Table 9-6: Ecological values and potential adverse effects on ecological sites in Warkworth North arising from the Project, Ecological Sites (ES) series drawings in Volume 3, PES map series.

Site	Potential effect of Indicative Alignment (approximate)	Ecological value	Magnitude of effect	Level of effect (without mitigation)
WN_T_Mahu_01 (SEA_T_2287)	Loss of riparian vegetation associated with bridge installation.	Moderate	Low	Low
WN_T_Mahu_02	38% of the site would be directly lost as a result of bulk earthworks. Loss of habitat, fragmentation and an increase in the extent of habitat edge. Physical barrier to less mobile fauna (e.g. lizards) between the two resulting forest fragments.	Moderate	High	Very high
WN_T_Koura_01	13% of site directly lost, but 50% of Critically Endangered kahikatea, pukatea forest would be removed. Loss of habitat, fragmentation and an increase in the extent of habitat edge, potentially compromising the viability of the remaining stand. Permanent, low level disturbance to sensitive native fauna, e.g. long-tailed bats (if present), from road and vehicle lights and noise.	01a – High 01b – Low 01c – Moderate	01a – Moderate 01b – Low 01c – Low	01a – High 01b – Very Low 01c – Low
WN_T_Koura_02	11% of site would be directly lost. Loss of vegetation but no significant further fragmentation. Permanent, low level, disturbance to sensitive native fauna (if present) from vehicle lights and noise.	Moderate	Moderate	Moderate
WN_W_Koura_01	18% of site would be directly lost as a result of bulk earthworks. Hydrology of the wetland is likely to be significantly changed as a result of diversion channels created.	Moderate	Moderate	Moderate

Site	Potential effect of Indicative Alignment (approximate)	Ecological value	Magnitude of effect	Level of effect (without mitigation)
WN_W_Koura_02	None of the site would be directly lost. Change in hydrology resulting in shift in vegetation community and habitat quality. Regionally threatened swamp maire is particularly vulnerable to reduction in water levels. Permanent, low level, disturbance to sensitive native fauna e.g. long-tailed bats (if present) from road and vehicle lights and noise, resulting in fragmentation of the wider valley for bats or suffer direct mortality due to vehicle collisions.	Very high	Low	Moderate
WN_W_Koura_03	3% of site would be directly lost as a result of bulk earthworks. Loss of habitat but limit further habitat fragmentation. Change to hydrology resulting in a shift in vegetation community and habitat quality. Permanent, low level, disturbance to sensitive native fauna e.g. long-tailed bats (if present) from road and vehicle lights and noise, resulting in fragmentation of the wider valley for bats or suffer direct mortality due to vehicle collisions.	Moderate	Low	Low
WN_W_Koura_04	None of the site would be directly lost. Permanent, low level, disturbance to sensitive native fauna e.g. long-tailed bats (if present) from road and vehicle lights and noise, resulting in fragmentation of the wider valley for bats or suffer direct mortality due to vehicle collisions.	Moderate	Negligible	Very low
WN_W_Koura_05	21% of site would be directly lost as a result of bulk earthworks. Loss of habitat but limiting further habitat fragmentation. Change in hydrology of the wetland through culverting which may increase conveyance of water through the wetland and a subsequent small reduction in water level. Permanent, low level, disturbance to sensitive native fauna e.g. long-tailed bats (if present) from road and vehicle lights and noise, resulting in fragmentation of the wider valley for bats or suffer direct mortality due to vehicle collisions.	Moderate	Moderate	High

Dome Valley Forest

Ecological values

The key attributes of the terrestrial and wetland ecological values of the Dome Valley Forest section are:

- Currently, plantation pine forest on steep, dissected hill country, interspersed with narrow riparian margins of native vegetation that line incised stream gullies.
- Areas of mature Eucalyptus, small podocarp broadleaf forest remnants, and mixed native and exotic regenerating scrub along roadsides and in recently harvested sites.
- A pair of live kauri snails (at the time of the site visit undertaken) and numerous whole kauri snail shells and shell fragments in several locations throughout Matariki Forest.
- 35 records from 2012 onwards, of Hochstetter's frogs within Matariki Forest and in the indigenous forest of the Dome Forest Conservation Area and surrounding environs.
- Bat surveys undertaken in the Dome Valley Forest area indicate Matariki Forest is an important landscape feature for the long-tailed bat population in the area.
- Contiguous habitat corridors along and across the Indicative Alignment (currently without forestry felled).

A summary of the ecological values of the sites surveyed is outlined in Table 9-7 and the sites are mapped in the Ecological Sites (ES) series in *Volume 3: Drawing Set*.

Assessment of ecological effects

The potential adverse effects on terrestrial and wetland ecology in the Dome Valley Forest area will include direct and indirect loss of vegetation, ecosystems and habitat and impacts on fauna.

The Project area largely traverses the plantation forest at approximately mid-slope, such that native vegetation within the Indicative Alignment is generally confined to the pine forest understorey and remnant areas of indigenous vegetation close by. Although Matariki Forest it is not indigenous forest, it is a large tract of maturing forest that provides habitat for a variety of native fauna (including several species that are of conservation interest due to their threat status) during their life cycle and facilitates the movement of indigenous species such as long-tailed bats and avifauna across the wider area.

The effects assessment on terrestrial, wetland ecology and At Risk fauna is cognisant of forestry operations and harvest cycles and acknowledges that the production forest is scheduled to be felled in any event.

Harvesting of Matariki Forest within the proposed designation is currently scheduled to occur prior to Project construction. The current forest harvesting plan shows that this results in the complete removal of tall stature pine within the proposed designation prior to the assumed commencement of the road construction in 2030. Large-scale modifications to available habitat for the fauna

species of conservation interest within Matariki Forest will reduce baseline ecological values prior to the road construction and will therefore lessen the relative impacts of the Project on ecological values. However, it should be noted that the forestry harvesting is unlikely to completely remove these species from the area, and the Project will still impact their highly vulnerable populations through habitat loss and overall loss of connectivity along and across the Project alignment.

Given the above, the assessment was been carried out for both the pre and post harvest scenario because , if the harvesting did not occur as programmed the level of effects would be relative to the higher exsiting ecological values and therefore worst case. A summary of these effects is presented in Table 9-7.

Table 9-7: Ecological values and potential adverse effects on ecological sites in Dome Valley Forest (preforest harvest) arising from the Project, Ecological Sites (ES) series drawings in Volume 3.

Site	Potential effect of Indicative Alignment	Ecological value	Magnitude of effect	Level of effect (without mitigation)
DVF_T_Koura_01	Bulk earthworks, tunnel works, and operational disturbance has potential to reduce the availability of habitat for long-tailed bats by functionally severing the flight paths. Loss or modification to waterways impacting Hochstetter's frogs. Vegetation and habitat clearance impact on kauri snails.	High	High	Very High
DVF_T_Koura_02	9% of the site would be directly lost as a result Project works. Impacts on Hochstetter's frogs associated with hydrological changes and sediment deposition. Temporary disturbance of heavy machinery and vegetation removal associated with construction impacting long-tailed bats from light, noise, vibration and potentially dust.	Very High	High	Very High
DVF_T_Hōteo_02 (SEA_T_814)	No direct impacts on the site. Permanent, low level disturbance to sensitive native fauna, e.g. long-tailed bats (if present), from road and vehicle lights and noise will be negligible given separation distance to alignment.	Moderate	Negligible	Very Low
DVF_T_Hōteo_03	No direct impacts on the site. Temporary disturbance to fauna during construction. Restriction of bat and bird connectivity from this site across the expanse of pine forest.	Moderate	Moderate	Moderate
DVF_W_Koura_01	No direct impacts on the site. Temporary, low level impacts of increased dust and runoff entering the wetland comparative to baseline levels associated with existing forestry operations. Potential changes in hydrology could lead to a shift in the vegetation community and thus habitat quality.	Moderate	Low	Low

Hōteo North

Ecological values

The key attributes of the terrestrial and wetland ecological values of the Hōteo North section are:

- The Hōteo River and its tributaries connect a number of remnant patches of lowland forest including the totara-dominated forest lining the Hōteo River, as well as patches of kahikatea swamp forest on floodplains and taraire forest on higher ground.
- The northern portion of the section grades into rolling farmland interspersed with a few small patches of indigenous treeland, often associated with small tributaries.
- Forest and treeland patches across the Hōteo North section are largely surrounded by pastureland and the majority of the sites surveyed were isolated and degraded due to the surrounding agricultural land use.
- Many of the wetlands are degraded due to stock access and modifications in the surrounding drainage systems. However, there are also High and Very high-quality remnant wetland patches where stock have been excluded.
- No kauri snails have been observed and given the stream habitats and limited riparian cover in the Hōteo North section it is unlikely to be suitable for Hochstetter's frogs.
- No Threatened or At-Risk forest birds were detected during the surveys in this section.
- No bats were detected at the five survey sites in the summer of 2017/18.

A summary of the ecological values of the sites surveyed is outlined in Table 9-8 and the sites are mapped in the Ecological Sites (ES) series drawings in *Volume 3: Drawing Set*.

Assessment of ecological effects

The potential adverse effects on terrestrial and wetland ecology in the Hōteo North area will include direct and indirect loss of vegetation, ecosystems and habitat and impacts on fauna.

The Indicative Alignment and proposed designation directly impact a number of the aforementioned forest and wetland patches. The Indicative Alignment proposes a viaduct (Bridge 11) that crosses a site comprising mature and diverse taraire forest which has been assigned an ecological value of Very High. Bridge 11 will minimise impacts to this very high value site compared to other potential road design options.

Table 9-8: Ecological values and potential adverse effects on ecological sites in Hōteo North arising from the Project. (Locations shown on Ecological Sites (ES) series drawings in Volume 3)

Site	Potential effect of Indicative Alignment (approximate)	Ecological value	Magnitude of effect	Level of effect (without mitigation)
HN_T_Hōteo_01	34% of the site would be directly lost as a result Project works. Due to stock access, the site is unlikely to be inhabited by less mobile, ground dwelling, fauna. Mobile fauna such as forest long-tailed bats are likely to use the site occasionally at most.	Moderate	Low	Low
HN_T_Hōteo_02 (SEA_T_683)	4% of the site would be directly impacted by the construction of the bridge. Rain shadow and shading effects from bridge. Fragmentation of the western edge of the site will increase edge effects. Temporary disturbance of fauna associated with heavy machinery and vegetation removal. Permanent, low level disturbance to sensitive native fauna during operation as a result of vehicle lights and noise.	Very High	Moderate	Very High
HN_T_Hōteo_03 (SEA_T_6851)	27% of the site would be directly lost as a result of Project Works. Lowering of water level of the Machaerina sedgeland. Temporary disturbance of fauna associated with heavy machinery and vegetation removal. Permanent, low level disturbance to sensitive native fauna during operation as a result of vehicle lights and noise.	03a – High 03b – Moderate	03a – High 03b – High	03a – Very High 03b – High
HN_T_Hōteo_04	The whole site would be directly lost as a result of Project works. Potential loss of bat habitat.	Low	High	Low
HN_T_Hōteo_05	39% of the site would be directly lost as a result of Project Works. Potential loss of bat and bird habitat. Temporary disturbance of fauna associated with heavy machinery and vegetation removal.	Low	Moderate	Low

Site	Potential effect of Indicative Alignment (approximate)	Ecological value	Magnitude of effect	Level of effect (without mitigation)
HN_T_Hōteo_06	The whole site would be directly lost as a result of Project works. Loss of habitat for small remnant populations of both mobile and immobile native fauna, including threatened copper skink.	Moderate	High	Moderate
HN_T_Hōteo_07	47% of the site would be directly lost as a result of Project Works. Minimal increase in edge effects.	Low	Moderate	Very Low
HN_T_Hōteo_08	23% of the site would be directly lost as a result of Project Works. Potential loss of bat and bird habitat. Temporary disturbance of fauna associated with heavy machinery and vegetation removal. Permanent, low level disturbance to sensitive native fauna during operation as a result of vehicle lights and noise.	High	High	Very high
HN_T_TeHana_01	43% of the site would be directly lost as a result of Project Works. Impacts arising from edge effects. Potential loss of bat and bird habitat. Changes in hydrology affecting wetland function and resulting impact on wetland bird habitat.	Low	Low	Very Low
HN_W_Hōteo_01 (SEA_T_6854)	56% of the site would be directly lost as a result of Project Works. Fragmentation of site and increased edge effects. Loss of wetland habitat through infilling, resulting in changes to hydrology of remaining wetland potentially resulting in complete loss of functional wetland habitat. Rain shadowing and increased shading of remaining wetland as a result of the bridge. Loss of habitat for Threatened and/or At Risk wetland bird species.	High	Very High	Very High

Site	Potential effect of Indicative Alignment (approximate)	Ecological value	Magnitude of effect	Level of effect (without mitigation)
HN_W_Hōteo_02 (SEA_T_685)	No direct impacts on the site. Changes in hydrology through lowering of the water levels could lead to a shift in the vegetation community and habitat quality. Loss of and abandonment of habitat of Threatened and/or At Risk wetland birds resulting from construction/ operational disturbance and bird mortality.	High	Low	Moderate
HN_W_Hōteo_03	45% of the site would be directly lost as a result of Project Works. Negligible effects on loss of habitat of Threatened or At Risk wetland birds and construction and operational disturbance.	Low	Low	Very Low
HN_W_TeHana_01	23% of the site would be directly lost as a result of Project Works. Negligible effects on loss of habitat of Threatened or At Risk wetland birds and construction and operational disturbance.	Low	Low	Very Low
HN_W_TeHana_02	99% of the site would be directly lost as a result of Project Works. Negligible effects on loss of habitat of Threatened or At Risk wetland birds.	Low	Moderate	Very Low

Terrestrial and wetland ecological sensitivity analysis across all sections

Sensitivities of the effects on terrestrial and wetland ecology values (and the fauna that occupy these habitats) to modifications to the alignment (lateral or vertical re-alignment) occur within all sections of the proposed designation boundary.

