5. **Project description**

This section should be read in conjunction with the Drawings (Volume 4) and Assessment Reports (Volume 3) that form part of the AEE documentation.

The information provided in this section and in the Drawings shows an ‘indicative alignment’. Detailed design may result in refinements of the alignment, which will remain within the designation boundary. The detailed design will be subject to consideration under the conditions of resource consent and the outline plan of works (OPW) process under s176A of the RMA. The OPW process is described in greater detail in Section 1.9 of this AEE.

This section discusses the following components of the Project:

- The design philosophy;
- Motorway design;
- Local private access roads;
- Traffic services;
- Walkways and cycleways;
- Emergency vehicle access;
- Permanent access tracks for maintenance activities;
- Cut slopes and fill embankments;
- Viaducts and bridges;
- Operational water management;
- Urban design; and
- Landscaping.

5.1 **Design philosophy**

In accordance with the objectives and design standards for the national RoNS programme, the Project will be designed, constructed and operated as a new motorway, being an extension of the existing SH1 from the NGTR at the Johnstone’s Hill tunnels to just north of Warkworth.

The Project will be a new off-line (ie an alignment that does not sit within the existing SH1 alignment) four-lane, dual carriageway road over a total length of 18.5km.

The overall approach to the design for the Project is as follows:

- Design elements of the Project to the relevant design standards, including the NZTA’s RoNS design standards and guidelines;
- Avoid, remedy or mitigate adverse effects on the environment;
- Minimise adverse effects on adjacent properties and identify appropriate mitigation measures;
- Maintain connectivity provided by existing infrastructure including local roads, providing property access and farm access;
- Provide for route security on the State highway network, including provision for alternate routes and adopting appropriate design standards for aspects such as stormwater (flooding);
• Adopt a ‘whole of life’ approach to the Project design in order to provide opportunities for optimised construction, operation and maintenance and associated effects, mitigation and costs; and
• Continue the NGTR, including carriageway capacity, approach to pavement and structure design, levels of accessibility, and landscaping and visual appearance.

5.1.1 Whole of Life

The GPS requires the NZTA to consider a range of matters in relation to transport projects and programmes, including value for money. This concept requires taking a long-term, whole-of-life approach to the design, operation and maintenance of the State highway network, inclusive of the social, environmental, cultural and economic effects.

The indicative design for the Project has been developed cognisant of adopting a whole of life approach to the design, operation and maintenance of the motorway as outlined through various sections of this report. Detailed design of the Project will consider whole of life factors in further detail, particularly in relation to:

• Pavements and surfacing – consideration of the predicted design life seal, predicted traffic volumes, median treatment and maintenance requirements and costs;
• Viaduct and bridge structures – consideration of material types and surface coatings, standardisation of structural fittings and components, future capacity requirements and drainage;
• Retaining walls and embankments – consideration of material types and structural design;
• Lighting – consideration of lighting design, levels and typologies;
• Traffic and safety services – consideration of whole of life requirements in relation to barriers, line marking and signage, traffic signals, Intelligent Transport Systems and gantries, inclusive of existing systems, technological advances and functional requirements;
• Stormwater collection, conveyance, treatment and disposal – consideration of the drainage design ie. culvert designs account for future development in the catchment and climate change, debris blockage, maintenance requirements such as wetland or swale planting in comparison to overall aesthetic considerations;
• Landscaping – consideration of ongoing maintenance requirements of various plant species, pest management, areas to be maintained by weed spraying, and metaled areas, litter and graffiti management; and
• Utility services – consideration of both existing and future utilities.

Coupled with the design and construction aspects outlined above, the whole of life considerations must extend to consent compliance and renewal in relation to stormwater discharges and coastal structures.
5.2 Motorway design

5.2.1 Design standards

The Project has been designed in accordance with the following standards:

- NZTA’s Motorway Design Standards for the south facing ramps at Pūhoi and grade separation of all local roads. The motorway will transition back to the existing State highway network via a roundabout located to the northwest of Warkworth.
- A minimum design speed of 100kph.
- A minimum Stopping Sight Distance (SSD) of 221m.
- A median divided carriageway incorporating:
  - 2 x 3.5m wide traffic lanes in each direction;
  - 2.5m wide left hand shoulder; and
  - 6m minimum median width including a 1.0m minimum right hand sealed shoulder and a Test Level 4 wire rope median barrier.
- A safe system approach for the motorway edge treatment, where continuous Test Level 4 wire rope barriers are located 4.0m from the edge line.
- A minimum horizontal curve radius of 820m.
- A maximum gradient of 6%.
- Vertical curves meeting both appearance and head light sight distance requirements of:
  - Sag curve minimum K = 50;
  - Crest curves minimum K = 109.

Refer to Drawing R-211 in Volume 4 for the typical carriageway details.

5.2.2 Design speed

The Project will extend through two distinct regions of topography and land use. In the northern third of the Project, the indicative alignment is elevated above rolling farmland, gently graded with gradients of less than 3% and provides large radii flowing curves where operating speeds are likely to be high. In these sectors a design speed of 110kph has been adopted.

For the southern two thirds of the Project, where the indicative alignment is more constrained by steep topography and the existing SH1, and includes a series of sustained gradients of up to 6.5%, a design speed of 100kph has been applied.

5.2.3 Indicative alignment description by Sector

For assessment and communication purposes, the indicative alignment has been split into six sectors as shown on Figure 5-1.

A description of the indicative alignment in each of the Sectors is outlined below. The description should be read in conjunction with the Drawings in Volume 4: Drawing R-100 – R-115 for detailed road plans of the indicative alignment, Drawings R-120 – R-151 for plan and long sections of the indicative alignment and Drawings R-211 – R-228 for typical cross sections.
The description of the Project Sectors commences at the NGTR (Johnstone’s Hill tunnels), where the indicative alignment will connect with the existing SH1, and extends northwards to the tie-in with the existing SH1 just south of Kaipara Flats Road. The chainages adopted for the Project start at Kaipara Flats Road.
Figure 5-1: Project Sectors
(a) Pūhoi Sector

The Pūhoi Sector extends from the northern portals of the Johnstone's Hill tunnels to the vegetated escarpment north of Pūhoi Road.

