are outlined in further detail in *Section 12.6: Effects on values of importance to Mana Whenua* of this AEE.

Historical associations with the landscape have been informed by *Technical Report 2: Built Heritage* and *Technical Report 3: Archaeological Assessment* in Volume 3, as well as *Technical Report 4: Geological Heritage Assessment* in Volume 3. Three areas that particularly contribute to landscape values within the Project area from a historical associations perspective are:

- Onehunga Wharf and surroundings;
- Aotea Sea Scouts Hall; and
- Waikaraka Cemetery and its surrounds.

12.10.4 Assessment of construction related landscape and visual effects

Construction of the Project will result in additional temporary adverse landscape and visual effects. Across the Project these effects are:

- In Sector 1, visual effects of the Project will be amplified during construction works. However, such works will be temporary in nature, and will take place within existing transport corridors where one might anticipate periodic highway construction;
- In Sector 2, there will be substantial disruption to the northern shoreline of Māngere Inlet during construction, and amplified adverse visual effects for Waikaraka Cemetery in particular. Such works will be temporary in nature, and will be outweighed by the subsequent enhancement of visual amenity, natural character and shoreline access following completion of the Project;
- In Sector 3, there will also be amplified adverse visual effects during construction, and temporary closure of the existing path. Such effects will be temporary in nature, and will occur against an industrial backdrop in a modified setting, and will be offset by enhancements to the shoreline path following completion of EWL;
- Sector 4, there will also be some adverse visual effects arising from construction activities, but these will be temporary, and will take place in the context of a landscape dominated by transport infrastructure and surrounding industrial and commercial properties; and
- Sector 5, the adverse visual effects will be amplified during construction, particular with respect of adjoining residential properties and on the immediate surroundings at Ōtāhuhu Creek. Such works will be temporary in nature, will take place in the context of an existing motorway, and will be offset by the enhancements once the Project is completed.

12.10.5 Assessment of landscape and visual effects

Effects are assessed for each of the Project sectors in the sections below. Measures to avoid, remedy or mitigate adverse effects are discussed within each sector. Such measures also fall under the umbrella of the ULDF (contained in Volume 4) and it should be read in conjunction with this assessment.

12.10.6 Sector 1 - Neilson Street Interchange and Galway Street connections

The main natural and urban landscape issues in Sector 1 are:

- Effects on Te Hōpua volcanic landform – its physical form, aesthetic values and legibility;
- Effects on connections between Onehunga Town Centre and Onehunga Wharf; and
- Visual effects of the EWL – particularly the Neilson Street Interchange overbridge and the Galway Street intersection.

The Te Hopua volcanic landform in Sector 1 has been substantially buried and modified through landfill reclamation, urban development and State highway construction. This historical development has resulted in modification of the tuff ring's physical landform and reduction of its legibility. The area is characterised by industrial buildings and transport infrastructure, and poor connectivity between Onehunga and the port and harbour.

The Project will reduce the legibility of Te Hōpua volcanic landform because of the increase in the number of traffic lanes encircling the outside perimeter of the crater and the construction of a new overbridge outside the north-west corner of the crater. The works will also accentuate the existing perception of the area as a transport interchange, reduce its visual amenity, and increase the visual barrier between Onehunga Town Centre and Onehunga Wharf. There will be a moderate degree of potential adverse effect compared to the existing situation.

12.10.6.1 Natural landscape

Potential effects in Sector 1 include physical damage of the Te Hōpua landform and effects on its legibility. There will be little physical damage of intact elements of the volcanic landform. The works will, however, further reduce the feature's legibility by:

- The increase in complexity of roading around the landscape feature;
- Interrupting the visual relationship between the crater/former lagoon and the Manukau Harbour with new approach ramps to the Neilson Street Interchange overbridge; and
- The Neilson Street Interchange overbridge will visually dominate a small section of tuff ring.

However, to put these effects into perspective, the volcanic landform already has low legibility and the works will mostly take place on areas that are already substantially modified.

The effect of the Project on the legibility or aesthetic value of Te Hōpua will therefore be only moderate.

12.10.6.2 Te Hōpua ONF landscape values

Te Hōpua has been identified as an ONF in the AUP (OP). The reasons for its classification are listed in Appendix 3.1 of the AUP (OP) and are the extent to which it:

(a) Contributes to the understanding of geology of the region;

(d) Is a component of a recognisable group of geologically associated features;

(e) Contributes to the aesthetic value or visual legibility of the wider natural landscape;

(g) Has potential value for public education; and

(h) Has potential to provide additional understanding of Auckland's geology.

Despite this classification, the previous modifications to Te Hōpua have reduced its naturalness as an ONF.

While the Project will encroach into the mapped ONF, the works will occur where the landform has been previously modified. The assessment of effects on geological heritage in *Section 12.8: Geological heritage* concludes that any effects on the subdued topographic feature in the northwest corner of the tuff crater will have only negligible effects.

Consideration of the extent of effects on the aesthetic value and visual legibility of the wider natural landscape with respect of the ONF needs to have regard to: the previous modifications; the dominant presence of development; and that Te Hōpua is not visually prominent and has low legibility. Taking these factors into account, the Project will have only moderate effects on the aesthetic value and visual legibility of the wider natural landscape with respect of the mapped ONF.

12.10.6.3 Natural character

The Project will add to the existing clutter of infrastructure around Te Hōpua and reduce its legibility as a former coastal landform. However, this part of the coastal environment is already characterised by infrastructure and other urban features. The works will mostly take place on land that has already been modified by earlier works.

The works will also remove an area of glasswort meadow in the vicinity of the Galway Street intersection. This is addressed in *Section 12.20: Ecology*. In terms of natural appearance, this area is small and dominated by a substantially modified shoreline and backdrop of industrial and transport infrastructure.

Any further reduction in natural character as a result of the Project will be small.

12.10.6.4 Urban landscape

Te Hōpua has always separated Onehunga Town Centre from its port. The Project will add a further physical and visual barrier between Onehunga Town Centre, the port and the Old Māngere Bridge.

Without mitigation, the degree of effect would be moderate relative to what are already poor connections. Measures to remedy and mitigate this situation that have been incorporated into the design of the Project include:

- Removing most of the heavy traffic that currently dominates the route between Onehunga and the Onehunga Wharf which will improve the amenity of this connection and provide opportunities for street upgrade works;
- Street upgrade works on both Onehunga Harbour Road and Onehunga Mall. The local overhead powerlines (distribution lines) along this section of Onehunga Harbour Road and Onehunga Mall are to be placed underground;
- A bridge will connect Onehunga Harbour Road with the Onehunga Wharf in the vicinity of The Landing. At this location the EWL is in trench so that the visual and physical connection will be re-established;
- The existing pedestrian and cycle bridge crossing over Onehunga Harbour Road will be replaced on the alignment of Old Māngere Bridge; and
- There will be improvements in the connectivity between Old Māngere Bridge and the proposed new coastal path to the east along the shore of Māngere Inlet, and to the west along Orpheus Drive which will no longer be part of an on-ramp to SH20.

While EWL will introduce a further visual severance between Onehunga and the harbour, such adverse effects will be offset by the positive effects of the improved physical connection to the Onehunga Wharf area and the adjacent cycle / pedestrian paths, and the streetscape enhancements.

The Aotea Sea Scouts Hall occupies an unusual location on what was formerly a spit between the crater lagoon and the sea. The Project will have both adverse and positive impacts on its setting and amenity. Adverse effects will arise because the approach ramps to the Neilson Street Interchange overbridge will be constructed east of the hall, with a slip lane and Orpheus Drive between the ramps and the hall. The ramp will be faced with an approximately 5m high retaining wall. The proposed on-ramp will be a more dominant structure increasing existing severance. However, Orpheus Drive access to the Aotea Sea Scouts hall will be much quieter than at present. To put the visual amenity effects in perspective, the eastern outlook from the Aotea Sea Scouts Hall is already affected by the existing State highway, and the hall's primary western outlook to the Manukau Harbour will not be affected.

12.10.6.5 Visual effects

The Project will increase the extent to which the area is dominated by state highway and road infrastructure. The most prominent elements will be the new Neilson Street Interchange overbridge, the Galway Street intersection, and the highway works around the outside perimeter of Te Hōpua tuff ring.

There are both positive and negative effects as a result of the Project on people within the vicinity of the Project.

For travellers on SH20, the EWL and connecting roads, the new interchange and associated roads around Te Hōpua will be in keeping with general expectations for such urban roads and State highway interchanges. However, the Project will increase the dominance of this node by highway works and detract somewhat from the composite views.

For pedestrians and cyclists, the Onehunga Wharf area is a node for walking and cycling routes. The Project will add to the visual dominance of traffic and roading already generated by the existing SH20

and Onehunga Harbour Road. Certain routes will however be improved by the removal of heavy traffic from local roads.

For the occupants of nearby buildings the outlook from buildings overlooking Te Hōpua crater is already dominated by foreground motorway. EWL will not fundamentally change, but will intensify, this character. Such effects will be in the context of an outlook dominated by industrial development, and will be offset to an extent by the removal of the existing heavy traffic from the immediately adjacent local roads.

For the Aotea Sea Scouts Hall, the approaches to the Neilson Street Interchange overbridge and slip lane will detract from the hall's visual amenity. Nevertheless, to put such effects in perspective, users of the Aotea Sea Scouts Hall are transitory, the eastern outlook is already affected by the existing State highway, and the hall's primary western outlook to the Manukau Harbour will not be affected.

For users of the Taumanu-Onehunga Foreshore and Manukau Cruising Club, the Neilson Street Interchange will become part of the outlook from parts of Taumanu-Onehunga Foreshore however, it will be relatively distant and will be viewed in the context of existing state highway.

12.10.6.6 Volcanic view shaft

The Galway Street intersection falls beneath a view shaft to One Tree Hill (O11), originating from SH20 at the Manukau Harbour Crossing. However, the view shaft contours in the vicinity are well above the height of the intersection and will not be affected by the Project.

12.10.6.7 Measures to mitigate potential adverse effects for Sector 1

In addition to the Project's design principles, mitigation measures and improvements proposed for this sector include:

- Streetscape works to improve the Onehunga Harbour Road vehicle connection between Onehunga Town Centre and the wharf, taking advantage of the substantial reduction in heavy traffic that will occur on this road;
- Locating the EWL in a trench adjacent to the Onehunga Wharf, and bridging the trench to connect with the Onehunga Harbour Road and with Orpheus Drive to the west;
- Streetscape works to highlight the pedestrian/cycle route between Onehunga Town Centre and Onehunga Wharf, tracing the crater rim on the west side of Onehunga Mall;
- Reinstatement of the cycle and pedestrian bridge connecting Onehunga Mall with Old Māngere Bridge (or its replacement bridge), which will connect also with the new coastal path along Māngere Inlet; and
- Providing the opportunity for an artwork encircling the crater to highlight its form and presence and restore some of the legibility that has been lost historically.

With the implementation of these measures, there will be a small improvement in connectivity between Onehunga and the Onehunga Wharf Area compared to the existing situation, and the artwork will restore some of the legibility of the landform and contribute to the aesthetic quality of the node.

12.10.7 Sector 2 – Foreshore works along Māngere Inlet foreshore including dredging

The main landscape and urban design issues in Sector 2 are:

- Effects on the inter-tidal mud-flats and remnant lava reefs along the northern shoreline;
- Effects on the natural character of Māngere Inlet;
- Visual effects of the Main Alignment; and
- Effects on connections between Onehunga and Māngere Inlet.

There will be both adverse and positive effects on Māngere Inlet. On the one hand, there will be adverse effects as a consequence of reclamation of the tidal mudflats, potential adverse effects of a road adjacent to the shoreline and the perception of EWL as a barrier between the land and Māngere Inlet. On the other hand, there will be positive effects from naturalising the shoreline, improving the quality of water discharges from the inland catchments, improving access to and along the shore, improving connections between Onehunga and the Māngere Inlet, and improving the image and mana of the inlet.

The balance of landscape, visual and natural character effects for Sector 2 will be substantially positive. EWL will provide the opportunity to help restore and rehabilitate Māngere Inlet. It will provide a positive frontage to the Inlet in response to many years of it having been neglected and poorly treated.

12.10.7.1 Natural landscape

The Project is to be constructed on embankment that straddles this shoreline, partly on land and partly in the CMA. The road will higher than the typical existing ground level. The road will accentuate the straight shoreline and form a barrier between the land and Māngere Inlet.

The Project incorporates naturalising the shoreline on the seaward side of the EWL to improve natural character and public connection with Māngere Inlet. A local precedent for such naturalisation is the Onehunga Foreshore Restoration Project completed in 2015.

The proposed works comprise two major landforms to echo the original shoreline, and to be in scale with Māngere Inlet as a whole. The landforms will comprise peninsulas faced in basalt rock designed to echo fingers of lava, pebble and shell banks (beaches), and marshland contained behind the pebble banks and peninsulas. The constructed landforms will restore a more natural appearance to the shoreline and rehabilitate the existing straight line sea wall, echoing the original pattern of lava flows and inlets. A coastal path will connect the landforms by means of a boardwalk which will provide a closer connection with the Māngere Inlet shoreline compared to the existing situation. The mangroves that will establish on the inland side of the boardwalk will soften the appearance of the road embankment.

The remnant lava flows at Pikes Point and opposite the end of Victoria Street are incorporated within the re-naturalised shoreline thereby giving them a more realistic looking context. The design will help embed the road behind the landforms.

The wetlands and biofiltration beds within the headlands will treat stormwater from the road and the Onehunga-Penrose Catchment. The intent is that the wetlands appear part of transitional shoreline features rather than typical land-based stormwater ponds. It is considered that naturalisation of the shoreline requires landforms of sufficient size to suit the scale of Māngere Inlet as a whole. The wetlands will contribute to that visual scale while fulfilling a water quality function.

The eastern landform contains two ‘headlands’ and a pebble-and-shell bank that will not have access from the walkway so as to provide some separation to improve the habitat value for seabirds.

The design approach to restoring Māngere Inlet was developed at the instigation of, and in consultation with, the Mana Whenua group. Hui held during the design process highlighted Mana Whenua’s view that the Māngere Inlet is currently in a poor state. Principles identified including restoring respect to the inlet and harbour, restoring water quality by treating stormwater to the highest practicable level, restoring habitat for species inhabiting the inlet, and allowing for people to connect with the inlet. At the same time, there is a desire to balance these outcomes with minimisation of reclamation.

The following design techniques have been used to maximise naturalisation of the shoreline while minimising the potential reclamation footprint, enhancing public access to the shoreline and aiding in restoring the mana of the Māngere Inlet:

- Limiting reclamation to separate landforms rather than a continuous reclamation seaward of the road embankment, and using boardwalks to connect the landforms into a park;
- Aligning the landforms perpendicular to the road to maximise the shoreline width relative to footprint;

- Detailing the shoreline to maximise features within the inter-tidal zone;
- Use of a combination of wetland and biofiltration beds to reduce the potential footprint for stormwater treatment;
- Using innovative techniques, such as internal timber baffles, to reduce footprint and increase the impression of the wetlands as continuous estuarine marshland.

12.10.7.2 Natural character

There is overlap between landscape and natural character matters in this sector, and, as with the former, there will be both adverse and positive effects on natural character.

On the one hand, there will be adverse biophysical effects because of the reduction of tidal mud flats, the subsequent reduction in foraging habitat for wading birds, and changes in natural coastal processes. On the other hand, there will be some biophysical benefits resulting from the improved quality of water discharged to the inlet and some offset measures incorporated in the design such as roosts and pebble/shell banks. At the same time, the shoreline will have a more natural appearance and will enable a more natural experience of Māngere Inlet.

There will be a mix of adverse and positive effects on biophysical aspects of natural character, and perceptions of natural character will be enhanced. Taking these matters together, it is considered that the Project will go some way to restoring natural character.

12.10.7.3 Urban landscape

Onehunga currently has only a weak connection with Māngere Inlet. The inlet is largely 'walled-off' behind industrial properties, access is limited to the end of a handful of no-exit roads, and the existing coastal walkway is somewhat isolated. While Waikaraka Cemetery does have a frontage to the inlet, it is inward focused with views partly blocked by a row of pōhutukawa trees.

The Project could potentially form an additional barrier between Onehunga and Māngere Inlet. However, it is considered it will strengthen connections in the following ways:

- EWL will provide a frontage making Māngere Inlet more visible and 'front of mind';
- IN this area EWL will have a markedly distinct character from the eastern parts of the route in recognition of the Inlet frontage. This can be achieved with design elements such as:
    - Operational speed environment in keeping with an urban arterial;
    - Alternate median treatment, planting street trees and installing high quality custom street furniture;
    - Wide promenade footpath and contrasting road and footpath surface materials;
    - Improving pedestrian and cycleway connections; and
    - City street light standards.
- The re-naturalised shoreline and coastal path will similarly create a positive frontage to the Māngere Inlet and enhance public connection to the inlet;
- The Project will complete the southern part of Onehunga's street grid by tying together three cul-de-sacs; and
- The Project will provide a choice of path along the Māngere Inlet. The road-side path will provide slightly more elevated views over the Inlet, as well as surveillance of the shoreline path.

12.10.7.4 Visual effects

There are both positive and negative effects as a result of the Project on people within the vicinity of the Project.

Travellers on the Main Alignment will constitute a new audience for views of Māngere Inlet. While the road itself will be in keeping with likely expectations for a major urban arterial, and the industrial backdrop on the inland side has relatively low amenity, the Main Alignment will nevertheless provide a high amenity outlook over Māngere Inlet to the backdrop volcanic cones.

There will be both adverse and positive effects on views across the Māngere Inlet. On the one hand, the Project will introduce a busy arterial road along the northern shoreline. However, to put this in perspective, the shoreline is currently characterised by a rip-rap sea wall, a thin band of vegetation and a backdrop of industrial properties. On the other hand, the proposed mitigation works will create a more naturalistic appearance, particularly for the elevated views from the Manukau Harbour Crossing. On balance, it is considered the views across Māngere Inlet will be enhanced.

For users of the coastal path, while the new coastal path will be affected by the presence of traffic, it will nevertheless have a higher amenity, be closer to the water and engage with a greater variety of landform and shoreline features and likely attract more users due to the improved visibility of the coastal path.

At the Waikaraka Cemetery, the Project will open a frontage to the cemetery and also to the sports fields planned by Auckland Council on the triangular area east of the cemetery. The Project will detract from the current secluded and relatively quiet atmosphere however, such effects will be softened by the retention of the existing stone wall and row of pōhutukawa along the boundary.

For adjacent industrial properties the effects on the visual amenity of adjacent industrial properties are not considered to be of any significance because the area does not have high visual amenity.

12.10.7.5 Measures to mitigate potential adverse effects for Sector 2

In addition to the Project's design principles, mitigation measures and improvements proposed for this sector include:

- Tying the cul-de-sacs into a completed street grid with a frontage to Māngere Inlet, and designing the road to convey a positive urban character;
- Naturalising the northern shoreline with landforms and inlets echoing the original shoreline features;
- Incorporating wetlands to treat stormwater from the industrial catchments, improving water quality in the inlet;
- Providing a coastal path to enable public access and appreciation of the naturalised shoreline;
- Incorporating elements to mitigate ecological effects including offshore roosts and areas of naturalistic shoreline with no public access; and
- Incorporating design measures to ensure an urban arterial character.

The proposed mitigation works combined with the design techniques discussed above will help to:

- Rehabilitate the natural appearance of Māngere Inlet;
- Rehabilitate the physical qualities of the Inlet;
- Soften the appearance of the Project and recognise the Inlet frontage;
- Enhance public access to and connection with the Inlet; and
- Help restore the mana of Māngere Inlet.

12.10.8 Sector 3 – Anns Creek from the end of the reclamation to Great South Road

The main landscape and urban design issues for Sector 3 are:

- Effects on remnant aspects of the natural landscape including the fresh-to-salt water sequence in Anns Creek, the lava field along the northern shore, and the associated vegetation;
- Effects on parts of the lava field classified as an outstanding natural feature; and
- Visual effects of the viaduct structure across Anns Creek and Great South Road.

The potential effects on biophysical aspects of the landscape in Anns Creek are significant because of the significance of the lava features and associated rare plant communities that include endangered plant species.

There will be some adverse effects on more general aesthetic aspects of landscape and natural character because of the scale of the viaduct and its alignment across parts of Anns Creek and Great South Road. While it will be prominent from a number of locations, it will nevertheless be in context with the industrial backdrop and with the modified nature of Anns Creek itself.

Measures to mitigate adverse effects include restoring the vegetation communities within Anns Creek, interpreting such natural features, recognising the Kāretu portage, improving avifauna habitat in adjacent parts of Māngere Inlet, and propagating the vegetation communities and endangered species to the new landforms in Māngere Inlet.

12.10.8.1 Natural landscape

Anns Creek is the only remnant of the inlets on the northern shore of Māngere Inlet. In contrast to Sector 2, Anns Creek is characterised by an intricate shoreline. In places the lava has a pāhoehoe surface, a smooth but rucked up appearance that evokes the fluid nature of hot lava. The vegetation associated with the lava is a distinctive shrubland and herb field that is a unique community containing rare and threatened plant species. Anns Creek itself contains a sequence between mudflats, mangrove forest, salt marsh, and brackish wetland. It is the remnant of an ecotone that would once have extended to a freshwater marshland around the toe of Mutukāroa-Hamlins Hill.

Although EWL is mostly on structure across this area, there is potential for piers and construction to damage the significant lava features and mosaic of vegetation communities (both terrestrial and estuarine). There is also potential for some indirect rain-shadow or shading effects on vegetation. The extent to which such effects are avoided will depend on the precise location of piers and the detailed construction methodology. This is discussed further in *Section 12.20: Ecology*.

In terms of aesthetic aspects, the viaduct and the Great South Road intersection will be prominent structures and will add to the industrial character of the area. To put this in perspective, the landscape is currently dominated by an industrial backdrop that includes containers often stacked higher than the proposed viaduct, an expansive rail marshalling yard, a power station, and an electricity transmission line. Anns Creek itself is partitioned into five parts by railway causeways.

The Anns Creek viaduct and its continuation over Great South Road will add to the industrial backdrop of what is already a substantially modified corner of Māngere Inlet.

12.10.8.2 Natural character

Within Sector 3 there is an overlap between effects on the natural landscape discussed above and effects on natural character. In summary, there will be potential adverse effects on biophysical aspects of natural character including the significant lava features, the associated lava-field vegetation community with endangered plant species, and the saltwater to freshwater communities.

In addition to potential adverse effects on lava features and vegetation communities, the EWL viaduct will also detract from the overall natural appearance of the area, although such effects will take place against the existing context of a substantially modified landscape with an industrial backdrop.

The Project design has been to avoid as far as practicable any adverse effects on the lava features and associated community. The remaining effects on the natural landscape and natural character will be mitigated by rehabilitating parts of Anns Creek itself. Such mitigation includes:

- A restoration programme that addresses the whole of the creek between Great South Road and the open Māngere Inlet including removal of weeds and dumped spoil (where practicable), and restoring indigenous vegetation;
- Restoring the top of Anns Creek immediately adjacent to Great South Road;
- Recreating similar conditions and propagating the lava-field vegetation community and endangered plant species to the new landforms in Māngere Inlet; and
- Interpreting the lava features, the associated plant communities, and the cultural significance of the Kāretu Portage.

12.10.8.3 Effects on ONF lava features at Anns Creek

Several areas of lava at Anns Creek are classified and mapped in the AUP (OP) as an ONF. The reasons for its classification are listed in Appendix 3.1 of the AUP (OP) and are the extent to which they:

"(a) Contribute to the understanding of Auckland's geology;

(c) Are outstanding representative examples of the diversity of landform and geological features of Auckland;

(d) Are part of a recognisable group of geologically associated features;

(g) Have potential value for public education; and

(i) The state of preservation of the feature."

There is also a distinctive assemblage of plants (ferns, herbs and shrubs) growing in conjunction with the lava including some rare and endangered species as discussed in *Section 12.20: Ecology*. The lava features are not classified for aesthetic or other landscape reasons, although they are distinctive and interesting.

The viaduct and Great South Road intersection piers construction work will largely avoid these features, although there will still be some adverse effects on the plant species below the proposed structures.

12.10.8.4 Urban landscape

The Project will have little adverse effect on the urban landscape in this sector. The road will be in keeping with the character of adjacent transport and industrial activities. While the Project will have some disruption on the industrial properties traversed, such disruption will be minimised by traversing properties on structure. At the same time, the Project will have positive effects by creating a more interconnected street network, connecting Onehunga Town Centre and the industrial areas with the intersection of Great South Road and Sylvia Park Road and tying in the cul-de-sac end of Hugo Johnston Drive.

12.10.8.5 Visual effects

Travellers on the EWL will constitute a new audience. The road will provide wide views because of its elevation, such views will include the industrial landscape, Māngere Inlet and Mutukāroa-Hamlins Hill.

For travellers on the Great South Road and KiwiRail lines the Project will be a prominent feature in views from the railway line and Great South Road. The grade separated Great South Road intersection will potentially affect views of Mutukāroa-Hamlins Hill for this audience. However, it will be seen in context

with the surrounding industrial character and is balanced by new views of Mutukāroa-Hamlins Hill from EWL.

For views across Māngere Inlet, the length of the viaduct will amplify the visibility and prominence of the EWL in such views. Nevertheless, the viaduct will be reasonably distant in views from across Māngere Inlet and will be seen in the context of the industrial backdrop, and will appear much lower than the backdrop of Mutukāroa-Hamlins Hill.

From Mutukāroa-Hamlins Hill, the Project will be one element of an expansive industrial landscape spread out below the hill.

For adjacent industrial properties the EWL will appear as a dominant feature, however effects on the visual amenity of adjacent industrial properties are not considered to be of any significance as the area does not have high visual amenity even compared to some other industrial areas.

Users of the coastal path that traces the shoreline of Anns Creek are the group of people most adversely affected in this sector. The new Main Alignment viaduct will cross the existing coastal path twice and will otherwise be a prominent backdrop to people using the path. While the effects will be moderately high, they will also be in the context of an existing industrial backdrop to this area. On the other hand, EWL will usefully extend the path to the east.

12.10.8.6 Measures to mitigate potential adverse effects for Sector 3

In addition to the Project's design principles, mitigation measures and improvements proposed for this sector include:

- Restoring the natural plant communities through removal of weeds and dumped spoil, enrichment planting, and pest control;
- Recreating similar conditions and propagating the lava-field vegetation community and endangered plants to the new landforms in Māngere Inlet;
- Interpreting and highlighting the significance of the lava and vegetation community from the coastal path and from the bridge overlooking the east Anns Creek area;
- An elevated shared path (the 'Kāretu portage shared path') to recognise the Kāretu Portage and to reduce the visual prominence of EWL;
- Connecting the east west pedestrian and cycle path to Great South Road and beyond (currently the path terminates at Hugo Johnston Drive);
- Improving the avifauna habitat in adjacent Māngere Inlet to support Anns Creek; and
- Softening the appearance of the Project to ensure its appearance is akin to an arterial road through design measures such as high quality street furniture, street trees, improved pedestrian and cycle connections, and signage.

12.10.9 Sector 4 Great South Road to SH1 at Mt Wellington

The main landscape and urban design issues are:

- Visual effects of the viaduct and ramps - including any impacts on views to landmarks: including Mutukāroa- Hamlins Hill;
- Visual effects for adjacent industrial and commercial properties; and
- Visual effects on Mutukāroa-Hamlins Hill.

The new Mt Wellington ramps will have some moderate adverse visual effects for passers-by on SH1 and surrounding roads, and for occupants of nearby industrial buildings. However, such effects will take place in the context of a landscape already dominated by transport infrastructure and industrial land uses.

There will only be slight adverse effects on Mutukāroa-Hamlins Hill. Rather, the hill's role as a landmark at the centre of transport routes will be accentuated.

Positive effects in this sector include:

- Improving connectivity for cyclists and pedestrians by the proposed elevated shared path where EWL is on structure between Māngere Inlet and 19 Sylvia Park Road and connecting through to Sylvia Park town centre;
- Improving connectivity and legibility of the road network through a new intersection at the corner of Great South Road, Sylvia Park Road and the Main Alignment along Māngere Inlet; and
- Recognition of the Kāretu Portage.

Overall the adverse and positive landscape and visual effects will be balanced in this sector.

12.10.9.1 Natural landscape

There will be few adverse effects on the natural landscape. The Project does not encroach onto Mutukāroa-Hamlins Hill which is the only significant natural feature in the vicinity. A small basalt cut face at Tip Top corner will be lost but, while it is a feature of interest because it expresses the underlying geology, the cutting itself is not natural.

12.10.9.2 Urban landscape

Changes to the urban landscape will consist of:

- A strip of industrial properties sandwiched between Sylvia Park Road and the railway line is to be removed to accommodate the widened road;
- The Great South Road intersection will become a more significant node which will have some positive effects on connectivity and urban form legibility;
- There will be connectivity and visual amenity benefits from the elevated shared path; and
- The overhead local power distribution lines along Sylvia Park Road will be undergrounded which will have a small positive effect on visual amenity.

12.10.9.3 Visual effects

The Sylvia Park Ramps will be prominent structures for travellers on both SH1 and the EWL. At present the Tip Top building is a waymark associated with a bend in SH1. For southbound SH1 travellers, the southbound EWL ramp will partially obstruct views of the Tip Top building from a section of SH1. For northbound SH1 travellers, the EWL southbound ramp over SH1 will have a small impact on views of Mutukāroa-Hamlins Hill. At the same time, the northbound ramp will open up new views of Mutukāroa-Hamlins Hill for travellers moving from SH1 west onto the EWL.

The existing Transpower 220kV HEN-OTA A transmission line will also be modified by Transpower to accommodate the ramps between EWL and SH1. The design to date involves replacing the lattice tower located on the boundary of 6 and 8 Monahan Road (opposite the Tip Top building) with a pole structure of similar height (around 54m) in an immediately adjacent location. The lattice tower located adjacent to the Turners & Growers site, is to be replaced by twin poles also approximately 54m high adjacent to the existing tower. These twin poles will be located between the north and south-bound EWL-SH1 ramps. New twin poles will be built on the north side of the ramps in order to lift the transmission line above the ramps. The new twin poles will be approximately 52m high and located in the triangle between the railway line, the Mt Wellington Highway, and SH1. The transmission lines will add to the visual clutter of an area already dominated by infrastructure. The additional height and clutter will be offset to some extent by the use of poles, which are generally regarded as being more attractive than conventional lattice towers.

For the rail lines and local road network the Project will increase the extent to which the area is dominated by transport infrastructure. The scale and character of Sylvia Park Road will change, and the Eastern Rail Line and Mt Wellington Highway will be crossed by additional overbridges. While it will add another layer, the interchange will be seen in the context of what is already a complex array of arterial roads, railway line, SH1, and transmission line.

The Great South Road intersection will also increase the prominence of EWL for users of the local roads and railway. However EWL will be seen in conjunction with a complex array of existing infrastructure.

For people using Mutukāroa-Hamlins Hill, the clearest views of EWL will be from knolls at the southern end of Mutukāroa-Hamlins Hill. The Sylvia Park Ramps in particular will be prominent structures in such an outlook. Nevertheless, the Project will be part of a middle-ground landscape already characterised by infrastructure and a matrix of industrial buildings. Therefore, there will be no effects of any significance on the visual amenity of Mutukāroa-Hamlins Hill.

Users of the new pedestrian/ cycle path will constitute a new audience. The proposed elevated shared path will add considerably to the interest and amenity of the path for users and will also mitigate views of EWL from the south.

For adjacent properties, potentially the most visually affected properties include those on both sides of SH1 including at Pacific Rise.

12.10.9.4 Effects on Mutukāroa-Hamlins Hill ONF

Those parts of Mutukāroa-Hamlins Hill that fall within the reserve boundaries are mapped as an ONF in the AUP (OP) decisions version. Reasons for which it is classified as an ONF are the extent to which the hill:

a) *Contributes to the understanding of Auckland's geology;*

b) *Is rare or unusual;*

c) *Is an outstanding representative example of the diversity of landform and geological features of Auckland;*

d) *Contributes to the aesthetic value or visual legibility of the wider natural landscape;*

e) *Has community associations or public appreciation;*

f) *Has potential value for public education;*

g) *Has potential to add to the understanding of Auckland's geological and biological history; and*

h) *The state of preservation of the feature.*

The AUP (OP) describes Mutukāroa-Hamlins Hill as a rare, unmodified example of the Waitematā sandstone ridges that underpin much of Auckland, and that it also contains the best example of a rhyolitic tuff deposit in Auckland.

The Project will not physically encroach onto Mutukāroa-Hamlins Hill, and will have minimal adverse effects on its landscape qualities. The hill's role as a landmark surrounded by transport routes will be accentuated. Whilst the EWL will affect views of Mutukāroa-Hamlins Hill from Great South Road these will be balanced by views for road users created by EWL.

For completeness it is also noted that Project will not affect the volcanic viewshaft from SH1 to Maungakiekie/One Tree Hill, which originates north of the Project and is oriented in the opposite direction.

12.10.9.5 Measures to mitigate potential adverse effects for Sector 4

The mitigation measures proposed for Sector 4 are set out in the ULDF and include:

- Connecting the east west walkway/cycleway to connect with the Sylvia Park Town Centre;
- Recognise the former Kāretu portage that was aligned along this route; and
- An elevated shared path (the Kāretu portage shared path) to recognise the cultural significance of the portage and reduce the visual prominence of EWL.

12.10.10 Sector 5: SH1 at Mt Wellington to the Princes Street Interchange

The main landscape and urban design issues are:

- Effects on the natural and cultural value of Ōtāhuhu Creek;
- Visual effects for travellers on SH1, particularly arising from the removal of vegetation and installation of noise walls; and
- Visual effects for adjoining properties.

Ōtāhuhu Creek is the significant landscape feature in Sector 5, being a main tributary of the Tāmaki River and culturally important as part of the Ōtāhuhu portage. The proposed works will have substantial positive effects by opening up the creek corridor, both physically and visually, and by restoring its image and mana.

There are potential adverse visual amenity effects for adjoining residential properties resulting from reduced separation from SH1, loss of the green buffer, installation of noise walls, and encroachment into properties. However, while noise walls have adverse visual effects in themselves, at the same time they will screen SH1 and reduce noise. There will be a potential reduction in amenity for travellers on SH1 because of the replacement of the existing green buffer with a hard-edged boundary of noise walls.

Proposed mitigation of visual aspects includes re-establishing vegetation in the SH1 corridor in front of the noise walls, and offering planting within affected properties on the opposite side of the noise walls. The combination of such vegetation will soften the appearance of the walls, reduce the potential for graffiti, and re-establish something of a green buffer on either side of the corridor.

12.10.10.1 Natural landscape

The only significant natural feature is Ōtāhuhu Creek, a tidal arm of the Tāmaki River important because it is also part of the historic Ōtāhuhu portage. The creek is constricted by the existing causeway and culvert of SH1. As a consequence, there is no longer an open channel along the creek. Rather, the creek upstream of SH1 is choked by mangroves. Ōtāhuhu Creek is also visually constricted by weed vegetation on the banks.

While the proposed EWL works include widening SH1 by one lane in each direction, at the same time it will remove the causeway and replace it with a bridge. An additional bridge to take temporary traffic diversions during construction is also to be retained on the east side of SH1 to provide a new pedestrian and cycle connection.

The landscape strategy is to restore Ōtāhuhu Creek as a physically and visually open waterway. The proposed works will have substantial positive effects by opening up the creek corridor (physically and visually), and restoring natural character. They will help restore the natural landscape of the Ōtāhuhu Creek in line with its cultural significance, and will increase the creek's visual presence as a waymark from SH1.

12.10.10.2 Natural character

The only location in which natural character effects arise is at Ōtāhuhu Creek. These matters overlap with natural landscape matters discussed above.

EWL will have positive effects on physical aspects of natural character because of the replacement of box culverts with a bridge, removal of incidental reclamation adjacent to SH1, and removal of weed species from the creek banks in vicinity of SH1. The opening up of the waterway and removal of weed vegetation that currently blocks views will also have some positive effects on the appearance of natural character.

12.10.10.3 Urban landscape

Works will be confined to the margins of SH1 and therefore effects on the urban landscape will be largely confined to effects on adjacent properties.

Within this sector, the main urban landscape matter is the reconfiguration of the Princes Street Interchange. While the works will not fundamentally change the existing situation, there will be connectivity benefits from increasing the capacity of the crossings and intersections and from the more direct and legible footpaths on the new configuration of the Princes Street overbridge.

The bridge to be used for temporary traffic diversion during construction of the SH1 bridge over Ōtāhuhu Creek is to be retained following construction to provide a new pedestrian and cycle connection linking the Princes Street East peninsula with the Panama Road peninsula. The bridge will improve connectivity between the two areas, and would also help connect coastal reserves along both sides of Ōtāhuhu Creek.

12.10.11 Visual Effects

For industrial properties, the visual amenity effects on these properties will be limited having regard to their industrial and typically inward-looking nature.

Most of Sector 5 is bordered by residential properties. There will be adverse visual effects because the separation with SH1 will decrease and noise barriers will be installed along the boundaries, in many cases replacing a green buffer. While noise walls have adverse visual effects in themselves, at the same time they will screen SH1 and have amenity benefits by reducing noise.

The visual amenity for travellers on SH1 will reduce because the existing green buffer will be replaced with a hard-edged noise barriers. To put such effects in perspective, the existing vegetation is of mixed quality, is limited in depth, and has gaps in places which reveal a mix of fence style and exposure to rear yards. Proposed mitigation includes planting in front of the noise barriers following construction.

12.10.11.1 Measures to mitigate potential adverse effects for Sector 5

In addition to the Project's design principles, mitigation measures and improvements proposed for this sector include:

- Replacing the existing causeway with a bridge;
- Removing incidental reclamation adjacent to the SH1 causeway;
- Avoiding noise walls within the creek corridor where possible;
- Re-establishing vegetation in the SH1 corridor in front of the noise walls;
- Removing weed species on the banks in the vicinity of SH1 to maximise views along the creek;
- Removing sufficient mangroves to reinstate an open channel both upstream and downstream of SH1; and
- Installing markers to highlight Ōtāhuhu Creek as a waymark on SH1.

12.10.12 Sector 6: Onehunga local road works

There are no landscape and urban design issues of any particular note within Sector 6.

12.10.12.1 Natural landscape

There are no natural landscape matters that will be affected. In each case the land is modified and there are no natural features of note.

12.10.12.2 Urban landscape

There will be some benefits in tying together the southern end of Onehunga's street grid. Captain Springs Road is relatively important in this respect because it extends through both industrial and residential parts of Onehunga, linking with Neilson Street, Church Street and Mt Smart Road. Likewise, the port link road will connect Miami Parade through to the Main Alignment.

The Project avoids encroaching onto Waikaraka Cemetery. It will not encroach on the historical basalt wall along its boundary and the basalt caretaker's cottage at the intersection of Captain Springs Road and Neilson Street.

12.10.12.3 Visual Effects

There will be no visual amenity effects of significance on users of Waikaraka Park. While Captain Springs Road will become busier, and will encroach into the berm on the Waikaraka Park side of the road requiring the removal of some street trees, the works will take place outside the existing park and, in particular, outside the stone boundary wall.

For the occupants of industrial properties, the widening of Captain Springs Road will encroach into the berm and require removal of some street trees in front of industrial properties on the eastern side of the road. While there will be some visual effects on these properties, such effects will be limited due to the commercial and industrial nature of these properties. The port link road will be entirely within an area devoted to large scale industrial activities and will have no adverse visual effects on adjacent properties.

12.10.12.4 Measures to mitigate potential adverse effects for Sector 6

There are no specific mitigation measures proposed for Sector 6 beyond incorporating good design principles.