The Warkworth North and Hōteo North sections contain heterogeneous habitat complexes. Therefore, these sections are more sensitive to lateral deviations of the Indicative Alignment at specific locations, compared to the Dome Valley Forest section (which is comprised almost entirely of commercial plantation forest and will be harvested prior to construction).

For example, within the Warkworth North section a movement of the alignment east or west in the upper Kourawhero Stream valley will result in the loss of part, or all, of specific high value sites, but may also then reduce or avoid the bisection of other features within the proposed designation to the south. Similarly, an increase in the vertical height of the Indicative Alignment in the Warkworth North section could result in wider batters that may also intrude into the Mahurangi River (Left Branch) or the high value wetlands of the upper Kourawhero Stream valley. Similar sensitivities apply to the southern area of the Hōteo North section where multiple Moderate to Very High value forest remnants and wetlands are located. Thus, sensitivities to spatial movement of the Indicative Alignment are moderate to high, particularly in the Warkworth North and Hōteo North sections.

Areas identified at most risk through the sensitivity analysis are also the areas that have been recommended as mitigation locations. The *Ecology Assessment Report* recommends avoidance, as far as practicable, of particular sites of Moderate to Very High ecological values, where practicable, and limitations on movement of the alignment into particular sites and on reductions in water table levels.

Although the majority of the habitat available in the Dome Valley Forest section does not have high botanical values, multiple Threatened and/or At Risk native animals (e.g., kauri snail, Hochstetter's frog and long-tailed bat) have been recorded within Matariki Forest. All of these species will be impacted when harvesting occurs. Consequently, if commercial harvesting of the forest is undertaken prior to the commencement of vegetation clearance necessary to facilitate the road construction, as is currently anticipated, this will significantly reduce the habitat value of the Dome Valley Forest section for the aforementioned fauna species and will reduce the relative level of effects resulting from the road construction and operation through the Dome Valley Forest section due to the change in baseline conditions.

9.5.4. Potential effects of road construction and operation on freshwater environments

The construction and operation of roads, particularly state highways, has a number of potential effects that are applicable to the whole Project, regardless of section. Such effects can be broken into construction and operational effects and are outlined below.

Construction effects

The major activities associated with the construction of the Project that may affect the freshwater habitats and their associated aquatic organisms are:

- Bulk earthworks and the associated discharge of construction water;
- Streamworks resulting in the loss of watercourses and habitat quality, including culverting;
- Diversion of existing waterways through newly created stream channels; and
- The construction of bridges and viaducts over watercourses;

These activities have the potential to result in:

- The discharge of sediment laden water into streams with the potential to increase the amount of suspended solids (TSS) and deposition on the streambed;
- Partial or total loss of freshwater habitats;
- Reduction in freshwater habitat quality;
- Changes to fish passage; and
- Loss of terrestrial habitat due to earthworks and subsequent construction activities.

Operational effects

The major activities associated with the operation of the Project that may affect the freshwater habitats and their associated aquatic organisms, if not appropriately managed, are:

- Contaminant run off;
- Stream and riparian zone shading from bridges and viaducts;
- Operation of culverts;
- Increased flood flows;
- Increased temperature of water flowing off impervious areas and stormwater ponds; and
- Increased streambank erosion.

These activities have the potential to result in:

- The discharge of sediment laden water into streams with the potential to increase the amount of suspended solids (TSS) and deposition on the streambed;
- Increased contaminant runoff;
- Changes to flow regimes;
- Partial or total loss of freshwater habitats; and
- Changes to fish passage.

9.5.5. Assessment of freshwater ecological values and effects

Warkworth North

Freshwater ecological values

Watercourses located along the Indicative Alignment within the Warkworth North section encompass those within both the Mahurangi River (Left Branch) catchment and the Hōteo River (Kourawhero Stream sub-catchment) catchment.

The key attributes of the freshwater ecosystem values of the Warkworth North section are:

- Freshwater environments are characterised by lowland aquatic habitats predominantly surrounded by grazed pasture.
- With the exception of the Mahurangi River (Left Branch), watercourses are typically small to medium sized tributaries that are highly modified. Many of these tributaries have historically been deepened and straightened to provide drainage to the surrounding low-lying areas.
- Freshwater ecological values of the two surveyed watercourses (Mahurangi River (Left Branch) and Kourawhero Stream) are moderate to high with surveys indicating excellent fish populations, good SEV scores and MCI scores that indicate good water quality. It is predicted that other watercourses within the Warkworth North section affected by the Indicative Alignment will have similar ecological values.
- An area of higher ecological value watercourses is present in the north of the section, on the upper Kourawhero Stream.
- The riparian margin associated with the Mahurangi River (Left Branch) is identified as an SEA (SEA_T_2287) in the AUP(OP) based upon 'Representativeness' and 'Status and Rarity'.

Two sites were surveyed, with an SEV survey at site WN_F_Koura_1, and a visual assessment at site WN_F_Mahu_1. The SEV score indicated a moderately healthy stream, within the typical range of scores seen for streams within rural catchments in Auckland.

The *Ecology Assessment Report* anticipated, through aerial photography and brief visual assessments, that the upper and lower reaches of the Mahurangi River (Left Branch) affected by the Indicative Alignment will have similar values to those observed at site WN_F_Mahu_1. The assessment also anticipated that the upper and lower reaches of the unnamed tributary upon which site WN_F_Koura_1 is located will have similar habitat values to that of site WN_F_Koura_1. The ecological values of the sites surveyed are outlined in detail in the *Ecology Assessment Report* and summarised in Table 9-9.

Assessment of freshwater ecological effects

The design of the Indicative Alignment has avoided impacts on the High value Mahurangi River (Left Branch) and the upper Kourawhero through the use of bridges and elevated on and off ramps, significantly reducing the impact on the River, nearby wetlands and reducing the loss of aquatic habitat. Some sections of the upper Kourawhero are to be diverted through new, ecologically functioning, channels either side of the Indicative Alignment. Watercourses that will be culverted are typically of low ecological value.

The addition of suspended sediment resulting from earthworks activities to freshwater environments poses a particular risk within the Upper Kourawhero Stream owing to the numerous natural wetlands within the system.

The magnitude and level of effects of the Project on freshwater ecological values in the Warkworth North section are outlined in Table 9-9.

Table 9-9: Ecological values and potential adverse effects on surveyed sites in Warkworth North arising from the Project, Ecological Sites (ES) series drawings in Volume 3, PES map series.

Site ID	Potential effect (approximate)	Ecological value	Magnitude of effect	Level of effect (without mitigation but with ESC in place)
WN_F_Mahu_1	**Construction** Reduction in water quality resulting from earthworks activities with a predicted average yearly increase of 12% within Mahurangi 'flats' River **Operation** Reduction in water quality resulting from stormwater runoff Degradation to habitat through shading from four bridges over the Mahurangi River, limiting the growth of aquatic plants and riparian vegetation within these shaded areas	High	Low	Low
WN_F_Koura_1	**Construction** Loss of habitat through altering catchments of upper tributaries by earthworks and through diversion of the Kourawhero Stream and tributaries. Reduction in water quality resulting from earthworks activities with a predicted average yearly increase of 17% within Kourawhero Stream. **Operation** Reduction in water quality resulting from stormwater runoff.	Moderate-High	Moderate	Moderate

Overall, the level of effects on freshwater ecological values within the Warkworth North section, prior to mitigation are Low to Moderate. The Mahurangi River (Left Branch) is crossed four times by the Indicative Alignment, with effects minimised through the use of elevated bridges. The northern end of the section contains a number of watercourses that are fed by streams and wetlands within the Matariki Forest that will require extensive culverting and stream diversion.

Dome Valley Forest

Freshwater ecological values

The key attributes of the freshwater ecosystem values of the Dome Valley Forest section are:

- Freshwater environments are characterised by steep hill streams located within plantation pine forest.
- Watercourses are typically small to medium sized tributaries draining steep hill country. Stream channels are a mix of silt/sand, gravels and cobbles with channels having high hydrological diversity. Watercourses higher in the headwaters tend to have 'harder' bottoms, and large cascade/pool sequences and waterfalls are common. The lower parts of watercourses typically have higher levels of silt/sand present. Riparian margins contain native regeneration and provide high shading and organic matter to the stream channel.
- Freshwater ecological values were High across all surveyed sites with surveys indicating very good fish populations, a high abundance of EPT species, excellent SEV scores and MCI scores that indicate excellent water quality. It is predicted that other watercourses within the section affected by the Indicative Alignment will have similar high ecological values.

Four freshwater sites were surveyed within the Dome Valley Forest section (DVF_F_Koura_1, DVF_F_Hōteo_1, DVF_F_Hōteo_2-1 and DVF_F_Hōteo_2-2), with full freshwater surveys undertaken at each of the sites. These sites were spread across the Matariki Forest block and are considered representative of the watercourses within this section.

The ecological values of the sites surveyed are outlined in detail in the *Ecology Assessment* and summarised in Table 9-10 below. It is expected that the majority of the Matariki Forest will be harvested prior to the construction of the Indicative Alignment. This is likely to reduce the ecological value of streams within plantation pine catchments within the Dome Valley Forest section prior to Project construction.

Assessment of freshwater ecological effects

The sediment models predict a moderately-low increase in average TSS loads at the test site within the Dome Valley Forest with an average annual increase in sediment loads of approximately 8.7% from existing levels. The addition of suspended sediment to freshwater environments poses a particular risk within the Waiteraire Stream due to the steep slopes and the large area of proposed earthworks within the catchment. This model does not account for any sediment coming from harvesting within Matariki Forest.

Effects of the Project on freshwater ecological values have been assessed based on existing ecological values, as well as anticipated future ecological values following forestry harvesting. The values of streams affected by the Project will need to be updated prior to construction to ensure the values present at the time are appropriately reflected in the overall mitigation necessary for the Project. The magnitude of effects on freshwater values within the Dome Valley Forest, based on existing ecological values, prior to mitigation, are high. The magnitude of effects based on the predicted ecological values following forestry harvesting, and prior to mitigation, are likely to be moderate (EIANZ, 2015) and require some form of mitigation to be applied.

Table 9-10: Ecological values and potential adverse effects on surveyed sites in Dome Valley Forest arising from the Project, Ecological Sites (ES) series drawings in Volume 3.

Site ID	Potential effect	Ecological value	Magnitude of effect	Level of effect (without mitigation)	Ecological value	Magnitude of effect	Level of effect (without mitigation)
		Existing ecological values			Predicted ecological values post harvesting		
DVF_F_Koura_1	**Construction** Loss of aquatic habitat through filling, cut off drains, stream diversions and stormwater wetlands. Reduction of water flowing to the site due to changes in hydrology.	High	High	Very High	Moderate	High	Moderate
DVF_F_Hōteo_1	**Construction** Loss of aquatic habitat through filling, cut off drains and culverting. Potential reduction of stream flow due to changes in hydrology.	High	High	Very High	Moderate	High	Moderate
DVF_F_Hōteo_2-1	**Construction** Loss of aquatic habitat through filling, stream diversions and culverting.	High	High	Very High	Moderate	High	Moderate
DVF_F_Hōteo_2-2	**No effects are anticipated**	High	Nil	Very Low	Moderate	Nil	Nil

Overall, the potential effects on existing freshwater ecological values within the Dome Valley Forest section are Very High prior to mitigation. The Indicative Alignment, including soil disposal sites, crosses a number of watercourses resulting in a high amount of stream loss through fill embankments, culvert installation, and stream diversions consequently leading to a loss of freshwater habitat. The potential effects on freshwater ecological values within the Dome Valley Forest section, based on predicted ecological values after harvesting, are Moderate.

Hōteo North

Freshwater ecological values

The Hōteo North section includes the lower reaches of the Waiteraire Stream, a number of unnamed tributaries of the Hōteo River, and the Te Hana and Maeneene catchments of the Oruawharo River.

The key attributes of the freshwater ecosystem values of the Hōteo North section are:

- Freshwater environments are characterised by highly degraded lowland aquatic habitats, with stock access and poor water quality that are surrounded by grazed pasture. Some reaches have intact riparian vegetation and/or fencing off from stock.
- Watercourses are typically small to medium sized tributaries that are highly modified, with many historically channelised. Fine silts and sand dominate stream channels, with abundant bank erosion present and extensive damage by cattle at many sites.
- Riparian margins are rare, with some pockets of existing native vegetation present, with overall shade and organic input to watercourses low.
- The Hōteo River (upstream of the viaduct proposed within the Indicative Alignment) and the adjacent tributary, Waiteraire Stream (on which site HN_F_Hōteo_1 is located), are defined as a Natural Stream Management Area within the AUP(OP).
- Downstream of site HN_F_Hōteo_2, the Hōteo River is classified as an Outstanding Natural Feature (ID49) for its incised meanders.
- Five fish species were recorded across the sites; shortfin and longfin eel, the whitebait species inanga and banded kokopu and redfin bully. Longfin eel, inanga and redfin bully are important species with a threat status of At Risk – declining.
- Freshwater ecological values are generally Low, with some discrete Moderate value sites including the Hōteo River and lower Waiteraire Stream. Surveys generally indicated poor fish populations, low abundance of EPT species, low SEV scores and MCI scores that were indicative of poor water quality.

A total of ten freshwater sites were assessed within the Hōteo North section, with full SEV surveys undertaken on nine streams: three within the Hōteo River catchment, three within the Te Hana Creek catchment, and three within the Maeneene Creek catchment.

Assessment of freshwater ecological effects

The sediment models predict a low increase in average TSS loads at the test sites within the Hōteo North section, with average sediment load increases of

approximately 0.4%, 4.5% and 1.5% from existing conditions predicted at Hōteo River (downstream of the unnamed tributaries), a tributary of Te Hana Creek and the Maeneene Creek, respectively. However, increases in suspended solids pose a particular risk to the unnamed pasture tributaries to the north of the Hōteo River viaduct, owing to the risk of flooding.