Heading north from Johnstone's Hill, the indicative alignment exits the Johnstone's Hill tunnels at approximately Ch. 65040m and curve west along the western side of SH1. The Okahu Viaduct, approximately 520m in length, will extend across the Okahu Inlet. The maximum height of the viaduct will be approximately 28m above the existing ground level.

The recorded heritage sites of Te Pā o Te Hēmara Tauhia, Titford Cottage and Titford House are located immediately to the east of the proposed alignment near Okahu Creek. On leaving the Okahu Viaduct the indicative alignment passes to the east of a previously unrecorded pā site and continues to the Pūhoi Interchange located near Pūhoi Road, approximately 1.5km from the northern portals of the Johnstone's Hill tunnels. The interchange will provide a connection between the existing section of SH1, north of Pūhoi to the built motorway (refer to Section 5.2.5 for further detail).

The indicative alignment extends over Pūhoi Road and the Pūhoi River on the Pūhoi Viaduct, approximately 300m in length with a maximum height of approximately 20m above the existing ground level.

This Sector incorporates a connection between the Hibiscus Coast Highway and SH1 immediately north of Johnstone's Hill (refer to Section 5.2.5 for further detail).

5.2.4 Hungry Creek Sector

The Hungry Creek Sector extends from the vegetated escarpment north of Pūhoi Road to Schedewys Hill. The indicative alignment through the initial part of this Sector is generally parallel to, and up to approximately 200m west of, the existing SH1. The indicative alignment in this sector requires substantial cut slopes and fill embankments. A cut slope approximately 600m in length with a maximum cut slope of approximately 50m is proposed between Ch. 61925m to Ch. 62525m (Cook Road) and a slope of approximately 460m with a maximum cut slope of approximately 50m is proposed between Ch. 60280m to Ch. 60740 (Watson Road).

An overpass, approximately 13m above the existing ground level with a length of approximately 35m, will be provided at Watson Road at Ch. 60220m to provide for the new motorway to pass over the private forestry road.

North of the intersection of Mahurangi West Road and the current SH1, the indicative alignment veers west away from the existing State highway. Between Ch. 59408m to Ch. 59588m, the indicative alignment passes over Hikauae Creek on the Hikauae Viaduct, approximately 180m in length with a maximum height of approximately 18m above the existing ground level. The Hikauae Viaduct maintains farm access beneath the structure.
(c) Schedewys Hill Sector

The Schedewys Hill Sector extends from Schedewys Hill (at the SH1 Bridge at Hikauae Creek) to Moirs Hill Road.

Upon exiting the Hikauae Viaduct, the indicative alignment extends west of Schedewys Hill and continues along the western side of a north-south oriented valley towards Moirs Hill Road. The indicative alignment extends across the Schedewys Viaduct. The viaduct will be approximately 370m in length with a maximum height above the existing ground level of approximately 44m.

At the southern extent of the forestry areas in this Sector, the indicative alignment separates into a split level carriageway over a length of approximately 4 km with a maximum vertical difference of approximately 10m.

The indicative alignment in this Sector will require substantial cut slopes and fill embankments. At Wreaks Road (a private forestry road) a cut slope of approximately 45m in height is proposed. Where the indicative alignment passes beneath Moirs Hill Road, approximately 1km west of the current SH1, a ‘box cut’ slope of approximately 40m is proposed.

(d) Moirs Hill Road Sector

The Moirs Road Hill Sector extends from Moirs Hill Road through to Perry Road.

A section of Moirs Hill Road between the existing SH1 and the Project will be realigned as part of the proposed designation to provide access for both local traffic and construction traffic.

From Moirs Hill Road, the indicative alignment continues through a series of valleys and ridges beyond the western edge of the Pohuehue Scenic Reserve. The largest cut slopes and embankments along the indicative alignment are proposed in this Sector. Specifically, four cut slopes approximately 50-60m in height are proposed between Ch. 56760 to Ch. 53820 from Moirs Hill Road north to a new access track south of Perry Road. Three major embankments approximately 20-50m in height are proposed.

Upon exiting the forestry area, the indicative alignment extends across the Perry Road Viaduct to the south west of Perry Road. The viaduct will be approximately 500m in length with a maximum height of approximately 45m above the existing ground level.

(e) Perry Road Sector

The Perry Road Sector extends from just south of Perry Road to the Woodcocks Road/Carran Road intersection.

The indicative alignment extends northward through the valley between Perry Road and Wyllie Road. The indicative alignment passes to the west of Genesis Aquaculture and extend for approximately 220m on the Kauri Eco Viaduct (approximately 20m above the existing ground level). The indicative alignment continues north before crossing Wyllie Road.

Two large cut slopes, approximately 50m in height between Ch. 52430m to Ch. 52930m (west of Perry Road) and 35m approximately Ch. 50540m to Ch. 50820m (east of Wyllie Road), are
proposed within this Sector. An embankment of approximately 30m in height is proposed between Ch. 52880m and Ch. 53160m.

Between Ch. 48982m and Ch. 49262m, the indicative alignment is located on the Woodcocks Road Viaduct across the Carran Road/Woodcocks Road intersection and the Left Branch of the Mahurangi River. The northbound viaduct will be 250m in length and the southbound viaduct approximately 280m in length. The viaduct will be approximately 12m above the existing ground level. The Woodcocks Road and Carran Road intersection will be realigned to improve local traffic access beneath the viaduct.

(f) Carran Road Sector

The Carran Road Sector extends from Woodcocks Road to the northern extent of the alignment at the existing SH1 just south of Kaipara Flats Road.

North of Woodcocks Road the indicative alignment heads eastward along a south-facing slope adjacent to the floodplain of the Mahurangi River Left Branch. The indicative alignment then heads along the base and lower northern slopes of a narrow valley to the new roundabout that will provide a connection to the existing SH1 just south of Kaipara Flats Road in the vicinity of the current weigh bridge (station).