12.10.13 General approach to landscape and visual effects mitigation across the Project

The general approach taken to landscape and visual effects across the Project is to avoid or mitigate effects through good design which is documented in the ULDF. The Transport Agency has worked with some stakeholders (including Mana Whenua) to develop an ULDF for the Project. The ULDF that has been prepared for the Project is contained in Volume 4.

The overall purpose of the ULDF is to:

- Demonstrate how the design of the Project supports the Transport Agency's strategic commitment to high quality urban design outcomes; and
- Demonstrate alignment between the Transport Agency and other agencies (e.g. Auckland Council and Auckland Transport) in integrating their planning, transport and urban design initiatives for the area.

The ULDF outlines some of the measures designed to mitigate adverse effects, and to go some way to restoring the existing environment. It comprises the following:

- Three high level design themes;

- Principles and outcomes that apply across the Project as a whole (e.g. outcomes for such elements as earthworks, bridges, paths, walls, road-side furniture, landscaping); and
- Principles and outcomes that apply to specific localities.

The three design themes underpinning the ULDF are:

Respect the place	Addresses such matters as responding to the natural and urban landscape, expressing the cultural footprint of Mana Whenua, and interpreting the area's heritage. In particular it is to assist in reversing the lack of respect given to the area during the development of the last 80 years or so.
Restore the whenua	Addresses the rehabilitation of the land and water, particularly the rehabilitation of Māngere Inlet and Ōtāhuhu Creek.
Reconnect the people	Addresses the transport connections for all modes (motorists, cyclists, and pedestrians), connection between Onehunga and the port, and connections between Onehunga and the Māngere Inlet.

The plans and drawings contained within the ULDF provide a vision for the integration of the Project with wider land use and development. It provides details and concepts which have been used in this AEE to assess the Project and, where appropriate, in the recommendation of mitigation for the Project.

The ULDF has been a source document which has informed elements of the Project design and will continue to do so beyond the concept design which is described in *Section 6.0: Description of the Project* of this AEE. By providing clarity on the expected design outcomes, the ULDF will promote consistent design quality throughout the detailed design and delivery of the Project.

The specific measures for each sector (set out earlier in this section) are incorporated into the ULDF. In general implementing the ULDF will:

- Soften the appearance of the main Alignment, reinforce it as an arterial road, and provide smooth transition between the landscape in which it sits;
- Ensure pedestrian connectivity is provided between the Main Alignment and the Māngere Inlet;
- Provide for connectivity between the Project, surrounding local roads, Māngere Inlet and Onehunga; and
- Recognise the Kāretu Portage.

These design outcomes will be achieved during detailed design of the Project by incorporating such as:

- Signage;
- Traffic calming measures;
- Carefully selected materials (including road and footpath surfaces);
- Street lighting;
- Specific design features which achieve a distinguished shared path;
- Custom street furniture for the Inlet frontage;
- Gateway structures;
- A design statement shared path where EWL is a structure in Sectors 3 and 4 (incorporating art) to highlight the Kāretu Portage; and
- Improved pedestrian connectivity.

Drawing from the ULDF, landscape concept plans have been prepared for the Project and are contained in *Plan Set 4: Landscape* in Volume 2.

12.10.14 Conclusion

The existing landscape forming the Project's setting has suffered the effects of being used as an industrial backyard for refuse landfills, noxious industries, and large scale infrastructure. This has resulted in the following:

- Te Hōpua tuff crater has been substantially modified and covered with urban development and infrastructure;
- The former intricate volcanic shoreline of the Māngere Inlet has been lost beneath refuse landfill;
- Māngere Inlet has been subject to contamination and has been walled off behind industrial development;
- Anns Creek has been partitioned by causeways, encroached upon by reclamation, and infested with weeds; and
- The former Kāretu and Ōtāhuhu portages have been submerged beneath urban development and Ōtāhuhu Creek has become constricted, both physically and visually.

While the Project has potential to increase visual dominance of transport infrastructure, the severance of the urban area from the coast, and reclamation of Māngere Inlet, the Project also has the potential to help reverse some of the adverse effects of historical development and to contribute to restoration of the landscape. Such a strategy lies behind the ULDF and the urban and landscape aspects incorporated in the Project. The strategies to achieve this are designed to:

- Rehabilitate and restore the degraded landscape of Māngere Inlet;
- Reconnect Onehunga with Māngere Inlet and its port;
- Enhance the legibility and aesthetic qualities of Te Hōpua tuff crater;
- Restore Anns Creek;
- Rehabilitate and re-open (physically and visually) Ōtāhuhu Creek;
- Recognise the Kāretu Portage; and
- Improve pedestrian and cyclist connectivity.

Overall, the adverse landscape and visual effects will be appropriately mitigated and there will be substantial positive effects. The Project, seen as a whole, will go some way to restoring the natural and urban landscape.

12.11 Noise and vibration

Overview

Construction of the Project will result in increases in existing noise levels during the construction period. Potential construction noise has been assessed in accordance with *New Zealand Standard NZS 6803:1999 Acoustics – Construction noise* (NZS 6803) and construction vibration in accordance with criteria within the Transport Agency's *State Highway Construction and Maintenance Noise and Vibration Guide.* During construction, some activities such as night works adjacent to dwellings have the potential to result in elevated noise that cannot be made to comply with the recommended criteria and these will be managed using best practice measures to achieve the most appropriate outcome practicable. Where possible permanent (traffic) noise mitigation measures will be installed at the beginning of construction in order to also mitigate construction noise.

Potential noise from operation of the Project is assessed against *New Zealand Standard NZS 6806:2010 Acoustics - Road traffic noise - New and altered roads* (NZS 6806). This Standard requires identification of sensitive receivers (such as dwellings and schools) within 100m of the road edge and establishes noise criteria categories for altered roads based on a Best Practicable Option (BPO) approach. The sensitive receivers for the Project are located in Sector 1 and Sector 5. Most buildings currently experience high levels of noise is due to their proximity to existing state highways and major local roads.

Once constructed, the Project will result in an overall reduction in noise levels currently experienced by sensitive receivers adjacent to SH1 and SH20 as a result of implemented noise mitigation measures. While high noise levels cannot be mitigated at all dwellings, the proposed mitigation involving acoustic barriers will result in significant noise level reductions of up to 9 dB compared to the existing levels at the most affected dwellings. Where acoustic barriers are not able to achieve noise levels suitable for residential amenity, building improvements are considered.

No notable adverse vibration effects from the operation of the Project have been identified.

12.11.1 Introduction

This section presents the findings of investigations undertaken to determine the actual and potential effects from noise and vibration associated with the construction and operation of the Project.

This section has been informed by *Technical Report 7: Traffic Noise and Vibration* and *Technical Report 8: Construction Noise and Vibration* in Volume 3.

12.11.2 Identifying the existing noise environment

The existing noise environment for the Project is characterised by a number of different land uses. The predominant environment in Sectors 1-4 is transport related and industrial in character which in places result in high ambient noise. In Sector 5, and lesser so Sector 1, other receivers include residential (short and long term accommodation) and active/passive recreational activities. In these Sectors, the presence of SH20 and SH1 respectively controls the high ambient noise environment.

For the purpose of assessing noise from roads, NZS 6806 focuses on identifying and managing effects on Protected Premises and Facilities (PPFs), which are sensitive receivers. PPFs are defined as buildings used for residential activities such as dwellings, hotels and motels in residential areas, marae, overnight medical care, boarding houses, elderly homes, educational facilities, and playgrounds within 20m of buildings used for teaching purposes. Commercial and business uses are not considered to be PPFs as they are not considered to be noise sensitive, and are therefore excluded from the assessment. NZS 6806 applies to PPFs in urban areas that are located within 100m from the edge of the closest traffic lane for the new or altered road.

The PPFs for the Project are predominantly the residential sites located close to the Neilson Street Interchange and adjacent to SH1 between Panama Road and the southern extent of the Project. There are no PPFs associated with Sectors 2, 3, 4 and 6. In total there are 401 PPFs that were assessed for the Project. Most of these PPFs currently experience high levels of noise due to their proximity to existing state highways and major local roads.

Short and long duration noise levels were measured at 14 locations within the Project area to establish the existing noise environment. The results are set out in Table 12-10.

Table 12-10: Traffic noise survey results

Location	Measured noise level	Derived noise level
Long duration surveys	**dB LAeq(24h)**	**dB LAeq(24h)**
13 Kotahi Road, Mt Wellington	65	n/a
24 Frank Grey Place, Ōtāhuhu (Auckland Motorway Alliance yard)	66	n/a
14 Onehunga Harbour Road, Onehunga (The Landing)	66	n/a
88 Panama Road, Mt Wellington	75	n/a
Short duration surveys	**dB LAeq(15min)**	**dB LAeq(24h)**
13 Frank Grey Place, Ōtāhuhu	67	65
1 Deas Place, Ōtāhuhu	70	68
36 Mataroa Place, Mt Wellington	68	66
102 Hillside Road, Mt Wellington	69	67
96 Captain Springs Road, Onehunga	65	63
Waikaraka Cemetery (water end)	54	53
31 Onehunga Harbour Road, Onehunga	74	72
16 Mona Avenue, Māngere Bridge	51	49
31 Norana Avenue, Māngere Bridge	49	48
Norana Park, Māngere Bridge	46	45

The noise surveys indicate that many of the PPFs are located in high noise environments. Of the 401 PPFs assessed along the Project, 257 are currently in Category A (up to 64dB $L_{Aeq(24hr)}$), 69 in Category B (64 to 67dB $L_{Aeq(24hr)}$) and 75 in Category C (more than 67dB $L_{Aeq(24hr)}$).

12.11.3 Construction noise and vibration assessment methodology

12.11.3.1 Construction noise standards

In assessing the construction noise and vibration effects, the main construction activities and equipment generating noise and vibration were identified and assessed against recommended project criteria to determine the actual and potential noise and vibration effects. A Best Practicable Option (BPO) approach was taken to identify methods to manage and mitigate potential adverse effects.

The standard used in New Zealand to measure construction noise effects is NZS 6803. The recommended noise limits from NZS 6803 are summarised in Table 12-11 and Table 12-12. The AUP (OP) incorporates the requirements of NZS 6803 in regards to construction noise.

Potential construction noise effects are typically assessed for compliance with NZS 6803, rather than as changes to existing noise levels. This is because construction noise is always noisier than ambient levels

and often cannot be reduced to the applicable operational noise levels of the zone. NZS 6803 anticipates this and makes allowance for higher noise levels.

As the construction works will exceed 20 weeks duration in most locations, the “long term duration” criteria of NZS 6803 apply, which are five dB more stringent than the typical duration criteria.

Due to the high ambient noise levels, including at night time adjacent to SH1 and SH20, alternative night time criteria were determined using the "background noise level plus 10" approach which is referenced in NZS 6803.

Whilst night works will be limited as far as practicable, some night works may still be required. The construction noise criteria of NZS 6803 provide for lower noise levels on Saturday and Sunday nights. However, due to traffic and safety considerations for existing SH1 and SH20, night works are unlikely to occur on Friday and Saturday evenings but will occur on Sunday nights when there are lower traffic volumes on these routes. In order to provide two consecutive quiet nights, it is appropriate that the lower "quiet night" noise levels apply to Friday and Saturday instead of Saturday and Sunday. This has been applied in Table 12-11.

For works not on SH1 or SH20, works may occur on Friday and Saturday nights especially if works are required to tie in with coastal tidal cycles. However, no residential receivers would be affected and works will still be subject to the criteria identified.

Table 12-11: Construction noise criteria for dwellings

Time of week	Time period	dB LAeq	dB LAmax
Sunday to Thursday	06.30-07.30	55	75
	07.30-18.00	70	85
	18.00-20.00	65	80
	20.00-06.30	60	75
Friday	06.30-07.30	60	75
	07.30-18.00	70	85
	18.00-20.00	45	75
	20.00-06.30	45	75
Saturday and Public Holidays	06.30-07.30	45	75
	07.30-18.00	55	85
	18.00-20.00	45	75
	20.00-06.30	45	75

Table 12-12: Construction noise criteria for industrial or commercial premises for all days of the year

Time period	dB LAeq
0730-1800	70
1800-0730	75

12.11.3.2 Construction vibration standards

The criteria within the Transport Agency Guide *State Highway Construction and Maintenance Noise and Vibration Guide* (the Noise and Vibration Guide 2013) were used to assess the vibration effects of the

Project. The guide establishes two categories for the assessment: annoyance (Category A) and building damage effects (Category B).

The annoyance criteria (Category A) of the Noise and Vibration Guide 2013 set criteria to avoid annoyance at receivers generally based on BS5228-2. The Category B criteria range from 1mm/s to 10mm/s based on the German DIN 4150-3:1999 Standard which is a conservative standard designed to avoid all damage to buildings. However, there is provision to relax the criteria if they cannot be practicably met, provided that a vibration expert is engaged to assess, monitor and manage potential construction vibration effects. This approach enables effects to be assessed during construction activities, with procedures established in advance of the works to respond to any identified adverse effects on buildings which may be or have been caused by the construction activities.

The BPO for vibration seeks to avoid annoyance by meeting Category A criteria, and if that is not practicable, then not to exceed the Category B building damage criteria. All identified risks will be managed by site specific mitigation and measurement at the time of construction.

12.11.4 Assessment of construction noise effects

Construction activities will result in increases in existing noise levels over the construction period. Such an increase is most noticeable in low noise environments, where construction noise is either a new source or a dominant source of noise.

The following activities have the potential to result in exceedances of the noise criteria:

- Piling, construction and demolition of bridges due to proximity of works to dwellings;
- Construction of retaining walls and acoustic barriers;
- Some bulk earthworks;
- Construction of structures and pavements, depending on acoustic screening;
- Pavement preparation and surfacing; and
- Precast bridge construction and lifting.

12.11.4.1 Commercial and industrial receivers

Commercial and industrial sites are located throughout Sectors 1 to 4. Many of the buildings are likely to be exposed to noise levels above 70dB L_{Aeq} during the day time and above 75dB L_{Aeq} during part of the night time. This is in the context of an existing high noise environment in most locations.

The effects of noise on commercial activities will vary significantly depending on the sensitivity of activities. Many industrial activities are unlikely to be adversely affected however retail, sales, offices etc. may be affected to a greater extent. The primary effect is likely to be an interference with communication as well as general annoyance where concentration is interrupted. In general, night time construction within the commercial or industrial area will result in low risk of annoyance due to premises being vacant.

Noise effects on commercial and industrial receivers will be considered on a case-by-case basis for sites where the recommended project level criteria are exceeded. Site specific noise management schedules will be developed and implemented in consultation with the affected receivers to manage effects where necessary.

12.11.4.2 Residential receivers

In Sector 1 there are a number of dwellings that already experience a high noise environment. The construction activity for the Project has been assessed to have a low risk of breaching the NZS 6803 night time noise limit at the residential dwellings, however these should be assessed on a case-by-case basis and appropriate mitigation implemented as required.

A significant number of dwellings are located within Sector 5 adjacent to SH1. These will at times be exposed to construction noise levels in excess of 70dB L_{Aeq} during the day and to noise levels of greater than 60dB L_{Aeq} during the night. The first row of dwellings adjacent to a works area will generally be exposed to high noise levels exceeding the noise criteria and the second row receiving noise levels compliant with the criteria. Night time construction noise may exceed the night time noise criteria at dwellings three to four rows from the area of works.

In the Māngere Inlet, dredging will occur 24 hours per day due to tidal constraints. The dredging is expected to comply with the 70dB L_{Aeq} daytime noise limit at all relevant receiver locations. The residential properties in Māngere Bridge are located at least 250m from the dredging activity which, at that distance will enable the noise associated with dredging to also comply with the 45dB L_{Aeq}-night time noise criterion at the residential receivers.

Standard NZS 6803 anticipates that at times, construction noise cannot comply with the recommended criteria. If this will occur, specific BPO mitigation measures will be adopted to avoid unreasonable noise as required by Section 16 of the RMA. The duration for which a construction activity (which exceeds the criteria) can be considered reasonable depends on site-specific circumstances and may vary from site to site and activity to activity. For example, if day time noise criteria are anticipated to be exceeded for several days but neighbouring residents are not at home, no one would be affected and therefore mitigation may not be required beyond communication with the residents. Night time works can similarly be managed by good communication, being time specific and, as a last resort, offering alternative accommodation in some circumstances.

12.11.5 Assessment of construction vibration effects

Vibration predictions are less reliable than noise predictions, due to difficulties with accurate modelling of ground conditions. Vibratory rolling, vibropiling and impact piling pose the greatest risk of exceeding the Noise and Vibration Guide 2013 criteria and creating adverse vibration effects. Based on the proposed construction methodology and the setbacks from buildings, risks of building damage were assessed and buildings identified where there is a medium or high risk of exceeding the criteria. As the setbacks between the works area and the buildings cannot be increased, low vibration methods of construction are recommended in specific circumstances.

12.11.5.1 Commercial and industrial receivers

Some commercial and industrial activities are located close to the proposed works within Sectors 1 to 4, within around 10m of the alignment. These commercial buildings will receive perceptible vibration when compaction is being undertaken, however it is unlikely that the unoccupied building damage limit (Noise and Vibration Guide 2013 Category B) would be breached at this distance.

The Noise and Vibration Guide 2013 criteria do not provide amenity (Category A) vibration limits for commercial buildings during the night time because these buildings are not normally occupied during these times. As a result, vibration intensive activities will generally be scheduled for the night time in commercial areas, wherever practicable (with controls in place to comply with the higher unoccupied Category B limits (building damage)). If a commercial building is occupied during the night time effects can be managed through good communication.

Overall it is assessed that vibration levels are unlikely to result in damage to commercial and industrial receivers.

12.11.5.2 Residential receivers

Dwellings in Sector 5 are typically located around 15m to 20m from the closest extent of works but some dwellings are located less than 10m from retaining walls or potential earthworks operations. As this sector is densely developed, a significant number of dwellings could experience effects from vibration during construction. Vibrating rollers used on the SH1 widening works are likely to generate most noticeable

vibration. The effects of vibration are likely to be more of nuisance (Category A) rather than avoidance of property damage (Category B).

12.11.5.3 Managing vibration effects

In the first instance, low vibration methodologies should be considered as far as practicable. Where not possible, alternative methods can be used to manage vibration effects. Methods may include engaging with the property owners and occupiers, pre-construction building condition surveys and monitoring of vibration levels.

12.11.6 Underwater Noise

Impact piling is proposed for the piers of the Anns Creek Viaduct, located approximately 600m from the low tide line of the Māngere Inlet. Piling is also required for the construction of the boardwalk between the headland features on the foreshore in Sector 2. This will require a significant number of piles to be driven at a typical distance of 20-40m from the toe of the road embankment.

The impact piling is predicted to produce high levels of underwater noise. Noise levels received by marine mammals that are above what they normally experience, can result in changes to their hearing sensitivity either temporarily or permanently.

Underwater noise is a matter for the coastal permits considered under the provisions of the regional coastal plan provisions of the AUP (OP). The assessment below has been developed in consultation with the Project ecologist and acoustic specialist. The AUP (OP) contains no noise limits, however blasting, impact and vibratory piling, and marine seismic surveys are listed as restricted discretionary activities that require an acoustic assessment addressing the following matters:

- The health and wellbeing of marine fauna (including threatened and at-risk species) and people from the noise associated with the proposal;
- The practicability of being able to control the noise effects;
- The social and economic benefits to the community of the Project (addressed in other sections of the AEE); and
- The extent to which the adverse effects of the noise will be mitigated.

The Māngere Inlet is not a notable feeding, breeding or rearing site for marine mammals nor is it a migration path for any marine mammals that may be affected by underwater noise. The only identified species of interest that may be affected by underwater noise in the highly unlikely event that they venture into the Māngere Inlet, are common dolphins and orca.

There is no New Zealand guidance on underwater noise effects. However, the US Department of Commerce National Oceanic and Atmospheric Administration provides guidance on the noise levels received by marine mammals which will likely result in changes in hearing sensitivity, either temporarily or permanently. The onset thresholds for the permanent loss of hearing in marine mammals caused by acoustic trauma are 230 dB re 1 µPa peak, and 187 dB re 1 µPa2/s SELcum. The maximum safe exposure noise levels are 154 dB re 1 µPa µPa2/s SEL for marine mammals.

Permanent hearing loss in marine mammals may be experienced within 10m from a single strike of the impact piling (230 dB re 1 µPa peak) and within 210m as a result of cumulative piling exposure(187 dB re 1 µPa2/s SELcum). Safe exposure levels will be experienced beyond 350m (154 dB re 1 µPa2/s SEL and below). The intertidal zone consists of shallow mudflats with low risk of underwater noise effects.

The following performance standards are recommended to be implemented:

- PTS onset threshold: 230 dB re 1 µPa peak and 187 dB re 1 µPa2/s SEL_{cum}
- Effective quiet: 154 dB re 1 µPa2/s SEL.

Specific measures to reduce or control the effects of underwater noise will be included in the Coastal Works CEMP (as set out in *Section 13.1.5: Management plans and other information*). This includes soft starts and gradually increasing the intensity of the piling and minimising duty cycle.

In the event that the main contractor determines that such piling is required elsewhere within the Project that is with 350m of potential marine mammal habitat, mitigation measures such as visual or passive acoustic monitoring of marine mammals and low power or shut down procedures will be prepared as part of the site specific noise management plans.

Overall, the presence of marine fauna that will be affected by underwater noise is unlikely in the area of piling and if they did venture into the inlet, the recommended performance standards will ensure a safe exposure level.

12.11.7 Measures to avoid, remedy or mitigate adverse construction noise and vibration effects

12.11.7.1 Construction noise management

The most effective way to control construction noise is through good on site management and communication within the Project team and with external parties. General noise mitigation measures that are good practice measures are set out in *Technical Report 8: Construction Noise and Vibration* in Volume 3.

A Construction Noise and Vibration Management Plan (CNVMP) will be prepared for the Project setting out how these measures will be implemented for the Project. The CNVMP will identify the noise risks and establish the management procedures that will be used in each area. It will include:

- Summary of project noise limits and assessments/predictions;
- General construction practices, management and mitigation;
- Noise management and mitigation measures specific to activities and/or the receiving environment;
- Monitoring and reporting requirements including procedures for handling complaints; and
- Procedures for review of the CNVMP throughout the Project.

Noise and vibration management schedules will be prepared for construction activities that have the potential to exceed the construction noise criteria. The schedules will identify the noise and vibration risks and set out how the BPO has been applied to the management and mitigation of noise for specific sites and activities. It is anticipated that schedules could be required for activities such as:

- Piling and demolition of bridges;
- Bulk earthworks in close proximity to dwellings; and
- Construction of structures and pavements close to dwellings.

Measures to mitigate effects could include on site structural mitigation (acoustic barriers) prior to commencement of works. Night time works can similarly be managed by good communication, being time specific and, as a last resort, offering alternative accommodation in circumstances.

12.11.7.2 Construction vibration management

Typical measures for mitigating and managing construction vibration effects include:

- Use of low vibration techniques where practicable (e.g. using bored rather than driven piles);
- Pre-start building condition surveys for buildings in close proximity to construction works that have been identified to cause high vibration levels;
- Monitoring of vibration levels where required, and

- Communication and liaison with affected parties.

These measures will be captured in the CNVMP.

12.11.7.3 Management of underwater noise during construction

The measures proposed to manage underwater noise during construction are set out in *Section 12.11.6* above.

12.11.8 Traffic noise and vibration assessment methodology

The assessment of operational effects involved establishing the existing noise environment and identifying any sensitive receivers referred to as PPFs within the Project area. This was followed by assessing the potential effects of the Project on these PPFs based on the modelled predicted noise levels for these PPFs from the Project and consideration of methods to mitigate actual and potential adverse effects.

The design year is a concept that is used for several engineering disciplines (refer to *Section 12.2: Traffic and Transport* of this AEE). It requires the design of a Project to be based on a future year, making an allowance for changes in traffic volumes over that time. NZS 6806 requires a design year between 10 and 20 years after the opening of the Project to the public. The year 2036 has been selected as the design year for the Project, which allows for an opening year up to 2026. The design year has been used to assess the difference between the do-minimum scenario where the Project is not implemented, and with the Project including mitigation.

There are three elements to the operational noise assessment:

1 Assess the actual and potential noise effects from operation of the Project;

2 Assessment of noise effects through determination of noise level changes; and

3 Assessment comparing the number of people that may be highly annoyed by traffic noise with and without the Project.

Firstly, NZS 6806 has been used to assess the actual and potential noise effects from operation of the Project. This Standard is based on the BPO approach and aligns with the duty to avoid unreasonable noise under section 16 of the RMA. The Standard establishes noise criteria categories which are not based on existing ambient noise levels, but are dependent on traffic volume and distinguish between new and altered roads. For this Project, the relevant category is that of altered road because the section of new road along the foreshore and connection to SH1 at Mt Wellington does not contain any PPFs within 100m and the remainder of the Project involves alterations to the existing SH1 and SH20.

NZS 6806 does not set rigid noise limits but gives categories (A, B and C) of noise criteria as set out in Table 12-13 and requires the BPO be identified to mitigate road traffic noise.

Table 12-13: Noise categories

Category	Altered Roads dB LAeq(24h)	New Roads with a predicted traffic volume >75,000 AADT at the design year dB LAeq(24h)	New Roads with a predicted traffic volume of 2,000 to 75,000 AADT at the design year dB LAeq(24h)
A (primary external noise criterion)	64	64	57
B (secondary external noise criterion)	67	67	64
C (internal noise criterion)	40	40	40

Under NZS 6806, structural noise mitigation options (e.g. road surface material and barriers) will be assessed, and if practicable, the noise levels within Category A should be achieved. If this is not practicable then structural mitigation should be assessed to achieve Category B noise levels. However, if it is still not practicable to comply with Categories A or B then building modification mitigation may be implemented to ensure the internal criterion of Category C is achieved. The upper category (Category C) provides a backstop against adverse health effects, such as sleep disturbance, by requiring the insulation of houses if the external noise would not be sufficiently reduced using the BPO. The preference is for structural mitigation rather than building mitigation in order to protect the widest possible area rather than rooms in specific PPFs only.

Secondly an assessment of noise effects through determination of noise level changes has been undertaken. This involved interpreting the general subjective responses of people based on international research to predict noise level changes along the Project.

Thirdly there has been an assessment comparing the number of people that may be highly annoyed by traffic noise with and without the Project. The assessment compared the percentage of people predicted to be 'highly annoyed' by traffic noise along the alignment for the existing and future (both with and without the Project) scenarios. This allowed the potential positive and negative effects to be assessed based on their significance and the number of people affected.

There are no national standards or rules in the Auckland planning documents for operational vibration from road traffic. The Norwegian Standard NS 8176.E.2005 specifically addresses transportation vibration and can be applied where relevant. However, traffic vibration is generated by uneven road surfaces, which will not occur from a new road that will be maintained under the Transport Agency's maintenance policy.

12.11.9 Assessment of operational traffic noise effects

Adverse traffic noise effects can include:

- Amenity effects on residents in the vicinity;
- Annoyance;
- Sleep disturbance; and
- Health impacts associated with these effects.

The assessment of effects from road noise has been undertaken in three stages being the assessment of compliance with NZS 6806, assessment of noise level changes, and comparing the number of people likely to be highly annoyed by traffic noise with and without the Project.

In undertaking the assessment, the following has been considered:

- Ambient noise levels (both measured and predicted);

- Future noise levels from traffic on the Project;
- Areas that may be adversely affected by road traffic noise from the Project based on an assessment of compliance with NZS 6806;
- Whether mitigation following the BPO would reduce these effects and can be practicably implemented and assessing the level of reduction that can be achieved; and
- The overall effects of the Project for the wider area, based on likely annoyance reaction from residents in the area.

For the purpose of assessment, the PPFs in Sectors 1 and 5 have been grouped into areas sharing similar characteristics with one in Onehunga and six along SH1. Figure 12-16 shows these areas.

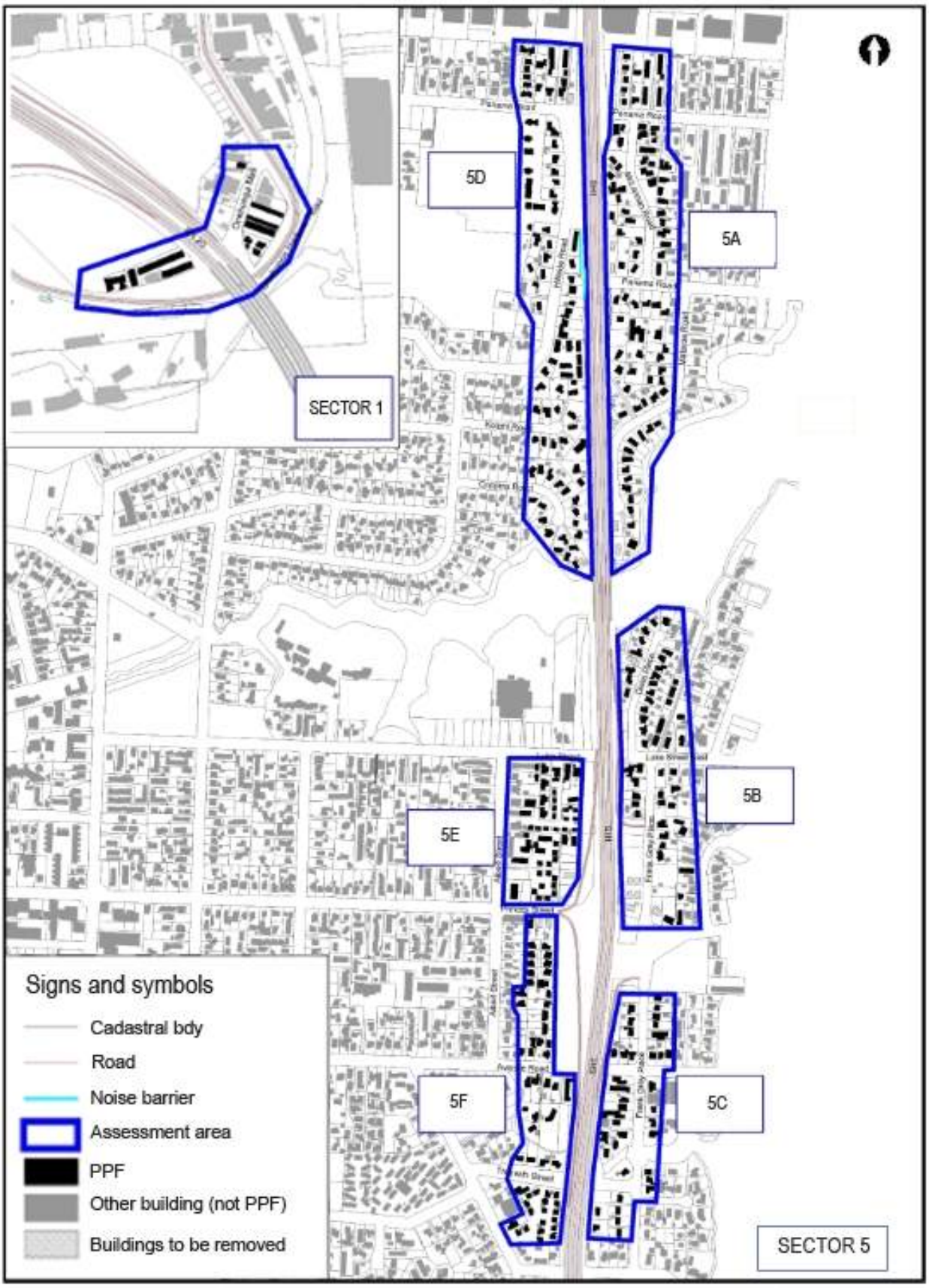
Noise modelling was used to predict traffic noise levels from the Project and to determine whether mitigation is needed for PPFs. The model accounts for terrain, ground conditions, atmospheric conditions and road parameters (e.g. road surface, traffic volume and speed, vehicle type and gradient) including existing safety and acoustic barriers.

For each of the noise assessment areas, the PPFs were combined into the categories of NZS 6806 (i.e. Categories A, B and C), and then the noise levels identified in five decibel bands (from less than 55 dB to more than 75 dB $L_{Aeq(24h)}$) to assess the number of people potentially affected by traffic noise. This process was undertaken four times to assess the existing situation (in 2016), the design year (being 2036) without Project, the design year with Project and the design year with the Project and preferred mitigation.

The change in noise levels for the design year without the Project (i.e. do nothing) and with the Project including the preferred mitigation are set in Table 12-14.

The location of the proposed acoustic barriers described in the following sections are shown in *Plan Set 3: Road Alignment* in Volume 3.

Figure 12-16: Grouping of PPFs for assessment



12.11.9.1 Sector 1, Onehunga

Several PPFs are located in this sector including two and three level apartment buildings, single level houses and a motel. All are located within an existing high noise environment. The existing noise levels for the 12 PPFs within this sector range from 60 to 73dB $L_{Aeq(24h)}$. In the context of the surrounding urban environment the existing noise exposure is considered reasonable, balancing the need for, and impact of, the road network to the locality.

The anticipated noise effects are from vehicles on SH20, the ramps, and local and business traffic movements. With no noise mitigation, the Project is predicted to change the overall noise level only insignificantly and to an unnoticeable degree. Recommended mitigation includes an acoustic barrier, being a 2.0 m acoustic barrier on SH20 adjacent to Onehunga Mall and building modification mitigation. With the recommended mitigation, noise levels for most PPFs are predicted to reduce slightly, with a number of Category C dwellings (requiring building mitigation) reducing to either a noise Category A or B in the design year (2036).

Overall, the Project with the recommended mitigation will have a slight positive effect with noise levels lower for the 2036 design year with the preferred mitigation option than compared to the 2036 Without Project scenario and also the present day scenario.

12.11.9.2 Sectors 2, 3 and 4

Sectors 2, 3 and 4 have not been assessed as there are no sensitive receivers.

12.11.9.3 Sector 5A, Mt Wellington (Southbound)

This sector extends from just north of Panama Road to Ōtāhuhu Creek (east of SH1) and is predominantly residential. The existing noise levels for the 86 PPFs within this area range from 53 to 75dB $L_{Aeq(24h)}$. At present, there are currently no acoustic barriers along this section of SH1.

With no noise mitigation, the Project will only slightly increase the ambient noise level experienced within this area. The dwelling at 73 Panama Road is predicted to receive the highest noise level increase from the Project, of just under 5 dB. The reason is the height of the dwelling in relation to Panama Road making the change in noise level difficult to mitigate through structural methods. Building modification mitigation will be considered for this property.

There will be a significant drop in the number of people adversely affected by noise levels from existing numbers in the design year, despite the increase in traffic volumes projected due to the proposed mitigation measures. There is also a reduction in the number of dwellings receiving noise levels in Category C which are changing to noise levels within either Category A or B.

Overall, the Project with the recommended acoustic barriers ranging from 1.1m to 3.0m and building improvements is predicted to provide an improvement to the existing noise environment in this area.

12.11.9.4 Sector 5B, Ōtāhuhu North (southbound)

This area extends from Ōtāhuhu Creek to Princes Street East, located east of SH1. It includes the southbound off-ramp of SH1 at the Princes Street Interchange. At present, there are no acoustic barriers along this section of SH1. This area contains 48 PPFs with existing noise levels ranging from 54 to 72dB $L_{Aeq(24h)}$. Most dwellings near SH1 are beyond the southbound off-ramp and somewhat separated from the traffic and therefore experience slightly lower noise levels.

The Project with the recommended 2.4m high acoustic barrier is predicted to improve the existing noise environment compared with both the Without Project scenario and the present day. The number of people calculated to be highly annoyed by noise is predicted to reduce due to the lower noise levels. Additionally, all Category C dwellings are predicted to receive reduced noise levels within either Category A or B with the recommended mitigation.

Overall, the Project with the recommended mitigation is predicted to provide an improvement to the existing noise environment in this area.

12.11.9.5 Sector 5C, Ōtāhuhu South (southbound)

This sector is located adjacent to the southbound lanes of SH1 and extends from Princes Street East to just north of Water Street in Ōtāhuhu (approximately 100m south of the Project extent). It contains 39 PPFs with existing noise levels ranging from 56 to 75dB $L_{Aeq(24h)}$. While most PPFs in this area are separated from SH1 by the southbound on-ramp, noise levels are elevated, with 9 dwellings currently identified within Category C. Similar to the two previous areas, it has no existing acoustic barriers and is predominantly residential.

With the recommended 1.8m to 3.0m high acoustic barriers, all but one existing Category C dwelling in the design year will change to receive noise levels in either Category A or B (as shown in Table 12-14). Building modification mitigation should be considered for the remaining Category C building. With the preferred mitigation, a reduction in the number of people potentially highly annoyed by the noise environment is predicted.

Overall, the Project with the recommended mitigation is predicted to provide an improvement to the existing noise environment in this area.

12.11.9.6 Sector 5D, Mt Wellington (northbound)

This sector covers the residential area west of SH1 from Panama Road to Ōtāhuhu Creek. At present, there is a concrete acoustic barrier which runs the length of four residential dwellings along Hillside Road. This area contains 109 PPFs. The existing noise levels in this area range from 56 to 74dB $L_{Aeq(24h)}$. with a large number of dwellings receiving noise levels above 65dB $L_{Aeq(24h)}$.

The proposed Springpark development at Panama Road (while not implemented) has obtained building consent by the land developer and has been considered as part of this assessment. The dwellings at 15A to 15D Coppins Road will be removed to facilitate the Project and therefore have not been considered.

The introduction of the recommended acoustic barriers ranging in height from 1.1m to 3m and building modification mitigation is predicted to result in a significant improvement in the residential noise environment, in particular, significant reductions for the 13 PPFs which are currently most affected by road traffic noise. Many Category C dwellings will receive reduced noise levels within Category A or B.

The number of people highly annoyed is predicted to reduce noticeably with the preferred acoustic barriers.

Overall, the Project with the recommended mitigation is predicted to provide an improvement to the existing noise environment in this area.

12.11.9.7 Sector 5E, Ōtāhuhu North (northbound)

This sector is located west of SH1 extending from Ōtāhuhu Creek to the northbound on-ramps at the Princes Street Interchange. The existing noise levels for the 49 PPFs range from 55 to 70dB $L_{Aeq(24h)}$. The PPFs within this area, particularly where located below the ramp level, are well shielded from noise generated on SH1.

With the introduction of the recommended acoustic barrier of 2.4m in height, 16 of the PPFs are predicted to receive a noticeable reduction in noise level. This includes all PPFs that currently receive noise levels in Categories B or C. While the overall number of people likely to be highly annoyed only reduces marginally, overall, the operation of the Project will have a positive effect on the existing noise environment as the PPFs in high noise areas of 65dB $L_{Aeq(24h)}$ or higher move into lower noise level bands.

Overall, the Project with the recommended 2.4m high acoustic barriers is predicted to provide an improvement to the existing noise environment in this area.

12.11.9.8 Sector 5F, Ōtāhuhu South (northbound)

This sector is located west of SH1 adjacent to the northbound off-ramp at the Princes Street Interchange. This sector extends to Water Street, approximately 100m south of the extent of the Project. This area is predominantly residential with dwellings set back from the northbound off-ramp of SH1 at the Princes Street Interchange. The area contains 58 PPFs, with existing noise levels predicted to range from 52 to 74dB $L_{Aeq(24h)}$.

A timber fence acting as a noise barrier has been installed adjacent to 113 Albert Street. The barrier construction is board and batten nailed timber and is unlikely to sustain the acoustic performance required by P40, the Transport Agency's Noise Mitigation Specification and NZS 6806. For this reason, the barrier has not been included in the existing situation modelling.

The recommended acoustic barriers ranging between 1.8m and 3.0m in height will result in an improvement in the overall noise environment with 11 of the PPFs receiving a noticeable noise reduction. The remainder of the PPFs are predicted to receive no or only marginal noise level reduction as they are sufficiently setback from SH1 to not require noise mitigation (refer to Table 12-14). With the recommended acoustic barrier, all but two dwellings are predicted to receive noise levels within Categories A or B compared to nine PPFs in Category C without the Project.