The Indicative Alignment crosses a large number of watercourses resulting in a high amount of stream loss, stream diversion and culvert installations. This will change the aquatic habitat of streams. The use of bridges and/or viaducts over the watercourses in this section, including locating piers out of the streambed and immediate riparian zone will minimise effects on these waterways.

Table 9-11: Ecological values and potential adverse effects on surveyed sites in Hōteo North arising from the Project, Ecological Sites (ES) series drawings in Volume 3.

Site ID	Potential effect	Ecological value	Magnitude of effect	Level of effect (without mitigation)
HN_F_Hōteo_1	**Construction** Reduction in water quality resulting from earthworks activities with a predicted average yearly increase of 0.4% (approximate) within the Hōteo River. **Operation** Reduction in water quality resulting from stormwater runoff. Degradation to habitat through shading from viaduct over the Hōteo River and SEA, limiting the growth of aquatic plants and riparian vegetation within these shaded areas.	Moderate	Low	Low
HN_F_Hōteo_2	**Construction** Reduction in water quality resulting from earthworks activities with a predicted average yearly increase of 0.4% within the Hōteo River. **Operation** Reduction in water quality resulting from stormwater runoff. Minimal impacts on aquatic habitat resulting from shading from viaduct.	Moderate	Low	Low
HN_F_Hōteo_3	Loss of aquatic habitat through filling, stream diversions and culverting headwater reaches.	Low	Low	Very Low
HN_F_Hōteo_4	Loss of all aquatic habitat through cutting/ filling and installing clean	Low	High	Low

Site ID	Potential effect	Ecological value	Magnitude of effect	Level of effect (without mitigation)
	water cut off drains that do not provide functioning aquatic habitat.			
HN_F_TeHana_1	Loss of all aquatic habitat through culverting and temporary loss of habitat through stream diversions upstream and downstream.	Moderate	High	Moderate
HN_F_TeHana_2	Loss of aquatic habitat through filling and culverting upstream.	Low	Moderate	Very Low
HN_F_TeHana_3	Alignment crosses stream within the upper reaches of its catchment and leads to loss of a very small section of stream.	Low	Negligible	Very Low
HN_F_Mae_1	Loss of all aquatic habitat through filling.	Low	Low	Very Low
HN_F_Mae_2	Loss of all aquatic habitat through culverting, and loss of habitat upstream through stream diversions and culverts.	Low	High	Low
HN_F_Mae_3	No effects anticipated.	Moderate	Nil	Very Low

Overall, the level of effects on freshwater ecological values within the Hōteo North section are moderate, with some areas of high value features having a moderate ecological effect. The catchments within the section are predominantly used for agricultural stock grazing, with many watercourses accessible by stock. Watercourses are generally highly degraded with poor water quality, limited riparian vegetation and poor quality aquatic habitat available for fauna and flora.

Freshwater ecological sensitivity analysis across all sections

The *Ecology Assessment* has identified the spatial and temporal sensitivities in relation to freshwater ecological effects.

The greatest spatial sensitivities to lateral movement of the Indicative Alignment are within the Warkworth North section and particularly the headwaters of the Kourawhero Stream and associated high value wetlands.

The Dome Valley Forest section has less spatial sensitivity. Any lateral deviation from the Indicative Alignment will essentially take the route through very similar habitat, with the assessment of effects of the construction and operation also similar.

The Hōteo North has low spatial sensitives, owing to the highly modified nature of the catchment.

The largest temporal sensitivity of the Project lies around the harvesting of Matariki Forest due to the existing high ecological value of the freshwater habitats within this area.

The forest harvesting cycle presents a particular sensitivity to the analysis of effects. If harvesting of the forest has occurred as expected, then the relative effects of the Project, particularly within the Dome Valley Forest section, will be less. Field surveys will need to be undertaken prior to construction, in order to update ecological values, and adjust mitigation accordingly.

In addition, with construction of the Project not likely to commence until around 2030 then the activities of private landowners may improve ecological values (i.e. through fencing and or planting riparian vegetation) on their properties prior to the Project construction commencing. Should this occur, then the ecological values of these waterways will be greater than currently assessed.

9.5.6. Measures to avoid, remedy or mitigate actual or potential adverse effects

This section provides a summary of the recommendations for mitigation of adverse effects on the existing ecological values arising from the Project. A mitigation package has been developed that applies a mitigation hierarchy that seeks to avoid, remedy, and then mitigate effects on ecological values[66].

Mitigation required for each of the ecological disciplines discussed above is presented in this section of the AEE. The landscape and ecological elements of mitigation are particularly closely integrated, and the mitigation outcome is dramatically improved by considering them together.

Section 10 of this AEE sets out an integrated mitigation approach which considers ecology, landscape, stormwater, cultural and potential amenity matters which have been brought together to ensure holistic ecological and wider mitigation outcomes that maximise environmental benefits.

The recommended mitigation is based on the assessment of the effects of the Indicative Alignment within the proposed designation boundary. The final details of mitigation will be confirmed at the time of detailed design based on the ratios recommended in the *Ecology Assessment*.

Mitigation principles

The following set of principles were used to guide the integration of mitigation outcomes:

- Mitigation should ensure that ecosystems are resilient such that they build structure and function and enable or enhance their adaptive capacity for the future.
- Mitigation purpose and the outcomes sought should be clearly defined.
- Mitigation is to respond to adverse environmental effects that cannot be avoided or remedied. It is one tool that can be used. Offsetting and compensation can also be used where loss cannot be reasonably mitigated.
- Mitigation should be a cohesive and integrated package of activities and outcomes.

[66] We note that there is a specific terminology that makes up the EIANZ mitigation hierarchy, which reflects the avoidance, remediation and mitigation of effects, and the offset or compensation for significant residual effects. However, for the purposes of this report we have collectively referred to all of these terms under the umbrella term of a single 'mitigation.

- A mitigation package should avoid an outcome that results in multi-fragmented partitioning of the environment and instead seek to connect and link systems across the landscape.
- Mitigation should be considered in the wider environmental context i.e. Ki Uta Ki Tai (from mountain to sea).
- Mitigation should link with existing ecosystems to build resilience in existing restored and constructed environments as applicable.
- Mitigation should include opportunities to integrate with other programmes, where possible and appropriate.

Route selection and design

Avoidance of key ecological features and minimisation of effects has been achieved through careful route selection (for the Indicative Alignment and the proposed designation).

In some cases, trade-offs have been made between features. This was most notable for the Mahurangi River (Left Branch) and Hōteo River. In both cases the continuous intact stream riparian margins were retained, and impacts avoided, and the benefits of this margin to terrestrial and aquatic biodiversity and function, was valued above some of the fragmented patches of vegetation (e.g., HN_W_Hōteo_01, HN_T_Hōteo_03b)) which are impacted by the Indicative Alignment. The *Ecology Assessment* recommends that, as much as is practicable, these key ecological features should be retained in the detailed design and construction of the final alignment.

Viaducts or bridges have been recommended as a means of avoiding or minimising direct impacts on high value rivers. The short bridge over the upper Kourawhero Stream has the benefit of avoiding direct impacts on the stream, while minimising the use of stream diversions and thus reduces modifications to the surface water hydrology minimising effects on wetlands. Minimising the impact of the Indicative Alignment on the wetlands of the Kourawhero Stream is also achieved through the lowering of the alignment to reduce the batter requirements so they do not intrude into the wetland areas.

Integrated Mitigation Framework

In line with the Project mitigation principles, mitigation for the potential adverse effects of the Project has been recommended within the Ecology Assessment with a view to maximising integration of the terrestrial, wetland and freshwater environmental ecological outcomes, and linking with Mana Whenua aspirations. These outcomes are necessarily linked with other desirable outcomes such as those for landscape and visual outcomes, stormwater management, heritage, cultural, social and amenity preferences.

The strategy for managing and mitigating the impacts of the Project on ecological values is founded on maintaining or enhancing the adaptive capacity of the environment. Ecosystems with high adaptive capacity are better able to respond to impacts and change without significant changes in crucial functions or declines in ecosystem services. The strategy provides for mitigation to be aggregated in specific locations, rather than spread along the length of the proposed designation boundary, to prevent the fragmentation and maximise benefits of the mitigation effort.

The integrated environmental mitigation framework means that in most cases the ecological mitigation and the landscape mitigation planting take a similar form and is located in the same key locations. Ecology is integrated with landscape and the form of stormwater treatment wetlands to provide a more continuous corridor of vegetation which will increase biodiversity throughout the proposed designation.

The integrated mitigation framework proposes that mitigation does not necessarily require for like-for-like loss and replacement at individual impact locations. The reason for this is to maximise the overall ecological benefits of the Project, to weigh mitigation in favour of values that are held highly within the region but are difficult to restore or replace, and to link ecosystems together to achieve an overall stronger outcome and achieve a greater adaptive capacity within the environment.

Section 10 of the AEE provides an overview of the integrated mitigation framework that incorporates all mitigation outcomes.

Mitigation for effects on terrestrial and wetland ecological values

The focus for mitigation is to establish areas of revegetation that provide a strong natural environment framework and lead to habitat creation and enhancement in identified priority areas that contain existing high value features. The recommended areas are shown in Figure 9-2 and are set out in Table 9-12 below.

Maps of the areas of landscape and ecological mitigation are provided in Ecological Mitigation Series (EM) drawings in *Volume 3: Drawing Set*.

Table 9-12: Ecology Mitigation Areas

Area	Mitigation
Mahurangi River (Left Branch) floodplains (Area A, EM1 *Volume 3: Drawing Set*)	• Design to incorporate bridges to avoid intrusion into the river and existing riparian margins (SEA) and elevating on/off ramps to avoid loss of riparian margins. • Riparian floodplain planting and habitat creation alongside the river.
Upper Kourawhero Stream and wetlands (Area B, EM2 *Volume 3: Drawing Set*)	• Design to incorporate bridge across the main stem of the upper Kourawhero Stream. • Design embankments to minimise encroachment into wetland area. • Weed control. • Edge/buffer planting of appropriate native species and enhancement planting within the respective wetland types. • Protect and enhance wetland habitat in the floodplain of the upper Kourawhero Stream through planting to further enhance the ecological values and functions. • Enhance connectivity throughout the valley with planting linking the existing portal escarpment the upper wetland

Area	Mitigation
	valleys, wetlands and downstream floodplains. • Use of proposed stormwater treatment wetlands in this area to compliment natural wetlands and provide additional wetlands habitat for fauna.
Dome Valley Forest (EM2–EM3 *Volume 3: Drawing Set*)	• Provide locations that enable successful mitigation for the loss of habitat (and potential habitat) resulting from the Project. • Area (or areas) within the Indicative Alignment of the Dome Valley Forest Section to be identified as a preferred area to provide a habitat for translocating fauna. • Where possible, large trees on eastern and western margins of the alignment to be retained to provide east–west crossover links for birds and bats. • Manage regrowth and plant native vegetation to provide habitat for native fauna. • Retain existing vegetated riparian margins of the streams, plant riparian margins of streams within the proposed designation. • Provide improved and permanent protected habitat for Hochstetter's frogs.
Hōteo River floodplains (Area C, EM4 *Volume 3: Drawing Set*)	• Restoration planting of a kahikatea–dominated lowland wetland to rehabilitate the ecosystem. Note planting should be cognisant of existing flooding issues and should not increase associated adverse effects. • Specific restoration planting of the margins of a tributary of the Hōteo River (HN_F_Hōteo_3) in sympathy with the floodplain planting to enhance the longitudinal and lateral benefits.
Upper Te Hana Creek tributary (Area E, EM5 *Volume 3: Drawing Set*)	• Planting proposed to protect streams and improve water quality and link with the SEAs to the east and the Kaipara Harbour coastal area to the west.

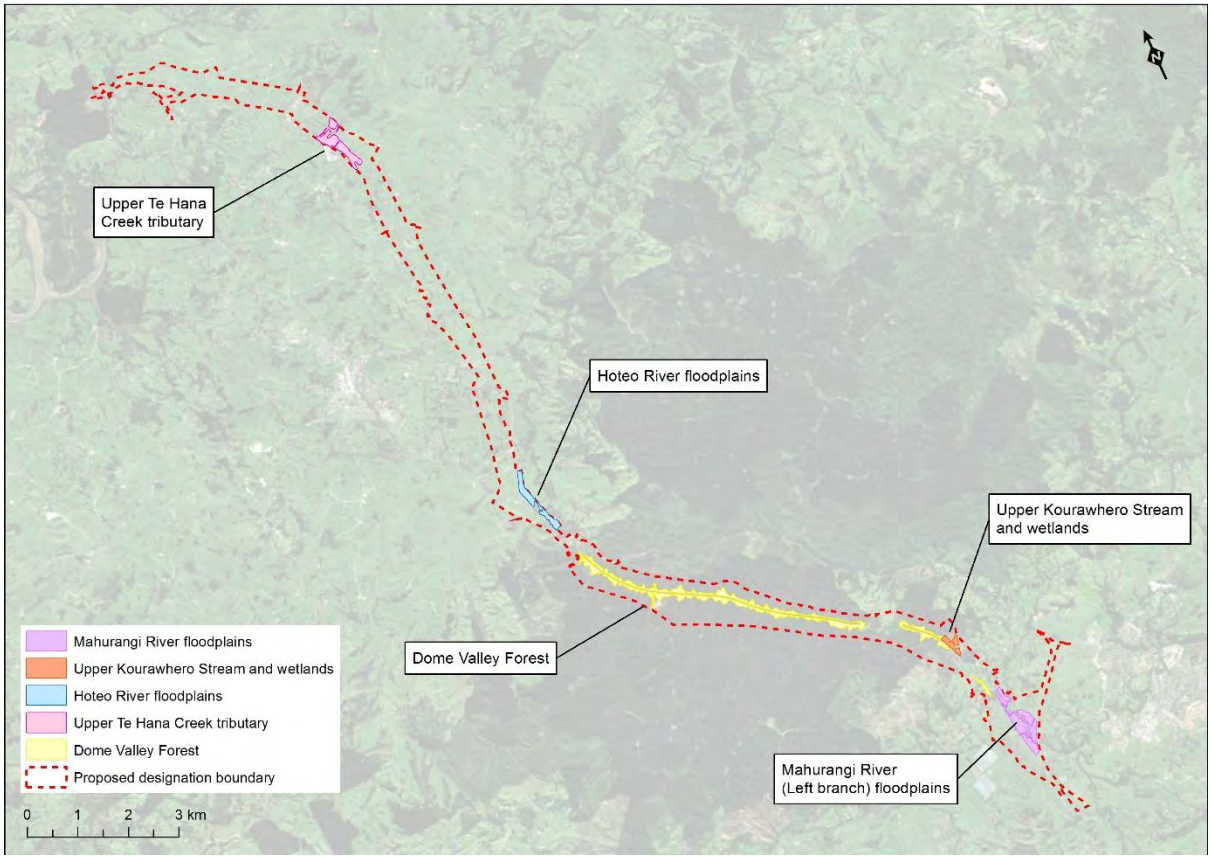

Figure 9-2: Map showing recommended mitigation areas

Mitigation measures are also proposed to address biosecurity risks as follows:

- Preparation of a Kauri Dieback Biosecurity Plan (KDBP) to avoid the spread of kauri dieback into uninfected areas; and
- All plants acquired for revegetation and landscaping should be appropriately sourced for the Ecological District and be purchased from nurseries that are free of myrtle rust and plague skink.