5.2.5 Interchanges and tie-in points

The indicative alignment includes the following connections:

- the Pūhoi interchange;
- southern tie-in connecting the alignment with the existing NGTR; and
- northern tie-in connecting the alignment with the existing SH1 through a roundabout just south of Kaipara Flats Road north of Warkworth.

(a) Pūhoi Interchange

The indicative design proposes an interchange providing a single lane northbound off-ramp and a single lane southbound on-ramp to and from Pūhoi in the vicinity of the Pūhoi Road and SH1 intersection. The vicinity is shown on Photo 5-1 below.
Photo 5-1: Pūhoi Road intersection with SH1

The northbound off-ramp descends from the main alignment to connect with Pūhoi Road approximately 80m from the existing intersection with the existing SH1. The intersection will be priority controlled with a splitter island between left and right turn lanes to channel traffic and will be designed so as to minimise wrong way movements onto the ramp. The south bound on-ramp intersection with SH1 will be located approximately 250m south of the existing SH1 and Pūhoi Road intersection. The on-ramp will allow for two ramp-metered lanes and at the ramp signalling, will point drop to a single lane ramp merge.

There is no provision in the indicative alignment for a northbound connection onto the new alignment at Pūhoi, or a southbound exit.

(b) Southern tie-in

At its southern extent, the indicative alignment connects directly with the existing NGTR (shown in Photo 5-2 below). From the southern abutment of the Waiwera Viaduct the existing single lane northbound through the northbound tunnel at Johnstone’s Hill will be remarked to provide two northbound lanes. These works will fully realise the design capacity of the Johnstone’s Hill Tunnels. Existing signage will be updated accordingly.
The existing SH1 Hibiscus Coast Highway southbound off-ramp, to the east of the indicative alignment, will be remarked as a 2-lane carriageway (one lane in each direction) to maintain a connection between the existing SH1 and the Hibiscus Coast Highway for traffic travelling to and from Orewa and Waiwera. This connection will provide local access and function as an alternate route to the motorway.

The existing northbound link from the Hibiscus Coast Highway to the existing SH1 will be closed to general traffic but will be retained to provide access for northbound emergency services only.

(c) Northern tie-in

At the northern extent of the Project, a new roundabout will provide a connection to the existing SH1 just south of Kaipara Flats Road (in the vicinity of the current weigh bridge). The roundabout will provide connections to the built motorway from both SH1 to the north and to Warkworth via the existing SH1 route.

5.3 Local and private access roads

All local roads that intersect with the indicative alignment will be grade separated.

The indicative alignment passes over Pūhoi Road and Woodcocks Road on viaducts in order to maintain access to Pūhoi Road, Woodcocks Road and Carran Road respectively. The indicative alignment passes over Wyllie Road on an overpass, and under Moirs Hill Road, maintaining local access.
A number of private access roads and access tracks may require realignment in order to maintain existing links east and west of the indicative alignment. These include:

- Watson Road, a private forestry access road;
- The Hikauae Access Track; and
- A cattle access track at the approach to the new roundabout at the northern extent of the Project.

A new access road may also be needed to provide access on the eastern side of the indicative alignment to land off Wyllie Road as the current access is severed by the indicative alignment.

5.4 Traffic services

Traffic services along the indicative alignment will include features such as:

- Permanent road signs (including variable message signs);
- Road lighting;
- Road markings;
- Barrier protection;
- Traffic count stations;
- Closed-circuit Television (CCTV);
- Speed enforcement;
- Emergency phones; and
- Emergency laybys.

The traffic services that will be in place when the motorway opens to traffic will be confirmed during the detailed design phase and will be designed in accordance with the relevant standards at the time the Project is constructed. Throughout the life of the motorway, it is anticipated that traffic services will be renewed and upgraded as required, to ensure the continued safe and efficient operation of the new State highway.

The Design team has provided for lighting at the Pūhoi Interchange on-and off-ramps and the approaches to the roundabout south of Kaipara Flats Road. The lighting design will comply with AS/NZS 1158:2005 (Standards New Zealand and Standards Australia, 2005) to a V3 category, or the equivalent standard applicable at the time the Project is constructed. Refer to Drawings R-201 and R-202.

5.5 Walkways and cycleways

In accordance with its intended status as a motorway, no separate provision will be made for pedestrians or cyclists along the alignment. Pedestrians and cyclists will be directed to the existing State highway through appropriate signage.

5.6 Emergency vehicle access

The existing Waiwera southbound off-ramp will be formed into a two-way road for both the northbound and southbound local traffic that is not using the NGTR toll road. This reformation will enable the existing Waiwera northbound link to be retained to form an emergency vehicle access
onto the northbound carriageway. Access will be controlled by a barrier at the motorway shoulder edge. This access point could also be used under traffic management to provide part of the diversion route for northbound traffic during any planned maintenance closure of the Johnstone’s Hill tunnels, or during closures on the existing SH1 north of this point (eg due to accidents).

The carriageway will, where practical, contain splits in the median barrier to provide safe controlled manoeuvring of southbound traffic where an accident is causing delays.

5.7 Permanent access tracks for maintenance activities

Permanent access tracks will be constructed to provide long-term access to the built motorway for maintenance and emergency vehicles only. This access is required for on-going maintenance of the road, and for bridges, stormwater treatment devices and culverts. The location and design of the access tracks will be confirmed during the Project’s detailed design phase.

5.8 Cut slopes and fill embankments

5.8.1 Cut slopes

The indicative alignment will extend through steep terrain with numerous ridges and valleys. As such, numerous cut slopes ranging in height up to 60m with many exceeding 10m will be required. Cut slope gradients adopted in the indicative design vary depending on the geology, weathering profile and designation boundary constraints, and range from 40° to 11°. Detailed cut slope designs will be carried out during the detailed design phase of the Project in accordance with standard geotechnical design guidelines and accepted New Zealand design criteria and standards.

A range of common stabilisation and construction management measures are available to manage potential slope instability (including rock fall hazards). Likely stabilisation measures include:

- Flattened cut batters and/or the rounding of the soil profile;
- Drainage, including horizontal bored drains, cut off drains and surface counterfort drains;
- Rock anchors or rock bolting;
- Undercutting to remove existing landslide masses and shear surfaces;
- Vegetation cover;
- Retaining structures, including anchored bored pile retaining walls;
- Scaling of the cut face to remove rocks;
- Compacted shear keys or buttress fill; and
- Rock fall barriers.