Of the two dwellings which remain in Category C, the dwelling at 113 Albert Street is double storey and elevated above SH1. Therefore acoustic barriers will not be effective and mitigation for the upper floor will be addressed through building modification mitigation with agreement of the landowner. Similarly, the dwelling at 48 Water Street is elevated above SH1 and is difficult to shield with acoustic barriers. Building modification mitigation will be investigated to address the effects on this dwelling.

Overall, the Project with the recommended mitigation is predicted to provide an improvement to the existing noise environment in this area.

12.11.9.9 Summary

The comparative assessment of the predicted noise levels indicates that the current high traffic noise and resulting annoyance levels would reduce for the majority of PPFs. The changes are due to improvements outlined as mitigation particularly for the residential areas alongside SH1, which currently have minimal or no noise mitigation. The changes expected for PPFs in each assessment area are shown in Table 12-14.

Table 12-14: Change in noise for PPFs along the alignment

Change in noise level (between the do nothing and preferred mitigation options)	Effect classification	Number of sensitive receivers in each assessment area						
		1	5A	5B	5C	5D	5E	5F
9 – 11 dB reduction	Significant positive	-	1	-	-	1	-	-
5 – 8 dB reduction	Moderate positive	-	18	3	11	12	3	7
3 – 4 dB reduction	Slight positive	3	15	4	8	16	13	4
1 – 2 dB reduction	Negligible	3	30	11	18	27	12	16
Less than 1 dB change	None	2	15	17	2	48	17	29
1 – 2 dB increase	Negligible	4	4	11	-	5	4	2
3 – 4 dB increase	Slight adverse	-	2	2	-	1	-	-
5 – 8 dB increase	Moderate adverse	-	1	-	-	-	-	-
Total PPFs		**12**	**86**	**48**	**39**	**109**	**49**	**58**

Overall, the Project provides positive effects for most people especially those presently affected by the most elevated noise levels.

12.11.10 Assessment of operational traffic vibration effects

Where roads are well-maintained, traffic vibration is unlikely to generate adverse effects. Vibration effects on adjacent properties arise where the road surface is in poor condition. The Transport Agency has a comprehensive road maintenance policy, and, as the Project is a new construction for the most part, adverse traffic vibration effects are not anticipated.

With the implementation of the Transport Agency road maintenance policy, it is unlikely that the Project road surface will ever degrade significantly, so effects are predicted to be negligible for all receivers.

12.11.11 Measures to avoid, remedy or mitigate potential operational traffic adverse effects

12.11.11.1 Operational traffic noise management

A BPO approach was adopted to identify options for noise mitigation where adverse effects were assessed to be at a level that mitigation was required. Under NZS 6806, where noise levels within Category A can be met with the implementation of the BPO for noise mitigation, then Category A applies. Where Category A cannot practicably be achieved, then mitigation to achieve the noise criteria within Category B is subject to the BPO test. If the noise criteria of Categories A or B are not practicably achievable, then the “backstop” Category C will be met with the adoption of the BPO.

There are three general methods to control traffic noise generation or effects:

- Noise reducing road surface materials;
- Acoustic barriers; and
- Building improvements.

The Project will use noise reducing road surface materials including Open Grade Porous Asphalt (OGPA) road surfacing (or similar) on the new road Main Alignment and dense asphalt (or similar) on the ramps.

Acoustic barriers are generally only considered appropriate where, as a minimum, an average of 3 decibels mitigation can be achieved (where many dwellings are located close to each other). No barriers are proposed where:

- Dwellings are significantly elevated relative to the road and a noise barrier would not be effective;
- The upper floor of multi storey dwellings cannot be mitigated; and
- The required barrier may be too high for a residential context.

The potential adverse visual, shading and safety effects of the acoustic barriers, and effectiveness of the mitigation measure, mean that they are not suitable in all circumstance.

Where acoustic barriers are not sufficient to achieve noise levels within Categories A and B, acoustic treatment/modification of buildings will be investigated. There are 22 PPFs with a residual Category C classification that may require building modification mitigation.

The recommended acoustic barrier and building modifications are set out in Table 12-15.

Table 12-15: Noise mitigation measures

Assessment Area	Approx. Barrier heights	Approx. Barrier lengths	Sensitive activities considered for building modification
Sector 1 (Area 1 in TR7)	1.8m	120m	2
Sector 5A (Area 5 in TR7)	1.1m height 1.8m height 2.4m barrier 3m barrier	39m 64m 299m 356m	13
Sector 5B (Area 6 in TR7)	2.4m height	240m	0
Sector 5C (Area 7 in TR7)	1.8m height 2.4m height 3m height	44m 127m 105m	2
Sector 5D (Area 2 in TR7)	1.1m height 1.8m height 2.4m height 3m height	40m 201m 242m 421m	3
Sector 5E (Area 3 in TR7)	1.1m height 1.8m height 2.4m height	41m 100m 305m	0
Sector 5F (Area 4 in TR7)	1.8m height 2.4m height 3m height	30m 306m 40m	1

The details in Table 12-15 are approximate and subject to detailed design. The location of the proposed acoustic barriers are shown in *Plan Set 3: Road Alignment* in Volume 3.

12.11.11.2 Operational traffic vibration management

The assessment of operational vibration has identified that due to the new road surface and implementation of the Transport Agency's road maintenance policy during operation, the Project is unlikely to generate adverse vibration effects.

12.12 Air quality

Overview

No specific resource consents or other RMA approvals are required for the Project in relation to operational air quality matters. Vehicle emissions are not controlled under district or regional plans.

The increase in concentration of operational air pollutants arising from vehicle traffic in Sector 5 is predicted to slightly exceed the NO2 (Nitrogen Dioxide) guideline level, both with and without the Project. In 2026 all other contaminant levels comply with the air quality standards along the length of the Project. Overall the effects from operational air quality are improved as a result of the Project. Reduced general traffic and heavy vehicles on key arterials and local roads will be beneficial for local air quality. Of note are local schools and early childhood centres in close proximity to existing busy roads which will benefit due to reduced traffic.

During construction, there are some specific sites along the Project with higher sensitivity to the construction air quality effects of dust. The generation of dust can be reduced by implementing a number of measures. For example construction roads can be well metalled and regularly watered during dry periods and excavated surfaces can be watered and stabilised immediately after works.

12.12.1 Introduction

This section outlines the actual and potential air quality effects which arise during the operation and construction of the Project.

There is a direct relationship between air quality and the number of vehicles on roads. Operational air discharges are generated by vehicles and include the combustion of fuels, brake wear and road dust. Vehicle emissions are of concern because many pollutants which are released are known to cause adverse health effects. These include gases such as NOX (Nitrogen Oxides) and VOCs (benzene) and particulate matters (PM10 and PM2.5).

During construction, the concrete batching facility based in Construction Yard 3 (Waikaraka Park) has the potential for adverse air quality discharges from cement associated with the mudcrete process. Construction works have the potential to generate dust from vehicle movements on access tracks, reclamations and areas being earthworked. The Project has some sensitive areas where hazardous air pollutants could arise (e.g. from closed landfills or asbestos dumps such as at 141 Hugo Johnston Drive). An assessment of air quality effects has been prepared as *Technical Report 9: Air Quality Assessment* in Volume 3.

12.12.2 Construction air quality

12.12.2.1 Assessment Methodology

The assessment has been undertaken in accordance with the *Transport Agency Air Quality Guide*[71]. The assessment of dust effects associated with construction works involves confirming that there are "no objectionable or offensive effects" as outlined in the Ministry for the Environment "*Good Practice Guide for Assessing and Managing Environmental Effects of Dust Emissions".* Effects are usually beyond the site boundary. No specific consents are required for the discharge of contaminants into air from construction of the Project, provided the relevant permitted activity standards are met. The standards for

[71] Transport Agency, June 2014

permitted activities include managing contaminants likely to affect human health, property or the environment, offensive or objectionable odour or dust beyond the boundary of the work site, and visible emissions. As there are no specific assessment criteria for dust, and as dust contains PM10, the dust generating activities have also been assessed against the Resource Management (National Environmental Standard for Air Quality) Regulations 2004 (NESAQ).

The Transport Agency Air Quality Guide presents a checklist to evaluate the construction air quality risk. The factors affecting the risk are the number of highly sensitive receivers and the scale of the earthworks activity. The area identified as potentially affected by construction dust nuisance are sensitive receivers located within 200m of the Project construction footprint. Specific activities identified as being sensitive to dust include residential properties in Sectors 1 and 5 and sites in Sector 4 used for uncovered car storage which are particularly sensitive to dust deposition. Due to the number of sensitive receivers and volume of earthworks the air quality risk is rated as high.

Construction dust effects are influenced by the location and separation distance between the construction areas and sensitive receivers along the Project, and the nature and extent of construction activities.

In accordance with the Transport Agency Air Quality Guide, as the dust risk associated with construction of the Project is assessed as being high, a Construction Air Quality Management Plan (CAQMP) should be prepared. This document (or section of the proposed CEMP) will describe a range of appropriate dust management and emission controls (as set out in Section 12.12.2.3), to be applied by the construction contractor at the time of construction to minimise the effects of dust.

12.12.2.2 Assessment of construction air quality effects

The potential air quality effects from construction of the Project include:

- Dust arising from construction activities, vehicle movements and wind entrainment from unsealed surfaces;
- Hazardous air pollutants from the disturbance of contaminated soils including landfills and asbestos;
- Odour and landfill gas (including methane) from the disturbance of closed landfills; and
- Engine exhaust emissions from construction vehicles.

The potential health effects of dust are closely related to particle size. Human health effects of airborne dust are mainly associated with PM10 (particles less than 10 µm), because these are small enough to be inhaled.

Total Suspended Particulate (TSP) is the particle size fraction that is most commonly monitored in New Zealand for the assessment of dust impacts. TSP is considered to be any particle smaller than 100 µm (microns) in diameter. Nuisance effects can be caused by particles of any size, but are most commonly associated with those larger than 20 µm (micrometer) because they will settle and deposit on surfaces. Deposited particulates have minimal physical health impact, but may cause nuisance in sensitive areas due to soiling. Because it is relatively large in size, deposited particulate usually falls out of the air within a short distance of the source and usually within 100m to 200m.

a. **Discharges from concrete batching**

The construction of the Project will require large quantities of fill which will likely be sourced from excavated marine sediments, then stabilised with cement to form mudcrete. The concrete batching plant and mudcrete operation will be located in Construction Yard 3 in Waikaraka Park and will produce approximately 1,000 tonnes of mudcrete per day. Potential discharges into air from concrete batching include dust from aggregates and cement powder.

Aggregate dust is usually inert, only causing nuisance (amenity) effects. However, cement dust is basically calcium oxide (CaO), which is highly alkaline when dissolved in water and can be corrosive to skin.

Concrete batching has the potential to generate fugitive discharges of dust, a fraction of which is likely to be PM_{10}. In practice, most of the material used on site has a considerably larger particle size – cement dust typically has an aerodynamic diameter in the range 30µm to 50µm, while sand and aggregates are larger still. Dust particles larger than about 20-30 µm in aerodynamic diameter have the potential to cause localised 'dust nuisance' e.g. soiling of surfaces.

Dust from concrete cutting (such as required for the removal of the Ōtāhuhu Creek culverts) also has the potential to generate cement dust if not appropriately controlled.

Provided the appropriate emissions controls and good on-site management are implemented, adverse effects of discharges to air from the concrete batching plant will be adequately avoided or mitigated.

b. **Dust from general construction activities**

General construction activities have the potential to generate dust. This includes from activities such as topsoil removal and spreading, earthworks, cut and fill operations, and the removal of existing hard surface such as paths and roads. Dust can also be generated from vehicles using access tracks and other construction areas, and from the removal of existing hard surfaces such as existing paths and roads.

The key area of concern is excessive dust deposits causing soiling of property, nuisance to highly sensitive receivers (i.e. residents and uncovered vehicle storage areas) and effects on network utilities (e.g. power lines). Dust can also affect visibility in the immediate work area and its surrounds.

The effects of dust from construction at sensitive receivers will be greatest during strong wind and dry conditions. Within the Project area, the dominant wind speeds are 1.5 to 5.0 m/s (for 58% of the time), with wind speeds in excess of 8 m/s being less frequent (for 5% of the time). Wind speed above 5m/s will start to give rise to airborne dust from exposed surfaces, particularly after extended periods without rainfall. High wind speeds above 10m/s have the most potential for excessive dust if winds are blowing towards the direction of sensitive receivers. Therefore, wind speeds with the potential to generate airborne dust are less frequent, occurring approximately 18% of the time. Wind speeds above 5.0 m/s are highest in the Māngere area (39% of the time) but much lower in Onehunga and Penrose (10.8% and 5.1% respectively).

The prevailing wind direction is south-westerly during the summer months (when the greatest risk of dust discharges occurs due to dry conditions). This will cause increased dust deposition to the north east of the Project construction area.

There are a number of measures that can be used to minimise the generation of dust during construction. These are set out in *Section 12.12.2.3* below.

c. **Hazardous air pollutants from contaminated soils**

There is a potential for offensive or objectionable odour to be discharged during disturbance of contaminated soils and closed landfills at Galway Street and Pikes Point East and West. The primary contaminants of concern are arsenic, copper, zinc and lead. If not appropriately managed, the discharges of dust from these areas may cause adverse effects on human health through either direct inhalation or ingestion.

The standards and guidelines for safe exposure to the identified soil contaminants are commonly set as annual averages, reflecting that adverse health effects from these airborne contaminants are more likely to occur after exposure to low levels over a long period of time. The construction proposed for this Project is not classified as a long period of time from an air quality perspective. In addition, the identified contaminants are likely to be adsorbed onto soil particles and therefore dust management methods will minimise effects.

The measures used to control general dust emissions (set out in Section 12.12.2.3) are equally appropriate for the control of discharges from contaminated sites as for general dust discharges. With the

use of these dust control measures, the potential for adverse effects due to discharges of dust from contaminated land is extremely low.

The site at 141 Hugo Johnston Drive (Construction Yard 4) is known to contain high levels of asbestos. If not appropriately managed, the disturbance of this site could discharge hazardous air pollutants in the form of airborne asbestos. For this to occur, the asbestos fibres must be present in sufficient concentration to pose a risk, and the exposure must be frequent and occur over long periods of time. The construction workers who will be uncovering and handling the asbestos directly are most at risk of exposure to airborne asbestos fibres. The risk of long term exposure is low, as the total construction duration at this location may be periods of weeks or several months at most. The use of personal protective clothing and training in handling the materials can minimise the risk to construction workers. Any asbestos found during excavation works will need to be handled and removed by a specialist asbestos containing materials contractor. The measures proposed for the investigation, handling and removal of asbestos material are addressed in *Section 12.18: Contaminated land* of this AEE.

d. **Odour and methane gas from landfills**

Construction of the Project requires disturbance of some historic landfill areas. The decomposition of material in areas of historic landfill results in the generation of gas and odour. There are several closed landfills along the Main Alignment and other areas where unknown fill material has been deposited. Monitoring completed for the Project has identified landfill gas in the wells installed at and near the Galway Street and Pikes Point East and West landfills.

The disturbance of these landfill areas can cause the following effects:

- The release of landfill gas which poses a safety risk due to the explosion risk; and
- The release of odour which poses a risk of nuisance or amenity effects.

Landfill gas is predominantly comprised of methane and also, depending on the types and age of the waste, may also contain hydrogen sulphide and small amounts of nitrogen, oxygen and hydrogen. It may also contain organic compounds that are potentially hazardous, such as benzene and toluene. Methane is not generally considered a toxic gas, however it is extremely flammable even in low concentrations when mixed with other chemicals. Hydrogen sulphide is also toxic and flammable at high concentrations and has a pungent odour. Odour may be generated by hydrocarbon contaminated soils within landfills, particularly when first exposed.

The monitoring of methane by use of portable methane gas detectors can to help minimise risk and provide early warnings should gas levels become dangerous. Typically the first alarm level would be 10% of the lower explosive limit, which in the case of methane at 10% of the 5% lower explosive limit is 0.5%. Hydrogen sulphide has a workplace exposure limit of 10 ppm (an 8 hour time-weighted average).

Potential adverse effects from landfill gas and odour can be mitigated by providing appropriate management and mitigation measures as set out in *Section 12.12.2.3*.

e. **Emissions from construction vehicles and machinery**

The operation of heavy vehicles and machinery during construction can potentially cause adverse air quality effects that create nuisance for nearby sensitive receivers particularly during strong wind conditions.

Construction vehicles will generally use arterial routes (e.g. Church Street and Neilson Street) and the State highways and less frequently, local roads. The total number of construction truck movements anticipated for spoil removal is in the order of 60 truck trips per day on Neilson Street, 110/day during construction of the embankment and 40 trucks/day during each of the other construction stages. Given the volumes of traffic in the vicinity of the Project, any additional traffic generated by construction activities will not result in a measurable increase in concentrations of vehicle related pollutants at locations close to highly sensitive receptors.

Other sources of emissions during construction include smoke and odour from diesel fuelled vehicles, generators and machinery which primarily result from poor engine maintenance. These can be minimised through regular checks and maintenance.

f. **Summary**

Through the use of appropriate emissions control and good on-site management, adverse effects caused by discharges of contaminants into air from the construction of the Project are able to be adequately avoided or mitigated and contained within the Project site boundaries.

12.12.2.3 Measures to avoid, remedy or mitigate potential adverse construction air effects

Using the Transport Agency Air Quality Guide, the Project is assessed as being of high risk and therefore air quality management must be incorporated into construction.

Mitigation measures for potential air discharges from the concrete batching plant will be addressed in a Concrete Batching Plant Management Plan (as part of the CEMP) and may include:

- The use of water on aggregate stockpiles and areas used for vehicle movement (fixed water sprays or water trucks) and windbreak fencing where appropriate;
- Transporting, storing and handling bulk cement in fully enclosed systems with any displaced air being discharged via bag filter units;
- Venting of air displaced from silos via filter units;
- Fitting cement silos with pressure relief valves (to avoid over-pressurisation) and high fill alarms;
- Cleaning up any spills as soon as detected by sweeping or vacuuming; and
- Requiring all bulk deliveries of cement to be made during operating hours, so that site staff can oversee the delivery.

Dust emissions from general earthworks and the disturbance of contaminated material (including asbestos) can be mitigated by measures during construction such as:

- Dampening down works areas (where necessary);
- Minimising exposed areas of earthworks;
- Loading spoil materials from a low height;
- Watering down works areas prior to commencement;
- Suspension of works during periods of high winds;
- Covering any stockpiles or soil heaps; and
- Establishing a wheel wash where necessary for construction vehicles, machinery and generators.

Regular checks and maintenance of construction machinery will reduce emissions.

The above mitigation measures and corresponding actions will be contained within the air quality section (forming a CAQMP) of the CEMP ensuring the proposed mitigation measures are applied by contractors when undertaking the works. Further discussion of the CEMP is contained in *Section 13.1.5: Management plans and other information.*

There are a range of controls available to manage the risks of landfill gas and the release of odour during construction. These controls are set out in detail in Appendix E of *Technical Report 17: Contaminated Land Assessment* and include:

- Managing earthworks with landfill waste by the installation of controls, minimisation of the excavation zone, and isolation from influences that could compromise the environment and human health;

- Appropriate handling, transportation and disposal of landfill waste (including a specialist in asbestos, where required);
- Management of landfill gas and odour during construction and long-term;
- Design considerations for permanent works including a high permeability leachate interception system;
- Leachate management and disposal during construction;
- Reinstating landfills with a landfill cap following construction; and
- Managing construction in confined spaces and human health contact with chemical and biologically contaminated materials.

Landfill gas will be monitored during construction activities.

12.12.3 Operational air quality

No specific resource consents or other RMA approvals are required for the Project in relation to operational air quality matters as discharges to air from mobile sources (in this case, vehicles using the road) are permitted under the AUP (OP)[72].

The methodology for assessing operational air quality effects is based on Transport Agency and Ministry for the Environment guidelines[73]. This broadly involves a staged technical assessment of effects, preparation of an environmental and social responsibility screen followed by a preliminary technical assessment using an air quality screening model. The air quality screening model predicts exposure levels at the kerbside and at the nearest sensitive location and then compares them to the relevant human health based air quality criteria for each road link. The criteria specified by the air quality standards and guidelines are designed to protect the health of the most vulnerable people in the community. The model provides a worst case assessment of potential air quality impacts.

As with other technical assessments the assessment consenting approach has adopted the year 2026 for assessing the differences between the air quality with and without the Project.

The screening assessment undertaken for the Project indicates that the air quality criteria will not be exceeded. This means that the air quality risk is low and therefore a more detailed technical assessment (beyond that undertaken) is not required for the Project.

12.12.3.1 Sensitivity of the receiving environment

Sectors 1 to 4 and 6 of the Project are areas with a relatively low sensitivity to potential adverse effects of air emissions on human health and amenity values. This is as a result of predominantly industrial land uses in these areas. The AUP (OP)[74] identifies that Business – Heavy Industry zone is an area with low air quality.

The parts of the Project that are most sensitive to potential air quality impacts of vehicle emissions are the dwellings/motel on Onehunga Harbour Road in Onehunga, and residential land uses adjacent to SH1 and at Princes Street. Whilst these residential land uses are more sensitive to potential adverse effects,

[72] Rule E14.4.1(A114), AUP (OP) Decisions Version.

[73] NZ Transport Agency, "*Guide to assessing air quality impacts from state highway projects*", December 2015 and Ministry for the Environment, "*Good practice guide for assessing discharges to air from land transport*", 2008.

[74] Chapter E14.4(Air Quality) of the AUP (OP) Decision Version.

they already experience high traffic volumes on adjacent roads, and contain many dwellings close to the road (i.e. within 20 m). Based on this, the existing air quality in these areas is poor.

An analysis of existing air quality data for the Project area indicates that background levels currently comply with the NESAQ. As with other urban areas of Auckland, air quality is influenced by both wintertime domestic solid fuel heating emissions and vehicle emissions. Industrial discharges are a much lower contributor to regional emissions contributing less than 10% overall. The prevailing wind direction and speed also have localised effects on air quality.

12.12.3.2 Assessment of operational air quality effects

The Project will result in a reduction of general traffic and heavy vehicles on key arterial and local roads including Neilson Street, Church Street, Onehunga Mall, Mt Smart Road, Mt Wellington Highway, Favona Road and Mahunga Drive. Reduced traffic on these roads will reduce vehicle emissions and improve air quality in the immediate environment. The redistribution of air quality from the removal of heavy vehicles from local roads in residential areas will have positive effects where there are a high number of sensitive receives (e.g. schools). Increases in traffic are predicted on the strategic routes such as SH20, SH1 and Sylvia Park Road. This increase is due to improved access diverting traffic away from residential and commercial areas. Further details of the traffic and transport changes resulting from the Project are set out in *Section 12.2: Traffic and Transport* of this AEE and in *Technical Report 1: Traffic and Transport Assessment* in *Volume 3*.

There are currently large volumes of heavy vehicles on the local road corridors connecting to SH1 and SH20. The congestion accessing the State highways is a notable factor influencing vehicle emissions both in the Project area and in the wider environment. Heavy vehicles are proportionally much higher emitters of pollutants than light vehicles. Of relevance for local roads is that, generally, reduced traffic movements equate to reduced emissions.

The Project will result in a redistribution of heavy vehicle traffic throughout the Project area and there is predicted to be a reduction in traffic on some local roads and an increase in others. The roads predicted to experience an increase in traffic are primarily within areas of industrial/commercial land use and minimal residential land use. Generally, increasing speed and reducing congestion in turn reduces emissions of PM_{10} and NOx. Increases in these emissions as a result of increased traffic on some local roads is assessed as being low with overall effects being negligible.

Operation of the Project is forecast to slightly increase emissions of NO_X and PM_{10} on the existing State highways with the Project, while significant reductions are predicted throughout the Onehunga-Penrose area and to a lesser extent in Māngere Bridge and Ōtāhuhu.

Figure 12-17 and Figure 12-18 show the redistribution of the concentration of heavy vehicle traffic, where green represents a reduction and red an increase (i.e. reflecting the location of the proposed Project).

Figure 12-17: Change in PM10 emissions (grams/day) with Project in 2026

Figure key: Increase Decrease

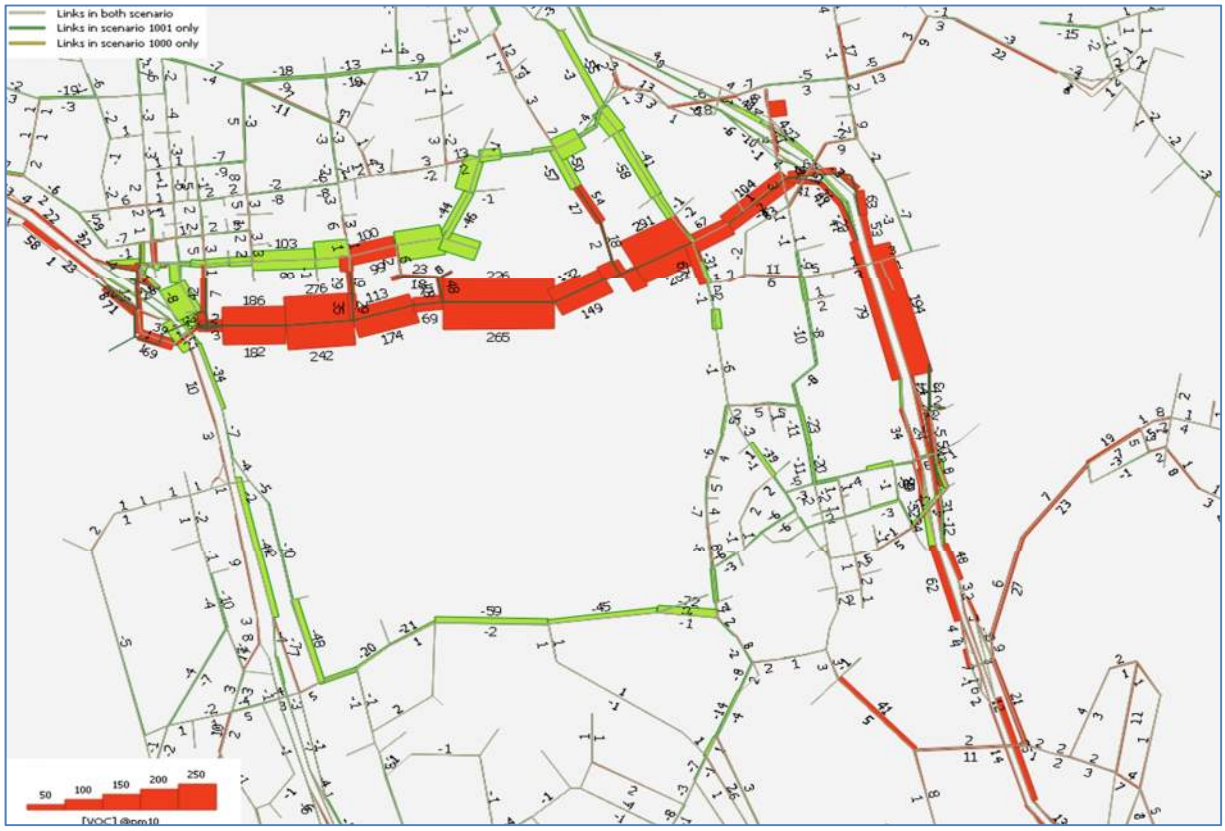
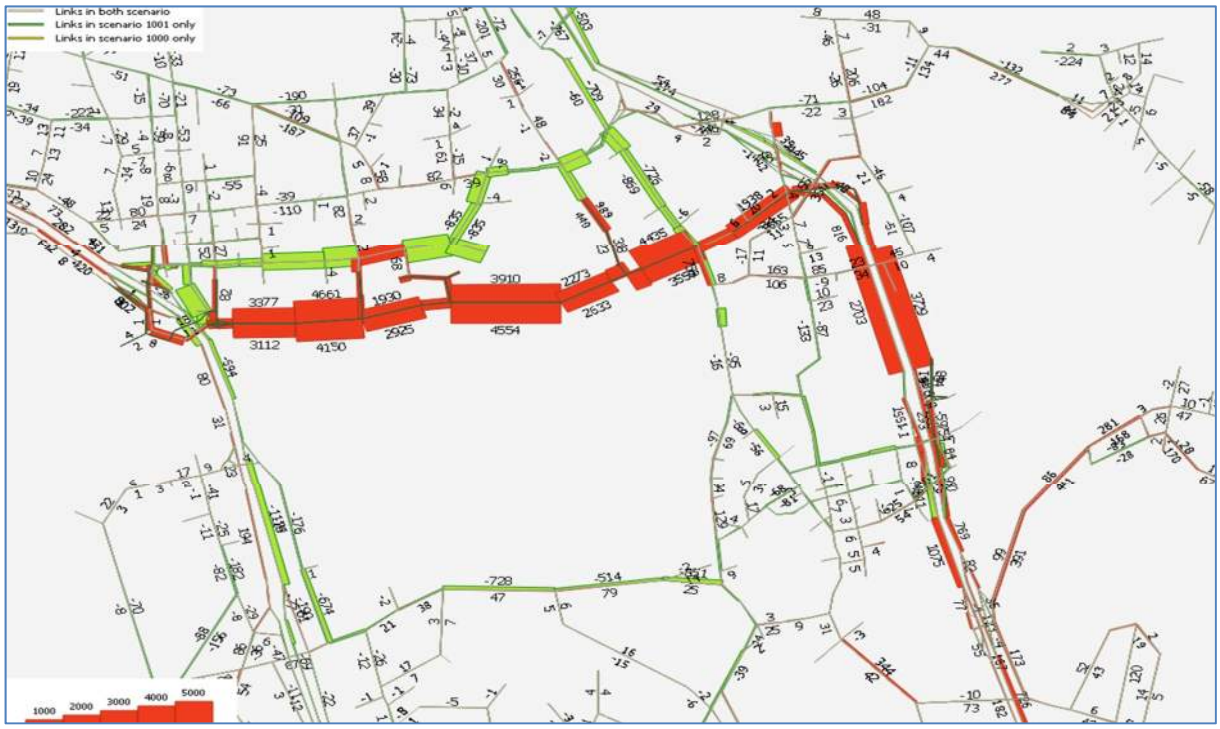


Figure 12-18: Change in NOx emissions (g/day) with the Project in 2026



Modelling indicates air quality improvements to a wider area than the direct Project area. As a result, sensitive activities located near existing busy roads will benefit from a reduction in vehicle emissions. Of note are a number of schools and early childhood centres which are adjacent to roads which will benefit from less traffic and congestion in the future. These are (as illustrated on Figure 12-18):

- Onehunga Primary School – 122 Arthur Street;
- St Joseph's School –125 Church St;
- Ōtāhuhu Intermediate School – 22 Luke St;
- Ōtāhuhu Primary School – 41 Station Road; and
- Te Papapa School – 219 Mt Smart Road.

There are other schools and childcare centres located within the wider Project area, however, these do not received the same benefit. These are:

- Young and Amazing – Mays Road;
- Piccolo Park – Mt Wellington Highway; and
- Waipuna Preschool Centre – Carbine Road.

The sectors of the Project that contain the most sensitive receivers are Sector 1 (Neilson Street Interchange) and Sector 5 (SH1 – Panama Road to the Princes Street Interchange). These areas already experience high traffic volumes and a number of houses are located close to existing roads. For these areas, the modelling indicates that cumulative concentrations from the operation of the Project, alongside the existing environment, are unlikely to exceed relevant operational air quality standards. However, people living in close proximity to SH1 will have a slight increase in exposure to vehicle-related contaminants. SH1 roadside PM_{10} concentrations are modelled to increase by 0.9 - 1.5 µg/m^3 and NO_2 concentrations by 2.6 - 4.0 µg/m^3. The cumulative concentration of NO_2 is predicted to slightly exceed the annual guideline in 2026 for one of the Project scenarios that has been modelled. As the screening model is highly conservative, it is considered unlikely that the increase in pollutants arising from vehicle traffic due to the Project in this location will exceed any of the relevant air quality standards or guidelines.

Significant reductions in vehicle emissions are predicted throughout Onehunga, and to a lesser extent Ōtāhuhu and Māngere Bridge.

All other contaminant levels will be compliant with the air quality standards.

Overall the operational air quality will be improved as a result of the Project, except for a few localised spots where the guidelines may be approached or exceeded, and the effects will be negligible.

12.12.3.3 Measures to avoid, remedy or mitigate potential adverse effects

The Transport Agency already undertakes monthly monitoring, using NO2 passive samplers at over 120 sites across the State highway network. The monitoring occurs at a variety of potential sensitive locations near State highways, including dwellings and schools. Where necessary, the Transport Agency responds by promoting projects to reduce emissions, optimising operations on the State highway and using information and technology to assist motorists with travel choices.

12.13 Construction traffic

Overview

The Project will have significant positive traffic and transport effects overall, however construction of the Project will result in some temporary adverse effects on road users arising from the required working spaces, the resulting temporary road layouts and increased heavy construction vehicles using existing state highways and local roads during construction. Construction activities will also require closure of some footpaths, pedestrian crossings, road shoulders, cycle lanes and traffic lanes as well as implementation of temporary speed limits resulting in travel time delays and effects to some property accesses.

The construction methodology for the Project has been developed to avoid adverse effects as far as practicable. Remaining effects can be managed by implementing appropriate and considered temporary traffic management during construction. There is established industry best practice for the safe and efficient management and operation of temporary traffic management during construction. This focuses on planning and implementing temporary traffic management safely, minimising disruption and inconvenience for road users and adjoining residents and businesses, and avoiding unnecessary disruption and cost by considering scheduling of construction works and activities.

Temporary traffic management will be implemented through a Project Construction Traffic Management Plan Framework (CTMPF) which will be supported by more detailed planning for specific sites or activities.

12.13.1 Introduction

This section presents the findings of investigations undertaken to determine the potential construction traffic effects of the Project. The assessment is supported by *Technical Report 10: Construction Traffic Impact Assessment* in Volume 3 including a draft CTMPF for the Project.

The Transport Agency's *Traffic Control Devices Manual* (2008) provides guidance on industry good practice for construction traffic, including, where necessary, regulatory requirements in relation to the use of traffic control devices. The primary standard, which forms part of the manual for planning, coordinating and implementing temporary traffic management during construction of the Project is the *Code of practice for temporary traffic management* (COPTTM). The Transport Agency's COPTTM describes best practice for the safe and efficient management and operation of temporary traffic management on all roads in New Zealand. COPTTM includes practices for the development of Temporary Traffic Management Plans for all roads in New Zealand and outlines requirements and guidelines for temporary traffic management.

The Transport Agency is the road controlling authority for all state highways including the motorways in Auckland. The Auckland Motorway Alliance (AMA) operates and maintains the Auckland State highway network on behalf of the Transport Agency. For this reason, all traffic management activities affecting the state highways associated with construction of the Project will require approvals from the AMA.

Auckland Transport is the road-controlling authority for all local roads within Auckland. All works and traffic management activities affecting the local road corridor will need to be approved by Auckland Transport through the Corridor Access Request application process. The Corridor Access Request process is set out in Section 26 of the Auckland Transport Code of Practice, and requires applications to comply with the following key requirements:

- Plan and implement temporary traffic management safely in accordance with the requirements in COPTTM;
- Minimise disruption and inconvenience for road users and adjoining residents and businesses; and
- Avoid unnecessary disruption and cost through conflicts in the timing of works and activities.

COPTTM and Auckland Transport Code of Practice are the two overarching documents that will be used to inform planning and implementation of any temporary traffic management activities required for the construction of the Project.

12.13.2 Methodology for assessing effects

The assessment of temporary traffic effects is primarily based on traffic engineering first principles and has been supported by traffic modelling. The traffic models (as discussed in *Section 12.2: Traffic and transport* of this AEE) were designed primarily for future forecasting of steady state and normal operating conditions but have been used to inform the construction traffic effects assessment noting that temporary traffic also consists of discrete and highly variable circumstances which traffic models cannot always accurately respond to. The modelling covers an area from Mt Albert Road and Greenlane in the north (across SH20 and SH1 respectively) to Manukau City Centre in the south. Details of the model development, calibration and validation are detailed in the Traffic Modelling Report attached to *Technical Report 1: Traffic and Transport Assessment* in Volume 3.

Two modelling scenarios were used to assess the temporary construction traffic effects of the Project:

- The 2017 Do-Minimum (includes opening of the Waterview Connection); and
- The 2026 Do-Minimum (includes the Waterview Connection but excludes the Project).

Construction of the Project is estimated to take place between 2018 and 2025, following the opening of the Waterview Connection scheduled in early 2017. The opening of the Waterview Connection itself is a significant change to the wider road network in Auckland which presents additional considerations for traffic effects of the Project.

While traffic data has been collected for the existing traffic conditions (at the time of preparing this AEE), these were not considered to be an appropriate representation of the base case conditions as the Waterview Connection has yet to open. The 2017 traffic model has been used to represent the base case for the initial year of construction (2018) due to the similarity in the year of representation and more importantly because it captures the Auckland road network after the Waterview Connection is open.

On the other end of the construction programme spectrum, the 2026 traffic model has been used to represent the final year of construction again because of similarities in the year of representation and because the effects of the Waterview Connection are represented.

Both the 2017 and 2026 traffic models include the additional auxiliary lanes on SH20 in both directions (between Queenstown Road and Neilson Street Interchanges) to reflect the early works programme currently scheduled for completion by early 2017.

12.13.3 Existing traffic environment

The description of the existing traffic and transport environment is included in *Section 11.0: Description of the Existing Environment* of this AEE. Further details on the existing environment, methods and findings of transport investigations are contained in *Technical Report 10: Construction Traffic Impact Assessment* in *Volume 3*.

12.13.4 Assessment of construction traffic effects

An assessment of the traffic effects expected during construction of the Project has been undertaken based upon the construction methodology set out in *Section 7.0: Construction of the Project* of this AEE. This construction methodology is indicative and will be subject to detailed design and confirmation by a Project construction contractor(s).

During construction, reduced speed environments, detours, narrowing or closure of lanes and temporary traffic signalling may result in temporary traffic impacts on the road network. These impacts include:

- Impacts on capacity of existing carriageways through shoulder/lane narrowing, realignment and temporary speed limits;
- Temporary closures of existing carriageways though lane/ramp/intersection closures and detours, temporary speed limits;
- Impacts arising from site access locations and movements through site access from a local road or motorway and escorted entry/exit manoeuvres;
- Impacts on public transport provision through traffic management and bus stop closures/ relocations;
- Impacts on pedestrians, cyclists, and mobility routes or crossings through footpath and cycleway closures/detours/realignments;
- Impacts on property access, parking, and manoeuvring through removal of roadside car parking, construction of temporary property access and reduction/closure of site manoeuvring areas;
- Possible damage to local roads; and
- Inconvenience from traffic management measures including changing road layouts at intersections and localised congestion.

Associated traffic nuisance effects including dust, fumes, noise and vibration are assessed in Sections 12.12 and 12.11 respectively of this AEE.

12.13.5 Effects on each sector across the Project Area

The following sections set out the anticipated traffic effects expected for each of the sectors during construction of the Project.

12.13.5.1 Sector 1 (Neilson Street Interchange)

The following effects have been identified which are specific to Sector 1:

- Simultaneous works on SH1 and SH20 have the potential to reduce wider network resilience due to reduced capacity on both motorway corridors at the same time;
- Reconstruction of the on/off-ramps at the Neilson Street Interchange could affect traffic access to and from the Onehunga area;
- Site access and egress points on SH20 have the potential to impact on traffic flows on the motorway mainline. The exact location and number of these access points will need to be confirmed by the construction contractor once the construction methodology has been confirmed in consultation with the Transport Agency as the road controlling authority;
- Construction may affect access to some private properties;
- Diversion of motorway routes have the potential to affect residential areas. However, diversions would be limited to non-local roads at non-peak times and at times of low traffic flow as far as practicable; and
- Road closures have the potential to create traffic effects at times of high traffic flows. However, these will be limited to non-peak times (such as overnight) as far as possible.