Mitigation for effects on fauna and avifauna ecological values

The Project may directly impact Hochstetter's frogs, native bats, kauri snails, lizards, and birds through loss of habitat. Recommended mitigation for the impact on these fauna species will include survey, salvage and relocation; species-specific management plans/protocols (where relevant); restrictions on timing of habitat clearance; pest animal and weed control and early mitigation where practical. In addition, wetland sites providing habitat to At Risk species are recommended to be avoided by the final alignment as far as practicable and maintenance of flyway connectivity and within the proposed designation is recommended through retaining existing vegetation or revegetation where this is not possible.

Recommended key components of fauna management are:

- Preparation and implmentation of an Ecological Management and Mitigation Plan (EMMP)
- Surveys prior to construction to establish presence of fauna and avifauna;

- Implementation of best practice fauna management protocols for translocation programmes (includingcapture, handling, retention and release, including timing);
- Managing vegetation clearance and earthworks in wetlands where avifauna is present to minimise effects, along with enhancement through pest animal and weed control and revegetation to buffer potential edge effects;
- Developing a construction programme that excludes vegetation clearance (excluding pasture) during forest and wetland bird breeding/nesting season (i.e. September to March inclusive);
- Surveys of potential bat roosting sites and protocol for vegetation removal including, where practicable, avoiding roost trees; and
- Pest animal and weed control at mitigation sites.

Mitigation for effects on freshwater ecological values

The loss of watercourses and ecological function under the Indicative Alignment and associated soil disposal sites through infilling of streams and culverting is unavoidable. As much as is practicable, it is recommended that the loss of streams, particularly those of higher ecological value, be minimised through detailed design of the final alignment i.e. at specific locations (Mahurangi River (Left Branch), Hōteo Viaduct and Upper Kourawhero) the use of stream crossings such as viaducts and bridges is recommended to prevent the loss of streams and their function. A number of these have been integrated into the current design and are key features in the Indicative Alignment.

Mitigation is required for the loss of habitat and ecological values for all permanent and intermittent streams under the AUP(OP). Not all watercourses potentially impacted along the Indicative Alignment were able to be surveyed during this early stage of the Project. These surveys will be completed prior to construction (as to stream permanence and ecological value), allowing the quantum of mitigation required to be confirmed. It is recommended that the Auckland Council SEV assessment is used to inform the ECR (Environmental Compensation Ratio) calculation (or similar best practice at the time), when calculating the specific quantum of mitigation that is required for the loss of stream habitat function.

In the interim, approximated stream lengths, as indicated by the overland flow path layer, and areas have been calculated to guide the mitigation package. This informed the estimations of the amount of potential mitigation required and whether the proposed designation boundary has the capacity to contain it all. These areas include the following across the Indicative Alignment:

- Approximately 27 km length of intermittent and permanent streams directly affected by the Indicative Alignment within the Project area (from approximately 150 km of stream length within the Project area).
- Approximately 18 km of new stream diversions are proposed as part of the Project These will be created in a manner that will provide at least equivalent ecological value to the stream length lost (See Appendix F of the *Ecological Assessment*).

Other recommendations relating to mitigating effects on freshwater ecology include:

- Sediment and erosion control should at the minimum comply with the guidance within Auckland Council TP90 and GD05, and Transport Agency ESC Guidelines (discussed in section 9.2 of this AEE).
- Streamworks should ideally be undertaken offline or should be isolated with water pumped around the area of works.
- Fish should be salvaged from all watercourses containing water at the time of streamworks.
- Peak fish migration occurs between September and February and streamworks should be avoided during this time if possible.
- Fish passage should be maintained through all temporary and permanent culverts with viable upstream habitat.
- Design of stream diversion channels to create a range of stable microhabitats for fish and invertebrates, including the creation of stable pool habitats and the inclusion of gravel and cobble habitat.
- Water quality treatment should follow the requirements of the AUP (OP) and guidelines in Auckland Council GD01 (discussed in section 9.12 of this AEE).
- Erosion control on stormwater outfalls to prevent scour of stream bed and banks in receiving watercourses. Water temperature is to be managed by ensuring that stormwater treatment wetlands are sufficiently shaded where practicable to ensure that any rise in water temperature is minimised.

Summary of positive ecological effects

The *Ecology Assessment* has identified a number of positive ecological effects following the implementation of management protocols and mitigation, including:

- Reduced contaminant loads to the Mahurangi River and the Hōteo River catchments as a result of capture and treatment of road stormwater runoff compared to the existing SH1.
- Aggregated mitigation providing integration of ecosystems to provide greater resilience.
- Pest and weed control at selected locations to improve the adaptive capacity of ecosystems.
- Improved N–S connectivity including between the Mahurangi River (Left Branch) and the upper Kourawhero Stream catchments.
- Increase in riparian planting for the protection and enhancement of water quality and aquatic habitat.
- Maintenance of flyway connectivity N–S and E–W within the proposed designation where suitable existing vegetation is retained and supported, if required, through revegetation following harvest of plantation forestry.
- Maintenance and enhancement of populations of land snails, lizards, Hochstetter's frogs, birds and bats in mitigation areas.
- Planting mitigation areas to achieve a positive increase in threatened indigenous ecosystems of the Auckland region.

9.5.7. Conclusion

The Project will result in the clearance of approximately 13 ha of native vegetation and wetland ecological features, approximately 1.5 ha of which has high/very high ecological value, resulting in a direct loss of biodiversity. There will also be indirect effects, for example, edge effects and changes to the water table, which may cause further degradation to remnants of partially cleared features. In addition, fauna will be impacted through loss of habitat (i.e. lizards, snails, Hochstetter's frogs, birds and bats). Adverse cultural effects also arise as a result of the works within these areas of high/very high ecological value.

Approximately 27 km of intermittent and permanent streams will be directly affected by the Indicative Alignment within the proposed designation boundary. Most of the affected watercourses are within Warkworth North and Hōteo North sections of the Project and are generally small, low-quality tributaries degraded by pastoral land use. Approximately 5 km of high-quality permanent and intermittent streams within the Matariki Forest will be impacted.

Movement of the alignment within the proposed designation boundary has the potential to significantly increase impacts on ecological features, especially adjacent to the Mahurangi River (Left Branch) and wetlands in the upper Kourawhero catchment in the Warkworth North section, and the Hōteo River floodplains area of the Hōteo North section. There is also some potential for the changes in alignment to have a beneficial effect on ecological features for example through reduced encroachment into areas of high value indigenous vegetation.

Ecological mitigation forms part of the broader integration mitigation package for the Project. The proposed ecological mitigation approach integrates terrestrial, wetland and freshwater environmental ecological outcomes by focusing revegetation, fauna habitat enhancement and stream restoration within a few focus areas that contain existing high value features. The purpose of this mitigation approach is to provide a cohesive, landscape-wide habitat framework to enhance biodiversity, provide ecological connections in a cohesive manner along and across the Project corridor. There are five key locations which have been identified in the Ecology Assessment as preferred areas for mitigating the impacts of the Project. These are mapped on the EM map series in *Volume 3* of the AEE and include:

- Mahurangi (left branch) – Stream management area and SEA;
- Upper Kourawhero stream and wetland complex;
- Dome Valley Forest – wetland, indigenous vegetation and preferred fauna habitat and flyway location;
- Hōteo River Flood Plains – includes 3 SEA locations; and
- Upper Te Hana Creek tributary.

The Ecology Assessment sets out other recommended mitigation for terrestrial and freshwater ecological effects. In summary, the recommended measures to avoid, remedy or mitigate effects on ecological values are:

- Where practicable and whilst considering design requirements, future alignment revisions enable specific high value features to be avoided as far as practicable;

- Identify priority mitigation locations based on existing ecological values and offer multiple and consolidated mitigation benefits to be achieved through an integrated approach;
- Maintain and provide connected habitat corridors to enable fauna movement and activity along and across the Project;
- Development and implementation protocols for managing relocation of fauna (snails, frogs, lizards); and
- Replace at least the equivalent ecological value of what was removed through terrestrial and stream riparian planting.

Not only does the proposed mitigation provide for the impacts of the project; over time it contributes to the return of some threatened significant ecosystems and habitats to the Auckland region. The integration and aggregation of mitigation in key priority areas provides greater resilience, diversity and connectivity within and between ecosystem types; as well as potentially across catchments.

Based on the findings of the *Ecology Assessment Report* and the recommended mitigation, effects from the construction and operation of the Project on terrestrial and wetland values is low and less than minor in an RMA context. Similarly, the effects on freshwater ecological values overall will also be low and less than minor. There will be ecological benefits arising from the Project.

9.6. Marine ecology and coastal avifauna

Overview

There are no works within the coastal marine area. However, sediment-laden runoff from open earthworks areas during rainfall events throughout Project construction and stormwater runoff from the road during operation of the Project will discharge to the Mahurangi and Kaipara Harbours. This discharge has the potential to adversely affect marine ecological values if not managed appropriately.

The marine ecological values within both the Mahurangi and Kaipara Harbours are moderate in the upper reaches where a high baseline load of sediment deposition currently occurs, and high in the middle and lower reaches.

Assessment of modelled acute rainfall events in conjunction with Project works indicated that a 30-year ARI event in the Mahurangi catchment and 10year ARI event in the Hōteo Inlet of the Kaipara catchment, if they occurred during earthworks, may result in Project-related sediment having significant adverse effects in the upper harbour benthic habitats, with potential flow on effects to coastal avifauna that forage on the benthic intertidal mudflats. If the cumulative amount of sediment released from the Project is above 5% of the baseline contribution, it is considered that there would be a significant adverse effect at these locations.

To minimise the potential for these effects occurring, best practice erosion and sediment control measures (as set out in Auckland Council and Transport Agency guidelines) will be designed and implemented to treat operational phase stormwater from the Project prior to discharge to aquatic environments and to minimise the effects of sediment runoff during construction.

Acknowledging that best practice erosion and sediment control will be in place and given that effects are directly related to the quantum of sediment released during storm events and the cumulative discharge exceeding 5% of the modelled baseline, mitigation responses have been developed. These responses are based on real-time monitoring of sediment discharge from erosion and sediment control devices and trigger levels based on sediment loads. Should these sediment triggers be reached, mitigation will be implemented as per the proposed conditions.

Whilst there is the potential for significant adverse effects to occur during acute events or as a result of the cumulative discharge, the Project related contribution to the long term sedimentation of the Mahurangi and Kaipara Harbours is assessed as very low. Mitigation is proposed in the event that sediment discharge exceeds 5% of the modelled baseline contribution or to mitigate for sediment discharge during acute rainfall events.

Overall, with mitigation provisions in place and benefits accruing within a generation (nominally 25 years), it is considered that adverse effects would be less than minor.

9.6.1. Introduction

This section summarises the findings of the assessment of the actual and potential effects of the Project on marine ecology values outlined in the *Marine Ecology and Coastal Avifauna Assessment* in *Volume 2* of this Application.

The *Marine Ecology and Coastal Avifauna Assessment* identifies the marine ecological values of the areas potentially affected by the Project, assesses the actual and potential effects of the Project on those values and identifies measures to avoid, remedy or mitigate the effects.

During construction of the Project, sediment-laden water will be treated and discharged, and during the operation of the Project treated stormwater runoff will be discharged. Discharges will be to streams and rivers that ultimately discharge to the Mahurangi Harbour and Kaipara Harbour.

The potential effects on the marine environment from construction are related to sediment discharged from the earthworks. The potential effects on the marine environment from operation are related to contaminants derived from the vehicles using the road and entering surface water via road runoff.

9.6.2. Existing environment and ecological values

This section outlines the existing environment and ecological values of the Mahurangi and Kaipara Harbours. Section 3.3.4 (Hydrology and drainage catchments) of this AEE identifies the harbours and contains a map of the catchment boundaries within the wider Project area (Figure 3-6).

Mahurangi Harbour

The Mahurangi Harbour is a drowned river valley, with vast intertidal flats and subtidal areas present in its middle to lower reaches. The harbour contains areas classified as SEA M1 and M2 in the AUP(OP), in addition to being recognised by DOC as an Area of Significant Conservation Value. Dense mangrove stands fringe the tidal flats of the upper estuary and side embayments. Seagrass patches have been noted in the middle to lower reaches. Estuarine vegetation that provide significant habitat for native fish, birds and invertebrates.

The water quality of the harbour has been ranked as excellent by Auckland Council. The concentration of common stormwater contaminants in surface sediment is typically below effects thresholds. The proportion of silt and clay within the harbour as a whole is rarely greater than 50% and surface sediment is oxygenated within the middle and lower reaches of the harbour.