Refer to Drawing R-011 for typical cut slope details.

5.8.2 Fill embankments

Given the terrain through which the indicative alignment will extend, the alignment will require the construction of embankments up to 50m above ground level. Embankment slope angles will vary from 14° (1V:4H) in Northland Allochthon terrain to 27° (1V:2H) in Pakiri Formation terrain. The majority of the embankment construction will likely be over Pakiri Formation, although some embankments will be required over Alluvium and Northland Allochthon.
Detailed and site-specific embankment designs will be carried out during the detailed design phase of the Project in accordance with standard geotechnical design guidelines and accepted New Zealand design criteria and standards.

Embankment construction will require the placement of large volumes of earthworks fill material and localised or site-specific treatment and additional stabilisation measures will be incorporated during detailed design and construction phases where they are demanded by the foundation conditions encountered. Shear keys and horizontal drainage layers are likely to be required for the majority of the large embankments to ensure their stability.

Reinforced embankments comprised of mechanically stabilised earth (MSE) slopes are proposed along the alignment to provide additional stability where steeper embankments (typically 45° or greater) will be required. MSE slopes will comprise geogrid reinforcement placed horizontally as layers of embankment fill are built up. The MSE slopes will be finished with a grassed slope facing. Erosion protection mesh may be pinned to the slope face to reduce the risk of erosion and establish vegetation if required. An example of a vegetated MSE slope is shown in Photo 5-3 below.

Photo 5-3: Example of a vegetated MSE slope under establishment

Refer to Drawing R-215 for typical fill embankment and MSE slope details.
5.9 Viaducts and bridges

The indicative alignment requires the construction of seven major viaducts\(^3\). Approximately five bridges may also be required to maintain local road access, provide farm access and flood relief.

Based on the indicative design, two different structural forms of viaducts and bridges will likely be used for the Project; concrete box girder and concrete beam and slab. Table 5-1 contains further details about each of these types of viaducts and bridges, including illustrative examples.

**Table 5-1: Structural Form of viaducts proposed for the indicative alignment**

<table>
<thead>
<tr>
<th>Structure type</th>
<th>Description</th>
<th>Illustrative example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete box girder structure</td>
<td>A concrete box girder will likely be used for viaducts with spans typically in the range of 70-75m. The concrete box girder viaducts will likely involve construction of the superstructure on precast segmental balanced cantilever technology.</td>
<td><img src="image" alt="Concrete Box Girder" /></td>
</tr>
<tr>
<td>Concrete beam and slab structure</td>
<td>A concrete beam and slab structure will likely be used for viaducts with spans typically in the range of 30-35m. The concrete beam and slab viaducts will likely involve construction of the superstructure on precast pre-stressed concrete super-tee beams and an in situ concrete deck.</td>
<td><img src="image" alt="Concrete Beam and Slab" /></td>
</tr>
</tbody>
</table>

The Sector descriptions in 5.3.3 provided details on the indicative viaducts and bridges proposed for the indicative alignment. Refer Drawings S-021 - S-111 for the general arrangement and typical sections of the proposed viaducts and bridges.

\(^3\) For the purpose of this report - a viaduct is a bridge structure with three or more spans
5.10 Operational water management

This section outlines the stormwater management proposed for the operation of the Project. Stormwater treatment proposed during the construction of the Project, ie erosion and sediment control, is described in Section 6.6 of this report and the Construction Water Assessment Report.

The proposed stormwater design for the operation of the Project adopts the following principles:

- Ensure the performance of the motorway to NZTA standards;
- Avoid, remedy or mitigate adverse environmental effects;
- Integrate the total operational water system (collection and conveyance network; treatment devices; culverts and diversions and consideration of the Mahurangi floodplain);
- Include full consideration of stormwater operational implications throughout the design life of the asset;
- Mimic the existing hydrologic regime and setting, to deliver outcomes that avoid, remedy or mitigate adverse environmental effects;
- Avoid or mitigate changes that might make the current flood issues in the Mahurangi River catchment worse;
- Provide for habitats in stream diversions where they existed prior to the Project. The designs will restore streams and recreate habitats to replicate the natural state and habitats that existed prior to the Project;
- Provide for fish passage in culverts for all permanent streams with future upstream habitats, and for intermittent streams where there is potential for fish habitat upstream; and
- Provide a Best Practicable Option (BPO) to avoid, remedy or mitigate adverse environmental effects, determined through a robust evaluation of options and adopting relevant standards.

5.10.1 Stormwater treatment

All stormwater runoff from the built motorway and rock cuts will be treated prior to discharge into the receiving environment. Stormwater quality treatment will be designed to:

- Remove at least 75% total suspended solids (TSS) on a long-term average basis in accordance with the ARP:ALW requirements;
- Remove many contaminants, such as particulate trace metals, particulate nutrients, oil, grease and bacteria on sediments; and
- Remove gross litter and floatables such as oil and volatile hydrocarbons.

Stormwater quantity treatment will be designed to:

- Convey flow for 100 year Average Recurrence Interval (ARI) by bypass or emergency overflow to minimise erosion; and
- Minimise erosion of streams by providing ‘extended detention’ and controlled release of runoff generated in a rainfall event of 34.5 mm over a 24 hour period. Exceptions are where discharges are in close proximity to the Pūhoi Estuary, where erosion is not considered to be a significant adverse effect due to continual changes in estuary bed conditions as a result of the tidal receiving environment.
The Water team has demonstrated that detention of runoff for the 2 year, 10 year and 100 year ARI rainfall events for flood attenuation is not required. Refer to Section 8 of the Operational Water Assessment Report.

The Water team has adopted stormwater treatment devices based on consideration of the BPO to prevent or minimise the effects on the environment. This BPO approach is based on the ARP:ALW requirement for the BPO to be implemented with respect to minimising the effects of operational water management and stormwater discharges. The concept design of stormwater management devices is based on Auckland Regional Council’s Stormwater Treatment Devices: Design Guidelines Manual (2003) (TP10).