12.13.5.2 Sector 2 (Māngere Foreshore)

The following effects have been identified which are specific to Sector 2:

- The construction of the foreshore embankment will require the closure of the Manukau Foreshore Walkway for pedestrians and cyclists. Alternative routes will be required for cyclists and pedestrians while the path is closed. These routes may include staged sections of the new foreshore walkway or temporary local road routes developed in consultation with Auckland Transport.

12.13.5.3 Sector 3 (Anns Creek)

The following effects have been identified which are specific to Sector 3:

- An increase in construction traffic movements around Great South Road and Sylvia Park Road to and from the proposed site yards without appropriate restrictions (such as turning movements) may result in adverse effects on the operation of the intersection;
- Temporary change in the configuration of the intersection layout at Great South Road and Sylvia Park Road. The final temporary intersection layout during construction will need to be confirmed in consultation with Auckland Transport and the Auckland Transport Operations Centre;
- Temporary lane closures and closure of the Great South Road/Sylvia Park intersection will be required to the facilitate the construction of the EWL/Great South Road/Sylvia Park Road intersection. Such closures will occur at night with appropriate diversion routes provided;
- Temporary closure of the footpath on the western side of Great South Road, eastern side of Sylvia Park Road and the Manukau Foreshore Walkway. Alternative provision for pedestrians and cyclists will be provided in consultation with Auckland Transport and Auckland Transport Operations Centre;
- Temporary delays to bus routes around Great South Road and Sylvia Park Road intersection due to construction works. The implications of the works at the intersection will be co-ordinated with Auckland Transport Metro;
- Temporary closure of freight rail lines servicing MetroPort and passenger lines on the southern rail line at Great South Road will be required during construction. Replacement rail bus services for passenger trains will also be required. The implications of the works at the intersection will be co-ordinated with MetroPort, KiwiRail and Auckland Transport Metro;
- Access to some of the properties on Hugo Johnston Drive, Sylvia Park Road and Great South Road will be affected during construction. Some secondary property access points may require closing during construction periods. Temporary property accesses will be constructed where necessary with some restricted traffic movements; and
- Parking will be temporarily removed from parts of the southern end of Hugo Johnston Drive during construction.

12.13.5.4 Sector 4 (Sylvia Park Road and Mt Wellington ramps)

The following effects have been identified which are specific to Sector 4:

- Access to some private properties along Sylvia Park Road will be affected; and
- Increase in delays around the Mt Wellington Highway/Sylvia Park Road intersection during construction.

12.13.5.5 Sector 5 (SH1, Panama Road and Princes Street)

The following effects have been identified which are specific to Sector 5:

- Potential for cumulative traffic effects if there are simultaneous works on the SH1 mainline at the Mt Wellington Interchange and the Princes Street Interchange;
- Simultaneous works on SH1 and SH20 have the potential to reduce network resilience due to reduced capacity on both corridors if not scheduled to minimise this effect;
- Reconstruction of the Panama Road Bridge could affect local access and buses. The bridge will need to be kept open to traffic, at least as a single lane, due to the bus route along Panama Road and the local access function across the motorway performed by the bridge. To safely operate the Panama Road Bridge as a single lane with shuttle working, temporary signals will be required. Manual operation of the signals at peak times would minimise delays for buses;

- Site access and egress points on the motorway have the potential to affect traffic flows on the motorway mainline. These access points will need to be co-ordinated across the Project with appropriate sight lines and signage provided to guide construction traffic and advise general motorists of the access/egress points;
- Construction may impact access to some private properties;
- Diversion routes from the motorway have the potential to affect residential areas. Where possible and practicable, non-local roads will be used for diversion of traffic; and
- Road or lane closures have the potential to affect motorists.

12.13.5.6 Sector 6 (Local roads)

The following effects have been identified which are specific to Sector 6:

- Construction may affect access to some private properties.

12.13.6 Site offices and construction access locations

Construction yards have been identified for the Project. These are set out in *Section 7.0: Construction of the Project* of this AEE. Construction traffic accessing the construction yards has the potential to generate adverse effects in the form of nuisance effects from increased traffic, congestion, queuing around the access points and increased degradation of the local road surface. Potential measures to reduce, or better manage, construction traffic numbers are set out in the draft CTMPF and include carpooling and minibuses for worker transport, active management of shift changeovers, and awareness of and planning around traffic peak periods including school hours. Mitigation measures are set out further in the sections below.

The effect of light and heavy vehicles travelling to and from site offices will be minor, and is able to be accommodated within the existing road network.

When the construction method is developed further, the exact location of construction site offices will be confirmed through the process of finalising the CTMPF. This process is discussed further in *Section 13.1: The Project Delivery Framework* of this AEE.

12.13.7 Measures to avoid, remedy or mitigate potential adverse construction traffic effects

The traffic and transport assessment set out in *Section 12.2: Traffic and transport effects* of this AEE has identified a range of significant benefits arising from the operation of the Project. During construction there will be adverse effects, primarily of a temporary nature. The following section outlines the measures which have been identified to avoid, remedy or mitigate actual and potential adverse construction traffic effects.

The general approach to mitigating adverse construction traffic effects has been to develop a Project construction methodology to avoid adverse effects as far as practicable. A summary of the actual and potential effects and the general methods to avoid, remedy or mitigate effects from construction traffic and traffic management is provided in Table 12-16. Location specific measures are provided in Table 12-17.

Table 12-16: Proposed methods to manage construction traffic effects

Project activity	Impact	Typical Mitigation Measures
Footpath closure/detour	• Inconvenience to pedestrians and residents along route • Disconnection of access to bus stops • Increased exposure of pedestrians to traffic	• Letter drops to affected residents in advance of works in the area • Provision of warning and advisory signage prior to and during the closure • Provision of pedestrian crossings and refuges or controlled crossing points • Advice to interested parties/stakeholders of closures in heavily trafficked areas • Provision of convenient pedestrian detour routes well in advance of the closure to provide safe and convenient crossing • Provision of temporary pedestrian access to property within the construction corridor
Pedestrian crossing closure	• Inconvenience to pedestrians • Reduced safety by removing access to existing crossing points	• Letter drops to affected residents in advance of works in the area • Provision of warning and advisory signage prior to and during the closure • Project ambassadors to advise of closures in heavily trafficked areas • Provision of convenient pedestrian detour routes well in advance and at the closed crossing to provide safe and convenient crossing • Installation of warning signage for road users to warn of crossing location changes where necessary
Cycle lane closures/path closures/detours	• Inconvenience to cyclists along route • Increased exposure of cyclists to traffic • Reduced safety	• Letter drops to affected residents in advance of works in the area • Provision of convenient detour routes well in advance of the closure to provide safe and convenient cycle routes • Consider temporary minor works to better support the safety of cyclists on detour routes • Install signage adjacent to the cycle lane prior to construction commencing to allow cyclists to alter their travel patterns • Install warning signage in advance of shoulder closures to alert motorists of cyclists • Install a temporary speed limit
Property access closures	• Inconvenience to residents and businesses along route	• Personal visit by Project team members to advise and discuss impacts of the closure with affected residents and businesses • Letter drops to affected residents and businesses in advance of works in the area • Provision of temporary car parking in an area within the length of the traffic control site • Provision of metal-plate crossings into properties where feasible and safe • Scheduling of works during holiday or low-demand periods of the year

Project activity	Impact	Typical Mitigation Measures
Shoulder closures	• Reduced safety • No room for incident management, breakdowns etc. • Increased severity of recurrent and non-recurrent congestion	• Install a temporary speed limit • Install signage in advance of shoulder closure
Lane closure - alternating flow operation Lane closure - contra-flow operation Lane closure - one-direction closure	• Inconvenience to road users • Reduced traffic capacity through site as a result of: • Fewer lanes than existing corridor • Increased side-friction resulting from narrowed lanes and reduced shoulders • Construction activities visible to motorists resulting in 'rubber necking' • Reduced capacity across a link due to stop-go operations • Diversion of traffic away from the closure onto inappropriate routes such as residential streets, past schools or other sensitive facilities • Disconnection of bus routes • Disconnection of access to bus stops	• Public notification in appropriate media channels, where necessary • Letter drops to residents and/or businesses (where necessary), which are located within the closure length or along detour routes • Installation of concrete/water-filled barriers along site to isolate the site from public • Installation of sight screens to reduce 'rubber necking' • Installation of secondary detour routes where necessary • Review and optimisation of traffic signals on detour and alternative routes where necessary • Use of VMS for recommending alternative routes. Where possible, alternative routes will be recommended at a cordon around the closure, well in advance, in such a way to avoid traffic following the prescribed detour route where an alternative is a more convenient route to their intended destination. Install such signage in advance of the closure (i.e. a month prior, to inform road users) • Provision of access via a temporary corridor or narrow lane within the closure for residents and businesses within construction corridor, where possible

Project activity	Impact	Typical Mitigation Measures
Road closure/detours	• Inconvenience to road users • Inconvenience to residents and businesses within closed road segment • Congestion on detour routes • Congestion on alternative routes • Diversion of traffic away from the closure onto inappropriate routes such as residential streets, past schools or other sensitive facilities • Disconnection of bus routes • Disconnection of access to bus stops	• Personal visit by Project team members to advise and discuss impacts of the closure with affected residents and businesses; • Public notification in appropriate media channels, where necessary • Advertising on radio or through internet where necessary • Letter drops to residents and/or businesses (where necessary), which are located within the closure length or along detour routes • Installation of secondary detour routes where necessary • Use of Variable Messaging Signs for recommending alternative routes. Where possible, alternative routes will be recommended at a cordon around the closure, well in advance, in such a way to avoid traffic following the prescribed detour route where an alternative is a more convenient route to their intended destination. Install such signage in advance of the closure (i.e. a month prior, to inform road users) • Scheduling of works during holiday or low-demand periods of the year • Staging of works to require night time or weekend full-closures only (with consideration of any night works restrictions identified in *Section 12.11: Noise and Vibration* of this AEE. • Consultation with the Transport Agency / Auckland Transport / Auckland Transport Operations Centre to develop detour routes and minimise bottle-necks on detours • Provision of barricades on the approaches to the closure to prevent public access and visibility to activities within the site • Extension of closures to intersections with arterial routes with access to residents only on the approaches to the works • Provision of access via a temporary corridor or narrow lane within the closure for residents and businesses within construction corridor, where possible • Review and optimisation of traffic signals on detour and alternative routes where necessary
Short term closures for installation of long-term closures / traffic control measures	• Congestion through closure as discrete closures are required for installing long-term (i.e. greater than 24 hour) closures	• Installation of long term work sites that require temporary barriers etc. to occur during night time or off-peak periods

Project activity	Impact	Typical Mitigation Measures
Site access	• Truck movements reducing traffic capacity through a closure; • Reduced traffic safety due to truck manoeuvring in or out of the closure; • Impact on capacity of access routes arising from higher proportion of trucks • Increased traffic on access routes resulting in congestion and increased travel times	• Provision of site accesses at the end of the closure only • Development and distribution of site access plans which specify permitted access movements, times and procedures • Limiting site access movements / plant deliveries to off-peak periods or night time • Avoid peak traffic flow periods where possible • Optimise intersection arrangements and signal phasing at site access points to maintain efficiency
Temporary speed limit	• Inconvenience to road users • Slower operating speeds • Potential non-compliance with speed limit	• Public notification in appropriate media channels, where necessary • Monitor and review use of Temporary Speed Limits to ensure the speed limit is appropriate for the environment • Speed controlling measures may be put in place, such as lane narrowing or introduction of horizontal curves

Table 12-17: Proposed methods to manage location specific construction traffic effects

Project activity	Impact	Mitigation Measures
Simultaneous works on both directions of Neilson Street Interchange	• Affect traffic access to and from the Onehunga area	• Consider programming the works to minimise traffic management at the interchange • If ramps are required to be closed this should occur as discrete night time closures
Simultaneous works on SH1 and SH20	• Reduced network resilience on both corridors	• Consider scheduling works to avoid works being undertaken simultaneously on SH1 and SH20
Simultaneous works at Mt Wellington Highway and Princes Street Interchange	• Inconvenience to road users	• Consider programming the works to minimise cumulative traffic management effects
Temporary changes to the intersection layout and closures of the Great South Road and Sylvia Park Road intersection	• Inconvenience to road users	• Consult with Auckland Transport and Auckland Transport Operations Centre to confirm the desired layout of this intersection during construction • Where possible, retain existing number of lanes at intersection • Provide advanced notice and publicity of closures at the intersection via a number of different methods. • Provide a pedestrian crossing across the northern arm of Great South Road
Works on Hugo Johnston Drive	• Some parking will be temporarily removed on Hugo Johnston Drive during construction	• Advanced notice will be given to businesses and motorists to make alternative arrangements.
Reconstruction of the Panama Road Bridge	• Potential affect to local access and bus movements.	• Works should be programmed and staged to retain access across the motorway at Panama

Project activity	Impact	Mitigation Measures
		Road. As a minimum, the bridge should be kept open to traffic as a single lane • Operation of any temporary signals on Panama Road should be performed manually, particularly at peak times
Site access and egress points on SH1 and SH20	• Potential to affect traffic flows on the motorway mainlines	• These access points will need to be co-ordinated across the Project with appropriate sight lines and signage provided to guide construction traffic and advise general motorists of the access/egress points • The contractor will need to confirm details of access points once the construction methodology has been developed in consultation with the Transport Agency as the road controlling authority

12.13.8 Construction Traffic Management Plan Framework

The draft CTMPF contained as Appendix A of *Technical Report 10: Construction Traffic Impact Assessment* in Volume 3 provides an outline for how the management of construction traffic effects will be developed during construction of the Project. The draft CTMPF has been prepared based on the indicative construction methodology set out in *Section 7.0: Construction of the Project* of this AEE. It details the standards to be adhered to, identifies the objectives in developing plans for specific sites or activities and the issues that must be considered, and how the effects of traffic management methods, and construction traffic on local roads could be managed during construction. Key team members' roles and responsibilities are also included. The final traffic management methodology will be determined by the contractor appointed to undertake the works, and the draft CTMPF submitted with this AEE will be reviewed, expanded and finalised to reflect the adopted methodology. The process for finalising the CTMPF (to become the Project CTMP) and the specific matters to be addressed are set out in *Section 13.1.5j: Construction Traffic Management Plan Framework* of this AEE.

During construction, the Project's CTMPF will be supported by a number of more detailed plans prepared to provide further details for specific sites or activities. The site or activity specific Traffic Management Plans (TMPs) will be produced on a case-by-case basis and approved by Auckland Transport for works on local roads and AMA for works on State highways.

The implementation of these measures through the Project CTMP and the TMPs will appropriately manage the construction traffic effects from the Project.

12.14 Social effects

Overview

The planning, construction and operation of the Project has the potential to generate both positive and adverse regional and local social effects. Overall the key regional and local effects are positive, a summary of the effects includes:

Regional effects

The key regional benefits relate to transport and accessibility, health and sustainability and growth and development of the area. Positive local social effects will arise from improved access to local facilities, improved amenity and access to the foreshore, opportunities for recreational development and impacts on health and well-being of communities.

Local effects

Particular social effects assessed as part of the construction and operation of the Project include:

- Quality of the living environment and amenity;
- Social cohesion;
- Material well-being; and
- Culture and identity.

There are both positive and adverse social effects identified during construction of the Project. The positive effects include a potential increase in local trade from construction workers, an opportunity for local residents to be employed on the Project and an opportunity for the community to be involved in delivery of Project elements. The identified adverse social effects during construction including traffic disruption, noise, dust and changes in access and will be mitigated by the implementation of measures within the CEMP, other measures included in the suite of management plans including a communications plan which will be crucial for managing potential effects.

The operation of the Project will result in a number of positive social effects including the removal of traffic on local roads, improved streetscape amenity, acoustic barriers adjoining residential properties in already noisy environments and improved access to local community facilities and public open space. Adverse social effects include reduced amenity from new road connections, loss of some community services and potential loss of jobs due to acquisition of business land and acquisition of residential housing.

Overall there are a number of recommendations proposed to avoid, remedy and mitigate potential effects and to realise the potential positive effects. These include a stakeholder management and communications plan, setting up of Community Liaison Groups (CLGs) or other groups, early property acquisition strategies, working in partnership with other groups to deliver benefits (such as a walking and cycling connection across Ōtāhuhu Creek, and new recreation facilities at Waikaraka Park) and recognising employment opportunities for the local community.

12.14.1 Introduction

This section provides an assessment of the Project in relation to social effects. An assessment of social effects focuses on the experiences (actual or anticipated, direct or indirect) of individuals, families/households or communities in response to changes brought on by the Project. There are both positive and adverse social effects of the Project on both a regional and local scale and these are experienced over the three Project phases of planning, construction and operation.

This section has been informed by *Technical Report 11: Social Impact Assessment* in Volume 3 as well as a number of relevant technical assessments and the assessment sections in other sections of Part G of this AEE.

12.14.2 Social Impact assessment framework and methodology

The social impact assessment has used the Transport Agency's Draft *Guide to Assessing Social Impact for State Highway Projects*[75] (the SIA Guide) as a basis for identifying and assessing the potential social effects of the Project. It also recognises the International Association for Impact Assessment definition and principles that should be considered when looking at social effects. The SIA Guide outlines a number of potential effects including way of life, cohesion, biophysical environment, quality of the living environment and amenity, family/social networks, health and well-being, material well-being, fears and aspirations, culture and identity and the political system. It also recognises the importance of considering social impacts from changes to transport patterns and movements for active transport, public transport and private vehicles.

The key regional and local social effects[76] related to the Project which are identified in *Technical Report 11: Social Impact Assessment* in *Volume 3* and outlined in Table 12-18 include:

Table 12-18: Regional and social effects of the Project

Social effects	Meaning
Regional	
Transport, accessibility and connectivity	The benefits through increased transport choice and connectivity to the rest of the Auckland Region.
Culture and heritage	The benefits through wider recognition of regionally significant heritage, geological and cultural features in the Project area.
Growth and development	The benefits that can be realised as part of the Project relating to growth and development, including the potential for new jobs to be created and existing ones to be retained.
Health and sustainability	The potential benefits the Project can realise in relation to the health of people through provision of active transport infrastructure.
Local	
The quality of the living environment and amenity	The 'sensory' impacts on people from construction and operation of the Project (i.e. noise, visual and air quality.;
Social cohesion	Access to community facilities and potential meeting places for locals such as public spaces or recreational transport routes. It also relates to stability of an area (e.g. a reduction/increase in crime or loss of community members) and impacts on services available to people.
Material wellbeing	Impacts on private properties, employment opportunities and access/accessibility i.e. changes to transport patterns and movements.
Culture and identity	Impacts on the distinctiveness or unique values of a place and any important cultural sites/values experienced there.

[75] Transport Agency, *Guide to Assessing Social Impact for State Highway Projects, October 2015.*

[76] It is noted there are other social effects outlined in the Transport Agency Guide and recommended in other literature / social impact assessments, however not all are relevant. These are screened in Appendix A of *Technical Report 11: Social Impact Assessment*.

The methodology used to assess the social effects for the Project is summarised in Figure 12-19. A slightly altered methodology was used for the assessment of the grade separated Great South Road Intersection. This is described in *Technical Report 11: Social Impact Assessment Supplementary Assessment.* This is described in more detailed in *Section 3* of *Technical Report 11: Social Impact Assessment* in *Volume 3*.

Figure 12-19: Methodology used to assess social effects

12.14.3 Existing social environment

A local study area has been established for the purposes of profiling the existing environment and for assessing the local social effects associated with the Project. The local study area is based on surrounding Census Area Units which are shown in Figure 12-20 below.

Figure 12-20: Local social impact study area and relevant CSU

For the purpose of assessing specific local effects, the study area has been broken down into three community areas as showing in Figure 12-20. These are discussed below.

12.14.3.1 Community Area 1: Onehunga

Community Area 1 covers the suburb of Onehunga. Onehunga is a light industrial and residential suburb located on the northern edge of the Manukau Harbour with a port and the area is 10km from the CBD. There are 4,341 occupied dwellings recorded in the community area. The majority of residential dwellings are located north of the Onehunga Town Centre with some on Onehunga Harbour Road.

Onehunga has some heritage housing, parks, a swimming pool and gym centre, community centre with library and a number of churches and schools. In recent years Onehunga has catered towards light industrial and commercial activities. Dress Smart is a notable large-scale retail outlet. Onehunga Mall, the main street, has cafes, convenience stores, retail, a police station and fire station. There are a number of recreational areas including Gloucester Park and Taumanu. The upper part of Onehunga Town Centre (north of Arthur Street) has had recent streetscape upgrades. Business interest in this area are represented by the Onehunga Business Association.

The suburb of Onehunga has a less demographically diverse community compared to the rest of the study area. The suburb is somewhat severed by SH20 (between Onehunga and Old Māngere Bridge, which used to be the local road bridge) although there is still some connectivity between these communities (e.g. the local school roll indicates students from Old Māngere Bridge go here and that people travel to Onehunga from Māngere Bridge, especially for the Countdown supermarket). Panuku Development Auckland has identified Onehunga as a 'transformation area' and will acquire the balance of land not needed for the Project at the Onehunga Wharf for an urban renewal project.

The land requirements that have potential social impacts include: the temporary occupation of land for construction (including an area of the Onehunga Wharf), and the permanent impact on business land (including the full purchase of land on Gloucester Park Road and Galway Street).

12.14.3.2 Community Area 2: Te Papapa, Penrose and Mt Wellington

Community Area 2 covers the suburbs of Te Papapa, Penrose and Mt Wellington (to the north of Panama Road Bridge).

Te Papapa contains a mix of residential and industrial land uses, many are located on land that was historically reclaimed from the Māngere Inlet and there are old landfills. Penrose and Mt Wellington have

predominantly commercial, light and heavy industry area land uses, with a relatively small residential population compared to the rest of the study area. The Onehunga rail line runs through Te Papapa and Penrose and through to Onehunga its final station. This was the first government-funded railway line in New Zealand. The industrial and residential properties in the area are primarily accessed via Neilson Street and Church Street, which provide the existing east west movements from the state highway network. There is an active Penrose Business Association.

This part of Mt Wellington has primarily commercial and industrial uses, with some large lot sizes containing light industry/commercial uses and large format retail including Sylvia Park Shopping Centre.

Key social environments include the Manukau Foreshore Walkway and the Waikaraka Cemetery and Park. The existing Mt Wellington Interchange provides key access onto SH1 north and south and links to Sylvia Park Road and Mt Wellington Highway. The suburb of Sylvia Park, the Sylvia Park Town Centre and wider community are also serviced by the eastern train line with stations at Sylvia Park that links to Britomart to the north and Ōtāhuhu and eventually Pukekohe to the south.

The land occupation/acquisitions relevant to potential social impacts include:

- The permanent acquisition (with replacement) of recreation land which currently provides the Manukau Foreshore Walkway and a smaller area of future reserve expansion land at Waikaraka Park);
- The temporary occupation of the southern area of Waikaraka Park; and
- The temporary and permanent land requirements from Ports of Auckland (relating to the disruption to businesses and employees), and other business land (primarily along Sylvia Park Road).

12.14.3.3 Community Area 3: Mt Wellington and Ōtāhuhu

Community Area 3 includes the suburbs of Mt Wellington south and Ōtāhuhu. The area to the north is the residential area of Mt Wellington, around the Panama Road Bridge. Ōtāhuhu is a mix of industrial / commercial uses to the west and primarily residential dwellings to the east. The suburb is accessed via SH1, through the existing Princes Street Interchange. The key public reserves in the area are Bedingfield Memorial Reserve and Seaside Park. The area is zoned for Ōtāhuhu College and contains a number of other early childhood, primary, intermediate and secondary education facilities.

Ōtāhuhu has been identified as one of the 10 priority areas for development in the region in the Auckland Plan and an area that is signalled for growth in the future (e.g. it has been identified as a Special Housing Area and has been up-zoned in the AUP (OP)).

The land occupation/acquisitions with potential social impacts in Community Area 3 include*:*

- The requirement to purchase 15 residential properties in entirety;
- Partial acquisition of 47 residential properties;

12.14.4 Assessment of regional social effects

The potential regional social effects from the Project relate to:

- Transport, accessibility and connectivity;
- Culture and heritage;
- Growth and development (including population and economic growth); and
- Healthy and sustainable communities.

These regional social effects are significantly positive. The key regional effect relating to transport will be an increase in transport choice and reduce travel times, therefore making it easier for local community members to access services and facilities in the wider Auckland Region. The upgrades to existing

interchanges will result in more predictable travel times for all transport modes and less congestion. *Technical Report 11: Social Impact Assessment* in Volume 3 outlines the population growth that is projected for Auckland and *Part A: Introduction and background* of the AEE outlines the importance of the local study area for its economic contribution to the region. The Project will provide for growth and development in the area (both business and residential growth) by providing more effective transport connections. In addition, the Project design does not preclude the future development of a mass transit link to the Auckland Airport.

The Project also has the potential to deliver significant benefits to the wider region through recognition of cultural, heritage and physical features within the Project area. These features include volcanic, geological and sites of cultural significance to Mana Whenua such as Te Hōpua and Anns Creek lava flow remnants. There are also potential opportunities to facilitate healthy and sustainable communities by offering good quality active transport connections and improvements to public transport options.

The Project also provides for an increased potential for community health benefits as a result of the Project as through providing improved cycling and walking facilities it will encourage the use of active modes (walking and cycling), by the provision of these facilities.

12.14.5 Assessment of local social effects

The Project is a project of national significance and a key transport project for Auckland (Directive 13.5 of the Auckland Plan), however the Project will result in some adverse social impacts in the local area, particularly during construction. The following are described as potential social effects (both positive and negative) arising from construction and operation activities:

- Quality of the living environment and amenity;
- Social cohesion;
- Material well-being; and
- Culture and identity.

The social effects are the 'human' experiences of other impacts, the effects of which are explained in other assessment sections and within the associated technical reports. The following section outlines the actual and potential social effects for the construction and operational phases of the Project with a particular regard to the people/communities who may experience them and cross references to the relevant section and technical report for more specific information on the effect.

12.14.5.1 Assessment of social effects during construction

The Project is of a significant scale in terms of timeframes and the size of works involved. The main effects from construction activities that are likely to have consequential social effects include (and are outlined in earlier sections of this AEE):

- Construction noise and vibration effects;
- Air quality effects;
- Traffic and access effects; and
- Landscape and visual effects.

a. **Quality of the living environment and amenity**

The potential adverse social effects on amenity values during construction include an increase in noise, dust, construction traffic and visual disruption during the construction period. This will mainly be experienced at a local scale (i.e. by surrounding residents/businesses and regular users of facilities). The construction period in this area will be significant (total time period potentially up to five years) and will therefore have a notable impact on the liveability and enjoyment of the area for people (especially near

to proposed construction yards) and the health and well-being of residents. These effects relate to construction noise and vibration (see *Technical Report 8: Construction Noise and Vibration Assessment* in Volume 3) and potential changes in air quality (reported in *Technical Report 9: Air Quality Assessment* in Volume 3).

Construction of parts of the Project has the potential to occur close to indoor and outdoor living areas in residential properties adjacent to SH1 in Community Area 3, which may disrupt sleep and other daily living patterns for residents. The scale of this impact is considered greatest for residents who may be doing shift work or families with young children who sleep during the day. In addition, night works have the potential to result in potentially significant disruption to people.

Any dust generated by construction activities can create a nuisance for people in their homes, and in the surrounding environment (e.g. it may inhibit people hanging their washing outside or may dirty the exterior of houses and cars parked near the street). There are also negative social effects associated with construction in landfill areas in Community Area 2 which can pose a risk to human health.

b. **Social Cohesion**

In all areas there is the potential for benefits from construction workers in the area such as reduction in crime resulting from a sustained presence of people and passive surveillance in public areas. There is also the potential for community events put on through the construction period which could specifically involve local residents and young people (e.g. opening of areas once construction has finished).

Construction may result in adverse effects on social cohesion in each of the Community Areas across the study area through impacts on community facilities and public open space. The Project requires land from eight open spaces. The majority of land required relates to small strips on the edge of open spaces that will have nil to very low effect on the ongoing usage of, or access to, the space. Three land requirements that will have an adverse effect on the community's use of spaces are:

- Gloucester Park (North and South) – the land required from Gloucester Park North has been minimised to avoid the recreational playing field as far as possible. However, the public will be excluded from the required areas during construction and will experience a reduced open space for recreation activities. In order to mitigate the construction effects, a Gloucester Park Reinstatement Plan will be developed in consultation with Auckland Council (Parks) which will address the reinstatement of the land at the completion of construction.
- Waikaraka Park – the southern portion (to the east of Waikaraka Cemetery) is required for a construction yard. For safety reasons, the community will be entirely excluded from this area throughout construction. The area of requirement has deliberately avoided the northern part of Waikaraka Park that is used for organised sport purposes. The requirement of the southern portion covers a large area that, whilst not currently a developed recreational area, Auckland Council has plans to develop the area for sports fields. To mitigate the temporary construction effects it is proposed to develop a Waikaraka Park Reinstatement Plan in consultation with Auckland Council (Parks) which will address the reinstatement (or potentially betterment) of the land at the completion of construction.
- Waikaraka Foreshore (East and West) Walkway – the entire length of the walkway will be closed throughout construction of the foreshore area. This will remove the community's ability to access the coast and undertake walking and cycling activities away from the existing heavily congested road environment. Temporary pedestrian diversions will be considered and addressed in the CTMPF (see Section 13.1.5). During construction pedestrian and cyclist access across the Old Māngere Bridge (or replacement structure) and into Onehunga Town Centre will be maintained at all times. Upon completion of the Project there will be a walking and cycling connection along the foreshore between Taumanu, Old Māngere Bridge and Sylvia Park. In the location of the existing walkways, this includes a commuter cycleway, footpath providing direct access adjacent to the road. There is also a shared path and boardwalk/walkway meandering along the foreshore to provide access to the coast in a more naturalised coastal environment. It is also recommended that the Transport Agency work with Auckland Transport to (as far as practicable) provide a temporary commuter cycle facility.

c. **Material well-being**

Across the Project area there is a potential positive social effect from the opportunity to provide employment to locals. This applies to local residents across the Project, but especially in Community Area 3 which is part of The Southern Initiative of the Auckland Plan.

People's material well-being may be impacted during construction due to temporary disruption of transport routes and access to private properties. The Manukau Harbour is used of water recreation including traditional watercraft. During construction, access to some areas of the Māngere Inlet will need to be temporarily restricted for safety reasons due to the dredging and reclamation activities. Restrictions to navigation will be agreed with the Harbour Master following finalisation of the construction methodology by the contractor(s) and will be publicised and appropriately signposted. The confirmed restrictions will be contained in the Coastal Work CEMP (See Section 13.1.5b for further details of the Coastal Works CEMP). In Community Area 1 disruption will be experienced for motorists using the Manukau Harbour Crossing as a result of works at the Interchange which may result in delays for people accessing places of employment and services (in particular those travelling from Māngere Bridge to Onehunga). Likewise, there will be disruption for those who walk/cycle from the Old Māngere Bridge and link into the Onehunga Town Centre. It is important that access in this area is managed appropriately due to the significance of this transport link for many people in the community and potential lack of alternatives (especially for those without a car).

In Community Area 2 there will be some disruption to services in the area such as along Sylvia Park Road during construction. Disruption to transport routes and access to private property during construction of the Project will also occur in Community Area 2. This will result in potential effects on employment (with loss of employment if businesses struggle during construction) and also access to services for the local community. In particular along Sylvia Park Road there are a number of affected properties. Further impacts on these businesses is contained in *Section 12.4: Assessment of business property, land use and disruption effects*. In Community Area 3, potential effects on material well-being will result from disruption at the Panama Road bridge (therefore reducing access) and at the Princes Street Interchange, which is an important link for Ōtāhuhu East residents accessing services (such as schools and employment) to the west. Construction traffic management measures will be in place to ensure appropriate diversions and access are in place throughout construction.

In all areas, there is the potential for local businesses to benefit from the passing trade of construction workers.

12.14.5.2 Assessment of social effects from operation

a. **Quality of the living environment and amenity**

The operation of the Project will result overall in positive social effects in relation to the quality of the living environment and amenity. In Community Areas 1 and 2 there will be improved amenity of the coastal edge for recreation use, improving public access to and along the CMA, which is seen as a positive social impact on people's quality of life and supportive of the planned urban growth in the wider Onehunga area (i.e. improving recreation facilities to support this future population). There will also be enhanced 'quality of life values' for residents (aesthetics, amenity and safety) associated with the proposed landscape treatment and new open spaces (including along the foreshore of the Māngere Inlet) and urban design integration. For businesses reduced traffic and heavy vehicles on local roads will positively benefit access for customers.

There will be increased amenity and quality of life associated with installation of acoustic barriers in Community Areas 1 and 3 including along part of SH20 and for residential properties adjoining SH1, especially where there are none currently or existing barriers are not up to the appropriate standard. This is a significant positive benefit.

There will also be improvements in the quality of the road environment and therefore safety for vehicle users and in particular for pedestrians and cyclists. This is considered a positive social impact for the

health and well-being of people in all community areas, but especially in Community Area 3 at the Princes Street Interchange (where there are currently safety issues for motorists, pedestrians and cyclists).

There will be potential adverse social effects relating to the quality of the living environment and amenity. These will mainly be felt in areas where there are new roads/connections built or there will be an increase in traffic. This will be particularly evident in Community Area 1 at the Galway Street connection, and at the foreshore (where there has previously been no road, therefore changing the noise and visual environment permanently for users) in Community Area 2. In Community Area 3 along SH1 the motorway will be moved closer to adjacent residents through the construction of an additional lane in each direction. The scale of the Panama Road Bridge and the Princes Street Interchange in Ōtāhuhu will also be increased, bringing the road environment closer to people's homes and therefore their living environments.

b. **Social Cohesion**

Improved connectivity to community facilities (including schools, recreational centres and reserves), and the Onehunga Town Centre and Sylvia Park Town Centre will be provided for through the provision of better quality walking and cycling networks, improved bus facilities, and pedestrian crossings and links, which are considered to have significant positive social effects on people's way of life and the social cohesion experienced across the study area.

Potential effects on specific community facilities from operation of the Project are discussed in more detail in *Technical Report 11: Social Impact Assessment* in *Volume 3,* however those of note include:

Aotea Sea Scouts Hall

In Community Area 1, there will be a change in the amenity experienced by users of the Aotea Sea Scouts Hall resulting from the change in the road environment in the surrounding area. The location of the proposed busy road outside the current location of the building is not a good outcome for the Aotea Sea Scouts Hall. The location and heritage values of the building are important to the Aotea Sea Scouts and part of their identity, and contributes to the strength of their relationship to the local Onehunga community. There have been ongoing discussions with the Aotea Sea Scouts about moving the Aotea Sea Scouts Hall which will have a potential negative social effect on users of the facility due to potentially changing the visual prominence of the building and therefore its identity for its users. Notwithstanding this the Project design will result in positive social effects in relation to social cohesion due to the decrease in noise levels anticipated to be experienced at the building, the change in traffic volumes on Orpheus Drive and change to local traffic. During construction it is recommended the Aotea Sea Scouts activities be relocated; if undertaken this will be in consultation with Aotea Sea Scouts.

Waikaraka Park

Through the development and implementation of the Waikaraka Park Reinstatement Plan, it is proposed to reinstate southern Waikaraka Park to facilitate establishment of an active open space. This is identified as a positive social impact as it will enable the accelerated delivery of Auckland Council's planned open space development for this site.

Onehunga Wharf

The local community in Community Area 1 has consistently expressed the importance of the Onehunga Wharf future development and that the Project shall not preclude this (see *Technical Report 11: Social Impact Assessment* and *Part E: Engagement of this AEE*). Following construction, the Project provides for improved capacity for future development of the Onehunga Wharf. While this is acknowledged as a consequential impact of the Project, the additional network capacity supports the aspirations of the community . This also supports the wider network improvements on Neilson Street, removing conflicts with through traffic movements which enables opportunities for the development of the Onehunga Town Centre. This is considered a key positive social effect of the Project.

In Community Area 3, the existing severed Ōtāhuhu areas (north and south of the Ōtāhuhu Creek) will benefit from a proposed pedestrian and cycle connection across the Creek. This will provide benefits for residents between these communities and potential for the wider greenways linkage for recreation and recognition of the Ōtāhuhu portage (a site of significance to Mana Whenua). This is considered a positive social effect, both in regard to quality of life and social cohesion but also in respect of recognising the cultural values of this area. There will be an adverse social effect due to the change in the road environment on SH1 (loss of vegetation, and lack of room for more landscaping mitigation), however this is considered to be of low social significance.

c. **Material well-being and quality of life**

In Community Area 1 there will be a positive effect on the community's material well-being through greater access to public transport (which will be more frequent and reliable, especially from Māngere to Onehunga), and access to new and improved walking and cycling networks between Onehunga and Sylvia Park Town Centre for both commuter and recreation use (e.g. 1.3km reduction in travel distance between these destinations). Promoting improved mode choice and enhancing recreation options for residents in this area is seen as a positive social impact on people's way of life and their material well-being, and supports the planned urban growth in the wider Onehunga area (improving recreation facilities to support this future population). In Community Area 2, remaining businesses in the Sylvia Park Road and Great South Road area will experience improved accessibility and travel time reliability, improving business operations and efficiency. Some businesses will be impacted by restrictions to, or closure of, access points (being left turn only onto Sylvia Park Road). In Community Area 3 there will also be improved walking and cycle connections east west on Panama Road, providing improved accessibility for the Panama Road community with Ōtāhuhu/Mt Wellington and between Princes Street East and Princes Street recognising this is an important connection for residents of this area to services (e.g. schools, shops and community facilities), which is considered a positive social effect for the well-being for residents and their quality of life.

Potential adverse social effects include loss of jobs from the permanent acquisition of business land, especially in Community Area 1 and Community Area 2. The option selection process for the Project has avoided acquisition of all businesses as much as possible, but especially those that employ large numbers of people. There are a number of business properties that are affected by the Project; these are generally small-medium sized businesses that employ a smaller number of people than businesses that have been avoided. In addition in Community Area 2 the existing heliport will not be able to continue in its current location during operation of the Project.

The Project will require acquisition of around 62 residential sites. Consequently, there is a loss of residential housing in Community Area 3, including some social housing. This area has a perceived lack of housing choice due to low average house prices and pressures on the housing market throughout the Auckland Region.

d. **Culture and Identity**

As noted above, a key positive social effect relating to culture will be the recognition of sites of significance to Mana Whenua and the general history of the Project area including (but not limited to):

- In Community Area 1: Te Hōpua, the Onehunga Town Centre, Gloucester Park North, Gloucester Park South and the Onehunga Wharf;
- In Community Area 2: Kāretu portage, Anns Creek and the Māngere Inlet foreshore; and
- In Community Area 3: The Ōtāhuhu portage through the connection across the Creek.

The specific impacts on cultural values are discussed in *Section 12.6: Effects on values of importance to Mana Whenua* of this AEE. There are no other notable social effects relating to culture and identity.