Benthic invertebrate community species diversity and richness is high in middle and lower reaches of the harbour. However, benthic invertebrate diversity is low in the upper harbour (upstream of Hamilton's Landing). A large range of fish and birds use the harbour, including several Threatened or At Risk bird taxa.

Overall, the *Marine Ecology and Coastal Avifauna Assessment* has concluded that the marine ecological values of the Mahurangi Harbour are high in the middle to lower reaches, and moderate in the upper reaches.

Kaipara Harbour

Kaipara Harbour is the largest enclosed harbour/estuary in New Zealand. It is divided into three main peninsulas and has a total surface area of 947 km^2. The harbour is recognised as a SEA and the southern part of the harbour contains a number of SEA-M2 and SEA-M1 areas as classified in the AUP(OP).

The Indicative Alignment and associated earthworks span three catchments (Kourawhero, Hōteo and Oruawharo) that drain into the southern part of the Kaipara Harbour. The Kourawhero and Hōteo catchments drain into the Hōteo Inlet, whilst the Oruawharo and Maeneene subcatchments drain into the Oruawharo Inlet.

The upper intertidal zone contains vegetation sequences consisting of mangrove forest and shrubland, indigenous saltmarsh, exotic grassland and rushland species. Vast areas of shallow intertidal mud and sandflats exist, which, along with mangrove and saltmarsh, provide important habitat for a number of avifauna species. Some of these avifauna species are Threatened or At Risk. Kaipara Harbour has vast seagrass meadows that support a wide variety of fish, invertebrates and birds. The harbour also has significant channel environments with healthy shellfish communities.

The water quality of the harbour has been ranked as excellent by Auckland Council. The concentration of common stormwater contaminants in surface sediment is typically below effects thresholds. The proportion of silt and clay within the harbour as a whole, is rarely greater than 50% whereas surface sediment has a low oxygenation depth.

Benthic invertebrate community species diversity and richness is low in the middle and lower reaches of the harbour, and moderate in the upper harbour (Oruawharo River and Hōteo River), mainly due to the abundance of a number of mud tolerant species.

The harbour has been modified through the establishment of intertidal oyster farms, dredging, mangrove removal and the invasion of *Spartina anglica* within various embayments.

Overall, the *Marine Ecology and Coastal Avifauna Assessment* has concluded that the Kaipara Harbour has high marine ecological values in the middle to lower reaches, and moderate marine ecological values in the upper reaches. Coastal avifauna ecological values are assessed as very high due to the majority of species associated with the coastal environment having a threat status of Threatened or At Risk.

9.6.3. Assessment methodology

The *Marine Ecology and Coastal Avifauna Assessment* focused on those parts of the coastal marine area within the Mahurangi Harbour and Kaipara Harbour where there is the potential for adverse ecological effects due water discharges from the Project. The assessment considered the Indicative Alignment, but also considered potential changes to the alignment (and design and location of ancillary components) within the proposed designation. Information on the marine ecological values within the Mahurangi Harbour and Kaipara Harbour was collated from existing literature. Targeted field surveys were carried out in order to identify existing benthic ecological values and assess sensitivity of habitats and organisms to potential effects of the Project.

The investigation of marine ecological values in the Mahurangi Harbour and Kaipara Harbour included:

- a literature review of the existing marine ecological values;
- benthic invertebrate infaunal and epifaunal surveys;

- sediment grain size surveys and analysis; and
- analysis of common stormwater contaminants in sediment.

The assessment drew together the existing marine and coastal avifauna ecological values, the potential construction-related effects (including sediment discharge and habitat disturbance), the potential operational-phase effects (primarily the discharge of treated stormwater) and potential cumulative effects on the marine ecological values and the lifespan of the upper harbour areas.

The assessment of potential effects on the Mahurangi Harbour from construction sediment has relied on the marine ecology and coastal avifauna assessment undertaken for the P2Wk project[67].

The potential effects from construction sediment were assessed for the Kaipara Harbour using the output of the Kaipara Harbour Coastal Modelling and Effects Assessment[68] that estimated the concentration of suspended sediments and depth and extent of sediment deposition under a range of construction scenarios (short term and long term).

The assessment of operational phase stormwater discharges was informed by contaminant load modelling.

The level of the Project's potential adverse effects on marine and coastal avifauna ecological values was assessed using the EIANZ, 2015, assessment matrix that incorporated ecological values and effect magnitude to predict an overall level of effects without mitigation.

9.6.4. Assessment of marine ecology and coastal avifauna effects

Potential adverse effects on the marine environment are primarily indirect, arising from the discharge of treated water runoff during construction and operation. Discharge of sediment laden water and treated stormwater runoff to the Mahurangi Harbour (via the Mahurangi River) and the Kaipara Harbour (via the Hōteo River and Oruawharo River) may occur throughout the construction and operation phases.

Construction phase effects

It has been estimated that 310 ha of earthworks area will be required for the Project. Of this, 270 ha is proposed to occur in the Kaipara Harbour catchment, mostly within the Hōteo River catchment but some within the Oruawharo River catchment. The total amount of earthworks in the Mahurangi Harbour catchment is estimated at 43.3 ha.

Erosion and Sediment Controls (ESC) to manage the potential effects of these earthworks activities will be an inherent part of the construction methodology of this Project and best practice ESC will be implemented as outlined in section 9.2 of this AEE. However, sediment runoff from open earthworks areas during large rainfall events discharging to the Mahurangi and Kaipara Harbours during construction of the Project has the potential to adversely affect marine ecological values.

Sediment may be released to the receiving environment during large storm events and has the potential to result in acute adverse effects associated with those events

[67] Further North (2013) Puhoi to Warkworth Marine Ecology and Coastal Avifauna Assessment Report
[68] NIWA, 2018

or long-term contribution over the Project construction period i.e a cumulative effect. The assessment undertaken addresses both and considered suspended sediment and that deposited on the sea floor.

Suspended Sediment

The concentration of total suspended solids (TSS) and the area and depth of deposited sediment under a 10 year and 50 year rainfall events have been modelled and mapped for the *Marine Ecology and Coastal Avifauna Assessment* under a 5-year construction scenario in the Mahurangi Harbour catchment and a 7-year construction scenario in the Kaipara Harbour catchment.

The models predict a reduction in the suspended sediment concentration in marine receiving water (TSS) to concentrations significantly below effects thresholds within approximately three days in all scenarios within both the Mahurangi and Kaipara Harbours. An exception to this was observed in a small area on the Kakaraia Flats (within the Kaipara Harbour), where suspended sediment concentration was modelled to exceed 80 g/m^3 for more than 72 hours under a 50-year ARI event. Overall, the *Marine Ecology and Coastal Avifuana Assessment* concluded that the level of effect of suspended sediments from construction of the Project on benthic invertebrates and marine/estuarine habitat values is negligible.

Deposited Sediment

Modelling predicts that following the rainfall event, the deposition of sediment in both the Oruawharo Inlet (Kaipara Harbour) and Mahurangi Harbours in a 10-year average return interval (ARI) rainfall event will result in relatively small increases in sediment depth in the upper reaches of each harbour predicted to receive sediment. The 10 year ARI events are considered to have a less than minor level of effect.

In the Hōteo Inlet, however, modelling estimates increases above baseline during a 10 year ARI of up to a 14% (5.4 ha) in the area subject to sediment depths between 5 and 10mm and up to a 10% (2.3 ha) in the area exceeding 10 mm in depth. Deposition of sediment at 5-10mm depth is likely to cause mortality to sensitive benthic invertebrate species through smothering, which in turn affects the community composition. Effects on community composition are likely to be significant in the shorter term (3-5 years), with recolonisation potentially occurring naturally over time. Deposition of sediment at depths greater than 10mm is likely to cause mortality to most, if not all, benthic invertebrates present. In the Hōteo Inlet, if the modelled quantum of sediment is released from the Project in a 10 year ARI event there would be a significant adverse effect on benthic communities.

In the 50 year ARI rainfall event in Mahurangi Harbour and the Hōteo Inlet part of the Kaipara Harbour, significant adverse effects on marine ecological values are predicted if the sediment quantum results from the modelling work are realised. A predicted increase of 21 ha will exceed 10mm in depth as a result of sediment generation due to the Project construction. If the modelled quantum of sediment is released from the Project in a 50 year event this would result in a significant adverse effect on benthic communities.

The modelled long term cumulative sediment contribution over the Project seven year construction period was found to be less than 1% in comparison to the current

baseline load generated in the wider contributing catchments. At this level of Project contribution, the effects on the long term lifespan of the Mahurangi and Kaipara Harbours is negligible.

Any potential adverse effects on avifauna during the construction phase of this Project will be indirect. During construction, there is the potential for adverse effects on marine water quality through increased suspended sediment. This can have potential impacts on the ability of visual foragers to locate prey items and can have flow-on effects to avifauna through reduced foraging resources due to deposition of Project related sediment.

Any potential effects on avifauna are dependent on potential effects on marine ecological values. Given the low to very low level of effect determined for the marine ecology and coastal avifauna assessment (during construction), the relatively low level of predicted additional deposition of Project related sediment and the short-term nature of the elevated TSS levels, the magnitude of effect on visual foragers to locate prey is assessed as negligible. The overall level of effect from both suspended sediment and the predicted additional deposition of Project related sediment is likely to have a negligible effect on migratory and resident wading, shorebird and marsh bird species in the upper, middle and lower Mahurangi Harbour and in the Kaipara Harbour.

Operational phase effects

During the operational phase of the Project, treated stormwater road runoff will be discharged to the Mahurangi Harbour via the Mahurangi River and the Kaipara Harbour via the Hōteo and Oruawharo Rivers. Stormwater treatment wetlands will primarily be used to treat operational phase stormwater from the Project prior to discharge to aquatic environments. Wetlands will be designed using best practice guidelines such as Auckland Council's GD 01. Devices designed with reference to such documents are expected to remove an average of 75% of suspended solids and associated contaminants from stormwater. Any residual sediment and associated contaminants discharged will largely be distributed within the upper estuary and upper harbour areas due to these areas being low energy depositional habitats.

The contaminant load model calculations indicate that there are no significant increases in stormwater contaminants within operational phase discharges to the Mahurangi and Kaipara Harbours, therefore the *Marine Ecology and Coastal Avifauna Assessment* concluded the potential adverse effects on marine ecological values are negligible.

Although operational phase stormwater discharges from the Project will contain low contaminant loads, there is the potential for these discharges to add to the long-term accumulation of common stormwater contaminants within marine sediments in both the Mahurangi and Kaipara Harbours. Stormwater contaminants are likely to have a very low to low level of effect on the value of the marine ecology within these receiving environments. Removing significant volumes of traffic from the existing state highway, where stormwater discharges are generally not treated, to the proposed state highway with treatment, will result in an overall reduction contaminant discharges and improvements to water quality.

The discharge of treated stormwater is likely to have a negligible effect on resident and migratory wading and cryptic marsh bird species in the Mahurangi and Kaipara Harbours.

The *Marine Ecology and Coastal Avifauna Assessment* concluded that the results of the assessment of construction and operational phases of the Project would not alter if the alignment were moved to a new position within the proposed designation.

9.6.5. Measures to avoid, remedy or mitigate actual or potential adverse effects

Mitigation principles have been developed for the Project and refer to taking an integrated approach, linking with Mana Whenua and other stakeholder's aspirations, and aggregating practical achievable mitigation into concentrated areas to achieve greater overall ecological outcomes. These mitigation principles are described earlier in section 9.5 of this AEE.

In order to manage potential adverse effects during construction, avoidance and mitigation measures include:

- Erosion and sediment control designed to regional best practice guidelines and standards.
- Staging of works and establishment of maximum open earthworks areas in the Hōteo catchment to reduce risk of sediment runoff.
- Storm event discharge monitoring and response.

Modelling of 10 and 50 year ARI rainfall events indicates that a 50-year event in both the Mahurangi and Kaipara Harbours (Hōteo catchment) and a 10-year event in the Hōteo catchment may result in a significant adverse effect on benthic invertebrate community composition and habitat quality that would require mitigation. Across the whole construction period, Project-related sediment discharges contribute to long-term sedimentation in both harbours and therefore contributes in a very small way to the cumulative effect of ecological decline.

For this Project, monitoring the depth and extent of Project related fine sediment, especially in the Kaipara Harbourarising from individual rainfall events is considered impractical because of the background characteristics of the environment and the inability to distinguish Project sediment from the background sediment given the quantum of the latter.

An alternative to visual and sample monitoring of sediment discharges in the harbours has been developed to mitigate the effects of sediment deposition. It is proposed that the actual sediment discharged from the Project during construction be monitored at representative erosion and sediment control devices to inform whether mitigation is required for larger acute rainfall events. These actual loads will be compared against catchment related mitigation triggers which if exceeded will require that a mitigation. Trigger levels have been proposed relating to the 10 year ARI event in the Hōteo Catchment and a 30[69] year ARI event in the Mahurangi catchment.

[69] The sediment load in a 30 year ARI event is proposed as the trigger level in the Mahurangi catchment, as we have modelled the 10 year ARI and 50 year ARI events, with significant adverse effects beginning to occur between these two events.

Likewise, with regards to cumulative sediment contribution, if large acute rainfall events occur during construction and if the total sediment contribution of the Project over the construction period exceeds 5% of the baseline, further measures to reduce sediment discharges to the harbours will be required to be developed and implemented. Mitigation measures that reduce the runoff of sediment from land to marine receiving environments that could be considered include additional planting of riparian margins (especially large streams) and retiring steep grazing or forestry land.

Mitigation, if required, should include additional planting of riparian margins (especially large streams) and retiring grazing or forestry land. The mitigation should be achieved within a generation (nominally 25 years). It is noted that the ecology and landscape planting proposed to mitigate adverse effects of the Project on terrestrial and freshwater ecology and landscape matters has multiple benefits, one of them being that it will, in the long term, result in reduced sediment runoff from those areas compared to the existing land use.