Wherever possible, the Operational Water team has designed permanent devices so that they can be located within the areas of earthworks for the Project, such as spoil locations. This serves to minimise the overall Project footprint.

The catchment areas identified for stormwater treatment include:

- All new motorway surfaces. These surfaces are assumed impervious, including the pavement, median and shoulder, drainage channels, rock trap channels, and longitudinal swales; and
- Rock cuts and re-vegetated areas above rock cuts where they cannot be readily separated.

Constructed wetlands are the Operational Water team’s preferred stormwater treatment device to treat new impervious areas within the Project area. Constructed wetlands perform well as treatment devices removing a range of contaminants and provide additional filtering and biological treatment performance in comparison to other treatment devices, such as ponds. In addition to water quality treatment, wetlands provide extended detention. Wetlands are also the BPO for stormwater treatment as they are durable and safer/easier to maintain for a motorway application.

Photo 5-4: Example of a constructed wetland - NGTR Nukumea Wetland

Approximately 27 wetlands may be required for the Project (refer to Drawings SW-101 – SW-115 for the indicative location of wetlands). Typical details for stormwater wetlands are provided in Drawing SW-501. An example of a constructed wetland is shown in Photo 5-4 above.
Sediment traps are proposed for the Project in drains at the base of rock cut faces designed to remove sediment at source. Refer Drawing SW-307 for the typical sediment trap details.

5.10.2 Culverts

Within the Pūhoi and Mahurangi River catchments many small tributaries and some larger rivers are crossed by the indicative alignment. Conveyance of normal flows and flood waters from one side of the motorway to the other will be required. In general, to minimise adverse effects on the natural functioning of streams, viaducts or bridges will cross the major streams, including the Okahu Creek, Pūhoi River, Hikauae Creek and the major branches of the Mahurangi River. Culverts are proposed for the crossing of stream tributaries, many of which are intermittent.

The Project includes 40 culverts within the proposed designation, with three culverts being concrete arches (two in the Mahurangi River catchment and one in the Pūhoi River catchment). (Refer Drawings SW-101 – SW-115 for the indicative location of the culverts). The total length of culverts in permanent streams will be approximately 1,120m and in intermittent streams approximately 3,000m.

The design and selection of culvert forms is influenced by a number of factors, including:

- Hydraulic capacity for the 100 year ARI storm event;
- Degree of hydraulic surcharge at the inlet and the effect of inundation upstream;
- Risk of debris blockage;
- Fish passage requirements;
- Energy dissipation requirements;
- Road geometry;
- Constructability and
- The ecological values of the stream.

The design of the culverts has taken the potential effects of climate change into account for life cycle sizing requirements.

For two culverts where the indicative alignment crosses the main tributaries of the Mahurangi River (Culvert 49500 and Culvert 54700), large concrete arch culverts are proposed because the design flows calculated for their respective catchments are too large for conventional concrete pipe culverts.

Culverts have been designed with best practice to include consideration of fish passage; erosion control and debris management; and energy dissipation, which are described in the following sections.

(a) Fish passage

The Project incorporates provision of fish passage in new culverts placed within the watercourses, in accordance with Auckland Council policy. Fish passage will be provided for all permanent streams with upstream habitats, with the exception of two culverts where the locations present hydraulic constraints. (Upstream drop structures create a barrier to fish passage at sites M23a and M23b.)
Fish passage will be provided in culverts for all intermittent streams where there is potential for upstream fish habitat (refer Sections 7.7.2 and 8.5.3 of the Construction Water Assessment Report and Section 7.1.5 of the Freshwater Ecology Assessment Report).

Two methods of providing fish passage are proposed: Baffle type fish passage and Natural bed type fish passage. Refer Drawings SW-202 and SW-203 for typical details of the fish passage typologies.

(b) Erosion control and debris protection

Erosion control and debris protection measures are proposed upstream and downstream of culverts to provide for the on-going functioning and performance of culverts by reducing the likelihood of debris blockages and erosion of the stream bed.

(c) Inlet debris structures

Debris can accumulate at a culvert inlet or become lodged in the inlet or barrel. Avoiding the blockage of culvert entrances is critical to maintaining the flow capacity of the structure and ensuring the culvert performs as designed.

A debris control structure is proposed at Project culvert inlets servicing large catchment areas with extensive bush or forestry. The structure will likely comprise of a steel rack at least 20m upstream of the culvert that will trap a proportion of large debris before it reaches the culvert. The debris rack will allow flow to overtop the trapped debris to maintain conveyance of flow through the culvert.

Culverts at high risk of blockage will be sized to accommodate 100 year ARI flow with the top water level not exceeding the culvert soffit level. For culverts servicing moderate sized catchment areas that include predominantly bush or forestry, the preferred mitigation measure is to install a relief inlet. The relief inlet will assist in avoiding flooding further up the embankment during any blockage of the culvert inlet by providing a secondary inlet for flows to enter the culvert. For culverts at low risk of debris blockage, no debris protection measures are proposed. Refer Drawings SW-305 and SW-306 for typical details of the proposed inlet debris measures.

(d) Outlet structures - energy dissipation

High velocity and energy of flow at culvert outlets can result in the erosion of stream channels and banks, causing adverse environmental effects. Energy dissipation structures are proposed at all Project culvert outlets prior to discharge into the natural stream.

Three types of energy dissipation structures are proposed for the Project:

- Riprap Basin - a rock lined basin containing a water pool at the culvert outlet. The basin is followed by a rock apron that spreads the flow and further reduces the velocity of the flow, helping to transition flow to the natural waterway downstream. Riprap basins are suitable for fish passage and are proposed for many of the culvert outlets.

- St Anthony Falls (SAF) Stilling Basin - a concrete structure that receives discharges from a culvert into a basin via a baffled chute with blocks on the invert and baffle blocks and a sill
at the downstream end. Combined, these three elements dissipate energy and return water downstream in a movement similar to the existing flow regime. Because a SAF stilling basin is not suitable for fish passage, it is proposed only for culverts where fish passage is not necessary based on the ecological assessments (refer Section 7.1.5 of the Freshwater Ecology Assessment Report).