12.14.6 Measures to avoid, remedy or mitigate potential adverse effects on social environment

12.14.6.1 Construction

For the construction phase of the Project, a CEMP and its subsidiary plans for noise / vibration, air quality and traffic will be prepared (see *Section 13.1.5* for further details). The CEMP will be the key implementation tool to facilitate the mitigation of adverse effects identified above in relation to quality of the living environment, social cohesion, material well-being as well as culture and identity. As part of the CEMP, it will be required that contractors perform to a high level in relation to managing stakeholder and community expectation, which is an important factor in managing social effects during construction. Communication in particular will be a key tool. This will allow the Transport Agency and contractors to understand how the community feels and ascertain the most appropriate way to manage community concerns as they arise through the construction period. The Transport Agency has considerable experience with communication and engagement and effects management for large transport Projects with multiple key stakeholders and landowners (e.g. the recent Waterview Connection Project and SH16 Causeway Project).

The implementation of the following key actions will mitigate social effects from the Project:

- Establishment of CLGs to minimise potentially adverse effects during construction through awareness of activities and input to obtain community input in to elements of the detailed design;
- Mitigation of the physical effects of construction activities are set out in *Section 12.11: Noise and Vibration*, *Section 12.12: Air quality* and *Section 12.13: Construction traffic* of this AEE. In order to mitigate the effects on residents from these activities, regular communication and liaison will occur, to inform them of works and liaise/respond to specific constraints or issues that they may have. This approach will assist these residents to go on with their lives over the construction period;
- For construction that must occur at night, consideration will be given to moving sensitive residents to alternative accommodation for the duration of the works (e.g. people with young children). This will be particularly relevant for works in Community Area 3 where there is a large amount of residential properties surrounding construction works;
- Preparation of a communications plan which may include communication of construction timeframes on signs close to key community transport linkages to enable the community to plan and be aware of potential disruptions resulting from construction. This plan and engagement materials should specifically consider accessibility of materials for members of the community e.g. offering translation services and a wide range of media for access by visually and aurally impaired people;
- Nomination of a full-time contact phone number for residents to liaise with the construction team on any issues that arise during construction (as a single point of contact);
- Formalisation of a complaints and response process (and monitoring thereof) for the above communications plan;
- Communication of construction timeframes on signs close to key community transport linkages to enable the community to plan and be aware of potential disruptions resulting from construction;
- Early establishment of a recreation space (e.g. field) on the southern Waikaraka Park area to provide for ongoing recreation use and replacement open space during construction in consultation with Auckland Council and the Maungakiekie-Tāmaki Local Board, to offset areas lost and/or disrupted during construction;
- Early planting of open spaces, management of graffiti on the construction site and construction yards and maintaining adequate lighting of those areas identified for public access during construction to provide residents and the community with useable community linkages and open spaces (recognising the disruption to recreation areas during construction);
- Liaison with key businesses and community facilities in construction planning and over the construction period to discuss issues of access and their operations (e.g. traffic diversions). If access cannot be managed then consideration should be given to relocating businesses and facilities, even

temporarily. For example, the Aotea Sea Scouts Hall may need to be relocated or the Club provided temporary facilities if it cannot operate in its location during construction or operation of the Project;

- Work with Auckland Transport to as far as practicable provide a temporary commuter cycle facility;
- Key walking and cycling connections are kept open and closures only occur at night;
- The liaison with businesses to include consideration of pedestrian and vehicle access signage for those businesses whose access will be disrupted or altered by construction works (e.g. signage to provide information on how to access The Landing and motel on Onehunga Harbour Road, during construction of the EWL Trench section);
- Early engagement on the land acquisition process, particularly for properties required in full (to enable people who want to get on with their lives to do so with certainty, including consideration of opportunities for people to stay in the area until necessary (if they do not want to move straight away). This will also enable businesses to understand their options and consider relocating prior to the site being required for construction, also mitigating the potential loss of jobs in the area. Early construction of the coastal path, particularly the section between Old Māngere Bridge and the Alfred Street link to provide access to Waikaraka Park and as a recreation walkway from Onehunga (acknowledging that access to this facility is currently predominantly from the west);
- Provide and sign parking areas to users of the Manukau Foreshore Walkway for the period that the Onehunga Harbour Road parking area is lost in construction (e.g. at Waikaraka Park or in other nominated locations in discussion with Auckland Council and the Maungakiekie-Tāmaki Local Board);
- Provide weekend car parking surrounding the Waikaraka Park and community buildings (e.g. on Captain Springs Road or in the construction yard at Waikaraka Park (south)); Community engagement initiatives to include local events to showcase construction activities and inform people on progress to address potential impacts on community cohesion over the construction programme; and
- Work with The Southern Initiative to promote training and employment opportunities for young people, as per The Southern Initiative objectives. While beyond the RMA, the Agency's procurement processes could include requirements (or use such requirements as an incentive evaluation criteria) for contractors who hire a certain percentage of local people and work with the Transport Agency and The Southern Initiative.

12.14.6.2 Operation

Once the Project is operational, adverse effects will be mitigated by a variety of methods:

- To mitigate adverse effects on people's quality of life from noise and vibration on the road, acoustic barriers will be constructed near private properties as outlined in *Section 12.11: Noise and Vibration* of this AEE. In delivering this mitigation, it is important that residents are consulted both on the site specific design requirements and the implementation programme;
- To mitigate the potential adverse effects on visual amenity and the quality of the living environment there will be landscaping included along the Project. This is outlined in detail in the drawings in *Plan Set 4: Landscape* in *Volume 2.* Opportunities to enhance community outcomes (e.g. community cohesion) include input on design (through the CLG) and potentially community planting days or similar to involve them in the implementation of the Project works;
- Involvement of CLG in detailed design of certain facilities along the route including the bridge over Ōtāhuhu Creek as a walking and cycling connection and alignment with Auckland Council greenways project;
- In order to mitigate impacts on open space areas, there will be reinstatement of the construction yard at Waikaraka Park for recreation facilities in partnership with the Maungakiekie-Tāmaki Local Board and Auckland Council Parks department;

- A signage plan will be prepared for community linkages and connections between walkways and open space/recreation areas (e.g. to Old Māngere Bridge, Taumanu, Gloucester Park, Waikaraka Park, Mutukāroa-Hamlins Hill, and through to Sylvia Park Town Centre); and
- Walking and cycling connections between Panama Road and Frank Grey Place to be undertaken in consultation with the local community and residents, including consideration of design for vehicle crossings where property accessways interface with the shared path.

12.15 Erosion and sediment control

Overview

Construction of the Project will involve land disturbing activities including earthworks and vegetation removal. These activities, if not appropriately managed, have the potential to increase the risk of sediment-laden stormwater runoff being discharged to the receiving environment. The Manukau Harbour, Māngere Inlet and the Tāmaki Estuary are the receiving environments for the Project and both contain areas of ecological value.

Erosion and sediment control measures will be implemented to minimise the effects of sediment runoff and construction stormwater on these receiving environments. These measures will be based on best practice erosion and sediment control in Auckland as set out in Auckland Council and Transport Agency guidelines. Preliminary Erosion and Sediment Control drawings have been prepared to demonstrate how erosion and sediment control could be delivered for the Project. These drawings are contained in *Plan Set 10: Erosion and Sediment Control*.

This section assesses the actual and potential effects of land disturbance activities (earthworks and vegetation clearance). It includes consideration of the erosion and sediment control measures that will be used to minimise sediment discharges from construction stormwater. This assessment is supported by *Technical Report 12: Stormwater Assessment* in Volume 3 and the Erosion and Sediment Control Plans in *Plan Set 10: Erosion and Sediment Control* in Volume 3.

Further assessment of the effects of sediment generated by the Project are also considered to the extent relevant in *Section 12.19: Coastal Processes* and *Section 12.20: Ecology* of this AEE. The ecological effects of vegetation removal are addressed in *Section 12.20: Ecology* of this AEE.

In assessing the actual and potential effects of land disturbing activities, the assessment has considered the following:

- The sediment yield potential across the Project areas; and
- Implementation of appropriate erosion and sediment control measures to manage construction stormwater during land disturbance activities (based on projected sediment yield).

Best practice in Auckland is generally considered to be compliance with Auckland Council GD05 - *Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region*[77] or similar design. In addition, the Transport Agency has its own guidelines, the *Erosion and Sediment Control Guidelines for State Highway Infrastructure: Construction Stormwater Management* (September 2014). This guideline has been prepared with the intention that it will meet or exceed the GD05 guideline.

12.15.1 The receiving environment

The receiving environments for this Project are the Manukau Harbour, Māngere Inlet and the Tāmaki Estuary. They include areas of significant ecological value (which are at greater risk of effects from sediment laden runoff) and areas of degraded water quality. These receiving environments are described

[77] Though not yet operative, this is considered to be best practice. When ratified, GD05 will supersede Auckland Council Technical Publication 90.

in further detail in *Section 11.0: Description of the existing environment* and *Section 12.20: Ecology* of this AEE.

The Project also includes works within watercourses and the discharge of construction stormwater to the freshwater sections of Miami Stream, Southdown Stream, Anns Creek and Clemow Stream. The ecological values of these watercourses is discussed in *Section 12.20: Ecology* of this AEE.

12.15.2 Sediment discharges

The land disturbance activities anticipated during the construction of the Project are set out in *Section 7.0: Construction of the Project* of this AEE. In summary, these involve a number of activities that have the potential to generate sediment (including contaminant laden sediment) including:

- Earthworks, including bulk earthworks, tracking and trenching where rainfall encounters exposed earth;
- Works in and around streams (e.g. culverts, retaining walls, piles and bridges) that disturb and entrain sediment; and
- Disturbance from construction of the road embankment, landscape features and stormwater wetlands in the CMA.

A Universal Soil Loss Equation has been used to determine the potential sediment yield associated with the Project. The Universal Soil Loss Equation is used to identify those parts of a site with a higher sediment generating potential taking into account soil loss, rainfall, soil erodibility, slope length and steepness, vegetation cover and erosion control practices. The Universal Soil Loss Equation calculations are set out in Appendix E of *Technical Report 12: Stormwater Assessment* in Volume 3.

Table 12-19 provides a summary of the estimated sediment yield potential for the Project. This provides the total areas of works and the potential sediment yield assuming there is no erosion and sediment controls installed for the Project, and then the potential yield with controls.

Table 12-19: Sediment yield potential for the Project

Project contributing catchment	Construction footprint	Sediment yield (tonnes per annum)	
		With no ESC	With ESC
Manukau Harbour Catchment			
Neilson Street Interchange	6.18	20.9	7.7
Foreshore Embankment	8.66	75.8	12.9
Southdown Reserve	2.51	25.3	5.6
Anns Creek	0.92	74.5	25.0
Total	**15.6 ha**	**170.6**	**38.2**
Tāmaki Estuary Catchment			
Clemow Stream	1.63	6.6	1.8
Ōtāhuhu Creek	1.54	8.4	2.3
Frank Grey Place	2.13	0.9	0.3
Total	**5.31**	**16.0**	**4.4**

The works within the CMA involve the construction of the embankment, landscape features and stormwater wetlands. The coastal works will require specific controls to minimise the discharge of sediment to the CMA. The assessment of effects associated with work in the CMA, including the

placement of material that has the potential to generate sediment. The fate of sediment when it does enter the CMA is discussed in *Section 12.19: Coastal processes* of this AEE.

The construction of the coastal features including the road embankment, stormwater treatment system and landscape features will commence with the construction of an outer mudcrete bund. This will encapsulate the area, effectively isolating it from tidal influences, and assist in reducing sediment discharges to the Manukau Harbour and the Māngere Inlet. Stormwater flows from the existing upstream catchment will be diverted around the working area through the use of diversion pipework or stabilised channels. Construction stormwater within the working area will be pumped to one or more of the sediment retention devices for treatment to ensure a dry working environment.

Section 6.3 of *Technical Report 12: Stormwater Assessment* in *Volume 3* provides a description of the relevant erosion and sediment control considerations and recommended approach for the areas of particular risk along the alignment including Anns Creek, Ōtāhuhu Creek and the Māngere Inlet foreshore.

12.15.3 Effects of sediment discharge on the receiving environment

Land disturbance activities during construction of the Project can increase the potential for erosion of disturbed earth during rainfall events which in turn leads to an increased risk of sediment-laden stormwater runoff being discharged to the receiving environment, including from contaminated land. Increased sediment in a receiving environment has the potential to have adverse effects, including:

- Damaging aquatic (marine and freshwater) habitats;
- Altering the morphology of streams and the foreshore of the CMA; and
- Reducing the clarity of the water in marine and freshwater environments.

The Manukau Harbour is a depositional environment which currently has a high suspended sediment contribution from the contributing catchments. The construction of the Project has the potential to contribute more sediment into this environment. An assessment of how sediment is transported in and around the Māngere Inlet and the Manukau Harbour is set out in *Section 12.19: Coastal Processes* of this AEE.

While a level of sediment is required for a functioning ecosystem, too much sediment can adversely affect ecosystems by smothering fish, invertebrates and shellfish species. It can also change the clarity and turbidity of the water. The effects of sediment from the Project on marine ecology are set out in *Section 12.20: Ecology* of this AEE.

Works in watercourses such as temporary and permanent diversions and the construction of culverts and other structural elements have the potential to disturb freshwater species and to increase the sedimentation of stream beds. Generally the existing watercourses in the Project area are of low ecological value, however, they still support a range of native freshwater species. The values of these watercourses is discussed in *Section 12.20: Ecology* of this AEE.

The mitigation measures for construction effects on water bodies within the vicinity of the Project are set out in *Section 12.20: Ecology* in Volume 3: *Technical Report 16 - Ecological Impact Assessment*. These includes retaining as much riparian vegetation and utilising temporary diversion measures away from waterway structure construction.

12.15.4 Measures to avoid, remedy or mitigate effects of earthworks and vegetation removal

The Project design has sought in the first instance to minimise land disturbance required during construction to minimise sediment generation. This has been achieved by:

- Reducing the overall construction footprint;

- Minimising land disturbance activities in sensitive ecological areas through the use of structures rather than reclamations, temporary staging for construction and the use of works exclusion areas; and
- Consideration of construction material and techniques particularly for coastal works.

Where land disturbance occurs during construction of the Project, both erosion control and sediment control measures can minimise the effects of construction stormwater on receiving environments. Erosion control does this by preventing sediment generation, and sediment control by managing sediment once it is generated.

Preliminary Erosion and Sediment Control drawings have been prepared to demonstrate how erosion and sediment control could be delivered for the Project. These drawings are contained in *Plan Set 10: Erosion and Sediment Control* in Volume 2.

There are a number of best practice land management techniques that can be used to reduce the amount of sediment discharged into receiving environments during land disturbance activities. This includes for discharge from disturbance of contaminated land. Both structural (physical) and non-structural (site management and staging of the works) measures will be employed with an emphasis placed on non-structural practices in the prevention of erosion in the first instance such as appropriate staging and sequencing of works.

Erosion and sediment control for the Project will likely involve the following approaches:

- Staging of the works:
  - Minimising the extent of disturbed earth required for the construction of the Project; and
  - Phasing construction operations in response to forecast and actual weather patterns.
- Installation of perimeter controls (predominantly earth bunds and drains) to:
  - Divert clean runoff away from the land disturbance area; and
  - Divert sediment laden runoff to the sediment retention devices.
- Rapid and progressive stabilisation of disturbed areas to:
  - Reduce the erosion potential of disturbed areas; and
  - Reduce the level of sediment generated during construction.
- Installation of sediment control devices, being:
  - Sediment retention ponds, or alternative sediment control devices;
  - Decanting earth bunds (where there is insufficient space to use ponds);
  - Silt fences and Super Silt Fences;
  - Silt socks and; and
  - Stormwater – inlet protection.

The decanting earth bunds and sediment retention ponds will be sized based on a 3% Catchment Criteria (30 m^3 per 1,000 m^2 catchment) in accordance with Auckland Council guidelines. Chemical treatment in the form of flocculant may be used to improve the effectiveness and efficiency of sediment retention ponds and decanting earth bunds. Flocculant can improve efficiency of devices by between 15-20% depending on the particular measure. The flocculant aids in the settlement of suspended sediment by causing sediment particles to join together to form larger particles and settle much more rapidly. Flocculant dosing will be via rainfall activated flocculant sheds. The flocculant dosing regime will be informed by bench testing of soil samples from both in-situ material and imported fill to determine the

most effective type and dosing rate of flocculant. The flocculant dosing rate may vary across the project due to the variance in soil conditions.

Erosion and sediment control measures must be installed prior to the commencement of land disturbance and maintained until the site is stabilised against erosion. The erosion and sediment control measures will be installed progressively, in advance of land disturbance activities and will be staged in co-ordination with planned earthworks and site preparation activities.

Once the erosion and sediment controls are in place, site monitoring by the contractor and the Transport Agency will occur to check that the proposed erosion and sediment control measures have been installed correctly and continue to function effectively for the duration of the works. In addition, water quality and visual assessments of the receiving environment will be undertaken during the works with particular attention being paid during and after periods of rainfall. Any noticeable change in water clarity in the receiving environment from that previous to the rainfall event and downstream of the earthworks activity will result in a review of the erosion and sediment control measures implemented and earthworks activity and changes made as necessary.

Where sediment retention measures capture sediment from areas of contaminated land, depending on the level of contamination, sediment removed from the sediment retention ponds and decanting earth bunds may need be disposed of to an appropriately managed facility. In the landfill areas along the foreshore (e.g. at Galway Street and the Pikes Point landfills), construction stormwater runoff from exposed landfill material will need to be discharged to the trade waste system for appropriate treatment.

The Preliminary Erosion and Sediment Control Plan drawings contained in *Plan Set 10: Erosion and Sediment Control* in Volume 2 will be finalised once the construction contractor(s) is appointed.

In addition to the Project-wide ESCP, it is expected that Construction Erosion and Sediment Control Plans (CESCPs) will be developed which will set out in detail how the construction will be carried out to meet the performance standards set out in the Transport Agency and Auckland Council guidelines. For example, Anns Creek is identified as particularly sensitive and challenging to control all discharges; therefore a CESCP will be appropriate for this location. The CESCPs will take cognisance of any requirements of the CLMP with regards to the presence of contaminants in any earthworks areas (see *Section 13.1.5g*) for further details of the CLMP).

The preparation of CESCPs prior to construction commencing will allow Auckland Council to have further input into the development of the proposed methodologies for specific sites and activities. Further details of the ESCP and the CESCP, including contents of those plans, is set out in *Section 13.1.5f* of this AEE.

The assessment of erosion and sediment control and the Preliminary Erosion and Sediment Control drawings contained in *Plan Set 10: Erosion and Sediment Control* in Volume 2, demonstrates that accepted erosion and sediment control measures and practices can be applied and acceptable sediment reductions achieved during construction of the Project.

12.16 Groundwater

Overview

The Project will have beneficial effects on groundwater flow in particular it will assist in improving the quality of groundwater and leachate from existing controls of landfills, discharging into the Māngere Inlet. This will be achieved by:

- The road embankment, landscape features and stormwater wetlands providing attenuation of contaminants (leachate) travelling in groundwater through the existing landfills;
- Improving the effectiveness of the Pikes Point leachate interception system and providing continuous on-site treatment of leachate in new stormwater wetlands; and
- The road embankment, landscape features and stormwater wetlands reducing saline ingress to existing landfills therefore contaminant flushing by creating a physical barrier.

The Project will result in a small rise upgradient (upstream) in groundwater level at the EWL Trench adjacent to Onehunga Wharf and between Galway Street and Waikaraka Cemetery. This has been addressed through design adjustments in specific localities to minimise effects. In particular, a more permeable embankment is proposed adjacent to Waikaraka Cemetery where existing groundwater levels are already very high.

Overall the Project is expected to have positive effects on groundwater (or leachate) contaminant levels and quality.

12.16.1 Introduction

This section assesses the actual and potential effects of the Project on groundwater levels and flow. A detailed description of the groundwater effects is contained in *Technical Report 13: Groundwater Assessment* in Volume 3.

Changes in groundwater levels can result in ground settlement. The effects associated with settlement from both groundwater and mechanical-related settlement are assessed in *Section 12.17: Ground Settlement* of this AEE.

The groundwater assessment involved developing a ground model and a conceptual groundwater model to provide an understanding of the ground conditions in the wider Project area. The models were informed by geological investigations and groundwater level monitoring to fill gaps in understanding of the ground conditions. The models were used to simulate existing groundwater levels and flow conditions and to investigate groundwater movement with the Project in place and particularly in and around the road embankment at the foreshore.

12.16.2 Existing environment

Within the Project area, groundwater flows:

- From elevated ground (generally volcanoes largely comprised of basalt) and discharges to the coastal areas of the Māngere Inlet as springs at the original inlet shoreline;
- From basalt flow margins into Anns Creek and Ōtāhuhu Creek; and
- Through the basalt margins offshore. Anns Creek, underlain by Tauranga Group alluvium, also drains water from Mutukāroa-Hamlins Hill (Waitematā Group sandstone and mudstone).

The Onehunga Bay and Māngere Inlet foreshore have been progressively reclaimed with landfill and engineered fill extending up to 500m inland from the present foreshore. There are four areas of landfill

within the Project: the Gloucester reclamation in Te Hōpua; Galway Street Landfill; Pikes Point East; and Pikes Point West closed landfills.

The main source of groundwater recharge is rainfall infiltration, both directly as rainfall and through stormwater soakage pits. Saline water ingress to basalt occurs beneath the Galway Street closed landfill and through the overlying landfill material and Miami Stream. Groundwater is lost from the system as springs, by groundwater abstraction, discharge to the harbour, and also by leachate interception from the Pikes Point closed landfills.

There are a number of groundwater abstractions in the Onehunga area. The main abstraction of water is by Watercare for public water supply. Watercare has four production wells (although only two are currently operational) with a total consented maximum take of 30,000m^3/day (8.5 Million m^3/year). Watercare has a consent condition to maintain a minimum water level in the wells of 0.5m above sea-level, however it is understood that the average maximum combined daily take is just over 100 l/s (around 22,000m^3/day) and pumping is generally maintained at around 1.8m above sea-level. Applications for new consents to replace those existing consents have been lodged by Watercare and are being processed by Council.

There are three spring-fed streams in the wider area discharging from basalt: Miami Stream, Captain Springs and Bycroft Stream. The latter two are located in Onehunga, inland from the Project and are not affected by the Project.

A leachate interception system, owned and operated by Auckland Council, is installed through landfill on the inside of the sea walls at Pikes Point West and East landfills. Typical volumes of leachate discharged to Watercare's trade waste from the leachate interception system at Pikes Point landfill are in the order of 50,000m^3 to 70,000m^3 per year (which is 140-190m^3 per day).

There is evidence of saline intrusion and leachate in the groundwater, especially along the foreshore area. Leachate is evidenced by high concentrations of copper, zinc and ammoniacal nitrogen. The ammoniacal nitrogen in particular exceeds the acceptable marine water quality guideline values by up to 50%.

12.16.3 Effects on groundwater

12.16.3.1 Landfill leachate interception and treatment

The Project will result in positive effects for leachate interception and treatment including improved effectiveness and on-site treatment.

Investigations of existing leachate quality in groundwater showed that concentrations of copper, zinc and ammoniacal nitrogen exceeded the *Australia New Zealand Guidelines for Fresh and Marine Water Quality* 90% Marine Water Quality guideline values in the majority of bores tested, and many also exceeded the guideline for cobalt and lead. Contaminant concentrations were most elevated in groundwater samples around the Galway Street Landfill.

The construction of the road embankment, landscape features and stormwater wetlands between Galway Street and Waikaraka Cemetery has the potential to attenuate contaminants travelling in groundwater through the landfill (leachate). These might otherwise enter the basalt beneath the landfill and discharge directly to the Māngere Inlet. This will reduce the concentrations of contaminants entering the inlet. The travel time range increases from 200% up to 500% compared to at present. The construction materials for the foreshore have been selected to optimise these travel times with an inner granular (permeable) section and a toe down to tuff or basalt and outer section constructed from mudcrete or similar (a low permeability material). At times of high rainfall, groundwater levels on the landward side of the embankment may rise and will discharge directly to the stormwater wetlands on the seaward side. The lengthening of travel times would not be achieved on such occasions but treatment will occur in the wetland system.

East of Waikaraka Cemetery, the road embankment will be constructed partly on land. This means that the road embankment will sit on the Pikes Point West and East landfills and will cover the leachate interception system at the landfills, necessitating its replacement. The location of the existing leachate interception system is shown on Figure 12-21.

Figure 12-21: Location of the existing leachate interception system

The replacement leachate interception system consists of a trench excavated through the landfill down to tuff or basalt and filled in part with low permeable material on the seaward side to act as a cut-off drain and in part with gravel. The replacement leachate interception system shown on the drawings in *Plan Set 9: Stormwater* in Volume 2. A perforated pipe will take leachate from the gravel section of the trench through the embankment and discharge it into the stormwater wetlands. It is anticipated that an average of 140-190m^3/day will be collected and discharged to the foreshore wetlands. The wetlands have been sized to accommodate the groundwater from the leachate interception system. The groundwater from the leachate interception will be will be directed into the stormwater wetlands in Landform 2 at an expected rate of 40m^3/day and into Landform 3 at a rate of 100m^3/day. At these volumes, the groundwater from the leachate interception system is a small proportion of the total volume of the stormwater wetlands. Provision has been made for pumping to the Watercare wastewater system as a back-up to the gravity system if monitoring indicates pumping is needed under exceptional circumstances to reduce groundwater level in the landfill (e.g. during a prolonged period of rainfall). Confirmation of the concentrations of contaminants within the leachate will be undertaken to confirm its suitability to be discharged into the stormwater wetlands.

Provision for removal of leachate by pumping will be made so that pumps could be installed and leachate removed if monitoring indicates pumping is needed under exceptional circumstances during construction to reduce groundwater level in the landfill.

The Project will improve the effectiveness of the Pikes Point leachate interception system and provide continuous on-site treatment in new stormwater wetlands. This will reduce existing contaminant (leachate) discharge to the Manukau Harbour and Māngere Inlet and avoid the need for pumping and transfer of both leachate and (potentially) clean water for treatment off site. Investigations of existing leachate quality in groundwater suggest that the leachate can be treated with stormwater in the wetlands. If further monitoring indicates higher levels of contaminants than expected, then pre-treatment could be achieved via a treatment system which will be installed within the road embankment. The monitoring associated with this is discussed further in *Section 12.16.4* of this AEE.

The Project will reduce saline ingress to existing landfills by creating a physical barrier to prevent salt water from entering the landfills. The contaminated material beneath the road will be removed from site to an approved disposal site. The design also means that the landfill remaining beneath the road will not receive any further water as it will be essentially sealed from upgradient flow, from saline ingress and

from surface ingress. This means that piles installed to support the road along this section will not form permanent pathways for leachate travel into the underlying basalt.

12.16.3.2 Changes in groundwater levels

The modelling of changes to groundwater from the Project indicate a raising or lowering of groundwater at some locations. This may have both positive and adverse effects.

A small rise in groundwater levels is expected on the upgradient side of the EWL Trench and lowering of groundwater on the down-gradient side. The structure will result in a rise in groundwater level of 250 to 350mm on the upgradient side of the trench reducing to 100mm approximately 250m inland.

There may also be a raising of the groundwater level from the road embankment where it is placed immediately adjacent to or over the Pikes Point landfills in the Māngere Inlet.. Changes in groundwater levels may result from the mounding of groundwater beneath or draining of groundwater into the proposed stormwater wetlands. These wetlands are illustrated in *Plan Set 9: Stormwater* and are:

- Wetlands in Sector 1 will be unlined and will result in small rises in groundwater levels that are not noticeable due to its location close to the coast;
- The wetland in Sector 3 will be adjacent to Hugo Johnston Drive and will not result in any changes to groundwater levels. The presence of asbestos on this site does not affect groundwater quality; and
- The wetland in Sector 5 is the enlarged existing Frank Grey Place unlined stormwater pond. The changes to groundwater levels are less than 50mm and will therefore not be distinguishable from normal groundwater level variations.

There will be a rise in groundwater levels at the Galway Street Landfill due to the EWL Trench and the controlled discharge of leachate through the embankment. This will result in a small rise in groundwater of 100mm extending 300m to 400m inland. The very small magnitude of groundwater level rise would not result in adverse effects.

Along the foreshore, there are areas that already have high existing groundwater levels. The eastern part of Waikaraka Cemetery has existing groundwater levels at less than 1m below ground level. This is likely to be due to the discharge of Captain Springs upgradient of this area and the incomplete capture of spring water in pipework. The effect of the embankment and adjacent lined stormwater wetland at this location raises the average groundwater level by 250mm to 350mm within 200m to 400m of the embankment. This brings the average groundwater level close to the ground surface. The replacement leachate interception system at the Pikes Point West landfill will help to limit the extent of this groundwater level rise, however alternative designs have been considered for the embankment to further limit this effect. These are discussed further in Section 12.16.4 of this AEE. If unmitigated, these changes in groundwater levels could result in adverse effects, particularly at Waikaraka Cemetery, however the proposed design mitigates this potential effect.

East of the Waikaraka Cemetery, the road embankment will be constructed in part over the existing Pikes Point West and East landfills, necessitating replacement of the existing leachate interception system. This results in a rise in groundwater levels of 100mm within 40m of the embankment, and 50mm at 60m to 80m inland. The very small magnitude of groundwater level rise would not result in adverse effects.

The road extension at Hugo Johnston Drive will result in consolidation of the underlying Tauranga Group sediments. This will result in less than 50mm change in groundwater which will not have a measurable effect.

At the SH1 bridge widening across Ōtāhuhu Creek, cuts required to facilitate the widening are less than 1m deep and well above groundwater level. No effect on groundwater is anticipated. Work at the Princes Street Interchange will require local cut of up to 2.5m. This cut will also be above groundwater level and therefore no effect on groundwater is anticipated.

Elsewhere, the Project will be constructed above groundwater level. Local embankments will be constructed which might result in local consolidation of sediments beneath and a small reduction in permeability, however no measurable change in groundwater level is expected.

12.16.3.3 Wetlands and Streams

The effects of the Project are largely small rises in groundwater level, rather than drawdown. The extent of groundwater level rise does not reach Bycroft Reserve, Captain Springs or Anns Creek. No effect on groundwater contributions to existing wetlands and streams is anticipated.

12.16.3.4 Groundwater Users

The Project is expected to result in small rises in groundwater level locally. The extent of effects does not reach any existing groundwater take. The Project will not impact any existing groundwater users.

12.16.4 Measures to avoid, remedy or mitigate effects on groundwater

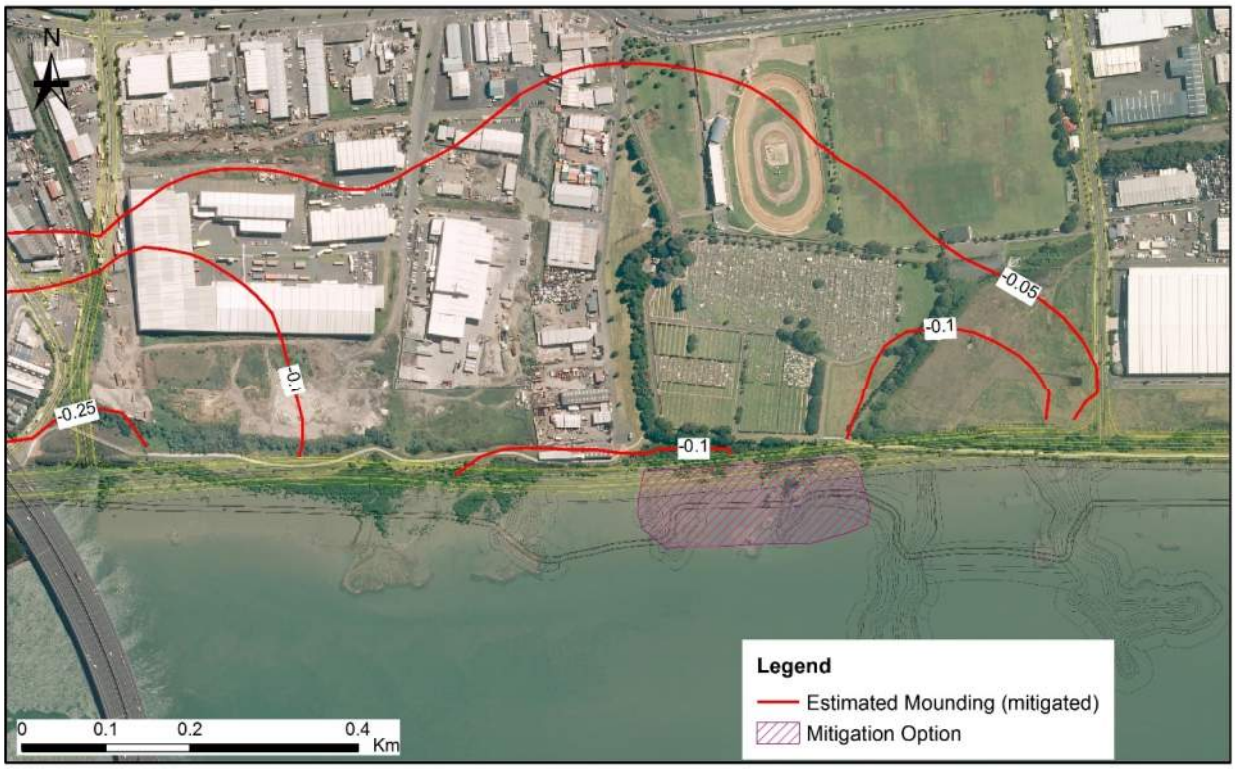
Potential effects on groundwater have been largely mitigated through the design of the Project.

The assessment indicates that the Project could result in adverse effects from the mounding of groundwater level beneath Waikaraka Cemetery due to already elevated groundwater levels in this location and the construction of the foreshore embankment.

To mitigate this, an alternative design is proposed for the embankment along this section. Marine muds proposed for the embankment will be replaced with a permeable material such as gravel over the depth of the basalt, and the stormwater wetland will be constructed above the gravel. This will allow groundwater to continue to discharge through the basalt. The magnitude of groundwater level rise can be reduced from 250mm-350mm within 200m-400m of the embankment to 100mm-150mm within a much reduced extent. The mitigated change in groundwater levels is shown in Figure 12-22.

The alternative design solution substantially avoids the groundwater level rise at Waikaraka Cemetery.

Figure 12-22: Mitigated change in groundwater levels as a result of the Project
(contours are in metres; negative number indicates groundwater level rise)



Monitoring is proposed during and following construction of the works between the Neilson Street Interchange and Anns Creek to:

- Confirm that the observed effects on groundwater levels do not exceed those modelled. If higher groundwater levels are observed, this may trigger the need for additional drainage that can be introduced following construction;
- Confirm that groundwater levels and quality in the Pikes Point East and West closed landfills are not raised in level by the installation of the embankment and replacement leachate interception system. If not then pumps installed as part of the works will be activated to remove excess leachate until groundwater is returned to a satisfactory level; and
- Confirm that the concentrations of contaminants within leachate means that it can continue to be treated in the stormwater wetlands. If not then pumps installed as part of the works will be activated to remove excess leachate until contaminants are returned to a satisfactory level.

The above measures and corresponding actions will be contained within the groundwater monitoring section of the CEMP to be implemented when undertaking the works. Further discussion of the CEMP is contained in *Section 13.1.5a* of this AEE.

12.17 Ground settlement

Overview

Construction of the Project requires cutting and filling of ground surfaces at a number of locations along the alignment. The areas surrounding these locations can experience ground settlement due to the mechanical settlement of ground from the movement of retaining walls, the consolidation of the ground due to lowering of the groundwater and consolidation or compression of the ground due to the construction of fills. This can result in total settlement and differential settlement which can affect buildings and structures, services and transport infrastructure.

Anticipated settlement has been modelled for the Project. This shows that ground settlement immediately beyond the Project footprint will typically be in the range of 0 – 10mm. This level of settlement will result in negligible effects on the structural integrity of adjacent buildings, services or transport infrastructure.

Mechanical and consolidation settlement associated with the proposed EWL Trench adjacent to Onehunga Wharf have been assessed as negligible and may extend a modest distance from the structure. Monitoring requirements will be developed and implemented for particularly sensitive infrastructure and in the vicinity of the EWL Trench. The monitoring will confirm the predicted settlement effects and allow management measures to be implemented should effects exceed those identified in this assessment.

Predicted ground settlement can be accommodated within the design of the Project or appropriate measures implemented to mitigate effects resulting in negligible residual adverse effects.

12.17.1 Introduction

This section presents the findings of investigations undertaken to determine the actual and potential effects of the Project from ground settlement. This assessment is supported by *Technical Report 14: Settlement Effects Assessment* in *Volume* 3.

The assessment of groundwater effects is set out in *Section 12.16: Groundwater* of this AEE.

12.17.2 Existing Environment

12.17.2.1 Geology

The geology of the Project area is explained in the *Section 11.0: Description of the Existing Environment* of this AEE. The features of particular relevance to the assessment of settlement effects are set out below.

The western portion of the Project area is comprised of basalt lava and tuff overlain and locally interbedded with a variable thickness of Tauranga Group alluvium, which comprises pumiceous silt, sand and gravel with muddy peat and non-welded and alluvially reworked ignimbrite and tephra.

The basalt flows are bound to the east by an uplifted block of Waitematā Group sandstone and siltstone, although some lava and tuff from Mt Wellington volcano has flowed around the block from the north east in the area of Anns Creek.

Uncemented dense to vesicular sand to gravel sized basalt fragments are mapped as underlying the area between Alfred Street and Captain Springs Road and north to Patrick Street. The ash/tuff also forms a lobe between Angle and Edinburgh Streets extending into the foreshore.

Recent marine sediments (part of the latest Tauranga Group) overlie the Manukau Lava Field and older Tauranga Group soils at the coastal margin and offshore, and partially infill at Te Hōpua (Gloucester Park).

The Onehunga Bay and Māngere Inlet foreshore have been progressively reclaimed with landfill and engineered fill extending up to 500m inland from the present foreshore.

Eastwards from Māngere Inlet, Waitematā Group rock underlies the north eastern end of Anns Creek, the southern part of Great South Road and Sylvia Park Road. Lithic tuff, comprising broken up pre-volcanic materials, basalt fragments and unconsolidated ash and lapilli, is mapped as underlying the area between Abattoir Lane and Portage Road to SH1, north towards Sylvia Park Road and south to Ōtāhuhu Creek. The tuff is thought to be sourced from the Mt Richmond and McLennan Hills craters which last erupted some 30,000 years ago. Pumiceous mud, sand and gravel with muddy peat and lignite beds, non-welded ignimbrite, tephra and alluvially reworked tephra of the Puketoka Formation (also part of the Tauranga Group) occur locally beneath part of SH1 adjacent to Sylvia Park and adjacent to Ōtāhuhu Creek.

12.17.2.2 Buildings, service and transport infrastructure

The majority of the existing building stock within the Project area can be characterised as low-rise industrial, commercial and residential buildings. A medium-rise building is currently being constructed adjacent to Te Hōpua. The building stock comprises a number of construction types, however, for the purposes of assessing susceptibility to the effects of settlement, it was considered appropriate to group them into two broad types being:

- Type A buildings are those that are expected to be susceptible to visual cracking in the event of slight differential ground movement due to cladding type (i.e. unreinforced concrete block walls, brick and mortar, glass panels, plaster or stucco); and
- Type B buildings are those that are expected to be susceptible to visual cracking in the event of slight differential ground movement (i.e. timber, steel cladding and precast reinforced concrete walls/panels).

Further detail of the existing building stock is provided in Appendix D of *Technical Report 14: Settlement Effects Assessment* in Volume 3. There are limited buildings along the Project that would be particularly sensitive to settlement due to their building type. Exceptions include The Landing and Aotea Sea Scouts Hall which have heritage value.

The Project area includes typical residential and industrial network utilities as well as major, regionally significant network utilities as described in *Section 11.0: Description of the existing environment*. The network utilities are shown on *Plan Set 12: Utilities Relocation* in *Volume 3*. Further detail regarding the existing utilities is provided in *Section 6.0: Description of the Project* and assessed in *Section 12.5: Network Utilities* of this AEE.