During the operational phase of the Project, the treatment of stormwater to remove 75% TSS and associated contaminants are likely to have a very low to low level of effect on the receiving environment.

9.6.6. Conclusion

Potential effects of the Project on marine ecological values may occur from the discharge of construction phase sediment and the discharge of operational phase stormwater. Recommended measures to minimise sediment runoff include erosion and sediment control designed to Auckland Council and Transport Agency guidelines and standards, staging of works and storm event monitoring.

Assessment of modelled rainfall events indicated that the 50-year event in the Mahurangi Harbour and 10- and 50-year events in the Hōteo Inlet of the Kaipara Harbour may result in Project-related sediment having significant adverse effects in the upper harbour benthic habitats, with potential flow on effects to coastal avifauna that forage on the benthic intertidal flats.

Project-related sediment discharges from erosion and sediment control devices should be monitored throughout the duration of the construction period and should the Project's contribution to cumulative sedimentation of the harbour be significantly greater than predicted (5% or more of the baseline), discharge of the same quantum of sediment should be reduced through mitigation measures within a 25-year period. In addition, it is recommended that sediment discharges during acute rainfall events that are greater than a 10-year event in the Hōteo catchment and greater than a 30-year event in the Mahurangi Harbour be mitigated in order to balance sediment discharged from those rainfall events also within a 25 year period. Options for reducing sediment discharges could include retiring steep farm or forestry land, additional riparian planting and stabilisation of stream banks. Such measures are proposed to be implemented after Project earthworks are complete.

The discharge of operational phase stormwater has been assessed as having a negligible level of adverse effects on marine ecological values.

With the recommendations above, it is considered that effects of the Project on marine ecological values overall can be appropriately managed and with appropriate mitigation applied, if required, can be considered to range from negligible to less than minor.

9.7. Construction traffic

Overview

The construction of the Project has the potential to impact the surrounding transport network. The mitigation proposed allows for an adaptive process that can be refined once the design has been progressed and construction methodology refined. The management of construction traffic effects will be through the preparation and implementation of the Construction Traffic Management Plan (CTMP). Temporary Traffic Management (TTM) will be in place in accordance with the Code of Practice for Temporary Traffic Management (CoPTTM). Localised construction traffic effects will be managed through the implementation of Site Specific Traffic Management Plans (SSTMPs).

The potential effects associated with construction traffic are assessed in the context of construction commencing in approximately 2030. It is intended that the preparation of the CTMP and SSTMPs will be undertaken by the contractor prior to construction works commencing. This approach allows for an adaptive method to effectively respond to further changes to the existing traffic environment and refinement of the Project.

With the proposed mitigation in place, adverse effects are considered to be no more than minor and minor.

9.7.1. Introduction

This section summarises the findings of the assessment of the actual and potential effects on the transport environment arising from construction traffic and temporary traffic management associated with the Project, as outlined in the *Construction Traffic Assessment* contained in *Volume 2* of this Application. The actual and potential effects on the transport environment arising from the operation of the Project are the subject of a separate report and are summarised in section 9.14 of this AEE.

The *Construction Traffic Assessment* addresses the actual and potential effects arising from traffic generated through the construction of the Project. The assessment also identifies the work that will be required on local roads located within the proposed designation to maintain local access.

9.7.2. Existing transport network

The existing transport network and environment is summarised in *Section 3* of this AEE.

9.7.3. Assessment methodology

The *Construction Traffic Assessment* assesses the potential impacts of construction traffic, based on the indicative construction methodology in *Section 5* of this AEE, on the transport network in two parts:

1. The effects of temporary traffic management measures and mitigation; and
2. The effects of construction traffic moving through the transport network.

The assessment of construction traffic effects has been divided into three sections as identified in *Section 5* of this AEE.

In accordance with best practice, the Project will be subject to a CTMP prepared in accordance with CoPTTM (including the local road supplement and Road Controlling Authority (RCA) specific procedures).

As part of its standard process for large projects, the Transport Agency develops CTMPs and SSTMPs (produced for specific activities or locations) in accordance with the CoPTTM. The purpose is to ensure that the construction traffic effects on the transport network will be

The *Construction Traffic Assessment* outlines recommendations which include appropriate management for an indicative construction methodology within the proposed designation boundary. Given the level of change that is anticipated in the Warkworth area prior to construction, it is considered appropriate that an update of the construction traffic assessment is undertaken closer to the time of construction to accurately consider the traffic environment of the day (including developments in passenger transport, walking and cycling).

The recommended mitigation approach (i.e preparation of management plans) will not require changing as that approach already requires consideration of the circumstances at the time of construction as does any authorisation from a road controlling authority under CoPTTM.

Temporary traffic management assessment

The methodology for assessing TTM effects is summarised as follows:

- Identification of the likely construction traffic resulting from construction activities and associated TTM requirements on the existing network;
- Qualitative assessments are required to determine the likely level of impact of the construction activities. This is based on experience and understanding of capacity reductions and delays caused by traffic management activities; and
- Assessment of potential routes to be used by construction vehicles.

Construction traffic assessment

Based on the indicative construction methodology the following was determined:

- Estimates of construction traffic for both type (e.g. light/heavy vehicles) and numbers travelling to and from each construction area of the Project; and
- Approximate number of staff likely to be required at each site and the volume of construction equipment and materials likely to be required to construct the Project.

Construction is assumed to commence around 2030. The transport modelling establishes the traffic environment predicted close to the time of construction. The year 2036 forecast model will most closely reflect traffic during the proposed construction programme. The modelling also took into account other committed nearby roading infrastructure projects including P2Wk, Western link road (partially complete) and the Matakana link road.

To assess the impact of construction traffic on the transport network, the following methodology was used:

- Based on the estimates of haulage requirements and potential routes, the construction traffic assessment identified the approximate number of additional vehicles estimated to travel on the existing road network during construction.
- The modelled traffic volumes for 2036 were compared to the capacities of the impacted road segments and turning movements, to assess whether there will be sufficient capacity to accommodate the expected heavy construction traffic.
- The intersections where there may not be sufficient capacity were identified, which were then modelled to estimate the impacts and inform the recommended mitigation.
- The South section, which includes Warkworth and would use SH1 as a haulage route, is the area where construction traffic is most likely to have adverse impacts on the network. For this section, SIDRA[70] intersection analysis was carried out to model the impacts of construction traffic at the intersections of SH1/Hudson Road and SH1/Matakana link road (future road intersection). These are the only intersections throughout the Project extent that are expected to be potentially negatively impacted by construction traffic.
- A sensitivity test was performed to assess whether the effects of construction traffic would remain the same if the transport network is further developed to include all of the road projects planned for Warkworth (these projects are described in detail in the *Operational Transport Assessment*).

The crash analysis carried out for the *Operational Transport Assessment* was examined to:

- Identify areas of safety concern along the indicative haul routes; and
- Include consideration of programmed safety improvements.

9.7.4. Assessment of construction traffic effects

Temporary Traffic Management

TTM is likely to be required at locations where construction activities will influence existing traffic. Existing traffic will be affected where there are interchanges and tie-ins, realignments, and locations where the Project will pass over or under existing roads. TTM measures would also be needed at site access points (SAPs). It is envisaged that SAP locations will be chosen so that they do not impede on the existing road.

The construction methodology is indicative, and the actual TTM used will be determined in SSTMPs closer to the time of construction. The final TTM plans will be developed as part of the CTMP process closer to the time of construction. SSTMPs will be prepared and submitted for approval to the RCA(s) before works begin. The key locations where TTM measures are likely to be required for the Project, and which have the potential to affect operating conditions on the existing road network, are shown in Figure 9-3 and Figure 9-4.

[70] SIDRA (Signalised and unsignalised Intersection Design and Research Aid) INTERSECTION is an advanced micro-analytical traffic evaluation tool that simulates traffic conditions at intersections.

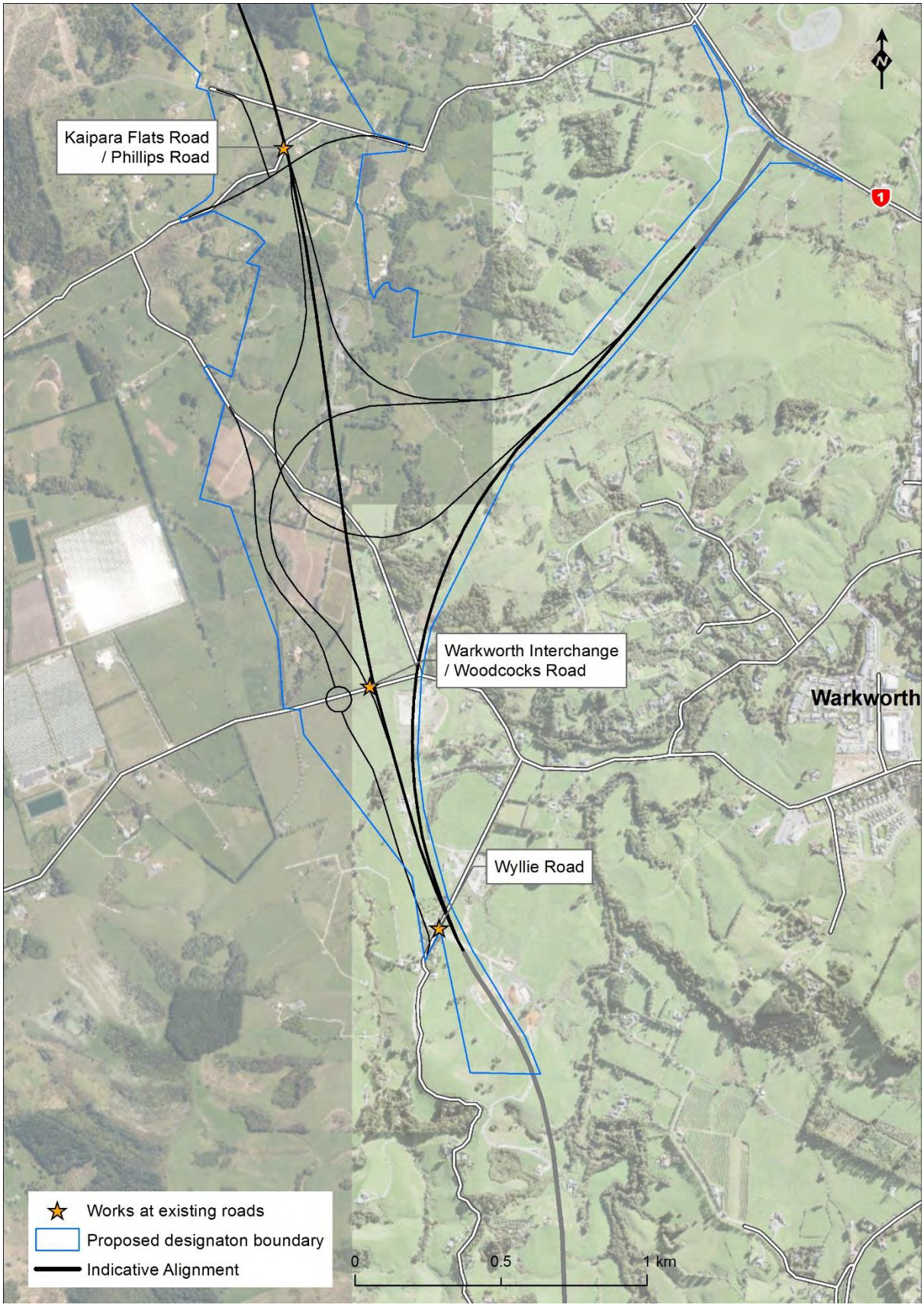
Kaipara Flats Road
/ Phillips Road
Warkworth Interchange
/ Woodcocks Road
Warkworth
Wyllie Road
Works at existing roads
Proposed designaton boundary
Indicative Alignment
0
0.5
1 km

Figure 9-3: Locations where TTM could impact traffic, Hōteo South

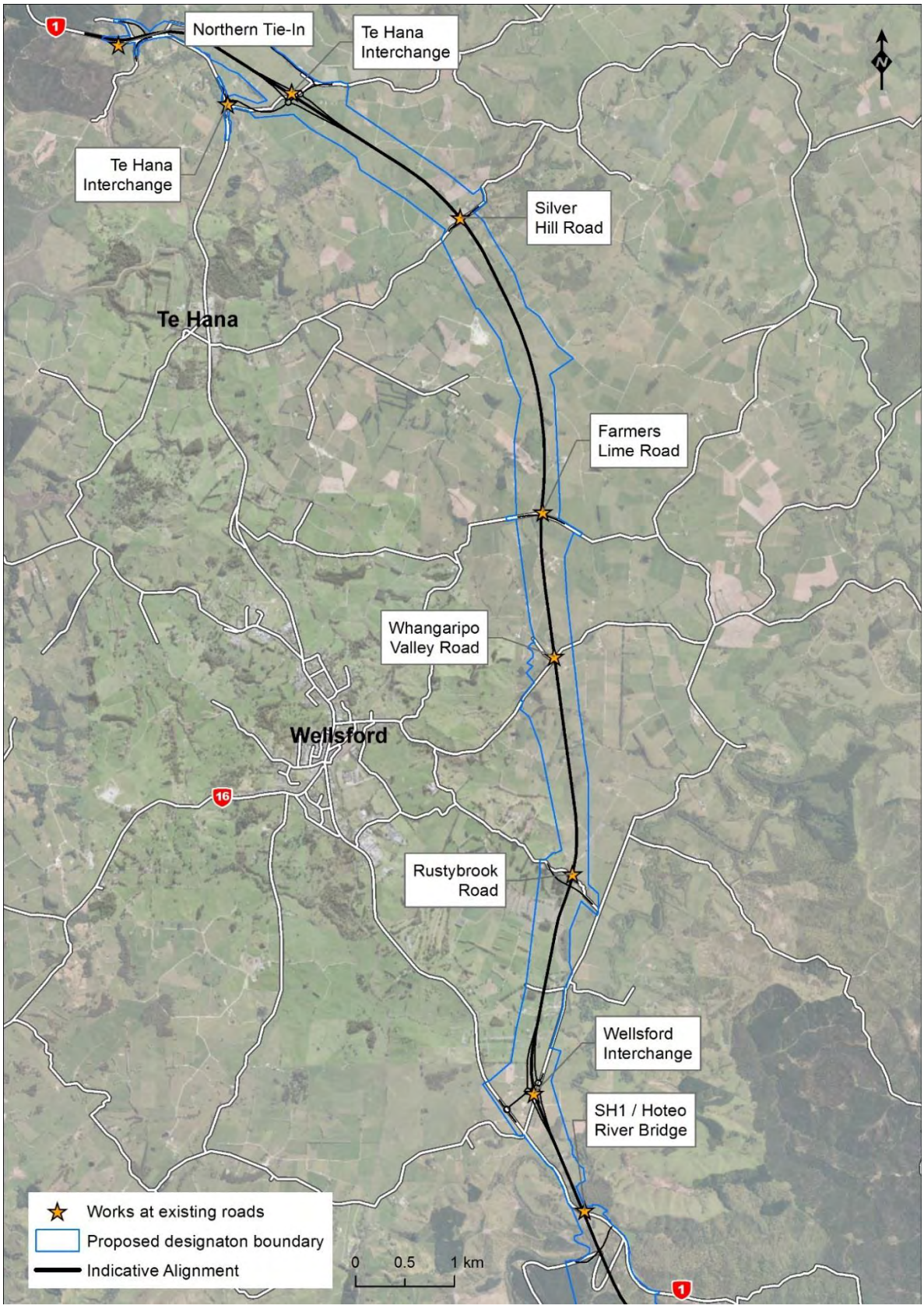

Figure 9-4: Locations where TTM could impact traffic, Hōteo North.