- **Impact Basin** - a box structure at the culvert outlet that dissipates energy by directing the flow onto a vertical baffle. It is applicable to a range of flows but is not suitable for fish passage or where there is potential for debris load. Impact basins are not proposed for any culverts but may be used for stormwater outfalls from wetlands.

Refer to Drawings SW-301 to SW-303 for typical energy dissipation structure details.

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**Photo 5-5: Example of an Impact basin - NGTR Otawera Wetland outfall**

**5.10.3 Permanent Stream Diversions**

Permanent stream diversions and flow channels are proposed where it is necessary to realign a natural stream channel for the Project. The mitigation objective for stream diversions is to recreate streams and habitats to replicate as much as possible the natural state and habitats of the streams that existed prior to the Project.
A number of stream diversions are proposed within three stream typologies the Water team has developed as follows:

- Stream Diversion Type 1 – ‘Lowland Stream’ that recreates habitats associated with a natural lowland stream. The total proposed stream diversion length is approximately 1,500m;
- Stream Diversion Type 2 – ‘Steep Stream’ that recreates habitats associated with a natural steep stream. The total proposed stream diversion length is approximately 1,575m; and
- Stream Diversion Type 3 – ‘Flow Channel’ for flow conveyance only. The total proposed stream diversion length is approximately 4,695m.

These typologies are shown on Drawings SW-401 to SW403.

Refer to Section 7.10 of the Operational Water Assessment Report for further detail on the proposed stream diversions.

5.11 Urban design

This section sets out the urban design principles incorporated into the Project design. The section has been. Bridging the Gap notes that at a national level “the primary guiding document promoting good urban design is the New Zealand Urban Design Protocol (NZUDP) (MfE 2005)”.74

The NZUDP identifies seven essential design qualities (known as the 7 Cs):

- Context: integration of the project with surrounding natural and land-use patterns;
- Character: reflecting and enhancing the distinctive character, heritage and identity of the surrounding environment, including its people;
- Choice: ensuring diversity and choice for people;
- Connections: maintaining and enhancing how different networks link communities together;
- Creativity: encouraging innovative and imaginative solutions that build a strong and distinctive local identity;
- Custodianship: ensuring design is environmentally sustainable, safe and healthy; and
- Collaboration: achieving appropriate solutions through collaboration with other experts and stakeholders.

NZTA has built on the NZUDP and identified a number of objectives (as contained in Bridging the Gap) by which to install urban design as an integral component of any project. The NZTA Urban Design Objectives are:

- Transport networks fit in sensitively with the landform, built and natural environment, and communities through which they pass.
- All systems of movement along and across the transport corridor are integrated into the design of projects with good connections and access for communities.

74 NZTA, 2013, Bridging the Gap, para 1.4
Design contributes to the quality of the built environment, public spaces and the road user experience.

Bridging the Gap identifies ten principles for urban design as follows:

- Designing for the context;
- Designing with nature;
- Integrating transport and land use;
- Contributing to good urban form;
- Integrating all modes of movement;
- Supporting community cohesion;
- Maintaining local connectivity;
- Respecting cultural heritage values;
- Creating a positive road user's experience; and
- Achieving a low maintenance design.

The following discussion uses the “7 Cs” of the NZUDP and the Bridging the Gap objectives and principles as reference points, to illustrate the matters relevant to the overall urban design of the Project, which will be confirmed during the Project’s detailed design phase.

5.11.1 Pūhoi Sector

(a) Context (effects on land use activities and form)

The indicative alignment in the Pūhoi Sector has been influenced by a number of features in the surrounding context, including:

- the location and orientation of the existing SH1 tunnel portals;
- the undulating topography of the area;
- the location of water courses and particularly Pūhoi River;
- the configuration of local roads and the Hibiscus Coast Highway;
- the location of cultural features including Te Pā o Te Hēmara Tauhia, the rediscovered and unnamed pā and historic Schollum House; and
- the location of Pūhoi Village.

In urban design terms, this Sector is the most complex because the features set out above create a range of constraints, and have potentially conflicting needs. The indicative alignment, both horizontal and vertical, seeks to meet functional requirements while minimising the intrusion of roading structures in relation to these elements of the surrounding context.

(b) Character (Effects on Urban Form)

The existing SH1 infrastructure already influences the character of the Pūhoi area and the roading infrastructure north of the Johnstone’s Hill tunnels creates a modified environment. Consideration during the Project’s detailed design phase will be given to provide a seamless transition from the existing NGTR to the Project.
The detailed design of the Okahu Viaduct and the Pūhoi Viaduct structures, together with planting design along the motorway embankments will be important to assist the roadway to integrate with its surrounding environment. Further guidance on design considerations for bridge design can be found in Bridging the Gap (see 4.11) and in NZTA’s “Urban Design Principles: Road Bridges”. Such guidance includes:

- The balance of structural elements should be carefully considered to minimise the bridge profiles, achieve symmetry and create a simple and elegant whole;
- Consideration should be given to the creation of light and shadow on the structure and how this will contribute to the overall appearance of the bridge structures;
- Particular attention should be paid to the design of piers and barriers. The substructure elements should not be designed in isolation. Their design should be integral to the overall form of the bridge. Structures that eliminate the need for headstocks and enable simple, elegant pier design will better draw the eye to the horizontal lines of the bridge deck and barrier;
- The external surface of the bridge should be free of drainage pipes or other services;
- The draining system should be concealed from all views; and
- Barriers should create clean, continuous lines that are not obscured or interrupted by non-structural elements. They should extend well past the abutments to anchor the bridges into the landscape.

The design of these elevated structures will be addressed in Urban and Landscape Design Sector Plans to be submitted as part of any OPW.

The Project affords an opportunity for iwi to realise the identity of Ngā Pā o Te Hēmara Tauhia in the landscape. The Hōkai Nuku Cultural Effects Assessment discusses these features and values in more detail.