Transport infrastructure within the Project area is described in *Section 11.0: Description of the existing environment* and assessed in *Section 12.2: Traffic and Transport* of this AEE.

12.17.3 Assessment Methodology

12.17.3.1 3D Settlement Prediction Model

The settlement effects assessment included a desktop assessment of Auckland Council records for historic investigations that have taken place within the vicinity of the Project over the past 30 years. From this, gaps were identified for areas requiring further examination by field investigation. Information gained from the field investigation included the soil and geologic profile, the in situ strength of the material and samples for geotechnical and environmental testing. The information from the desktop assessment and the field investigation fed into a model producing 3D maps which was utilised for risk analysis of ground

settlement across the Project designation and the surrounding properties. The same model was used in the groundwater assessment set out in *12.16: Groundwater* of this AEE.

This assessment considers the potential effects based on the estimated settlements that give the highest risk of damage.

12.17.3.2 Types of ground settlement

Ground settlement comprises two key measures; total settlement and differential settlement. Total settlement is the maximum amount a structure has settled with respect to its original position. Differential settlement represents the change in the ground surface slope between any two different locations that are settling at different rates. The potential for settlement to result in damage to structures depends more on differential settlement rather than total settlement. For damage to occur, a structure must be subjected to differential settlement that will result in structural distortion.

There are three potential sources of total and differential ground settlement associated with construction of the Project. These are discussed below.

Mechanical settlement of the ground due to the movement of retaining walls

This settlement results from movement of a retaining wall as it is loaded. The load is applied as material is either excavated in front of the wall or is backfilled behind it. The resulting lateral displacement of the wall most commonly translates to a vertical settlement above it, and will occur in close proximity to the rear of the wall. These settlements will occur relatively quickly, during or immediately following wall construction. Where retaining walls are used to support fill in areas of relatively weak ground there is also the potential for ground settlement to occur below and beyond the toe of the wall.

Consolidation or compression of the ground due to the construction of fills

Consolidation or compression of the ground occurs when fill is placed on weak underlying non-engineered fill, urban refuse (landfills), soft recent marine sediments and, possibly, undifferentiated Tauranga Group deposits. Consolidation settlement is time-dependant, and directly related to the nature, thickness and permeability of the underlying materials. For this project, the majority of this settlement will occur during the construction period, with ongoing secondary consolidation and creep settlements continuing at a reducing rate post construction.

Consolidation of the ground due to lowering of the groundwater

Temporary lowering of the existing groundwater level may occur during construction due to the excavation required to prepare a foundation platform. These changes in the groundwater regime are discussed in detail in *Technical Report 13: Groundwater Assessment* in Volume 3. The lowering of groundwater levels cause a reduction in pore water pressure and therefore an increase in effective overburden pressure. This will result in compression of the fill, marine sediments or Tauranga Group deposits over time. The consolidation settlements are time-dependant, and influenced by the amount of groundwater drawdown, and the nature, thickness and permeability of the underlying material and the existing seasonal variation in groundwater levels.

12.17.3.3 Severity of settlement

The Burland[78] method has been used to assess the severity of potential effects on nearby buildings. This method involves assigning a category of damage which identifies the typical damage likely to result from

[78] Burland (2012) – "*Building Response to ground movements*", Volume I, ICE Geotechnical Manual, Institution of Civil Engineers.

settlement. The five categories range from Category 0-Negligible through to Category 5-Very Severe. The cut off for this screening is a maximum slope of 1/500 and a building settlement of 10mm (which is within the general seasonal ground movement range experienced in Auckland). These limits are considered by Burland to provide a conservative basis for identifying buildings requiring further investigation. None of the buildings considered by the assessment are identified as requiring further study. As ground settlement beyond the Project footprint is not expected to be extensive, the conservative (Category 0, Negligible) approach to identifying susceptible buildings has been utilised.

12.17.4 Assessment of ground settlement effects

The design and indicative construction methodology for the embankment and large retaining walls is set out in *Section 7.0: Construction of the Project*. Settlement in some areas will occur over the Project construction period while in some areas settlement may continue into the operational phase at reducing rates. Mechanical settlement from the construction of retaining walls will occur during the construction phase.

The assessment that follows is divided into three distinct areas: effects on building and structures, effects on services and effects on transport infrastructure.

12.17.4.1 Effects of settlement on buildings and structures

The location of the Project combined with the proposed construction methodology means that there is a negligible risk of structural damage to buildings during construction and operation of the Project. Across the Project, the predicted settlement beyond the Project footprint is less than 10mm and therefore the assessment of building damage category is “Negligible” using the Burland method.

Within Sector 1, excavation of the EWL Trench adjacent to Onehunga Wharf has the potential to cause both mechanical and consolidation settlement extending a modest distance from the structure. The effects on nearby buildings and infrastructure are still assessed as negligible (i.e. less than 10mm). There are a number of buildings, including The Landing heritage building, which are located in close proximity to the EWL Trench.

12.17.4.2 Effects of settlement on services

There are a number of existing services crossing or in close proximity to the proposed alignment that may be impacted by settlement. Close liaison with utility operators will be required through the design and the construction phase of the Project. Existing rail lines and shallow founded transmission towers will need to be monitored, utility operators consulted and some utilities may need to be relocated or protected (refer to *Section 12.5: Network Utilities*).

Predicted total settlement contours have been combined with the as-built service drawings to show the potential settlement effects on services located outside the alignment. This shows that construction of the Project will have negligible adverse effect on services along the alignment due to relatively small changes in grade and horizontal strain. The services within the Project that will need protection or relocation during construction for various reasons, including for settlement related effects, are identified on the drawings in *Plan Set 12: Utilities Relocation* in Volume 2.

12.17.4.3 Effects of settlement on transport infrastructure

Effects on transport infrastructure result from changes in road gradients as a result of settlement. The calculated level changes to roads which are not being reconstructed as part of the Project are less than 10mm which is considered negligible.

The existing rail line located south of Great South Road/Sylvia Park Road intersection has been assessed and falls outside the area of predicted settlement for the Project meaning that no settlement is expected. Settlement monitoring can be used to confirm no detectable settlements extend to the railway if deemed necessary by KiwiRail. Discussion with KiwiRail regarding potential settlement is ongoing.

12.17.5 Measures to avoid, remedy or mitigate potential adverse ground settlement

The effects of ground settlement on buildings and infrastructure outside the Project footprint are anticipated to be negligible (i.e. less than 10mm). Ground settlement monitoring will be undertaken during the construction of the EWL Trench adjacent to Onehunga Wharf to confirm the assessed settlement and to monitor effects.

The settlement monitoring associated with the EWL Trench will involve ground and building markers that are monitored at set intervals before, during and following construction to identify any settlement greater than that anticipated and to allow appropriate remedial actions to be taken. The Landing building is a listed heritage building located relatively close (approximately 30m) to the EWL Trench. In addition to building settlement markers, structural monitoring in the form of pre-and post-construction structural condition surveys is proposed and will be included in the CEMP. This is due to the building's heritage values and construction type (it is constructed of concrete and is unlikely to be reinforced). Construction methodologies will be altered to respond to vibration and settlement effects.

Some infrastructure such as rail lines and existing transmission towers on shallow spread foundations, is particularly sensitive to changes in grade due to ground settlement. Consultation with utility operators will continue during the detailed design and construction of the Project to confirm the need for any specific protection or monitoring of assets during construction (where these are not already proposed for relocation). If required, this could include pre-construction surveys and ongoing monitoring during construction to allow appropriate remedial actions to be taken. The preparation of the NUMP requires confirmation of specific protection or monitoring of assets with network utility operators and documentation of these requirements. Further discussion of the NUMP is contained in *Section 13.1: Project delivery framework*.

12.18 Contaminated land

Overview

The Project area has a large number of known (and potentially unknown) contaminated areas from a wide range of historic and current hazardous activities and industries including extensive modification of the original coastline of the Māngere Inlet.

Construction management measures are proposed to minimise effects of works in contaminated land during construction. These include measures applied generally across the whole project and specific measures for works within sensitive areas: the Galway Street Landfill, Pikes Point East and West Landfills and the asbestos contaminated site at 141-199 Hugo Johnston Drive. These measures will be documented in the final CLMP for the Project.

There will be beneficial outcomes from the Project through capture of discharges from contaminated land, including leachate from the replaced Pikes Point leachate interception system, and treatment within the new stormwater wetlands.

The Project area has a large number of known (and potentially unknown) contaminated areas, arising from a long history of industrial and commercial uses and activities, and through extensive modification of the original shoreline. This section assesses the actual and potential effects of the Project as a result of disturbance of contaminated land. These include the potential discharge of contaminants to air, land and water (surface and groundwater) where there may be an effect on the environment or an effect on human health. This assessment is supported by *Technical Report 17: Contaminated Land* in Volume 3 (which relies on *Technical Report 12: Surface Water* and *Technical Report 9: Air Quality* in Volume 3).

To identify known and potentially contaminated sites, a Preliminary Site Investigation (PSI) was undertaken within the Project area as well as the wider catchment of Onehunga, Te Papapa, Penrose and Ōtāhuhu. The PSI is contained in Appendix A of *Technical Report 17: Contaminated Land Assessment* in Volume 3.

A PSI was the chosen methodology for identifying the actual and potential contamination present in the Project area because there is so much known contaminated land present, and it is of a very wide-ranging nature. The PSI was prepared according to the Ministry for the Environment, *Contaminated Land Management Guidelines*[79].

In accordance with the NES Soil, the PSI assessed the actual and potential risks to human health posed by the Project as they relate to contaminants in soil.

For the purposes of better understanding the nature of contamination present in the area, and to inform the development of the design, soil contamination testing was performed at drilling sites completed for geotechnical and groundwater assessment purposes. The results are summarised in *Technical Report 17: Contaminated Land Assessment* in Volume 3.

A full suite of management measures will need to be employed across the site to appropriately manage the wide range of potential (and often unknown) materials present. These measures are discussed in further detail in Section 12.18.3 of this AEE.

[79] Ministry for the Environment, *Contaminated Land Management Guidelines, Number 1, Reporting on Contaminated Sites in New Zealand* (Revised 2011).

12.18.1 Existing areas of known and potentially contaminated land

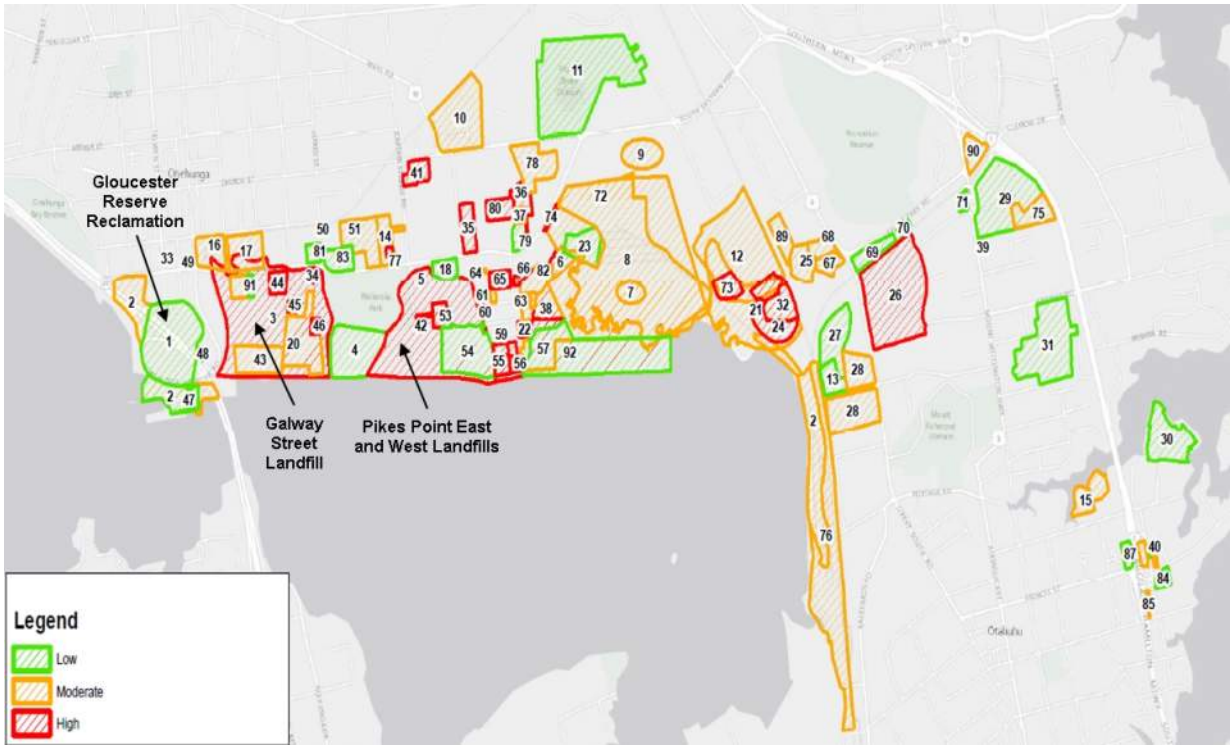
The Project area has a large number of known (and potentially unknown) contaminated areas, arising from a wide range of historic and current hazardous activities and industries including extensive modification of, and filling within, the original coastline of the Māngere Inlet. Some filling has also occurred (albeit on a much smaller scale) at Ōtāhuhu Creek.

The activities that are particularly relevant to the assessment of effects include:

- Areas where landfills received municipal solid waste continuing until the 1980's;
- Areas with uncontrolled fill;
- A range of historic hazardous activities and industrial land use activities including horticulture, industrial and commercial land uses; and
- Ongoing (current) industrial and commercial land uses.

The potentially contaminated sites are shown on Figure 12-23. The red, orange and green sites represent high, medium and low risk sites based on the potential risk posed by contamination. Further discussion of each site (identified by the numbers on the figure) is contained in the Contaminated Sites Inventory (Appendix A1 of the PSI (Appendix A) in *Technical Report 17: Contaminated Land Assessment* in Volume 3*)*.

Figure 12-23: Potentially contaminated sites within the wider Project area



Included within the sites shown above are former landfill areas managed by Auckland Council as closed landfill. The most significant of these are:

- Galway Street Landfill (also referred to as the 75 Acre Reclamation) (Site 3); and
- Pikes Point East and West Landfills (Site 42).

Geotechnical investigations reviewed for the PSI have shown that these landfills to do not incorporate modern landfill design elements such as low permeability liners or caps to restrict rainfall. Therefore, the leachate from the landfill areas is likely to be contaminating the surrounding soil and groundwater. The contaminants of concern within these areas are likely to be metals, polycyclic aromatic hydrocarbons, semi volatile organic compounds, volatile organic compounds, microbiological, nutrients, asbestos and landfill gas.

On the Onehunga Foreshore there is currently a leachate interception trench operated by Auckland Council within the Pikes Point East and West landfill areas. The existing system is described in *Section 6.0: Description of the Project* of this AEE.

12.18.2 Effects of working on contaminated land

Although there are extensive areas of contaminated land with the Project area, the extent of excavation within those sites is relatively limited. The following sections assess the potential effects during construction and operation of the Project.

12.18.2.1 Construction Effects

The actual and potential construction effects from disturbance and discharge of contaminated land can impact:

- The environment from the disturbance of contaminants and associated discharge of contaminants to air, land and water (surface and groundwater) (as a matter covered by regional plans); and
- Human health – including site workers and/or the public from the discharge of contaminants (as a matter covered by the NES Soil).

a. **Effects on the environment**

The disturbance of contaminants and discharges to the environment will occur from earthworks in contaminated land. This could result in potential discharge through:

- Percolation of contaminants into groundwater;
- Overland flow (runoff) of contaminants from exposed surfaces during rain events;
- Movement of groundwater contaminants into the stormwater drainage network, which may ultimately discharge to the Māngere Inlet marine environment;
- Discharges of groundwater into the marine environment;
- Contaminated dust mobilised during dry windy conditions and/or during earthworks; and
- Discharges of landfill gas and other volatile organic compounds to air.

These discharges could have adverse effects on ecological values including terrestrial flora and fauna, biota in freshwater and biota in marine water environments.

Effects of the discharge of contaminants to air and water are assessed in *Section 12.12: Air Quality* and *Section 12.21: Surface Water* in the AEE respectively.

There will also be potential effects on groundwater from discharges resulting from disturbance of landfills.

Auckland Council holds existing resource consents for the discharge of in situ contaminants to ground and extraction of groundwater at the closed landfills on an ongoing basis (the leachate interception trench referred to above). The Project will require the relocation of the existing leachate interception trench at Pikes Point Landfill. The Transport Agency will manage the relocation of the leachate system as part of the construction phase, and the replacement system will be transferred to Auckland Council as an asset

for the ongoing management of landfill discharges. The reconstruction of this leachate interception system is discussed in further detail in *Section 7.0: Construction of the Project* of this AEE.

During construction, measures will be put in place to appropriately manage potential risks to human health that arise from the disturbance of contaminated land in the existing environment. This will be done in consultation with Auckland Council as a consent holder where existing discharge consents (including for in situ discharges from landfills) are held.

b. **Effects on human health**

The exposure pathways to human receptors include:

- Inhalation (of dust, asbestos, landfill gas or volatiles);
- Ingestion (of contaminated soil or water); and
- Skin contact with contaminated soil or groundwater.

During construction, measures will be put in place to appropriately manage potential risks to human health that arise from the disturbance of existing contaminated land in the existing environment. The management measures will include specific requirements for the handling and disposal of contaminated material as set out in *Section 12.18.3* of this AEE. These measures will apply throughout the Project.

In addition there are two particularly sensitive contaminated land areas for construction activities:

- Works in the site at on 141-199 Hugo Johnston Drive where a stormwater wetland and parking/manoeuvring area is proposed. Investigations for the Project have shown that there will be significant quantities of asbestos in this area. The asbestos is likely to be a mix of asbestos containing material and free fibres within the soil. Discharges to air of asbestos fibre pose potential risks to human health. The asbestos does not pose a risk to groundwater.
- Works in the landfill areas at Galway Street and Pikes Point East and West, where the works will necessitate disturbance of landfill refuse and gas and odours may be expected. Due to the proximity of the coastal receiving environment this area has ecological sensitivity and the works will potentially affect human health. Specific health and safety controls will be required.

Additional management measures are proposed for these sites. These measures are discussed in *Section 12.18.3* of this AEE.

Overall, the effects of the Project on the environment due to construction activities in contaminated land, following implementation of the proposed management and mitigation measures will be minor.

12.18.2.2 Operational Effects

During operation of the Project, potential effects arising from ongoing activities in contaminated land, include:

- Discharge of landfill gas into subsurface utilities, posing potential health risks for maintenance workers;
- Discharge of contaminants due to disturbance of contaminated soil during periodic maintenance works along the road, including maintenance of utility services;
- Interception of contaminated groundwater and discharge through to the environment from the Pikes Point landfill leachate interception system. As noted in *Section 12.16: Groundwater* of this AEE, the performance of the system will be improved by installing a low permeability liner on the lower side of the interception trench, and through elimination of seawater by tidal control of stormwater discharges along Māngere Inlet.

Groundwater, including groundwater quality, the fate and transport of contaminants in groundwater, and the leachate interception trench at the Pikes Point East and West Landfills are assessed in *Section 12.16: Groundwater* of this AEE. This identifies that groundwater discharging from the landfill areas contains elevated levels of some contaminants.

During operation of the Project, people potentially at risk from exposure to contaminated land are maintenance workers. The concentrations of the contaminants are not likely to pose a risk to human health.

12.18.3 Measures to avoid, remedy or mitigate potential adverse effects

The Project design has been informed by contaminated land considerations, in particular:

- Specific design requirements for those locations where the Project crosses closed landfills; and
- Auckland Council's existing leachate interception trench adjacent to the Pikes Point East and Pikes Point West landfills will be replaced.

In order to manage known and unidentified contamination along the Project during construction, a CLMP will be developed. The CLMP will set out appropriate management measures for contaminated land disturbance to minimise the effects on human health and the environment. It will also set out a protocol for the testing, identification and offsite disposal (where necessary) of contaminated soil during construction. The contents and approval process for the CLMP are discussed in further detail in *Section 7.0: Construction of the Project* of this AEE.

A draft CLMP has been prepared for the Project demonstrating how the proposed contaminated land management measures could be implemented during construction of the Project. This is contained in Appendix D of *Technical Report 17: Contaminated Land Assessment* in Volume 3.

The CLMP will be finalised once a construction contractor has been appointed. The implementation of the approved CLMP will be overseen by a Suitably Qualified and Experienced Practitioner. The process for finalising the CLMP is set out in *Section 13.1.5: Management plans and other information* of this AEE.

The works within contaminated soil during construction will be managed as follows:

Matter	Management measure
Managing contaminated soil and disposal during construction.	Management and tracking of soil movements and appropriate disposal. This may involve sampling of stockpiled material to establish whether it is suitable for re-use as fill for the Project or depending on the level of contaminants, which class of landfill for disposal will be required.
Discharges of dust generated by land disturbance activities	Controlled by standard dust suppression measures. The measures to manage dust during construction are set out in Section 12.12.2: Construction air quality of this AEE.
Discharge of sediment from land disturbance activities	Controlled by standard erosion and sediment control measures designed to manage sediment during construction. These measures are set out in *Section 12.15: Erosion and sediment control* of this AEE.
Exposure to landfill gas	Monitoring of landfill gas during land disturbance activities within areas of known landfill (Galway Street and Pikes Point East and West Landfills). The potential risks from discharges of landfill gas vapours will be mitigated using active and/or passive ventilation of the work zones. The measures/ monitoring are set out in *Section 12.12: Air quality* of this AEE.
Potential human health risks for the construction work force	For the construction work force this risk will be managed through robust health and safety plans. Potential risks for the public, including residents and workers at industrial sites in the area will be controlled by exclusion of the public from works areas using fences, work site barriers and appropriate signage.

Matter	Management measure
Discharge of leachate from the Pikes Point Landfill leachate interception system	Replacing and upgrading the leachate interception system and providing treatment within the new stormwater wetland on the Māngere foreshore. The leachate interception system will be owned and operated by Auckland Council under existing consents for this system. The stormwater wetland is discussed in further detail in *Section 12.21: Surface water* of this AEE.

The specific measures for managing construction within landfill waste at Galway Street and Pikes Point will include the installation of controls, minimising the excavation zone, and isolating influences that could compromise the environmental and human health controls. The specific measures are set out in the Draft CLMP contained in *Appendix D* of *Technical Report 17: Contaminated Land Assessment* in *Volume 3*.

The specific measures for managing construction within the known asbestos site at 141-199 Hugo Johnston Drive will include controls for the excavation and handling of material containing asbestos to manage the release of respirable asbestos fibres into air. The specific measures are also set out in the draft CLMP.

Overall, the effects of contaminated land during operation of the Project will be positive with opportunities to appropriately manage contaminated stormwater and leachate discharges by treating them in new wetland and biofiltration systems. The risk posed by landfill gas for maintenance activities can be appropriately managed.

12.19 Coastal processes

Overview

The Māngere Inlet and Ōtāhuhu Creek have both been extensively modified through progressive reclamation and coastal structures.

The northern foreshore of the Māngere Inlet has been substantially modified due to reclamation of an estimated 1.8km^2 of the original 7.5km^2. The Project will involve 18.4ha of reclamation in the Māngere Inlet. The reclamation represents a 3.5% loss of area of the Inlet and 0.1% of the whole Manukau Harbour. The extent of the reclamation has been minimised to the greatest extent practicable, while still achieving the Project objectives and delivering benefits to the environment from stormwater treatment and coastal edge naturalisation. The reclamation will result in changes to the coastal processes in the Māngere Inlet.

To construct the reclamation, the current proposal is that a 15ha subtidal area within the Māngere Inlet will be dredged and a channel created between the dredging site and the construction yard at Waikaraka Park. The dredged sediment will be used for the production of mudcrete. The average release of sediment from dredging and mudcrete will be 35 tonnes/day during the construction period which is 2.5 to 5% of the natural sediment flux. The effects of sediment from the dredging and mudcrete operations will be temporary, occurring for a period of about one year. The adverse effects on coastal processes from dredging within the Māngere Inlet will be minor.

At Ōtāhuhu Creek, the three box culverts will be replaced with a bridge, a new bridge constructed to enable construction of the replacement bridge and declaiming of approximately 0.5ha of land on the southern side of the creek.

Removal of the culverts will enable a new tidal channel to be formed close to the original 1940s alignment. The new bridge structure and associated declamation will have a beneficial effect mainly as a result of re-introducing the coastal processes that relate to natural character.

Overall, with the implementation of measures outlined in this section, the adverse effects of the dredging, reclamation and coastal structures on coastal process within the Māngere Inlet and Ōtāhuhu Creek will be minor.

12.19.1 Introduction

This section assesses the actual and potential effects of the Project on coastal processes within the Māngere Inlet and Ōtāhuhu Creek from the reclamation, dredging and discharges to the CMA. Coastal processes relate to the coastal hydrodynamics (the movement of fluid), sedimentation (the supply, transport, erosion and deposition of sediment) and morphology (the natural form). The assessment is supported by *Technical Report 15: Coastal Processes Assessment* in Volume 3.

The assessment started with developing and understanding how the coastal areas have responded to historical coastal developments. Modelling of the Project in Māngere Inlet was undertaken to gain an understanding of the likely changes in the hydrodynamic and sedimentation processes. Morphological changes that relate to any encroachment into the Inlet channel and other tidal channels were also assessed. The results were analysed to determine the effect of changes to the existing environment resulting from the Project. A more detailed assessment was undertaken for the Māngere Inlet as the scale of work is much greater than at Ōtāhuhu Creek.

12.19.2 Existing Environment

The Māngere Inlet and the Ōtāhuhu Creek are described in *Section 11.0: Description of the existing environment* of this AEE. The matters that are of particular relevance to this assessment are set out below.

12.19.2.1 The Māngere Inlet

Māngere Inlet is part of the Manukau Harbour and is a semi enclosed basin composed of shallow tidal creeks, mangroves and large expanses of intertidal mudflats. It encompasses an area of approximately 5.6km^2.

The Inlet is a sediment and contaminant sink, experiencing sediment movement, particularly during windy conditions. Sediment is predominantly from redistribution around the Manukau Harbour and the Inlet rather than from catchment sources. Overall, it is assessed that the average present day sedimentation rate is 10mm/yr.

Sediments within Māngere Inlet consist of mud and fine grained sand. Core sampling indicated that sediment texture has been muddy since pre-human times. The results of the sediment sampling are contained in Appendix E to *Technical Report 15: Coastal Processes Assessment* in Volume 3.

An understanding of the historical response of the Māngere Inlet to development and reclamation can provide a better understanding of how coastal processes will respond to the Project. In 1853 the Māngere Inlet was an open basin with an entrance estimated to be 630m wide. The construction of the impervious rock causeway at the southern end of the Old Māngere Bridge reduced the width of the entrance to approximately 240m. As a result, the Māngere Inlet entrance deepened from approximately RL4.5m to RL7.7m, and wave energy entering the Māngere Inlet reduced.

The northern foreshore of the Māngere Inlet has been substantially modified due to reclamation of an estimated 1.8km^2 of the original 7.5km^2 (being a 24% change) of the Māngere Inlet. This loss is mainly as a result of landfill along the northern and eastern coastlines. Other small reclamations have occurred at the southern end of the Manukau Harbour Crossing and inside Harania Creek. This reduction in area has led to the loss of natural features and the loss of tidal prism within the Inlet.

The observed historical changes have been more pronounced with narrowing of the tidal Inlet channel than with reclamation. Changes to the Inlet due to reclamation have tended to be relatively benign as the reclamation did not encroach into the main tidal channel. Reclamation effects have probably been masked by the effects of narrowing the tidal Inlet channel and the increase in mangrove coverage (now occupying 20% of the inlet over the past 60 years). Narrowing of the tidal Inlet channel has created a coastal inlet whereas it was originally part of the wider harbour environment. This has resulted in a deepening of the main tidal channel and a reduction of wave energy entering the Inlet.

12.19.2.2 Ōtāhuhu Creek

Ōtāhuhu Creek is a tidal creek which flows into the Tāmaki Estuary. Currently the coastal area of the creek to the west of SH1 is approximately 5ha, 95% of which is covered with mangroves. The soils in this catchment are well-drained, being of volcanic origin.

In the late 1950s triple culverts were installed under SH1. The culverts comprise three 2.1 x 2.1m box culverts, 33m long, with an invert at about 0.5m above mean sea level. The culverts have adequate capacity to accommodate extreme flood events, as well as storm surges and tsunami.

Upstream and downstream of the culverts, seabed levels in the main tidal channel of the culverts are lower. This indicates that the tidal flows are sufficient to maintain a formed channel rather than for it to be infilled. Aerial photography indicates that the total area covered by mangrove forest has increased since 1940 especially upstream of the bridge. This suggests that the culverts have potentially limited the transportation of sediment out into the estuary promoting a better environment for mangrove growth.

Based on a review of the as-built drawings for the culverts, it appears that the immediate area was reclaimed with the SH1 motorway construction. The reclaimed area was in the order of 0.6ha or about 12% of the Ōtāhuhu Creek CMA.

Figure 12-24 and Figure 12-25 show the Ōtāhuhu Creek area in 1940, prior to construction of SH1, and in 2008.

Figure 12-24: Ōtāhuhu Creek 1940 (the approximately location of crossing shown)

Figure 12-25: Ōtāhuhu Creek 2008

12.19.3 Assessment of effects on coastal processes (Māngere Inlet)

The Project involves the following activities that have the potential to affect coastal processes in the Māngere Inlet:

- Reclamation of 18.4ha of the CMA (above MHWS) along the northern coastline of the Inlet and an additional area of permanent occupation (below MHWS) for the embankment, headlands and boardwalks of 5.9ha;
- Piers in the CMA for the foreshore boardwalk occupying approximately 53m^2;
- Piers in the CMA through Anns Creek occupying approximately 73m^2;
- Dredging a 15ha subtidal area and a channel within the Inlet for the production of mudcrete used in the foreshore; and
- Replacing the secondary tidal channel at the eastern end of the Inlet that will be covered over by the construction of the eastern headland.

12.19.3.1 Reclamation

Reclamation resulting in permanent loss of the CMA for construction of the foreshore has the potential to result in changes to the tidal regime, the sedimentation regime and coastal morphology.

The design of the Project to date has given particular consideration to the potential effects on coastal processes with the purpose of avoiding or minimising effects by:

- Minimising intrusive reclamation in the area near the Inlet entrance (by Galway Street up to Albert Street) as past intrusion into the Inlet entrance has resulted in more noticeable effects on the Inlet.
- Avoiding reclaiming into the tidal channels as this would alter the morphology of the channels and result in a different distribution of tidal flows and sedimentation regime. The exception is at the eastern end of the reclamation where a secondary tidal channel that feeds into Anns Creek is located

close to the northern coastline. In this location a new tidal channel has been included in the design with the same dimensions as the existing channel.

- Incorporating coastal features such as headland structures and rocky foreshore into the recreated coastline.

Discharging stormwater from the proposed treatment wetlands through the headland structures into the tidal channels to assist with dilution of that stormwater into the receiving environment. The extent of the reclamation has been minimised to the greatest extent practicable, while still achieving the Project objectives and delivering benefits to the environment from stormwater treatment and the recreated coastline.

Generally natural changes in hydrodynamics (the movement of liquid) or morphology (the form of the seabed) are slow enough that an inlet can adapt gradually. However sudden changes caused by human intervention such as from new structures and landfill will shift Māngere Inlet's equilibrium. These shifts will force a change within the Māngere Inlet until it reaches a new equilibrium. The Māngere Inlet has adjusted to morphological changes in the past by a combination of the entrance scouring and sedimentation. These processes are ongoing.

The Project has a proposed reclamation area (above MHWS) of 18.4ha (or 0.184km^2) and a coastal occupation footprint (the below MHWS) of 6.7 (or 0.067km^2), compared to the existing area of the Inlet of 5.7km^2. The Project will increase the reclamation area from 24% of the Manukau Harbour area to 27%, a relative increase of 3.5%. Table 12-20 shows the areas and reclamation of the Māngere Inlet and the Manukau Harbour from 1850's to present day.

Table 12-20: Changes to the Māngere Inlet since 1850

	1850	2016 (existing)	With Project
Māngere Inlet			
Māngere Inlet area	7.5km^2	5.7km^2	5.5km^2
Area of reclamation within the Māngere Inlet	-	1.8km^2 (24% of the original inlet)	2km^2 (27% of the original Inlet)
Māngere Inlet entrance	630m	240m	No change.
Manukau Harbour			
Manukau Harbour area	376.5km^2	368km^2	367.8km^2
Total area of reclamation within the Manukau (including the Project)	-	8.5km^2 (2.26% of the harbour)	8.7km^2 (2.31% of the Harbour)

The piers for the proposed viaduct structures through the coastal areas of Anns Creek Estuary and Anns Creek West will occupy an area of about 73 m^2 or 0.0001% of the inlet area. The viaduct surface will occupy 0.8ha of the CMA.

Reclamation reduces the footprint of the CMA and correspondingly reduces the tidal prism. The tidal prism is the volume of seawater exchanged between MHWS and MLWS upstream of a reference point (e.g. Old Māngere Bridge). The Project will reduce the tidal prism by 3.5% to 12.2 million m^3. Reducing the tidal prism reduces the tidal currents.

The entrance to the Inlet is likely to respond to this change. With a lesser tidal prism, the cross-sectional area of its entrance will reduce to reach a new equilibrium condition. Some accretion (build-up of material) could therefore be expected at the entrance, probably in the order of 35m^2 cross-sectional area or 0.25m depth. This depth is less than the normal fluctuations of the entrance. Historically the seabed has been more elevated. The entrance will continue to limit the amount of wave energy entering the Inlet.

The reclamation will result in the following additional changes compared to the existing situation:

- The maximum tidal current change occurs within the new embayments along the northern coastline with a change of 0.1 m/s in a spring tide. Away from the new land area, the maximum change in tidal currents occur offshore of the new headlands with a change of 0.1m/s. Away from these locations the maximum change is 0.05 m/s during a spring tide. These changes are not significant.
- The general circulation and extent of tidal currents will be the same as the existing regime.
- Overall there will be a slight increase in average sediment deposition within the inlet from 9.8mm to 10.5mm (7% change).
- There will be an increase in deposition within the new embayments along the recreated coastline with an increase of 5mm/year to a new level of up to 30mm/yr. Mud deposits could therefore be expected in these locations as would have occurred with the original and existing environment.
- Sedimentation will continue within the Inlet at a rate of about 10mm/yr. This has the potential to affect the discharge of stormwater as the intertidal areas in front of stormwater pipes silt up. The recreated coastline design, however, incorporates discharging the stormwater into the tidal channels which have a tendency to erode rather than accrete. This potential effect is therefore minimised.
- The tidal channels will have approximately the same level of erosion as the existing situation. These channels should therefore remain in a morphological stable condition.
- Within the area of the proposed Anns Creek viaduct over Anns Creek the peak tidal velocities are less than 0.2 m/s. As this is less that the velocity required to mobilise marine mud, no scouring of sediment around the piles is expected.

Historical developments within the Māngere Inlet have probably had a significant adverse effect on the original environment. The changes related to those effects have now become part of the existing environment against which this Project is assessed. It is considered that the changes to the existing situation from this Project will have the following effects:

- The Inlet will remain a depositional environment with minimal erosion risk to the coastline.
- Potential erosion risk of the coastline associated with this Project is low as it will be protected from inundation and wave action.
- Adverse effects associated with coastal processes within the Inlet for the foreshore works are minor.
- Adverse effects associated with coastal processes within Anns Creek for the elevated structures are negligible.
- While the reclamation associated with the recreated coastline does have adverse effects on the existing environment, the recreation of coastal features such as headlands and foreshore is beneficial in terms of the processes.
- The Project design has allowed for the effects of climate change (sea level rise and increased windiness) over 100 years, and tsunami events.

Although changes will occur with the implementation of the foreshore works, the tidal current circulation and the sedimentation patterns are similar. Overall the effects of reclamation and the permanent occupation of the seabed by new structures on the coastal processes of the Māngere Inlet are considered to be minor.

12.19.3.2 Dredging and sediment

Dredging may be undertaken to provide source sediment for the production of mudcrete to construct the reclamation for the new foreshore.

A sub-tidal area of 15ha on the north western side of the Māngere Inlet is proposed to be dredged to provide the source material for mudcrete (refer to Source 1 on Figure 12-26). The dredging will occur at

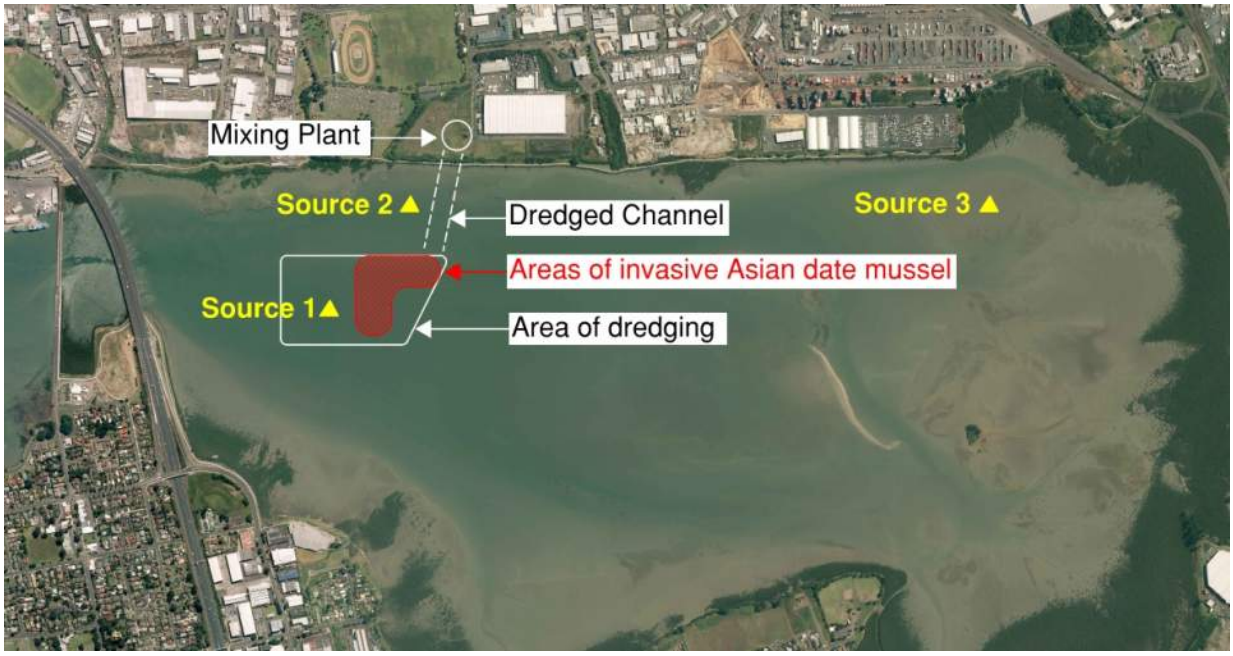
an average depth below existing seabed levels of 1.5m. As part of the dredging operation an area of Asian date mussels will be removed.

To undertake the reclamation efficiently without having to rely on the tides, a temporary navigation channel of approximately -2.5m RL will also be created between the dredging site and the construction yard at Waikaraka Park (Source 2).

The construction of Headland 3 will require the relocation of the current channel in this location. A 10m wide new channel will be created around the headland with the existing channel infilled as part of the reclamation (Source 3).

A more detailed plan showing the dredging area, temporary construction channel and relocated channel around Headland 3 is contained as Figure F1 in *Technical Report 15: Coastal Processes Assessment* in *Volume 3*.