The types of potential mitigation measures that may be used to ensure that the effects of TTM on the transport network are minimised as far as practicable are summarised as follows:

Project connections

The construction of interchanges and tie-ins with the local road network will be undertaken through a range of measures such as lane closures, temporary diversions, and shoulder closures. In some instances, construction work such as that proposed for the Te Hana Interchange, the realignment of Wayby Valley Road or Carran Road can be undertaken off line with minimal conflict.

The southern tie-in with P2Wk will likely be undertaken via shoulder closure and effects will be managed through use of a SSTMP.

Local roads in the vicinity of interchanges, such as Wayby Valley Road, will be realigned first to maintain local access. Where possible these interchanges will be completed off line, and once built can then provide grade separation of local traffic and construction/haulage traffic. During the construction of interchanges SSTMPs will be in place which will outline the specific TTM type and timing to be in place, to ensure that traffic impacts are minimised as far as practicable.

Local roads

The construction of the Project will require modification of thirteen local roads and one crossing of SH1. Of the local roads that intersect with the Project, four are intended to be realigned to avoid crossing the alignment (Wyllie Road, Carran Road, Phillips Road, and Vipond Road). Nine roads (eight local roads and one existing SH1 crossing) will pass over or under the Project with some of these also requiring realignments of sections of the road.

Local road access will be maintained during construction, but where appropriate will be subject to TTM for safety reasons.

Indicative construction activities at the crossing of the existing SH1 relate to the construction of viaduct and embankments to enable the Project to cross over both SH1 and the Hōteo River. The *Construction Traffic Assessment* outlines that these works will not impede traffic on SH1, with the exception of brief closures of SH1 while the bridge structure is put in place. Such closures could be done at night, and, irrespective of the hour of the day or night, will be carried out in accordance with CoPTTM to ensure that they are carried out safely and with minimal impact on traffic.

The *Construction Traffic Assessment,* section 4.2 outlines in detail the potential effects associated with TTM in regard to specific local roads throughout the Project alignment. TTM will be required for safety reasons and to manage the effects of lane closures, temporary diversions and closure of shoulders.

Site Access Points (SAPs)

SAPs would be chosen in locations that allow for safe access without impeding on normal traffic flows. Any proposed SAP locations would require SSTMPs that consider the following:

- Available capacity;
- The need for temporary capacity to be added;
- The ease of adding and maintaining the access and any temporary infrastructure;
- Potential restrictions on construction vehicle turning movements (such as left in left out);
- Sight distance; and
- Proximity to quarries.

TTM has the potential for adverse effects on the surrounding traffic environment. Through the proposed measures as outlined in section 9.7.5, these effects will be appropriately managed so that effects are minor.

Construction traffic assessment

The *Construction Traffic Assessment* identifies the proposed construction access locations, haul routes and construction traffic volumes that would be likely to use these accesses and haul routes.

Effects of light vehicles

Light vehicles are assumed to travel to and from the office compounds in each location, with the main office likely incorporated into the South section due to proximity to Warkworth and Auckland. Movements will be concentrated at the beginning and end of the working day.

At this stage it is anticipated that majority of light vehicles will come from Auckland or Warkworth and would be in the counter-peak direction. However, the modelling undertaken shows the existing SH1 through Warkworth and south of Kaipara Flats Road will still be congested during peak hours so there is a potential for additional delays and queuing on the existing SH1 if light construction vehicles use this route. Any light vehicles accessing site compounds north of Warkworth are assessed as having negligible impacts on the transport network.

Staff travel plans are recommended to help reduce the effects of the light vehicles on the transport network.

Effects of heavy vehicles

At various stages of the Project heavy commercial vehicle (HCV) numbers will largely correspond to the volume of fill and pavement aggregate needed to be transported to each of the sections.

The South section will have a shortfall of fill, which will need to be imported from the Central section or from a quarry. The Central and North sections will be self-contained with sufficient structural cut to fulfil their needs. The Central section will have excess structural cut which could be hauled to the South section using forestry roads and SH1 until tunnel bores are complete, at which time the earthworks footprint can be used as the haul route.

In total, there are currently four quarries within proximity of the Project which have been identified as potential sources for fill and pavement material for the overall Project:

- Matakana Quarry (south part of the Project area);

- Rodney Aggregates Supplies (west of the North section);
- Atlas Quarry (north of the North section); and
- Milbrook Quarry (north of the North section).

There are two periods of time in which hauling is expected to occur:

- Year 3 – Year 5 of construction: Fill will be transported to the South section from the Central section and from Matakana Quarry or another quarry.
- Year 6 – Year 7 of construction: Pavement aggregate will be transported; to the South section from Matakana Quarry or another quarry, to the North section from one of the three northern quarries, and to the Central section from any of the four quarries.

The estimated number of heavy vehicles the proposed works will generate with aggregates from quarries in both the south and north is outlined in Table 9-13 below.

Table 9-13: Heavy Vehicle numbers and movements (one-way vehicles per hour)

Section	Year 3-5	Year 6-7 South	Year 6-7 North
South section			
From Matakana Quarry	6	13	26
From Central section	8	0	13
Central section			
From Matakana Quarry/South section	8	0	13
From Rodney Quarry/North section	0	13	0
North Section			
From Central Section	0	13	0
From Rodney Quarry	0	44	31

Due to the staging of proposed works there will be variation in the number of daily HCV movements to and from the site throughout the duration of construction.

South section

SH1 between Hudson Road and the P2Wk roundabout (under construction) is currently the most heavily congested area of the Project. It is the only area along the alignment that may be adversely impacted by construction traffic. The congestion is predicted to be worst (during a "normal" week) during the weekday evening peak. The 2036 model forecasts significant delays in the evening peak along this stretch of SH1, although it is noted that significant delay is also forecast without the Project. Construction traffic added to the network during peak hours will worsen the forecast congestion and these vehicles may have difficulty in making turns at priority intersections.

This section of SH1 would likely be part of the haulage route from south easterly directions (such as the Matakana Quarry). To reduce the impacts of haulage in this section, a specific haulage route is suggested as follows.

- Trucks hauling from south easterly locations to the southern section of the Project should turn right out of the future Matakana link road onto the existing SH1 at the SH1/Matakana link road intersection, where there will be traffic signals.
- The route should be a loop using left turns into Kaipara Flats Road.
- The return route would use Woodcocks Road, Mansel Road, Falls Road and Hudson Road, with a right turn back onto Matakana link road from the existing SH1 at the traffic signals. This route will avoid opposed right turns at priority intersections. It will also avoid Mahurangi College.

Signalised and unsignalised Intersection Design and Research Aid (SIDRA)(ie traffic modelling) analysis was undertaken for the two main intersections in the scenario of the above haulage route being implemented, these being the intersections with Hudson Road and Matakana link road. The SIDRA analysis used 2036 forecast flows.

The modelling indicates that the intersection of SH1 with Hudson Road will be operating close to capacity in the evening peak. However, the addition of approximately 26 construction vehicles per hour would only have a minimal impact on delays. Minimal delays were also predicted in a sensitivity test, which doubled the proposed number of HCVs going through the intersection.

The intersection of SH1 with Matakana link road is the main connection between Matakana Quarry and the South section construction sites. Typical HCVs through this intersection will be between 25 and 40 vehicles per hour (vph) but will largely depend on the aggregate source used for the Central section. During the morning peak and inter-peak periods, the intersection is predicted to be operating well within capacity and increases in delays of less than six seconds are predicted for all movements, even with the high end number of HCVs. Evening peaks will be adversely affected for certain movements because of the addition of construction HCVs.

The remainder of the roads in the South section are not forecast to have issues with congestion in 2036. The expected HCV volumes generated by the Project construction are predicted to be small in comparison to the remaining capacity of these roads.

Central section

The Central section passes through the Dome Valley. There are two places where traffic will be able to turn off SH1 onto the forestry roads and access the construction compound, being Dibble and Coach Roads (both are forestry roads). SH1 through this section of the Project area has few intersections and no forecast issues with congestion in 2036.

The Safe Roads Alliance plans to install (amongst other things) median barriers and wide centre line treatment along the full length of the 15.2km corridor along SH1 through the Dome Valley. These works are programmed to be completed by October 2021. The barrier and other works proposed will not impede access for construction vehicles as the proposed barrier design shows gaps in the barrier at the entrances to the proposed internal haul routes. The barrier and other works proposed will slow speeds and prevent other vehicles from overtaking HCVs. This will improve safety on SH1, but may adversely affect travel time, as cars will have to wait for passing lanes to overtake slow-moving HCVs. The largest volume of hauling to the Central section

is expected to take place during the last two years of construction, when pavement aggregates are to be hauled. By that time, the Project alignment will likely be able to be used as a haul road. Therefore, the volume of construction HCVs travelling on SH1 through the Central section is likely to be low, and the impact of the slower speeds of these HCVs on other traffic is expected to be reduced.

The Central section is not expected to experience negative traffic impacts from construction traffic. There are areas of high crash risk along the proposed haul route in this section, though these risks will be mitigated by the planned safety improvements in the Dome Valley. It is important that a safety assessment be carried out in accordance with the CoPTTM as part of any SSTMPs prepared for this section. In addition, the locations of SAPs in this section will be carefully considered, as this section of road may present challenges for sight distance and space for temporary added capacity (such as turning lanes into the site) required to allow for easy site accessibility. If possible, SAP locations should minimise the amount of distance construction HCVs need to travel on the existing SH1, especially through the Dome Valley.

The Matariki Forest is planning to be harvested along SH1 through the Dome Valley prior to Project construction. As Project construction is assumed to begin in 2030, there is the potential for interaction between Project construction traffic and logging trucks from the forest harvest operation. The projected forest truck movements were assessed based on information provided by RMF. It is not expected that logging vehicles will cause capacity issues for Project construction traffic, provided that (as recommended) the Project does not haul during the evening peak through Warkworth, where logging trucks may contribute to congestion if they pass through at evening peak.

North section

Haulage routes in the North section will be along rural roads, mainly Wayby Valley Road, which will provide access to the intersection with SH1 and the Wellsford interchange. The section of SH1 between River Road and Wayby Valley Road, including the SH1/Wayby Valley Road intersection is identified as a location with high collective safety risk and it will be important for a CoPTTM safety assessment, including sight lines, to be carried out when the SSTMP is prepared for this location. The Project alignment may provide an alternate route when it is considered suitable for hauling.

The North section is not expected to experience negative traffic impacts from construction traffic. Assessments will need to be updated prior to the start of construction to reflect the traffic environment at that time.

Sensitivity testing

The final construction methodology will be determined by the contractor appointed to undertake the works. Whilst changes to the methodology can occur, the *Construction Traffic Assessment* is considered conservative for the following reasons:

- The volumes of light and heavy construction traffic were assumed as relatively high (a worst case scenario has been applied);

- 2036 traffic forecasts were used, although the construction is anticipated to start in 2030;
- Many light vehicle movements will be at the start and end of shifts (nominally 7am and 7pm) which will generally be outside of peak traffic volumes on the surrounding roads; and
- The development of a CTMP will enable more efficient implementation of traffic management activities to maximise efficiency of traffic flow and minimise disruption.

The *Construction Traffic Assessment* includes a sensitivity test which took into account all currently planned transport projects in Warkworth being constructed by the time the Project is constructed. This sensitivity test indicated the recommendations would still apply, in particular that hauling should cease on SH1 through Warkworth during the weekday and evening peak and holiday peaks. This is especially important for heavy vehicles hauling from Matakana Quarry (or any quarry in that area) using Matakana link road, to avoid causing adverse impacts on the Matakana link road/existing SH1 intersection.

Passenger transport effects

Only a small number of regular passenger transport services use the existing SH1. The regular passenger transport services (Intercity and Mana Bus services) allow pre-booked passengers to board and alight on SH1 at Warkworth, Wellsford and Te Hana. The InterCity bus stop in Warkworth is in central Warkworth, not on SH1. The stops in Wellsford and Te Hana are on SH1, but the construction operations will be well east of these locations and will have no impact.

There is a high number of school bus runs in the Project area due to its rural location and number of students living far from schools. The schools in Warkworth are well served by school buses using Woodcocks Road and Hill Street. Bus boarding and alighting takes place on Mahurangi College grounds and not on Woodcocks Road, so construction traffic is not likely to impact on this boarding/alighting. Provided that access for buses is maintained for these routes and suitable set-down areas are maintained, it is expected that the effects on passenger transport during construction will be minor.