Pūhoi Village has a distinct character that strongly relates to its cultural heritage and landscape context. The current entrance to the Village from SH1 is understated. While ensuring the maintenance of connections to the village, the ramps and, more particularly the viaduct structure, will significantly alter the character of the arrival experience from SH1 to the Village. The SH1/Pūhoi Road intersection is a critical location that will require careful consideration in the Project’s detailed design phase. Particular attention to the design of feature entry elements, lighting, planting and signage will be co-ordinated to enhance the arrival experience.

The Pūhoi River has cultural significance for both pre-European and European settlement, as it was historically an important transportation route. Today it is an important recreation route, being used by kayakers travelling from Pūhoi down to the coast and Wenderholm Regional Park. Detailed design will have particular regard to how the Project’s structures will be experienced from the River.

(c) Choice

In relation to the Project, the urban design quality of ‘choice’ is mainly relevant to enabling and maintaining choice of transport routes.
The ability to achieve wider transport choice is balanced against the needs to maintain route choices in the immediate environment.

(d) Connections (effects on circulation)

As noted previously, this Project is one component of an improved State highway route that will contribute to achieving improved connectivity between Auckland and Northland and more immediately between Auckland City and the northern area of the Auckland Region.

The alignment will maintain a connection between SH17 and the existing SH1 immediately north of Johnstone’s Hill. This connection will maintain local access and the alternate route to the NGTR.

Importantly, the Project will provide a northbound off-ramp and southbound on-ramp at Pūhoi, providing a connection to the historic village and maintaining connections to the existing SH1. While the indicative alignment results in an increased prominence of roading structures in this area, which impact on the character of the entry to Pūhoi Village, it also improves the legibility of the turn-off for visitors. Given the understated character of the existing turn-off, it is currently easy for visitors to miss the turn-off to the Village. The new configuration will improve the connectivity to the Village for visitors. With appropriate design consideration it can function as a gateway feature.

The indicative alignment maintains the recreational connection provided by the Pūhoi River, by bridging over the river. The Pūhoi Structure Plan (discussed in Section 29.4.6 below) outlines opportunities to improve open space linkages through the Pūhoi area, particularly along stream and river corridors. There are currently no walkways connecting from Pūhoi Village through to the estuary or beyond to the Wenderholm Regional Park. The elevated nature of the proposed Pūhoi Viaduct provides the opportunity to provide pedestrian connections across (under) the motorway in the vicinity of the Pūhoi River.

While there is no proposal to make provision for cycle access within the indicative alignment, the Project may open up opportunities to provide improved cycle access along the existing SH1 alignment in the future.

The Project also affords an opportunity to improve access to the pā sites in the Pūhoi area if this is considered appropriate by local Iwi. The pā sites are currently in private ownership. The pā sites provide historical context to the long settlement history of the area. These opportunities are addressed in the Hōkai Nuku Cultural Effects Assessment.

(e) Creativity (effects on amenity for road users and from surrounding areas)

At the time of detailed design (preparation of urban and landscape design sector plan) there will be an opportunity to apply creativity to ensure context-sensitive design for structures, earthworks and management of stormwater. Input of suitable expertise, including landscape architecture, art, bridge architecture, and cultural advice will be required to ensure appropriate outcomes. It will be particularly important to recognise the history of settlement (pre- and post-European) and to create a distinctive sense of arrival in relation to the Pūhoi Village. The design of structures, earthworks, and landscape treatment and incorporation of art features should contribute to creating a distinct sense of place. The road will be experienced both by those travelling along the
route and those in the surrounding areas (refer to the Landscape and Visual Assessment Report). Creativity in detailed design will respond to the following:

- Established corridor treatment for the adjoining NGTR;
- Natural patterns/ecology of the land and waterways;
- Natural waterway systems;
- Landform patterns;
- Cultural values of the area (both Maori and Pakeha); and
- Sense of arrival at Pūhoi Village.

**Custodianship**

For the Pūhoi Sector, the urban design quality of ‘custodianship’ relates particularly to the protection of the natural waterways and the ecology of the area, the protection of landforms and the landscape values of the area and the protection of cultural heritage resources. These matters are addressed by specific Assessment Reports (refer to the Freshwater and Landscape and Visual Assessment Reports, and the Hōkai Nuku Cultural Effects Assessment).

**Collaboration**

At the time of detailed design it will be important to consider the inter-relationship between a number of factors including: engineering technical requirements; potential for ecological enhancement; respect for cultural values; respect for landscape values; the enhancement of visual qualities. The development of an Urban and Landscape Design Framework (ULDF) (in accordance with the NZTA ULDF Guideline) will require collaboration between a number of disciplines including: urban design, engineering, cultural, heritage, landscape architecture, ecology, and noise.

### 5.11.2 Perry Road Sector

The Perry Road Sector passes to the west of a rural area that contains a concentration of rural residential properties clustered along Perry Road. The indicative alignment does not impact on any road or walkway connections used by these properties. The indicative alignment is visually contained by intervening topography and will not adversely impact on the rural character enjoyed by the majority of properties in this rural residential area. A detailed assessment of potential landscape and visual effects is set out in Section 5 of the Landscape and Visual Assessment Report.

The indicative alignment passes along the toe of the hills that rise to elevated properties on Wyllie Road, to the west of the right branch of the Mahurangi River. The indicative alignment crosses the northern end of Wyllie Road (approximately 480m south of Woodcocks Road), and will maintain the road access by creating an overpass. An additional accessway to the east of the alignment will be required to maintain access to properties located east of the indicative alignment that are currently accessed from Wyllie Road south of this crossing.

At the detailed design phase, careful consideration will be given to the treatment of the Wyllie Road overpass and immediate surroundings in order to mitigate the adverse character effects arising from an elevated structure within a rural environment. The overall design of the elevated structure will be carefully considered to minimise the structure’s profile, achieve symmetry and
create a simple, elegant whole. In particular, the design of substructure elements will be considered as an integral part of the design. Colour, texture and lighting can be used to enhance the experience for those travelling under the alignment along Woodcocks Road. Abutments will be designed to integrate the elevated structure into the surrounding landscape. The external surface of the elevated structure will be free of drainage pipes and other services.