Figure 12-26: Location of dredging areas



In total, 300,000m^3 of sediment will be dredged externally to the Project with a rate of 750m^3 per day. The dredging will occur over a period of approximately one year. The dredging will be undertaken by mechanical dredging. This is considered to be an effective method in minimising the release of sediments as most of the dislodged material remains intact and falls back into the dredged area. During the dredging, the sources of sediment are from the dredger bucket and overflow from the receiving barge.

Once sediment is processed to form mudcrete, it will be placed within the CMA to form the reclamation. During the reclamation construction, approximately 75,000m^3 of mudcrete will be exposed to the tide. Mudcrete mixture is sticky, attracted to seawater and binds together rather than releasing into the water, therefore minimal sediment discharge is anticipated during construction. It is anticipated that a maximum of 2.5% of mudcrete could be dispersed into the Māngere Inlet. To minimise the discharge of sediment, the construction of the reclamation will be staged and erosion and sediment controls will be implemented to minimise total suspended solids (TSS) and deposition.

It is estimated that the average release of sediment (and mudcrete) from dredging and mudcrete will be 35 tonnes/day or 18 tonnes/tide during the construction period. This compares to the average natural flux of sediment into and out of the Inlet of 700 tonnes on a spring tide and 350 tonnes on a neap tide. The sediment release is therefore some 2.5 to 5% of the natural sediment flux. The dredged material is

the native material, not an introduced source, so the water quality associated with sediment release will be similar to the native material when re-suspended.

The location of the sediment plumes will be predominantly into the Inlet as naturally occurs. The total release of sediment for the Project is about 10,500 tonnes. It is estimated that the maximum deposition away from the mixing zones will be 10mm with an average of 3mm over the whole Project. This compares to an average deposition within the inlet of 10mm/year (i.e. 43,000 tonne/year) with 25mm/year at the northern coastline.

In the context of the Manukau Harbour which is noted for having high natural levels of total suspended solids and sediment deposition, the sediment plumes from the dredging and mudcrete operation will have a minor adverse effect. It will be temporary, persisting for a period of about 1 year. The impact on marine ecology from sediment and contaminants are addressed in *Section 12.20: Ecology* of this AEE.

Modelling has indicated that following construction, while sedimentation is likely on the flanks of the 15ha dredged area, the central part of it will remain as a basin. This is likely to be a remnant feature long term but will be within the subtidal area of the Inlet. Overall the long term effect of the dredged area on coastal processes is considered to be minor.

To minimise adverse effects on the Inlet geomorphology, the dredged channel between the dredging site and the Waikaraka Park construction yard will be infilled immediately following construction. This will require filling the channel with 25,000m^3 of material. Areas which will not be infilled will, over time, act as a sink for sediment and infill themselves over time. Coastal processes will restore/reach equilibrium.

The construction of the easternmost foreshore landscape feature encroaches into an existing tidal channel in this location. This channel will be relocated by dredging a new channel a short distance from the existing channel. The new channel will have a similar geometry to the existing channel to minimise morphological changes.

Overall the effects of sediment from the dredging and mudcrete operations will be temporary, occurring for a period of about one year and with the implementation of appropriate management measures (set out below), the adverse effects on coastal process within the Māngere Inlet will be minor.

12.19.4 Assessment of effects on coastal processes (Ōtāhuhu Creek)

The Project involves the following activities that have the potential to affect coastal processes in the Ōtāhuhu Creek:

- Constructing a new bridge alongside the existing culverts for use during construction and then retained as a bridge providing pedestrian /cycle access;
- Removing the three box culverts and replacing them with an approximately 112m long bridge;
- Realigning the main tidal channel close to its 1940 historical alignment; and
- Declaiming approximately 0.5ha of land on the southern side of the creek by removing fill material.

The proposed bridge will span the original creek to effectively declaim the area. On the northern side, the abutment more-or-less follows the original landform. On the southern side the new landform will declaim about 0.5ha comprised of 20,000 m^3 of material. Complete declamation to the pre-culvert landform is not feasible as it would interfere with private property adjacent to SH1 in this location.

As a result of the culvert removal, a new tidal channel will be formed. The channel will be realigned close to the original 1940s alignment at a mid-span location. This will move the channel southwards and away from the northern abutment. The new channel will be about 3m wide and 1m deep, subject to confirming downstream dimensions. The excavated channel material may be used to fill in the existing channel.

The piers associated with the new bridge structures will occupy approximately 10m^2 or 0.02% of the upstream CMA. The bridge structure will occupy 0.12ha of the CMA.

The area has a low energy wave climate, particularly with the presence of the mangroves and this will continue with the Project in place. The tidal currents, without the culverts, will be relatively low. Tidal flows will be in the order of 5m^3/s at 0.5m RL. With a new channel with similar dimension to the original channel the tidal currents will be below 1m/s at 0.5m RL. Flood flows could be in the order of 30m^3/s for the 100 year ARI and this is easily accommodated within the new bridge opening. Based on this, the area will remain a depositional environment with minimal erosion risk to the coastline although the tidal channel will exhibit erosion from time to time.

Given the extent of mangroves, erosion of the flat intertidal area following construction of the bridge will be limited. Some erosion of the tidal channel could be expected as part of the readjustment and would be an ongoing process.

Overall the new bridge structure and associated declamation will have a beneficial effect mainly as a result of re-introducing the coastal processes that relate to natural character.

12.19.5 Measures to avoid, remedy or mitigate potential adverse effects on coastal processes

In managing the adverse effects of the coastal works during construction, the following measures are proposed:

- The construction of the reclamation in the Māngere Inlet will be staged to minimise exposed areas of the reclamation;
- The dredged channel between the dredging site in the Māngere Inlet and the Waikaraka Park construction yard will be infilled following construction to minimise adverse effects on the Māngere Inlet geomorphology;
- A deflector structure or silt fence will be established at the eastern end of the Project to limit the TSS and deposition in the Anns Creek Estuary area. The details of the measures will be set out in the CESCP for the works;
- Erosion and sediment control measures and perimeter controls will be installed for the foreshore works and bridge construction;
- One-off comprehensive water quality monitoring will be undertaken for the dredging and mudcrete operations within the Māngere Inlet for a spring and neap tide during the initial phase of the Project and confirmation of the trigger level to be established as part of the CESCP for the works;
- Weekly water quality monitoring will be undertaken for the dredging and mudcrete operations within the Māngere Inlet;
- A Contingency Plan will be in place for trigger level exceedances within the Māngere Inlet during construction which may require changes to the dredging methodology;
- Sediment deposition rates in the Māngere Inlet will be monitored at nominated locations after completion of the reclamation to confirm the modelling predictions;
- Specific measures to manage concrete dust from the removal of the Ōtāhuhu Creek box culverts to prevent this entering the creek; and
- Options for declamation in the Manukau Harbour will be investigated.

12.19.6 Conclusion

Overall, with the implementation of the measures outlined above, the adverse effects of the dredging, reclamation and coastal structures on coastal processes within the Māngere Inlet and Ōtāhuhu Creek will be minor.

12.20 Ecology

Overview

The ecological values of the majority of the Project area have been degraded by previous extent of urban and industrial development. However, the complex terrestrial, freshwater and marine ecosystems within Anns Creek and Māngere Inlet still contain high values and are identified in the AUP (OP) and the Auckland Council Regional Plan: Coastal (ARP C) for these high values.

The Project will have significant effects on some of the values in the identified areas, but includes mitigation where possible and also offers the opportunity to restore and enhance other ecological values resulting in positive effects.

The most significant effect of construction on terrestrial ecology will be impacts on the remnant lava flow vegetation along the coastal edge of Māngere Inlet and Pikes Point, and the loss of threatened ecosystems and vegetation in Anns Creek. Anns Creek is the only area remaining in the Auckland region where native herb species, including threatened species, grow together on lava. The magnitude of the adverse effect in this locality has been assessed to be high.

All of the freshwater ecosystems within the Project area are assessed as having low ecological values. The most significant effect to freshwater ecology is from the permanent loss of habitat in Miami Stream and Anns Creek. The magnitude of the adverse effect has been assessed as moderate.

The most significant effect on marine ecology is the permanent loss of intertidal mudflats along the northern Māngere Inlet from construction of the road embankment, landscape features and stormwater wetlands. The magnitude of the adverse effect is high because the effect is permanent.

The most significant effect to avifauna is the permanent loss of vegetation and habitat in Anns Creek and the loss of foraging habitat in the Inlet. The loss of habitat at Anns Creek will put the threatened species Banded rail and Bittern further at risk. The magnitude of the adverse effect is considered to be high.

The positive effects from the Project include the reduction of sediment, particulate and dissolved contaminant load to the CMA which will benefit the marine organisms and avifauna in the intertidal zone. The other positive effects are the restoration of saltmarsh habitat, enhanced habitat on along the coastal edge and in Anns Creek and an increase in habitat diversity within the stormwater wetlands which will benefit avifauna, marine and freshwater organisms.

The EIANZ Guidelines used in the ecological assessments state that very high, high and moderate levels of effect require avoidance or mitigation, whereas low and very low levels of effect are normally not of concern, but design, construction and operational care should be taken to minimise adverse effects. The design and location of the Project has avoided and minimised some effects while residual effects are addressed through a suite of measures. These measures are included in construction and operation aspects of the Project to mitigate and offset the effect on ecological values.

12.20.1 Introduction

This section presents the findings of investigations undertaken to determine the actual and potential ecological effects of the Project on terrestrial (including lizards), freshwater and marine ecology and avifauna. The assessment is supported by *Technical Report 16: Ecological Impact Assessment* in Volume 3.

The approach to identifying ecological values and effects in this section is based on the *Environment Institute of Australia and New Zealand Ecological Impact Assessment Guidelines 2015 (*the EIANZ Guidelines). The EIANZ Guidelines provide a method for assigning value to habitats for the purposes of assessing actual and potential effects of activities. In accordance with the EIANZ Guidelines, the magnitude of each adverse effect combined with the ecological value of the existing environment provides an understanding of the level of the adverse effect. Each of the effects identified in this section have been assessed in terms of this approach.

The identification of ecological values has relied on the following:

Terrestrial: Desktop investigations, literature reviews and ecological, botanical and herpetofauna field surveys of the Māngere Inlet, the coastal foreshore, Te Hōpua, Anns Creek and Ōtāhuhu Creek.

Freshwater: Desktop investigations, literature reviews, field surveys, fish and macroinvertebrate sampling in Miami Stream, Southdown Stream and Clemow Stream.

Marine: Desktop investigations, literature reviews, review of aerial photography and Auckland Council GIS layers, marine ecology and sediment data and reports, and intertidal and subtidal sediment and benthic invertebrate sampling within the Māngere Inlet.

Avifauna: Desktop investigations including aerial photography, previous avifauna surveys, published and unpublished literature, ornithological databases; land and shorebird observations and summer and autumn avifauna surveys.

A detailed discussion of the assessment methodology and the finding of investigations are contained in *Technical Report 16: Ecological Impact Assessment* in Volume 3.

12.20.2 Existing ecological environment

12.20.2.1 Existing terrestrial habitats

Terrestrial habitats are land based plant and animal communities. The Project area lies within the Tāmaki Ecological District where vegetation has been modified by urban and industrial development and by reclamation of the foreshore and intertidal areas. The ecological values of the majority of the Project has been degraded. The Project area lies within a threatened land environment where between 10 to 20% of indigenous vegetation cover remains and less than 20% of that is legally protected.

The ecological values of the coastal foreshore of Māngere Inlet and Anns Creek are strongly influenced by the volcanic history of the area and by the extent of urban and industrial development. The northern shore of Māngere Inlet has been highly modified.

The complex of terrestrial, freshwater and marine ecosystems within Anns Creek and Māngere Inlet are identified as SEA in the AUP (OP), CPA in the Auckland Council Regional Plan: Coastal, and Significant Natural Areas in the Operative Auckland Council District Plan: Isthmus Section.

The lava flow vegetation at Anns Creek and along the foreshore of the Māngere Inlet are the last remaining areas of this ecosystem type in Auckland. Volcanic boulderfields are identified as a scarce ecosystem type in Auckland and is an area identified at a national level as a naturally uncommon ecosystem type with a threat status of ‘endangered’. The substrate of the lava flows results in a unique and unusual assemblage of native plants, including threatened plant species.

Anns Creek is identified for ecological sequences from saltwater to freshwater, and for the mosaic of vegetation types present including basalt lava shrubland. Ecological gradients are present with mangroves to glasswort and bachelors button, and into marsh clubrush in the brackish areas, and then into raupo at the edge of the lava flow. Figure 12-27 and Figure 12-28 show the typical vegetation at Anns Creek.

Figure 12-27: Anns Creek East, mosaic of mangrove saltmarsh and lava shrubland

Figure 12-28: Anns Creek West, lava shrubland on pahoehoe lava

Anns Creek is the only area remaining in Auckland where native herb species, including threatened species, grow together on lava, and is the type locality for Coprosma crassifolia. These threatened species are set out in Table 12-21.

Table 12-21: Threatened species in Anns Creek and Māngere Inlet from survey reports and Auckland Museum herbarium

Name	Threat Status (de Lange *et al* 2013)	Location	Date of most recent record	Found in this survey
Geranium retrorsum	Nationally vulnerable	Anns Creek	17 Feb 2004	
Geranium solandri	At risk declining	Anns Creek	7 Feb 2004	yes
Myoporum laetum	Regional threat status: gradual decline	Māngere Inlet	23 Nov 1993	yes
Pellaea falcata	At risk declining	Anns Creek	10 Dec 1993	
Pomaderris phylicifolia	Nationally endangered	Anns Creek	27 Dec 1983	
Puccinellia stricta	Regional threat status: acutely threatened	Manukau Foreshore Walkway	12 Jan 2001	yes

Pikes Point contains basalt lava flows and shrubland ecosystems and Te Hōpua contains saltmarsh wetland. Figure 12-29 and Figure 12-30 show these areas.

Figure 12-29: Mangroves on lava at Pikes Point

Figure 12-30: Te Hōpua, glasswort herbfield and sea rush wetland

Southdown Reserve is located at 127-139 Hugo Johnson Drive. It comprises native and exotic plantings, riparian vegetation and mangroves. The reserve has been identified as a Hazardous Activities and Industries List (HAIL[80]) site contaminated with asbestos. Further discussion of the asbestos contamination is contained in *Section 12.18: Contaminated Land* of this AEE.

The Anns Creek Reserve located at 811-813 Great South Road contains a freshwater wetland.

Ōtāhuhu Creek contains mangroves and intertidal habitat for wading birds.

The areas discussed above are outlined in Table 12-22 below.

[80] Under the *Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011*.

Table 12-22: Significant Ecological Areas in the Project area

Site Name	Vegetation Types criteria	Description of criteria met	SEA or ONF	AUP (OP) criteria	Overall Rating
Anns Creek East	Lava Shrubland, Marsh clubrush reedland, tall fescue grassland, mangroves, saltmarsh herbfield, raupo reedland	Contains naturally uncommon ecosystem type that is threatened. Supports threatened and at risk plant species. Indigenous vegetation within wetland. Type locality for taxon. Important as intact sequence. Indigenous vegetation extending across environmental gradient. Supports typical species richness for type.	SEA-T-5309 ONF192	Representativeness (H) Threat status and rarity (H) Uniqueness or Distinctiveness (H) Diversity (H)	Very High
Anns Creek West	Mangroves, saltmarsh ribbonwood	Contains naturally uncommon ecosystem type that is threatened.	H13-21 ONF192	Threat status and rarity (H)	High
Anns Creek Estuary (within the Māngere Inlet)	Lava shrubland, mangrove	Contains naturally uncommon ecosystem type that is threatened. Supports threatened and at risk plant species. Indigenous vegetation within wetland. Type locality for taxon. Important as intact sequence. Supports typical species richness for type.	SEA-T-5304 SEA-M1-21 ONF192	Representativeness (H) Threat status and rarity (H) Uniqueness or Distinctiveness (H) Diversity (H)	Very High
Lava flow at Pikes Point	Lava shrubland, mangroves	Contains naturally uncommon ecosystem type that is threatened. Supports threatened and at risk plant species.	SEA-T-9022 H13-23	Threat status and rarity (H)	High
Te Hōpua crater	Glasswort-sea rush-oioi rushland	Indigenous vegetation within a wetland.	SEA-T-6103	Threat status and rarity (M)	Moderate
Southdown Reserve	Mangroves, oioi saltmarsh	Indigenous vegetation within a wetland. Forms part of a network of sites.	SEA-T-6104	Threat status and rarity (M) Stepping stones, Migration Pathways and Buffers (M)	Moderate
Anns Creek Reserve Wetland	Freshwater wetland	Indigenous vegetation within a wetland.	SEA-T-5308 H13-25	Threat status and rarity (H) Stepping stones, Migration Pathways and Buffers (M)	High

The wider Project area includes a range of potential lizard habitat types including areas with replanted native vegetation (e.g. the privately owned 69 Captain Springs Road), vegetated reserve margins with refugia including piled basalt rocks and wood debris (e.g. the Manukau Foreshore Walkway) and complex grasslands that provide basking habitat and refugia (e.g. Captain Springs Road).

The majority of potential lizard habitat was classified as 'poor' quality, but small areas of 'moderate' and 'high' quality habitat were observed during field surveys. As part of the surveys, an assessment of the prevalence of herpetofauna within the Project area was undertaken[81]. Native lizards were not detected during surveys to date. Table 12-23 shows the recorded lizard sightings within 10km of the Project.

Table 12-23: Lizard records within 10km of the Project (date range 1998-2015) (DOC 2016).

Species		# records	Threat Class	Location of nearest record
Lampropholis delicata	Plague Skink	7	Unwanted Organism	Māngere
Mokopirirakau granulatus	Forest Gecko	1	At Risk - Declining	Ōrākei
Oligosoma aeneum	Copper Skink	4	Not Threatened	Ōtāhuhu
Oligosoma ornatum	Ornate Skink	1	At Risk - Declining	Ōtāhuhu

12.20.2.2 Existing freshwater habitats

Freshwater habitat is considered to be streams with permanent or intermittent flows which have the capacity to provide aquatic habitat and freshwater/brackish[82] wetlands. It does not include ephemeral streams, seepages or overland flow paths.

The Onehunga, Mt Wellington and Penrose Catchments are within Auckland Council's Maungakiekie-Tāmaki State of the Environment reporting area which covers 36km^2 and represents 0.7% of Auckland. The freshwater report card grade given to the area in 2014 (the most recent available report) was Grade F, the lowest possible grade[83]. Freshwater quality indicators used to derive this grade include water quality (Grade E), flow patterns (Grade D), nutrient cycling (Grade F), habitat quality (Grade F) and biodiversity (Grade F). Approximately 58% of the respective catchment surface area is impervious, compared with a regional average of 9%. In general, river health in Maungakiekie-Tāmaki rivers is considered to be impaired as a result of urban development. The effects of urban development include elevated water temperatures, reduced biodiversity value, changes to the natural flow patterns and increased pollution from contaminated stormwater.

The streams in the Project area were identified by field survey[84] and are:

- Miami Stream adjacent to Miami Parade (portions of which are tidal);

[81] These surveys were undertaken outside of the optimal season for detecting herpetofauna. Prior to any habitat or vegetation disturbance due to the Project, herpetofauna surveys during the summer months will be carried out with the appropriate avoidance and mitigation measures put in place should organisms be detected (in accordance with the recommendations in the AUP (OP)).

[82] Brackish/tidal areas are an overlap between freshwater and marine ecology. The ecological assessment note which areas are covered within each of the ecological disciplines.

[83] Auckland Council State of the Environment 2014 Report Card for Maungakiekie-Tāmaki.

[84] Using the Stream Classification criteria in the AUP (OP).

- Southdown Stream located in the vicinity of the Southdown Reserve;
- Anns Creek;
- Mutukāroa-Hamlins Hill stream (outside the Project footprint);
- Clemow Stream, a tributary of Tāmaki River located near Clemow Drive; and
- Ōtāhuhu Creek portage (tidal).

These streams are shown on Figure 15-2 in *Section 11.0: Description of the environment* and described in further detail in that section, and in *Technical Report 16: Ecological Impact Assessment* in Volume 3. The figures below show some of these streams.

Figure 12-31: Miami Stream freshwater reach

Figure 12-32: Upstream section of Southdown Stream

Figure 12-33: Anns Creek

Figure 12-34: Clemow Stream

A Stream Ecological Valuation (SEV) assessment[85] was undertaken at these streams to assess the overall ecological function of the aquatic ecosystems. The SEV takes into account the hydraulic, biogeochemical, habitat provision and biodiversity functions of the stream. Using the SEV, scores can range from Poor (with 0 being the lowest) through to Excellent (with 1.0 being the highest). Fish and macroinvertebrate communities in the streams were also sampled to identify the species present. Aquatic macroinvertebrates encompass a wide range of species, including many insects, crayfish and clams. The diversity, or species richness, of aquatic macroinvertebrates provides an indication of the overall quality of aquatic habitats.

The findings of the assessment of the streams is generally consistent with assessments of other waterways in the Maungakiekie-Tāmaki area. The Mutukāroa-Hamlins Hill stream was classified as Intermittent and no SEV assessment or fish or macroinvertebrate sampling was undertaken as a consequence. Of the remaining streams, three had low ecological value based on poor habitat diversity and condition, low invertebrate and fish diversity and abundance, and high (untreated) stormwater input. Anns Creek has the most evenly spread distribution of aquatic macroinvertebrates (indicating a healthy balance of different types and function of macroinvertebrates), whereas the other sites were dominated by one or two taxa which typically indicates a highly modified ecosystem. Based on these indicators, and the SEV assessment method that assesses streams based on four 'functions' (hydraulic function, biochemical function, habitat function and biodiversity function) Southdown Stream, Clemow Stream and Miami Stream were classified as 'Low' freshwater ecological value (Table 12-24).

All of the streams surveyed were short stream reaches in predominantly piped catchments, so the opportunity for migratory species to penetrate further upstream was low.

Anns Creek represents a low lying coastal estuarine sequence with nationally '*At Risk*' fish species present. The presence of large shoals of juvenile and adult inanga means that the freshwater component at Anns Creek has value as a waterway that supports the potential for spawning and juvenile rearing in an area of the Manukau Harbour where inanga spawning habitats and juvenile rearing potential has been substantially diminished. However, the remaining metrics suggest a low ecological value for Anns Creek.

Table 12-24: Freshwater ecological values based on the EIANZ 2015 classification of freshwater values[86]

Stream	Value	Criterion
Miami Stream	Low	A highly modified watercourse with poor diversity and abundance of aquatic fauna and significant water quality issues. Very high degradation.
Southdown Stream	Low	A highly modified watercourse with poor diversity and abundance of aquatic fauna and significant water quality issues. Very high.
Anns Creek East	Low	A watercourse with high ecological or conservation value but which has been modified through loss of riparian vegetation, fish barrier, and stock access or similar, to the extent it is no longer reference quality. Slight to moderate degradation.
Clemow Stream	Low	A highly modified watercourse with poor diversity and abundance of aquatic fauna and significant water quality issues. Very high degradation (e.g. modified urban stream).

[85] Undertaken using Auckland Council publication *Stream Ecological Valuation (SEV): a method for assessing the ecological functions of Auckland streams,* Technical Report 2011/009 (October 2011).

[86] For further discussion of the EIANZ classification system see *Section 3.3.5.1* of *Technical Report 16: Ecological Impact Assessment* in *Volume 3*.

Stream	Value	Criterion
Ōtāhuhu Creek	Low	A highly modified watercourse with poor diversity and abundance of aquatic fauna and significant water quality issues. Very high degradation.

12.20.2.3 Existing marine ecosystems

The marine environments within the Project area are the Māngere Inlet and tidal Ōtāhuhu Creek. The CMA boundary in these areas is shown on the various plans contained in Volume 2: Drawing Set. Mean High Water Springs was surveyed by the Project team in early 2016.

Overall, the existing marine ecological values in the Māngere Inlet and Ōtāhuhu Creek are moderate.

a. **The Māngere Inlet**

The northern shore of the Māngere Inlet has been extensively modified through reclamation, port activities, creation of landfills, roading and other infrastructure, resulting in the loss of natural embayments and establishment of a linear shoreline. Along some sections of the modified shoreline, a sea wall protects the coastal edge from erosion. There are numerous stormwater discharge points into the CMA along this shore.

Anns Creek, in the northeastern corner of the Inlet, comprises a short section of open stream, extensive mangrove stands and some areas of saltmarsh. The mangrove stands in this area have been historically severed in a number of locations by the establishment of rail corridors, with remnant stands physically isolated from the main mangrove area. The CMA boundary is adjacent to the rail corridor in this area.

The figures below show the areas referred to in the Māngere Inlet.

Figure 12-35: Northern shoreline of the Māngere Inlet

Figure 12-36: Intertidal area along the northern shoreline

To the east of the SH20 Manukau Harbour Bridge (by Galway Street) there is an area of glasswort saltmeadow.

Along the northern shore, Miami Stream discharges into the main Māngere Inlet via a culvert under the Manukau Foreshore Walkway. Upstream of the culvert the stream is tidal and lined with mangroves (for approximately 210m). Further upstream, for a short distance (approximately 40m), Miami Stream becomes more freshwater habitat dominated for a short distance prior to becoming culverted.

Māngere Bridge and the Onehunga Wharf constrict water flows between the Inlet and the wider Manukau Harbour. The Inlet is a sediment and contaminant sink, with flood flows having greater suspended

sediment compared to ebb flows. Sediments and contaminants discharged via stormwater to the Inlet settle out in sheltered intertidal inlets and embayments. The subtidal area adjacent to the Onehunga Wharf is dredged periodically.

The marine ecological characteristics of the northern shore of Māngere Inlet (excluding avifauna) are summarised in Table 12-25:.

Table 12-25: Marine Ecological Values of the northern shore of Māngere Inlet

Ecological value	Characteristics
Low	• Marine sediments dominated by silt and clay grain sizes. • Habitat highly modified (in parts).
Medium	• Benthic invertebrate community typically has moderate species richness, diversity and abundance. • Benthic invertebrate community has both (organic enrichment and mud) tolerant and sensitive taxa present. • Shallow depth of oxygenated surface sediment. • Contaminant concentrations in surface sediment generally below ANZECC interim sediment quality guidelines (ISQG[87])-high or Auckland Council Environmental Response Criteria (ERC[88])-red effects threshold concentrations. • Few invasive opportunistic and disturbance tolerant species present. • Estuarine vegetation provides moderate habitat for native fauna, excluding Anns Creek which provides high habitat values.

The Māngere Inlet is identified as having degraded coastal water under Policy B7.4.2 of the AUP (OP).

The eastern shore of the Inlet was reclaimed to establish the Westfield yards, whereas the southern shore is less modified. The Harania and Tararata Creeks on the southern side remain relatively intact. Ngarango Otainui Island (also known as Nga Rango Erua o Tainui) is located in the south east of the Inlet. Dense mangroves fringe the eastern and southern shores, whereas the northern shore comprises less dense and patchy areas of mangroves.

b. Ōtāhuhu Creek

Ōtāhuhu Creek is a tidal creek which flows east to northeast into the Tāmaki Estuary. The creek is crossed by SH1, with three box culverts supporting the alignment. At the site of the Ōtāhuhu Creek Bridge, there are deep muds with a narrow incised low tide channel on the eastern side of the box culverts and the channel is wider on the western side. There are extensive mangroves, with the terrestrial environment bordered by a variety of exotic vegetation, SH1 and residential land use.

Maximum current velocities in the Tāmaki Estuary are lowest at Ōtāhuhu Creek. For this reason, intertidal mudflats are extensive in the estuary. Mangroves fringe the low tide channels and dominate the mudflats. The mangroves occupy approximately 95% of the CMA west of the existing SH1 alignment, with negligible saltmarsh present between mangroves and land around the SH1 crossing. The figures below show Ōtāhuhu Creek.

[87] ANZECC *Interim sediment quality guidelines from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, 2000.

[88] Auckland Regional Council, *Environmental Response Criteria Thresholds*, 2004.

Figure 12-37: Ōtāhuhu Creek

Figure 12-38: Ōtāhuhu Creek box culverts

The intertidal areas within the Ōtāhuhu Creek (outside the Project footprint) are recognised in the AUP (OP) as a significant ecological area as they provide extensive areas of foraging habitat for wading birds (AUP (OP) SEA-M2, 45c).

The marine ecological characteristics of the Ōtāhuhu Creek (excluding avifauna) are summarised in Table 12-26.

Table 12-26: Marine Ecological Values of the Ōtāhuhu Creek

Ecological value	Characteristics
Low	• Benthic invertebrate community dominated by organic enrichment tolerant and mud tolerant organisms with few/no sensitive taxa present. • Marine sediments dominated by silt and clay grain sizes. • Invasive, opportunistic and disturbance tolerant species dominant.
Medium	• Benthic invertebrate community typically has moderate species richness, diversity and abundance. • Shallow depth of oxygenated surface sediment. • Contaminant concentrations in surface sediment generally below ANZECC interim sediment quality guidelines (ISQG)-high or Auckland Council Environmental Response Criteria (ERC)-red effects threshold concentrations. • Estuarine vegetation provides moderate habitat for native fauna. • Habitat modification limited.

12.20.2.4 Existing avifauna

Avifauna (bird) habitat and species are present within the Māngere Inlet and the Tāmaki Inlet. Avifauna present within the Project area include coastal and shore birds, cryptic marshbirds (Banded rail and Bitten) and land birds. Ecological values have been assigned to individual species as well as features/habitat based on EIANZ impact assessment guidelines.

a. **Habitats**

A number of significant ecological areas within the wider area are identified in the AUP (OP), the Operative District Plan and the Auckland Council Regional Plan: Coastal as having values of importance to avifauna species. The marine and terrestrial ecological overlays in those documents are in recognition of these values.

The avifauna habitat features within the Project area include the Onehunga Foreshore, Māngere Inlet northern and southern coastal margins, Miami Stream, Anns Creek lava flow shrubland and wetland, and the upper Ōtāhuhu Creek arm which is part of the Tāmaki Inlet.

The wider Manukau Harbour has been identified as an important site for national and international migrant shorebirds. The Inlet above the Manukau Harbour Crossing is dominated by extensive areas of intertidal mudflats, much of which is exposed at low tide. A small island, Ngarango Otainui, is located at the eastern end of the Inlet, and has an associated small rocky reef. Other reefs, consisting either of volcanic rock or accumulations of Pacific oysters occur elsewhere in the Inlet, particularly along the northern shoreline, and are used as temporary mid-tide roosts by birds, although most are covered at high tide. There is also a small sandbank towards the western end of the Inlet and a longer shellbank towards the eastern end which are utilised by birds, though again they are covered on even neap high tides.

The Tāmaki estuary is utilised by a range of New Zealand resident and migratory shore birds, with the mid-to-lower reaches being particularly important due to the availability of roosting and feeding areas. Many shorebirds move between the Manukau and Waitematā Harbours. In the upper Ōtāhuhu Creek, there are deep muds with a narrow incised stream channel on the eastern side of the box culverts and the stream is wider on the western side. There are extensive mangroves, with the terrestrial environment bordered by a variety of exotic vegetation, SH1 and residential housing.

Table 12-27 below provides a summary of avifauna habitats and ecological values for the Project area.

Table 12-27: Summary of avifauna habitats and ecological value

Feature	Description	Ecological value	Ecological significance
Māngere Inlet	Provides important (and seasonal) foraging and roosting habitat for numerous Threatened and At Risk shorebird, including national and international migrants. The intertidal mudflats are utilised by the following species within the Māngere Inlet: New Zealand Pied oystercatcher, Eastern Bartailed godwit, Lesser knot, Wrybill, Banded and Northern New Zealand dotteral. The subtidal areas of Māngere Inlet are utilised by the following species: Tern and Shag.	Very High	SEA
Anns Creek	Mangroves in the intertidal area form part of a unique gradient. Wading bird habitat contiguous with ecological sequences from saltmarsh to freshwater wetland in Anns Creek and with mangrove ecosystems along the coastline. AUP (OP) identifies Banded rail and Bittern in the salt marsh, mangroves and the wetlands.	Very High	SEA
Pikes Point Reef	Hide tide roosting area for the Royal spoonbill.	High	
Upper Ōtāhuhu Creek	Narrow stream channel surrounded by extensive mangroves; adjacent - terrestrial habitat predominantly exotic trees. This area provides minimal habitat for avifauna.	Low	-

A review of previous surveys in the area and summer and autumn surveys carried out for the Project resulted in the findings shown in Table 12-28.

Table 12-28: Distribution of Threatened or At Risk species associated with the alignment

Species	Threat classification	Ecological value	Location
Reef heron	Nationally Endangered	Very High	Forage and roost in the Māngere Inlet, likely in the wider Tāmaki Inlet too.
Royal spoonbill	Naturally Uncommon	Moderate - High	Forage (shallow water below tideline or stream mouths) and roost in the Māngere Inlet. Favoured roost spots included the rocky reef along northern shoreline and large exotic trees on Ngarango Otainui.
Banded rail	Declining	High	Utilising mangroves along northern shoreline of Māngere Inlet, possibly into Anns Creek.
Australasian Bittern	Nationally Endangered	Very High	Identified in the AUP (OP) as present around Anns Creek.
Wrybill	Nationally Vulnerable	Very High	Forage (intertidal) and roost in the Māngere and wider Tāmaki inlet. National migrant, largely present during NZ winter.
Lesser knot	Nationally Vulnerable	Very High	Forage (intertidal) and roost in the Māngere and wider Tāmaki inlet. International migrant, largely present during NZ summer.
Eastern bar-tailed godwit	Declining	Moderate - High	Forage (intertidal) and roost in the Māngere and Tāmaki Inlets. International migrant, largely present during NZ summer.
NZ pied oystercatcher	Declining	High	Forage (intertidal) and roost in the Māngere and wider Tāmaki inlet. National migrant, largely present during NZ winter.
Northern NZ dotterel	Nationally Vulnerable	Very High	Forage and roost in the Māngere and wider Tāmaki inlet.
Variable oystercatcher	Recovering	Moderate - High	Forage and roost in the Māngere and wider Tāmaki inlet.
Pied Stilt	Declining	High	Forage (intertidal) and roost in the Māngere and wider Tāmaki inlet. National migrant, largely present during NZ winter.
Caspian tern	Nationally Vulnerable	Very High	Forage (subtidal) and roost (shell and mud-banks) in the Māngere Inlet, likely in wider Tāmaki inlet.
White-fronted tern	Declining	High	Forage (subtidal) and roost (shell and mud-banks) in the Māngere Inlet, likely in wider Tāmaki inlet.
Red-billed gull	Nationally Vulnerable	Very High	Forage (mostly stream mouths) and roost in the Māngere and wider Tāmaki inlet.
Black-billed gull	Nationally Critical	Very High	Forage (mostly stream mouths) and roost in the Māngere Inlet, likely in wider Tāmaki inlet.
Black shag	Naturally Uncommon	Moderate - High	Forage (fishing in channels and subtidal) and roost in the Māngere Inlet, likely in wider Tāmaki inlet.

Species	Threat classification	Ecological value	Location
Little black shag	Naturally Uncommon	Moderate - High	Forage (fishing in channels and subtidal) and roost in the Māngere Inlet, likely in wider Tāmaki inlet.
Little shag	Not Threatened	Moderate	Forage (fishing in channels and subtidal) and roost in the Māngere Inlet, likely in wider Tāmaki inlet.
Pied shag	Nationally Vulnerable	Very High	Forage (fishing in channels and subtidal) and roost (reefs and sandbanks) in the Māngere Inlet, likely in wider Tāmaki inlet.

Overall, the coastal and shorebird assemblage was determined to be of very high value due to the number of threatened and at risk species. The cryptic marshbird assemblage (Banded rail and Bittern) was determined to be of very high value due the threatened and at risk classifications. The land bird assemblage was determined to be of low value due to it comprising primarily introduced and also widespread and common native species.

12.20.3 Assessment of effects on ecology

12.20.3.1 Terrestrial ecology – Assessment of effects

The potential adverse effects on terrestrial ecology will include direct and indirect loss of vegetation, ecosystems and habitat along the shore of the Māngere Inlet and in the Anns Creek area. There will be adverse ecological effects on naturally uncommon ecosystem types and habitats for threatened plant species. These effects are set out in Table 12-29.

The most significant terrestrial ecology effects will be construction impacts on the remnant lava flow vegetation along the coastal edge of Māngere Inlet and Pikes Point, and the loss of threatened ecosystems and vegetation in Anns Creek.

The terrestrial areas associated with Anns Creek West have been avoided by locating the new road north of the remnant coastal vegetation in this location.

Anns Creek East contains a high diversity of habitat types, with a mosaic and ecological sequence of shrubland, mangrove and saltmarsh habitat, and sequences with freshwater. The location of the new road has been moved to the northern part of Anns Creek East (compared to earlier alignments) in order to avoid effects on the highest value areas and to minimise effects on the remaining areas. The use of bridges rather than embankments or fill/reclamation will further minimise effects in this location, however, while gaps between the bridge structures will allow moisture, the structure will shade significantly more vegetation impacting on the ecosystem. It will be difficult to completely avoid adverse effects on threatened lava shrublands and threatened plant communities in Anns Creek East from the Project. The combination of effects in the western and eastern arms of Anns Creek will lead to adverse effects on this area.

Table 12-29: Potential adverse effects on Significant Ecological Areas in East West Link alignment

Site Name	Vegetation Types	Potential Effects	Plan values	Overall Value	Magnitude of Effect	Level of Effect
Anns Creek East	Lava Shrubland, Marsh clubrush reedland, tall fescue grassland, mangroves, saltmarsh herbfield, raupo reedland	Fragmentation and reduction in size of lava shrubland, mangroves, saltmarsh through placement of viaduct piers and access staging; loss of threatened plant habitat; loss or degradation of naturally uncommon lava shrubland ecosystem; cumulative loss; increased weeds.	SEA_T_5309 ONF192	Very High	High	Very High
Anns Creek West (south of Mighty River Power Co-Generation Plant)	Mangroves, saltmarsh ribbonwood	Effects avoided through alignment on northern side.	H13-21 ONF192	High	Negligible	Low
Anns Creek Estuary (Māngere Inlet)	Lava shrubland, mangrove	Adverse effects on lava shrubland and loss of mangroves, through placement of piers and staging; potential loss of threatened plant habitat; potential loss or degradation of naturally uncommon lava shrubland ecosystem; cumulative loss; Increased weeds.	SEA_T_5304 SEA_M1_21 SEA_Mw1 ONF192	Very High	High	Very High
Lava flow Pikes Point	Lava shrubland, mangroves	Fragmentation and reduction of lava shrublands and mangroves close to coast. Avoidance of outer mangroves and lava shrublands.	SEA_T_9022 H13-23	High	Moderate	High
Lava Flows (at Waikaraka Cemetery and west)	Lava shrubland, mangroves	Loss of naturally uncommon ecosystem type that is threatened.	-	Moderate	Moderate	Low
Lava flow (Victoria St)	Mangroves	Reduction in size of mangrove ecosystems associated with lava flow.	-	Moderate	Moderate	Low
Saltmarsh at Māngere Bridge (by Galway Street)	Glasswort herbfield, mangroves	Loss of mangroves and glasswort herbfield.	-	Moderate	Moderate	Low
Te Hōpua crater	Glasswort-sea rush-oioi rushland	Avoided.	SEA_T_6103	Moderate	Negligible	Very Low
Southdown Reserve	Mangroves, oioi saltmarsh	Avoided.	SEA_T_6104	Moderate	Avoided	Avoided
Anns Creek Reserve	Freshwater wetland	Avoided.	SEA_T_5308 H13-25	High	Avoided	Avoided
Ōtāhuhu Creek	Mangroves	Replacement of culverts with bridge.	-	Moderate	Low	Low

Potential effects on lizards (if present) include mortality and injury, habitat loss and fragmentation, and displacement into unsuitable habitat. These effect are shown in Table 12-30.

Table 12-30: Assessment of ecological effects on lizards (if present)

Potential Effect	Threat class	Ecological Value	Magnitude of Effect	Level of Effect
Adverse effects				
Injury/death	Not threatened At Risk	Moderate High	Very high Very high	Very High Very High
Habitat loss/displacement	Not threatened At Risk	Moderate High	High High	Moderate Very High
Habitat fragmentation	Not threatened At Risk	Moderate High	Moderate Moderate	Low High
Positive effects				
Habitat enhancement	n/a	Moderate	Low	Low
Habitat creation	n/a	Moderate	Moderate	Low

Lizard injury and death will be avoided as far as practicable by lizard salvage during vegetation clearance activities. It is unlikely that it will be possible to capture all lizards, but the 'very high' level of effect identified in this table will be avoided in the first instance.

Native amphibians are not known to inhabit lowland streams in the area.

12.20.3.2 Freshwater habitats – Assessment of effects

The potential adverse effects and benefits on freshwater ecological values are discussed in terms of temporary (land preparation and construction effects) and permanent (i.e. permanent footprint and operational) effects. These effects are set out in Table 12-31.

Table 12-31: Assessment of Effects for Freshwater

Potential Effect	Ecological Value	Magnitude of Effect	Level of Effect	Temporal Nature
Adverse effects				
Temporary disturbance beyond the permanent occupation footprint	Low	Moderate	Very Low	Short term
Discharges from erosion and sediment control devices	Low	Low	Very Low	Short term
Permanent habitat loss in Southdown Stream	Low	Moderate	Very Low	Permanent
Permanent habitat loss in Miami Stream	Low	Very High	Moderate	Permanent
Permanent habitat loss in Anns Creek	High	Moderate	Moderate	Permanent
Discharge of treated road runoff and stormwater	Low	Low	Very Low	Permanent
Positive effects				
Reduced contaminant load discharged to streams	Low	Low	Very Low	Permanent

Potential Effect	Ecological Value	Magnitude of Effect	Level of Effect	Temporal Nature
Increased habitat diversity	Moderate	Low	Low	Permanent

The Project will involve earthworks for land preparation, road widening and construction, bridge construction and construction of stormwater treatment wetlands. The temporary adverse effects on freshwater ecological values include disturbance to freshwater habitat and fauna as a result of instream works to construct diversions and install culverts and increased sediment load from open earthworks during construction if not appropriately managed. These activities may cause an increase in sediment discharge to streams. This will result in an increase in suspended sediment concentrations and some localised sediment deposition near discharge points and estuarine depositional environments.

Erosion and sediment control measures can minimise the extent of soil erosion and sediment yield discharging to these streams during construction. The erosion and sediment control measures proposed for the Project are described in *Section 7.0: Construction of the Project* and assessed in *Section 12.15: Erosion and sediment control* of this AEE. The Project erosion and sediment control measures will be designed and established in accordance with Auckland Council's GD05 and the Transport Agency's Erosion and Sediment Control Guidelines. Implementation of these measures will minimise the effects of sediment discharge during construction.

The adverse effects of physical habitat disturbance within the freshwater environments will be minor.

The permanent works involve the installation of new culverts, extending existing structures, diverting watercourses and constructing stormwater wetlands within streams. This will result in the permanent loss in sections of streams affecting freshwater ecology.

Extending the culvert at Southdown Stream will result in the permanent loss of approximately 15% of stream habitat of the total stream length which is 130m. The adverse effects on this stream will be minor.

The new stormwater wetland within Miami Stream results in the permanent loss of approximately 20m of freshwater habitat and habitat function. This is the only open stream section of Miami Stream remaining and its ecological value in the wider catchment is marginal. The adverse effects on this stream will be moderate.

Extending the existing culvert adjacent to Great South Road for stormwater treatment will result in the permanent loss of approximately 10m (1.2%) of freshwater habitat in Anns Creek East. The adverse effects on this stream will be moderate.

Stormwater treatment is proposed for all new impervious surfaces associated with the Project. This will cater for a 1 in 10 year rainfall event and removal of 75%[89] of total suspended solids and associated contaminants prior to discharge to receiving environments. In addition, where works occur within and adjacent to areas of existing state highways, runoff from both the new and existing impermeable surfaces will be treated. The improved water quality entering streams will result in positive effects on freshwater habitats and increased habitat diversity within the stormwater wetlands which may provide habitat for common species.

12.20.3.3 Marine ecology – Assessment of Effects

The primary potential adverse effects on marine ecological values are from the permanent loss of marine habitat, temporary habitat disturbance during construction, the discharge of runoff from earthworks during construction and the discharge of treated stormwater during operation. These effects are set out in Table 12-32.

[89] Stormwater treatment will be designed to remove 75% of total suspended sediment and associated contaminants on a long term average basis.

Table 12-32: Assessment of effects for marine ecology

Potential Effect	Ecological Value	Magnitude of Effect	Level of Effect	Temporal Nature
Adverse effects				
Construction of road embankment	Moderate	High	High	Permanent
Construction of landscape features and stormwater wetlands	Moderate	High	High	Permanent
Occupation of the CMA by permanent bridge structures	Moderate	Moderate	Moderate	Permanent
Loss of estuarine vegetation at Galway Street	Moderate	Moderate	Moderate	Permanent
Loss of estuarine components of Miami Stream	Very Low	Very High	Low[90]	Permanent
Cumulative effects of permanent loss of CMA (assessed at Māngere Inlet scale)	Moderate	Low	Low	Permanent
Physical disturbance beyond the permanent occupation / reclamation footprint	Moderate	Moderate Low	Moderate Low	Short term Long term
Subtidal dredging (assessed at the Māngere Inlet scale)	Moderate	Moderate Low	Moderate Low	Short term Long Term
Disturbance to sediment contaminants during construction	Moderate	Low	Low	Short term
Noise and vibration	Moderate	Low	Low	Short term
Changes to coastal processes (assessed at the Māngere Inlet scale)	Moderate	Low Low	Low Low	Short term Permanent
Structures affecting connectivity of ecological features / habitats	Moderate	Moderate	Moderate	Permanent
Operational phase disturbance	Moderate	Negligible	Very Low	Permanent
Discharges from erosion and sediment control devices	Moderate	Low-Moderate	Moderate	Short term
Discharge of treated road runoff	Moderate	Low	Low	Permanent
Discharge of treated catchment stormwater and landfill leachate	Moderate	Low	Low	Permanent
Positive effects				
Reduced contaminant load discharged to the CMA (Assessed at the Māngere Inlet scale)	Moderate	Moderate	Moderate	Permanent
Increased habitat diversity (assessed at the Māngere Inlet scale)	Moderate	Low Moderate	Low Moderate	Short term Permanent

[90] EIANZ guidelines do not cover habitats with very low value. The assessment matrix has been modified in this instance to reflect total loss (very high magnitude) of a small habitat with very low ecological values, resulting in a permanent low level of effect.

Construction of the road embankment along the northern shore of the Māngere Inlet for the Project will involve the reclamation of 5.6ha of intertidal mudflat habitat. This represents 1% of the Māngere Inlet. Mudflat and benthic organisms within the embankment will perish during construction.

Construction of the landscape features and stormwater wetlands will involve the reclamation of 18.36ha of intertidal mudflat habitat, including low tide channels created by the numerous stormwater discharge points along the northern shore.

In the context of the northern shore of the Māngere Inlet, the magnitude of the effect of the reclamation is considered to be high, but when assessed at the wider Māngere Inlet scale the magnitude of effect is considered to be low.

Physical disturbance to marine habitat beyond the permanent occupation / reclamation footprint during construction is considered to be moderate in the short term (during construction) and minor in the long term (during operation).

Subtidal dredging for construction of the reclamation will result in a temporary increase in suspended sediment and deposited sediment due to sediment loss from the dredger bucket and barge during dredging. The effect of subtidal dredging is considered to be moderate in the short term and minor in the longer term as estuarine habitats naturally recover from disturbance over time and recolonisation by benthic invertebrate organisms occur.

The installation of the erosion and sediment controls during earthworks on land will mean that the adverse effects of the discharge of the treated construction stormwater runoff will be minor. In a large rainfall event where there is a release of sediment from open works, there is a chance that the deposition of sediment could smother benthic invertebrates. This is likely only to arise from a small area of open earthworks and the risk can be managed through regular monitoring of treatment devices to ensure they are in place/operating including checks prior to significant rainfall events.

The disturbance of marine sediments containing elevated concentrations of contaminants is considered to be low, based on the low risk to ecology described in *Technical Report 15: Coastal Processes Assessment* in Volume 3 and the temporary nature of the effect.

The effect of the changes in noise and vibration and coastal processes from the Project construction on marine ecological values is assessed as being low.

Bridge structures are planned in Anns Creek Estuary, through Anns Creek East and West and replacing the SH1 culverts at Ōtāhuhu Creek with a bridge. The area of marine environment that will be permanently removed due to the bridge structures is approximately 90 m^2. The adverse effects of permanent habitat loss from the installation of permanent bridge piers will be moderate.

The construction of the road embankment at Galway Street will result in the permanent loss of the SEA estuarine herbfield area at this location. Although this herbfield is an important habitat, it is small compared to the overall estuarine herbfield habitat within the wider Māngere Inlet. Therefore, the adverse effects of this loss will be low.

Structures associated with the Project will affect connectivity of ecological features / habitats. This has been assessed as having a moderate adverse effect.

It is estimated that approximately 190ha of marine environment has been historically reclaimed in the Māngere Inlet, primarily along the northern shore and around the Manukau Harbour Crossing abutments. The area of proposed reclamation and permanent occupation of the CMA (reclamation, landscape and stormwater features, bridges and boardwalks) in the Māngere Inlet is 25.0ha. Cumulative effects of permanent loss of CMA has been assessed as having a low level of effect.

The loss of the estuarine components within Miami Stream is considered to be very high. However in the context of loss in mangrove habitat within the wider Māngere Inlet and Manukau Harbour, the adverse level of effect has been assessed as low.

The discharge of treated leachate, catchment stormwater and road runoff stormwater will have a low level of effect on the mudflat and benthic organisms.

a. **Ecological Benefits**

Currently the main contaminant load discharging to the CMA is from contaminants in groundwater, stormwater and sewer leakage to ground and /or cross-connection with stormwater. The Project will reduce the contaminant load from these sources being discharged to the CMA. This will lead to a positive effect on marine ecological values by reducing contaminants to the marine environment. This positive effect will be moderate.

Increased habitat diversity within the foreshore stormwater treatment wetlands is expected to be low as the predominantly freshwater wetlands will attract freshwater organisms rather than marine organisms. The mudcrete landscape features to be created along the northern shore of the Inlet will encourage colonisation of hardshore organism communities such as limpets, anemones, coralline algae, mussels and chitons. If these communities develop, the sustained positive effect in the medium to long term is considered to be moderate.

12.20.3.4 Avifauna – Assessment of effects

The adverse and beneficial effects of the construction and operation of the Project on avifauna values are:

- The direct loss of foraging, roosting or breeding habitat (permanent or temporary);
- The indirect effects on food supply (availability, quality and abundance) through sedimentation and disturbance; and
- Mortalities of individual birds.

These effects are set out in Table 12-33.

Table 12-33: Assessment of effects for avifauna

Potential Effect	Avifauna assemblage	Ecological Value	Magnitude of Effect	Level of Effect	Temporal Nature
Adverse effects					
Habitat loss	Shorebirds	Very High	Low	Moderate	Permanent
	Cryptic marshbirds	Very High	Moderate	Very High	Permanent
	Landbirds	Low	Low	Very Low	Permanent
Cumulative effects of permanent loss of CMA (assessed at Māngere Inlet scale)	Shorebirds	Very High	Low	Moderate	Permanent
Disturbance – Construction	Shorebirds	Very High	Low	Moderate	Temporary
	Cryptic marshbirds	Very High	High	Very High	Temporary
	Landbirds	Low	Negligible	Very Low	Temporary

Potential Effect	Avifauna assemblage	Ecological Value	Magnitude of Effect	Level of Effect	Temporal Nature
Disturbance – Operation	Shorebirds	Very High	Low	Moderate	Permanent
	Cryptic marshbirds	Very High	High	Very High	Permanent
	Landbirds	Low	Negligible	Very Low	Permanent
Food supply – Construction	Shorebirds	Very High	Low	Moderate	Temporary
	Cryptic marshbirds (Banded rail)	Very High	Low	Moderate	Temporary
Food supply – Operation	Shorebirds	Very High	Negligible	Low	Permanent
	Cryptic marshbirds (Banded rail)	Very High	Negligible	Low	Permanent
Mortalities – Construction	Cryptic marshbirds	Very High	Very High[91]	Very High	Temporary
	Landbirds	Low	Negligible	Very Low	Temporary
Mortalities – Operation	Shorebirds	Very High	Negligible	Low	Permanent
	Cryptic marshbirds	Very High	Low	Moderate	Permanent
	Landbirds	Low	Negligible	Very Low	Permanent
Positive effects					
Reduced contaminant load discharged to the CMA	Māngere Inlet shorebirds	Very High	Moderate	Low	Permanent
Increased habitat diversity	Māngere Inlet avifauna	Moderate	Low	Low	Permanent

The adverse effects from construction noise associated with earthworks and plant movement on shorebirds populations is likely to be a negligible and of a temporary nature both at a local and population level. Around Anns Creek, construction will result in the disturbance of Banded rail and Bittern. At a wider context or population level the adverse effects on Banded rail and Bittern is likely to be moderate.

The indirect effect on food supply for shorebirds and cryptic marshbirds, at a local level, will be minor and of a temporary nature. In the wider context, and at a population level, the indirect effect on food supply due to the Project will be negligible for all species. The adverse effects from physical habitat disturbance within the freshwater environments across the Project area is considered to be minor and in the short term.

Given the relatively low numbers of Tern and Shags foraging in the Māngere Inlet, the availability of extensive similar foraging habitat elsewhere in the Manukau Harbour, and the short term and confined nature of the elevated suspended solids levels for the dredging, the adverse effects of dredging on terns

[91] If Banded rail are found to be breeding, otherwise a negligible magnitude of effect.

and shags will be minor in the context of the local environment. This effect will be negligible at a population level.

Although unlikely, there is the potential for Banded rail to be nesting along the coastal margin associated with Anns Creek Estuary during the construction period. Historically this species has been greatly impacted through the loss of habitat in Auckland. As such, there could be construction mortalities on Banded rail at a local level if they are nesting in this location. At a wider context, the magnitude of such an effect at a population level is considered to be minor.

The majority of species that may be breeding within the construction footprint include common native and introduced land birds nesting in trees and scrub. There have been no threatened or at risk land bird species recorded associated with the Project. Due to the widespread and mobile nature of these species, the effect of construction mortalities on these land birds populations is considered to be negligible.

Threatened and At Risk avifauna species recorded in association with Anns Creek include Banded rail within the intertidal mangrove stand (and possibly the estuarine rushes) and Bittern. Removal of vegetation associated with this vegetation sequence will result in the loss of habitat for these species. Historically these species have been greatly impacted through the loss of habitat in the Auckland region. The adverse effect of this permanent habitat loss is considered to be moderate.

It is estimated that approximately 190ha of marine environment has been historically reclaimed in the Māngere Inlet, primarily along the northern shore and around the Manukau Harbour Crossing abutments. The proposed reclamation is 18.4ha. The reclamation of intertidal foraging habitats adds to the incremental/cumulative effects of habitat loss for shorebird species. The effect of this habitat loss will be moderate for the shorebirds.

The operational disturbance to shorebirds populations is likely to be a negligible. The indirect effect on food supply for shorebirds and Banded rail will be negligible at both local and population levels. Operational effect on avifauna mortality is unlikely to change from current conditions, and therefore the effect is negligible. While around Anns Creek, particularly during breeding and nesting, the potential for mortality is increased and adverse effect is high for Banded rail and Bittern mortality. At a wider context or population level the effect is likely to be moderate.

a. **Ecological Benefits**

The expected ecological benefits for avifauna arise from the Project by reducing the discharge of contaminants (from groundwater, stormwater and other discharges). The reduced contaminant load being discharged to the CMA will lead to a positive effect on shorebird foraging habitat and food resource of the Māngere Inlet. The positive effects will be moderate.

Increased habitat diversity within the foreshore stormwater wetlands is expected to provide some different habitat for common native and introduced bird species such as Pukeko and waterfowl. The mudcrete platforms and headlands will encourage colonisation of hardshore organism communities, and increase biodiversity and food source for oyster catchers. The overall benefit is expected to be low due to the small scale of the habitat and uncertainty around whether hardshore organisms will naturally colonise these features.

12.20.4 Measures to avoid, remedy or mitigate potential adverse effects on ecology

Design development for the Project sought to avoid or minimise potential adverse effects on ecology (and other matters) as far as practicable. Key principles that guided design were:

- Minimising reclamation footprint to minimise the areas of permanent loss of foraging habitat;
- Minimising fragmentation and loss of significant vegetation species and ecosystems including Te Hōpua crater saltmarsh, Anns Creek East, Anns Creek Estuary and lava shrublands at Pikes Point, Waikaraka Cemetery and Victoria Street;

- Use of bridge structures rather than embankment in Anns Creek;
- Avoiding streams and ecological areas for network utility diversions;
- Providing longer bridge spans to minimise the areas of permanent loss of habitat;
- Placing bridge piers to avoid areas of higher ecological values, particularly at Anns Creek Estuary and Anns Creek East;
- Minimising the loss and disturbance to high and moderate quality lizard habitats, and opportunities to incorporate lizard habitat in landscape design; and
- Investigating opportunities for declamation.

Based on the assessment approach set out in the EIANZ guidelines, very high, high and moderate levels of effect require avoidance or mitigation, whereas low and very low levels of effect are normally not of concern, but design, construction and operational care should be taken to minimise adverse effects. The section below discusses the mitigation proposed for the construction and operation of the Project. Residual effects that have not been mitigated within the scope of the Project are also addressed below.

12.20.4.1 Particular areas for mitigation

The following mitigation has been considered for ecological effects:

- The existing saltmarsh wetland in Te Hōpua crater (Gloucester Park South) will be enhanced through weed control and buffer planting of appropriate native species (e.g. flax, manuka, taupata, cabbage tree) around the edges. Landscaping will expand the existing wetland vegetation (e.g. through planting of oioi, sea rush, glasswort, salt marsh ribbonwood).
- Saltmarsh habitat will be restored and recreated along the coastal foreshore.
- Adverse effects on the lava flow vegetation will be minimised by excluding areas from the construction footprint. The remaining basalt lava flows and lava shrubland habitats at Pikes Point and Victoria Street will be enhanced through weed control.
- The planting and restoration of coastal plant species as part of the stormwater wetlands and landscape planting along the coastal foreshore edge and potentially in other coastal locations in Crown ownership.
- Construction and pier exclusion areas with the lava flow shrublands and saltmarsh habitats in Anns Creek East, including locating the Project as close to the northern edge of Anns Creek East as possible.
- Reduce the width of the Project footprint as far as practicable by reducing the separation distance between bridge structures.
- Further refinement of bridge pier locations in Anns Creek East during detailed design to further avoid and minimise adverse effects and restrictions on construction activity within the pier exclusions areas.
- Restrictions on vegetation alteration or removal or land disturbance activities in Anns Creek East outside the construction footprint.
- Construction yards confined to the existing consented development areas in Anns Creek East.
- Weed control and pest control covering a total area of approximately 10ha.
- Legal protection and enhancement of threatened plant communities (lava shrublands) in Anns Creek East through weed control and long-term conservation management, subject to landowner arrangements.
- Rehabilitation of lava shrubland species through planting on the new coastal edge, using eco-sourced local genetic stock (e.g. Coprosma crassifolia, ngaio, akeake, saltmarsh ribbonwood, oioi, Austrostipa stipoides, Puccinellia stricta (salt grass)) and planting of threatened coastal species such as Mimulus.

- Restoration of coastal ecosystems in Ōtāhuhu Creek through declamation and restoration of fringing saltmarsh and riparian vegetation along a section of the creek.
- Identify opportunities to create, enhance and connect lizard habitats within the Project area. Habitat enhancement includes the provision of habitat elements (logs and natural debris) and pest control if deemed appropriate.
- Prior to earthworks commencing, identify lizard release sites within the wider Project area in a location that provides lizard refuge and food. This site must be sufficient to support a viable population of native lizards for all species present before development.
- Restoration planting at Anns Creek, especially enhancement of inanga spawning areas.
- Enhancing remaining waterways through riparian planting and habitat enhancements.
- Research scholarships for assessing translocation of hard shore organisms to the landward edge of the new landform features in order to facilitate colonisation and assist communities becoming self-sustaining.
- Investigate opportunities to establish new saltmarsh habitat between terrestrial and mangrove vegetation on the eastern shore of the Māngere Inlet to replace areas which will be lost under the EWL footprint and provide new habitat.
- Investigate options to increase the abundance of intertidal organisms within the Māngere Inlet (e.g. by the seeding of bivalves) and to increase the abundance of intertidal prey items within the Māngere Inlet.
- Investigate opportunities to enhance habitat at or in the vicinity of Ngarango Otainui Island, particularly the macrocarpa trees which provide roosting habitat for royal spoonbill. Given macrocarpa have a limited lifespan, more trees could be planted as future roosting habitat for this species.
- Investigate, in collaboration with DOC, potential offsets for residual adverse effects on shorebirds.
- Planting saltmarsh to replace areas which will be lost under the EWL footprint. Ideally this should be done in a location that may be utilised by Banded rail.
- Recreate the Anns Creek East raupo wetland, currently utilised by Australasian Bittern, in an appropriate location (e.g. within the Anns Creek Reserve).

These mitigation measures will be detailed in an Ecological Management Plan (ECOMP) for the Project. The ECOMP is discussed in further detail in *Section 13.1.5* of the AEE.

The proposed mitigation in land not owned by the Transport Agency will be subject to the agreement of the landowner. Initial discussions have taken place with landowners and will continue as the design progresses.

12.20.4.2 Particular areas for monitoring

The following monitoring is also recommended to further minimise potential effects and to determine the success of the proposed mitigation:

- Monitoring temporary stream diversions during construction to identify if any change to construction methodology are required to respond to monitoring;
- Prior to construction establish a framework for adaptive monitoring during earthwork / construction for elevated discharge of total suspended sediment and/or sedimentation within the CMA (also see *Section 12.19.5* of this AEE regarding monitoring of sedimentation during construction);
- Post-construction monitoring of the seaward edge of the new landforms along the northern shore to determine if they are successfully inhabited by hard shore sessile marine invertebrates;

- Post-construction monitoring of the quality of the treated stormwater from the stormwater wetlands along the northern shore to confirm the performance assumed in the Project assessments, including the marine ecology assessment; and
- Prior to construction, monitoring to determine if Banded rail and Australasian Bittern are breeding in areas of potential nesting habitat within the proposed Project footprint. This will be used to inform the construction methodology and programme.

12.21 Stormwater

Overview

All stormwater discharged from the Project will be managed for quantity and quality to minimise adverse effects on the receiving environments of the Manukau Harbour, Māngere Inlet and the Tāmaki River.

The following principles have guided the approach to stormwater management for the Project:

- Treat all stormwater from all new impervious surface (roads) associated with the Project to remove 75% of total suspended solids (TSS) on a long term annual average basis; and
- Treat all stormwater from existing impervious surfaces associated with SH20 and SH1 within the Project footprint where stormwater treatment is not currently provided. These areas will be treated to the same standards as new impervious surfaces.

This will result in an improvement in stormwater quality being discharged from these areas to the Manukau Harbour and the Tāmaki River.

In addition, the Project provides an opportunity to capture and treat stormwater from the wider Onehunga and Penrose Catchment in the proposed stormwater treatment areas on the Māngere Inlet foreshore. This will be treated using BPO principles as set out in *Section 6.5.4.2*. This will result in a significant improvement in the quality of stormwater discharging to the Māngere Inlet. Further, leachate intercepted at the Pike Point Landfill can also be treated in the foreshore stormwater treatment areas.

Overall, the stormwater discharge effects of the Project are positive. The Project will result in significant reductions in the quantity of suspended solids, metals, hydrocarbons, nitrogen and coliforms discharging via stormwater to the coastal receiving environments.

12.21.1 Introduction

This section assesses the actual and potential effects of the Project on stormwater quantity and quality. It deals with stormwater generated by impermeable surfaces associated with the new road that require treatment and the opportunity presented by the Project and incorporated in the concept design to provide additional treatment of existing stormwater and groundwater from adjacent catchments.

This assessment is supported by *Technical Report 12: Stormwater Assessment* in Volume 3. It is also closely linked to the assessment of groundwater contained in *Section 12.16: Groundwater* of this AEE due to interactions between groundwater, leachate and stormwater within the Project area.

This assessment of stormwater effects was informed by both desktop and field investigations. The desktop assessment included a review and analysis of available information and data including Auckland Council records and databases and other relevant studies that have been previously undertaken in the Project area. The field investigations included stormwater and groundwater sampling and monitoring, marine sediment sampling and biota sampling. Stormwater models informing this assessment include flood risk models undertaken previously for Auckland Council as well as project specific hydrology and hydraulics studies, water quality modelling and soil loss modelling. The discussion relating specifically to groundwater investigations is covered in more detail in *Section 12.16: Groundwater* of this AEE.

Stormwater treatment devices have been designed to achieve the treatment standards set out in Auckland Council's *Technical Publication 10 - Stormwater management devices: Design guidelines manual* (2003) (TP10). Within the manual, treatment device efficiency is expressed in terms of a percentage reduction in contaminant load within stormwater achieved through the treatment device. The typical standard applied is 75% removal of TSS on an annual average basis. TSS removal also provides a surrogate measure for reduction in other contaminants (e.g. zinc and copper).

Stormwater flow estimates have been based on the Auckland Regional Council *Technical Publication 108 - Guidelines for stormwater runoff modelling in the Auckland Region* (TP108) as well as results from flood studies carried out by Auckland Council for the surrounding areas (circa 2004). The methodology for flood risk assessment is described in further detail in Section 6 of *Technical Report 12: Stormwater Assessment* in *Volume 3.*

During construction, sediment is entrained in stormwater from earthworked areas and is managed through erosion and sediment control measures. These are discussed in *Section 12.15: Erosion and sediment control* of this AEE.

12.21.2 Existing environment

Stormwater is water that originates during rainfall events and runs off from both pervious surfaces and impervious surfaces such as roadways, roofs and hardstand areas. Stormwater quantity and quality within the Project vicinity is influenced by several factors including:

- Rainfall;
- Tidal characteristics in the coastal receiving environments;
- Existing stormwater catchments;
- Soil type; and
- Land use within the stormwater catchments affecting stormwater runoff quantity and quality.

The Project traverses two major catchments, the Manukau Harbour (including the Māngere Inlet) and the Tāmaki River.

There are several freshwater and saline watercourses along the Project. These watercourses are described in *Section 12.20: Ecology* of this AEE.

Much of the Onehunga and Penrose area drains to ground soakage rather than freshwater streams. Therefore, the receiving environments for Project stormwater are typically the existing stormwater networks, ground soakage or to the CMA.

The soils in the Project area catchments include areas of clay, volcanic soils underlain by basalt and historical fill areas. The geology of the area is described in detail in *Section 11.0: Description of the existing environment* of this AEE.

Land use is generally fully developed urban catchment with residential, commercial and industrial uses.

The existing quality within the stormwater system has been investigated as part of the Project through the review of previous studies, monitoring and testing of samples and through water quality modelling. Monitoring of the quality of stormwater events captured a range of rainfall events. The stormwater quality monitoring results are set out in detail in Appendix B of *Technical Report 12: Stormwater Assessment* in Volume 3.

In summary, the primary contaminants of concern that were identified in stormwater from the existing catchments include:

- Zinc, copper, lead and TSS (typical of stormwater contaminants;
- Faecal coliforms / E. coli; and
- Ammonical Nitrogen.

Monitoring results indicate that TSS and metal concentrations are similar to other untreated urban Auckland areas. Mean faecal coliform concentrations are an order of magnitude higher than the Auckland average. The baseflow results for faecal coliform are exhibiting extremely high faecal coliform

concentrations. These concentrations (and findings of previous studies) indicate that there may be sources of untreated wastewater entering the stormwater system. Ammonical nitrogen is also present in the stormwater indicating the potential interaction with leachate from the adjacent landfills.

12.21.3 Assessment of effects

12.21.3.1 Project approach to the management of stormwater

The following principles have guided the approach to stormwater management for the Project:

- Treat all stormwater from all new impervious surface (roads) associated with the Project to achieve 75% TSS on a long term annual average basis;
- Treat all stormwater from existing impervious surfaces associated with SH20 and SH1 within the Project footprint where stormwater treatment is not currently provided. These areas will be treated to the same standard as new impervious surfaces; and
- Identify opportunities to treat stormwater from other contributing catchments where this can be achieved within the Project footprint.

Wetlands and swales are natural treatment systems which remove contaminants by sedimentation, bio-uptake and trapping of particulates by planted water bodies. These are the preferred method of treatment for the Project where there is sufficient space within the Project footprint. In addition, there are two existing stormwater treatment ponds associated with SH1 and SH20 that will be upgraded to wetlands as part of the Project to provide a more efficient treatment device for existing and new stormwater.

Treatment wetlands are proposed in the following locations within the Project:

- Converting the existing stormwater pond within the Neilson Street Interchange into a wetland;
- A new wetland at the southern end of Hill Street;
- A new wetland at Hugo Johnston Drive; and
- Converting the existing stormwater pond at Frank Grey Place (Ōtāhuhu) into a wetland.

The locations of these proposed wetlands are shown on the drawings in *Plan Set 9: Stormwater* in Volume 2 and further details are set out in Appendix D of *Technical Report 12: Stormwater.* The design of the wetland treatment system is described in further detail in *Section 6.0: Description of the Project* of this AEE.

Where space is more constrained, buried proprietary stormwater treatment systems are proposed. The devices will be similar to “stormfilters”, a proprietary stormwater treatment device approved by Auckland Council for use within Auckland. These are currently in use along sections of the existing SH20 road corridor. Stormfilters are modular, rechargeable, media-filled cartridges which absorb and retain pollutants contained within stormwater runoff including total suspended solids, hydrocarbons, nutrients, and soluble heavy metals. Approximately 29 proprietary stormwater treatment systems are proposed for the Project. The indicative location of these are shown on the stormwater drawings contained in *Plan Set 9: Stormwater* in Volume 2.

The design of the proprietary stormwater treatment devices is described in further detail in *Section 6.0: Description of the Project* of this AEE.

Along the Māngere Inlet foreshore, the location of the proposed road with respect to existing stormwater infrastructure, closed landfills and the coastal edge presents a unique set of constraints and opportunities which has resulted in a stormwater design approach for this part of the Project that differs from the general stormwater design approach. Stormwater treatment devices along the foreshore will treat runoff from some 600 ha over and above the Project area. There will be five new treatment areas located at Galway Street, Alfred Street, Captain Springs Road, Miami Stream and east of Miami Parade.

The proposed stormwater treatment method in the foreshore area is a combined wetland and biofiltration system, designed to minimise the footprint while maximising treatment. A system of pipes, underdrains and weirs will convey flow through the systems for treatment before discharge to the Māngere Inlet. Because of the existing stormwater network levels, the treatment areas will be at approximately mean sea level and will discharge through one way valves designed to avoid salt water getting into the freshwater area. The stormwater treatment areas be constructed so that they can be adapted for climate change (sea level rise) over time. The design of this system is described in further detail in *Section 6.0: Description of the Project* of this AEE and shown on the stormwater drawings contained in *Plan Set 9: Stormwater* in *Volume* 2.

12.21.3.2 Stormwater quality for road surfaces

Stormwater quality effects arise as particles from car exhausts, tyres and brakes, silt, oils and litter collect on road surfaces. Many of these small particles adhere to sediments which are washed off impervious surfaces and transported through stormwater runoff to discharge to the receiving environment.

The total Project road impermeable surface area is 47 ha. This is comprised of 22 ha of new road, and 25 ha of existing road surfaces (on SH20 and SH1).

To mitigate effects associated with stormwater, runoff from new and modified road surfaces (that is, all 47 ha) associated with the Project will be captured and passed through stormwater treatment devices. This will be achieved through constructed wetlands where practicable and, where not practicable through proprietary treatment systems.

12.21.3.3 Additional treatment for Onehunga and Penrose Catchment

A large proportion of the existing stormwater infrastructure within the Onehunga and Penrose Catchment is currently untreated and discharges straight to the CMA. The overall catchment directly discharging to the foreshore area via the stormwater pipe network is approximately 600 ha which drains to 11 existing outfalls along the foreshore.

The Onehunga and Penrose Catchment is a long established urbanised catchment where limited space and the depth of stormwater outfall pipes through landfill areas constrain opportunities for retrofitting stormwater treatment measures further upstream.

Stormwater from the Onehunga and Penrose Catchment will be captured through five new wetland/biofiltration areas along the foreshore.

The Project will result in positive effects by treating stormwater contaminants from a large part of the Onehunga and Penrose Catchment before it is discharged to the Māngere Inlet.

12.21.3.4 Stormwater quantity

Potential adverse flooding effects have been identified through review of Auckland Council records, previous flood studies and hydraulic assessment. Mitigation measures put in place that are in accordance with good practice methods. The proposed new road is set at levels above extreme flood events, high tides and storm surge, allowing for 100 years of predicted climate change effect. In some locations, including along the Māngere Inlet foreshore, this sets the road level higher than some properties upstream. Pipes, inlets and overflows are therefore designed to pass higher flows through the road embankment to avoid increasing flood risk at those properties.

There is potential for the road embankment to provide an improved level of protection to properties from coastal inundation events as a result of any sea level rise. However, there are residual flood risks associated with reliance on one-way valves and pump stations. The risk and consequence of failure of valves and pumps will have to be considered throughout the design development.

12.21.3.5 Stormwater outfalls

Stormwater from the Project will discharge to the existing stormwater network or via outfalls to the CMA and existing streams. The outfalls include existing, upgraded and new outfalls and are set out in detail in Appendix D of *Technical Report 12: Stormwater*. In summary the outfalls are:

- new coastal outfalls;
- new outfalls to streams; and
- upgraded or extended existing coastal/freshwater outfalls.

These outfalls are shown on the drawings contained in *Plan Set 9: Stormwater* in Volume 2.

The effects of stormwater discharges from these outfalls on coastal processes and ecology within the Māngere Inlet and the Ōtāhuhu Creek are assessed in *Section 12.19: Coastal processes* and *Section 12.20: Ecology* of this AEE. In summary, outfalls have been designed to minimise stream and coastal erosion. The coastal outfalls will result small channels in adjacent marine sediments particularly evident during low tide. The adverse ecological effects of discharge of treated stormwater from the Project into the receiving environments is negligible.

12.21.3.6 Leachate stormwater Interaction

In addition to the stormwater discharging from these catchment areas, groundwater from existing landfills along the foreshore contains leachate. Some of this leachate is captured through the existing Pikes Point leachate interception system and discharged to the Watercare wastewater system for treatment. The remainder discharges to the CMA. The new road embankment and foreshore landscape features provide extended travel time for contaminated groundwater which will allow additional attenuation and will significantly reduce contaminants in groundwater entering the CMA. This Project benefit is discussed in further detail in *Section 12.16: Groundwater* of this AEE.

The foreshore stormwater treatment system also provides the opportunity to treat leachate from the Pikes Point leachate interception system rather than continuing to discharge to the trade waste system. As part of the construction of the Project, the leachate interception system needs to be relocated providing an opportunity for a more efficient leachate interception system to be installed at this location. This Project benefit is discussed in further detail in *Section 12.16: Groundwater* of this AEE.

12.21.3.7 Combined project effects

Overall, the Project will result in an improvement in stormwater quality discharging to the Māngere Inlet.

The Project (including new stormwater treatment facilities for stormwater from the wider catchment) results in significant reductions to the quantity of suspended solids, metals, hydrocarbons, nitrogen and coliforms discharging via stormwater to the receiving environments. The following changes to long term annual average contaminants discharge are expected as a result of the Project:

- A reduction in total suspended solids from 870 to 210 tonnes per year (a 75% reduction);
- A reduction in total zinc from 2.67 to 1.17 tonnes per year (a 56% reduction);
- A reduction in total copper from 0.24 to 0.08 tonnes per year (a 66% reduction); and
- A reduction in total nitrogen from 19 to 10 tonnes per year (a 47% reduction).

Other predicted water quality benefits are:

- Contribution to a potential reduction in contaminants reaching the Māngere Inlet from closed landfill leachate. This is covered in further detail in *Section 12.16: Groundwater* of this AEE;
- Improved resilience to contaminant spills or contaminant dumping through containment in the stormwater treatment devices;

- New freshwater ecological environments created in constructed wetland and biofiltration systems. This is covered in further detail in *Section 12.20: Ecology* of this AEE; and
- Protection of the Māngere Inlet from wastewater discharges that may enter the stormwater system.

12.21.4 Measures to avoid, remedy or mitigate effects on stormwater

The overall benefits for stormwater quality identified in this section relies collaboration between the Transport Agency and Auckland Council and on the stormwater system being well designed, constructed, maintained and operated. This section sets out the measures to address these matters.

A concept stormwater design has been prepared for the Project and has formed the basis of the assessment of effects contained in this and other sections of the AEE. The design will be subject to further refinement during detailed design following confirmation of the designations and granting of resource consents. The following matters will need to be addressed as part of the process for finalising the design:

- All road related stormwater to be designed to achieve 75% TSS removal;
- All existing areas of SH20 and SH1 that will be treated as part of the Project will be designed to achieve the same standards of 75% TSS removal;
- The stormwater treatment system along the foreshore is to achieve the best practicable treatment standards considering the constraints. The concept design achieves 75% TSS removal overall across the five treatment areas*;*
- The use of biofiltration systems within the foreshore stormwater wetlands;
- Detailed investigations and design to address the likelihood and consequence of blockages, valve, pump and electrical failures and other extreme events with the outcomes incorporated into the final design; and
- Further Auckland Council design input into the proposed stormwater system, particularly those aspects that will become Auckland Council assets.

During operation, it is important that the stormwater system is properly operated and maintained to maintain stormwater treatment efficiency. This will be addressed in operation and maintenance plans for the stormwater treatment devices, network and pump stations. The plans will include:

- Details of routine and post-event inspection;
- Required planned maintenance programme to ensure continued levels of service; and
- Clean-up procedures for spills.

The operation and maintenance plans will also include the preparation of emergency response and action plans for the stormwater treatment devices, network and pump stations that include the details the required actions and procedures to be carried out in the event of failure of any part of the stormwater infrastructure to ensure the safety of road users and the community.

The operation and maintenance plans will be developed by the Transport Agency and implemented by the asset owner (either the Transport Agency or Auckland Council depending on the specific treatment device).

12.21.5 Conclusion

Stormwater runoff from new (22 ha) and existing (25 ha) impermeable surfaces associated with the Project will be treated before discharge to remove the majority of contaminants. This will result in an improvement in stormwater quality being discharged from these areas.

Stormwater runoff from approximately 600 ha of additional area in the Onehunga and Penrose Catchment will be captured and treated in stormwater treatment areas on the Māngere Inlet foreshore. This will result in a significant improvement in the quality of stormwater discharging to the Māngere Inlet.

Further, the foreshore embankment and treatment areas attenuate leachate from existing closed landfills, reducing contaminants reaching the inlet through groundwater. The wetlands also provide the opportunity to treat intercepted leachate rather than continuing to discharge it to the tradewaste system.

New project infrastructure will be designed to meet industry standard flood risk protection standards although there will be residual risks associated with reliance on pumps, one-way valves and piped systems.

Overall, the effects of the Project on stormwater are positive.