5.11.3 Carran Road Sector

(a) Context (effects on land use activities and form)

The indicative alignment is located well to the west of the existing Warkworth settlement and ties into the existing SH1 just south of the Goatley Road / Kaipara Flats Road intersection. In the long-term the new motorway will provide a strong defensible edge to the Warkworth settlement in an appropriate location.

(b) Character (effects on urban form)

Detailed design of the road margins and batter slopes will be important to assist with integrating the new motorway infrastructure with the rural context and reduce the visual prominence of the roadway. In particular, the use of landforms and planting to integrate the road infrastructure into the rural setting will be important.

The dense mature vegetation to the northwest of the Goatley Road / Kaipara Flats Road intersection creates a threshold defining a change to a more rural character. The location of the Project's northern tie-in is appropriate in this context. Detailed design of the roundabout intersection, using references to cultural associations with the area will be important to achieve a suitable arrival point to Warkworth.

The provision of a bypass to Warkworth and the removal of heavy freight traffic from the existing SH1 route through the settlement will reduce the severing effect of the existing SH1 corridor. This will improve the character and amenity within the core of the town. Consideration will be given to the treatment of this corridor when the new alignment is established.

(c) Choice

The Project will provide additional choice by enabling those travelling both north and south to bypass Warkworth. This choice is a positive effect of the Project both for those using the route and for residents and users of Warkworth.

(d) Connections (effects on circulation)

The Carran Road Sector does not diminish any existing connections through Warkworth and its hinterland. The Project has the potential to improve local connectivity within Warkworth. The removal of heavy traffic and general traffic diverted to the Project will reduce the severing effect of the current SH1 and will enable more cohesive connections between different areas of the town and will improve access across the existing SH1 corridor to a number of community facilities. Traffic modelling for the Project predicts greater traffic flows entering central Warkworth from the north (refer to the Operational Traffic Assessment Report).
For those travelling north to Warkworth the last off-ramp before the northern Warkworth connection will be Pūhoi. Accordingly, the northern Warkworth entrance is likely to become the more prominent entrance to the town centre. This change in entrance will provide a catalyst for changes to the land-use pattern within the town and at its periphery as it grows.

The indicative alignment does not impact on any existing walking trails within the Carran Road Sector.

(e) Creativity (effects on amenity for road users and from surrounding areas)

At the detailed phase of the Project’s design it will be important to apply creativity to the design of the northern tie-in intersection as an entry point to the settlement of Warkworth. Features of the intersection design, including landscape design and art features, will reflect the distinct characteristics of the settlement and its historic, cultural associations. Input of suitable expertise, including landscape architecture, art and cultural advice will be required to ensure appropriate outcomes.

Creativity will be applied to stormwater management to respect and enhance the natural landscape patterns through the rural area. As the indicative alignment connects to the existing SH1 within a valley system that is poorly drained, there is an opportunity to re-establish the natural wetland features within this part of the proposed designation.

Creativity applied to the treatment of the margins of the roadway will assist to define the long-term growth boundary of the Warkworth settlement.

(f) Custodianship

For the Carran Road Sector, the urban design quality of ‘custodianship’ relates particularly to the management of stormwater and its relationship to natural watercourse systems. This relationship is addressed in detail in the Construction Water, Freshwater Ecology and Operational Water Assessment Reports.

The Project will also have implications in relation to the land-use patterns in the surrounding area and particularly how the settlement of Warkworth grows. As Warkworth has been identified in a number of growth management planning documents as a rural settlement that is suitable for growth, the indicative alignment is well located to provide a long-term defensible growth boundary, enabling flexibility to accommodate growth at the settlement’s periphery.

(g) Collaboration

In order to ensure context sensitive design is achieved in relation to the indicative alignment margins and the northern tie-in to the existing SH1, collaboration between a number of areas of expertise will be required. The development of an ULDF (in accordance with the NZTA ULDF Guidelines) as a condition of designation and an associated sector specific ULDSPs, will require collaboration between a number of disciplines, including: urban design, engineering, cultural heritage, landscape architecture, land art and ecology.
Collaboration by the Project team with Auckland Council and Auckland Transport will also be beneficial to understand and plan for the potential land-use and amenity changes within Warkworth when the bypass enabled by the Project is achieved.

5.11.4 Experience of corridor users

The Project provides a continuation of the NGTR to the south. A consistent design treatment will be used to provide continuity to the travel experience for road users. This consistent treatment will include use of landscaping and planting, treatment of earthworks and batter slopes, structure design, and highway furniture. It is important that there is a transition to the context and that appropriate features are introduced that respond to the immediate surroundings.

Elevated structures through the corridor will afford visual connections to the wider landscape. Particular attention will be paid to the design of barriers across elevated bridges and viaducts. Achieving good visual connections to the wider environment will need to be balanced with considerations of minimising noise effects on surrounding receivers and creating a suitable edge to the structures.

Particular design attention will be required in relation to the connections with the Pūhoi Village and Warkworth entrance. The treatment of structures and the corridor in these areas will enhance the sense of arrival and reflect the distinct characteristics of the settlements and their historic, cultural associations.

Recommendations in accordance with NZTA practice to ensure that during the Project’s detailed design phase the context of the structures, especially at Pūhoi and in the Carran Road and Woodcocks Road Sectors, are appropriately addressed.

5.12 Landscaping

Landscaping will be undertaken as part of the Project and will serve a number of purposes, including to:

- Integrate the Project into the landscape;
- Mitigate the visual and landscape effects of the Project;
- Mitigate the ecological and stormwater effects of the Project; and
- Stabilise batter slopes.

Detailed landscape plans will be provided as part of future OPW(s) for the Project.

Broadly, the following roadside landscaping is proposed:

- Retention of existing vegetation and extensive planting between the alignment and the existing SH1 in areas where the alignment is not contained by the landform, to provide screening and visual integration; and
- Planting based on established vegetation patterns along the alignment to integrate the highway and screen it from the residential settlement areas.
Planting design will draw from the existing patterns and compositions within the landscape (both natural and culturally induced, eg shelter belts, where applicable) to ensure appropriate aesthetic and environmental outcomes. New planting will reflect subtleties in local landscape character.

Further consideration is contained in Section 7.3 of the Landscape and Visual Assessment Report.