Pedestrian and cycle effects

The numbers of pedestrians and cyclists within the area of the project are generally very low, with the exceptions being mainly within the townships of Wellsford and Warkworth.

There will be additional traffic on SH1 during construction which could increase the exposure of pedestrians and cyclists to potential conflicts.

The contractor, in developing the Project CTMP and SSTMPs, will need to give due consideration to the safe passage of pedestrians and cyclists through the areas controlled by TTM and routes used by construction traffic, particularly if haul routes are near school access routes. The effects of the construction activities on pedestrians and cyclists can be managed so that they are minor.

9.7.5. Measures to avoid, remedy or mitigate actual or potential adverse effects

As a result of the Project, the *Construction Traffic Assessment* has identified a number of potential impacts along SH1 and on the local road network. Construction traffic will require detailed mitigation strategies at the construction planning stage. The effects and mitigation strategies identified in this assessment can be used to inform the traffic management methodologies to facilitate the successful construction of the Project.

The following measures are recommended in order to mitigate construction traffic effects of the Project:

- A CTMP will be developed for the Project which will respond to traffic conditions at the time of construction, given the foreseeable change in the Warkworth area.
- A hauling operations plan and a staff travel plan will be developed for the Project.
- For any works that will impact traffic on existing roads, a SSTMP will be prepared that includes a plan for TTM in accordance with the standards in CoPTTM. This will ensure that the TTM measures are put in place safely and that the impacts on traffic are minimised as much as practicable.

The following measures will be taken into account in the development of the CTMP and SSTMPs:

- As part of developing the CTMP and associated SSTMPs for the Project, suitability of detour routes where short-term road closures are considered necessary to facilitate construction works will be addressed. Future assessment will take into account seasonal variations in traffic flows and conditions, and the construction of the Project will avoid exacerbating traffic issues during periods of increased traffic (such as holidays) when developing the overall schedule of works for the Project.
- Both Woodcocks Road and Carran Road will be signed as access routes to SH16 for use when SH1 is either closed or congested during holiday periods. These situations would be for a relatively short period of time. The SSTMP for this location will specifically include plans to accommodate these situations if closures of either of these roads is needed.
- Generally, any required road closures throughout the Project extent will be carried out at times of lowest traffic, and at night if possible.
- For roads requiring realignment, to ensure continued local access is maintained during the construction of the Project, the realignment of local roads will be undertaken prior to the severance of the original connections.
- Proposed SAP locations will require SSTMPs that consider available capacity for queuing vehicles, the need and ease of maintenance of adding temporary capacity, potential restrictions on vehicle turning movements, sight distance, proximity to quarries, and site-specific conditions.
- The section of SH1 through Warkworth and south of Kaipara Flats Road will be congested during peak hours. Construction traffic will avoid this part of SH1 as much as possible, and when it cannot be avoided, travel will be outside of peak hours. Light vehicles coming from Auckland will use P2Wk rather than SH1. Light vehicles from Warkworth will use local roads and avoid travelling through Warkworth during the evening peak (between 4 pm and 6 pm).

- If construction light vehicles are expected to use Woodcocks Road and Hill Street, appropriate treatments will need to be put in place during the morning and evening school peaks at Mahurangi College and Warkworth Primary School. The need for these treatments will be evaluated as part of the SSTMP prior to the work commencing.
- To reduce the impact on the road network of staff vehicles, a travel management plan will be included in the CTMP. For example, staff will be encouraged to carpool to sites, and a contractor could consider reducing traffic impacts by providing a bus or shuttle service from Auckland, Warkworth, or wherever the bulk of employees are located.
- Trucks hauling from south easterly locations (i.e. Matakana Quarry) to the South section are anticipated to turn right out of the future Matakana link road onto the existing SH1 at the SH1/Matakana link road intersection, where there will be traffic signals. The route will be a loop using left turns Kaipara Flats Road. The return will use Woodcocks Road, Mansell Road, Falls Road and Hudson Road, with a right turn back onto Matakana link road from the existing SH1 at the traffic signals. This route will avoid opposed right turns at priority intersections. It will also avoid Mahurangi College.
- Haulage trips from a south easterly location (such as Matakana Quarry) will not be made during the evening peak hours of 4 pm to 6 pm to avoid the most congested time for this section of SH1.
- SSTMPs must take into account passenger transport, pedestrian, and cyclist access as well as vehicle access.
- Site access points in Matariki Forest will require coordination with forest owners, as forest harvesting may also require use of those access points.
- Truck drivers must have appropriate training in sharing the road with vulnerable users.

With the above measures in place the *Construction Traffic Assessment* concludes that effects associated with construction traffic will be minor.

9.7.6. Conclusion

The construction traffic movements and TTM required to construct the Project have the potential to impact on the surrounding road network if not appropriately managed. The management of these effects requires detailed mitigation strategies at the construction planning stage.

The approach proposed will allow for flexibility that will respond to traffic volumes at the point of construction and for specific measures toward managing localised effects. This adaptive method will be achieved through the preparation of the CTMP. Specific localised effects will be managed through the preparation and implementation of SSTMPs. TTM will be undertaken in accordance with CoPTTM.

Based on the findings of the *Construction Traffic Assessment*, and with recommended mitigation including the preparation and implementation of a CTMP, and the CoPTTM requirements associated with SSTMPs and TTM, it is considered that the overall traffic effects from construction of the Project will be no more than minor.

9.8. Construction noise and vibration

Overview

Construction of the Project will result in temporary increases in noise and vibration levels. Potential noise and vibration effects from the construction of the Project have been assessed in accordance with the Transport Agency's *State highway construction and maintenance noise and vibration guide* (the Transport Agency Construction Noise and Vibration Guide), which in turn refers to relevant national and international standards. For construction noise the Transport Agency Construction Noise and Vibration Guide relies on *New Zealand Standard NZS 6803:1999 Acoustics – Construction Noise (NZS 6803)*, which is widely used throughout New Zealand and has been applied to all recent large scale roading construction projects in New Zealand.

The Project area is sparsely populated and being a predominantly rural area, the ambient noise levels in the Project area are often low. The noise and vibration levels associated with the construction of the Project, even if within applicable criteria, may be noticeably more apparent at nearby sensitive locations such as dwellings (referred to as Protected Premises and Facilities (PPFs)) than existing levels. A conservative approach has been taken when predicting construction noise and vibration levels. When taking into account mitigation proposed, daytime criteria are likely to be complied with in most cases, however, small exceedances are possible. A Construction Noise and Vibration Management Plan (CNVMP is recommended as the mechanism by which the primary methods to manage effects of construction noise and vibration are specified. Night time noise criteria will generally be exceeded if night time works are undertaken, these will be mitigated and managed through the implementation of a CNVMP and associated conditions.

There will be a degree of temporary disturbance and alteration to the amenity of the area. These effects should be to an acceptable degree for most people, who will be able to continue with normal activities albeit with some temporary disturbance.

It is envisaged that with a CNVMP process in place, construction related effects can be appropriately managed and are overall more than minor.

9.8.1. Introduction

This section summarises the findings of the assessment of the actual and potential noise and vibration effects arising from the construction of the Project, outlined in the *Construction Noise and Vibration Assessment* contained in *Volume 2* of this Application. Noise and vibration effects in relation to the operational phase of the Project are the subject of a separate report and are summarised in section 9.15 of this AEE.

The existing noise environment, identification of sensitive receivers, results of the assessment of construction noise and the associated potential effects are described in detail in the *Construction Noise and Vibration Assessment.* This section presents the findings of that assessment, namely the potential noise and vibration effects associated with the construction of the Project which has informed the proposed mitigation measures.

9.8.2. Existing noise environment

The ambient noise environment in the vicinity of the Project is relatively low due to the absence of major local roads and industry. The exceptions are the southern and northern tie-ins with P2Wk and the existing SH1, and where the Indicative Alignment crosses the existing SH1 in the vicinity of the Hōteo River, where traffic on SH1 affects ambient noise levels.

For consistency with the operation noise assessment for this Project the term PPFs has also been used to define locations for assessment of construction noise and vibration. For this Project PPFs are dwellings. Monitoring was undertaken at selected PPFs which are currently exposed to road traffic noise and also those that are not overly exposed to road traffic noise, providing a representative sample of the range in noise conditions. Noise monitoring was undertaken in accordance with New Zealand Standard *NZS 6806:2010 Acoustics - Road traffic noise - New and altered roads* (NZS 6806).

For those PPFs located in close proximity (<200 m) to SH1, road noise was noted as an audible noise source. Noise levels at PPFs located further away from SH1 were dominated by farm and other rural noises. For most of the Project the existing ambient noise levels near the proposed designation boundary are considered to be dominated by natural environmental sounds. Noise levels ranged from 24 dB $L_{Aeq(24h)}$ in rural areas to 54 dB $L_{Aeq(24h)}$ closer to SH1.

No existing vibration sources were identified either within the proposed designation boundary or surrounding the Project area which would immaterially influence the perception or other effects of potential construction vibration which typically occur a higher levels than typical ambient traffic vibration.

9.8.3. Construction noise and vibration assessment methodology

Overview

Construction activities are inherently noisy and can result in noise levels much higher than the existing ambient noise levels. This is particularly relevant in areas where there are low existing noise levels and construction activity would be the dominant noise source.

The assessment methodology for determining construction noise and vibration effects was undertaken via the following:

- Identification of PPFs located within 200 m of the proposed designation boundary;
- Determination of the appropriate construction noise and vibration criteria;
- Determination of the noise sources associated with construction activities, prediction of the noise and vibration levels from each construction activity and determination of the appropriate setback distances from the activity to achieve compliance with the appropriate criteria (without mitigation);
- Identification of PPFs at risk of exceeding the criteria for both noise and vibration, and recommendation of mitigation and management measures to address this risk.

The number of PPFs at risk of exceeding the noise criteria was assessed for noise and vibration in three scenarios:

1. Construction activities assumed to occur along the Indicative Alignment.
2. Construction activities occurring on a potential alignment located closer to the eastern side of the proposed designation boundary.
3. Construction activities occurring on a potential alignment located closer to the western side of the proposed designation boundary.

The predictions in scenarios (2) and (3) represent a hypothetical situation of the works being undertaken immediately adjacent to the proposed designation boundary, in reality the alignment would be at least slightly stepped in from the proposed designation boundary. These scenarios are therefore considered to be conservative. The *Construction Noise and Vibration Assessment* split the Project into three sections that align with the indicative construction methodology; South, Central and North.

Noise assessment criteria

NZS 6803 is the relevant standard for the assessment of construction noise in New Zealand and is considered to be the most appropriate standard on which to base an assessment of construction noise effects for this Project. The *Construction Noise and Vibration Assessment* also considered the AUP(OP) construction noise criteria, however, these AUP(OP) criteria are based on a 'typical' construction period. In many areas, the Project construction will be longer than 20 weeks, therefore the long-term duration criteria, as detailed in NZS 6803, are the appropriate criteria for assessment. Construction works in some areas, and in relation to individual PPFs may be less than 20 weeks in some instances. The long-term criteria are five decibels more stringent during daytime than the criteria for "typical duration" construction works (up to 20 weeks' duration).

NZS 6803 sets noise criteria which are to be met where practicable. Where full compliance with the criteria is not practicable, then measures should be employed to deal with potential exceedances. The construction noise criteria are generally higher than the criteria for operational noise because construction is a temporary activity with a finite duration.

For residential areas and rural dwellings, NZS 6803 allows higher noise criteria during daytime hours so that construction activity can take place (see Table 9-14). For Sundays and public holidays, lower noise criteria are set to provide respite from construction noise. Similarly, night-time criteria are low and only allow very quiet operations or operations remote from dwellings to be carried out to avoid sleep disturbance.

Table 9-14: Recommended upper limits for construction noise received in residential zones and dwellings in rural areas (Source: NZS 6803).

Time of Week	Time Period	Long Term Duration	
		$L_{Aeq(t)}$ dB	L_{AFmax} dB
Weekdays	0630–0730	55	75
	0730–1800	70	85
	1800–2000	65	80
	2000–0630	45	75
Saturdays	0730–1800	70	85
	1800–0730	45	75
Sundays and Public Holidays	0730–1800	55	85
	1800–0730	45	75

NZS 6803 does not anticipate that full compliance will necessarily be achieved at all times and at all receivers. It focuses on the implementation of the best practicable option (BPO) for construction noise management and mitigation, rather than requiring that the criteria be achieved.

Vibration criteria

The AUP(OP) and the Transport Agency Construction Noise and Vibration Guide have been considered in terms of construction vibration criteria. While both documents are based on the same fundamental standards, the criteria in the Transport Agency Construction Noise and Vibration Guide were taken forward as the primary basis for assessment of this Project as it has a more refined process accounting for substantial variabilities in vibration sensitivities. The construction vibration criteria provided in the Transport Agency Construction Noise and Vibration Guide are outlined in Table 9-15 below.

Table 9-15: Construction vibration criteria

Receiver	Location	Details	Category A mm/s PPV[71]	Category B mm/s PPV
Occupied PPFs	Inside the building Free-field[72]	Night time 2000h to 0630h	0.3	1
		Daytime 0630h to 2000h	1	5
Other occupied buildings	Inside the building	Daytime 0630h to 2000h	2	5

[71] Peak particle velocity. This is the instantaneous maximum velocity reached by the vibrating surface as it oscillates about its normal position.
[72] Description of a location which is at least 3.5m from any significant sound reflecting surface other than the ground.

Receiver	Location	Details	Category A mm/s PPV[71]	Category B mm/s PPV
All other buildings	Building foundation	Vibration transient	5	BS 5228-2[73] –Table 4 of *Construction Noise and Vibration Assessment*
		Vibration continuous		BS 5228-2 - 50% of values in Table 4 of *Construction Noise and Vibration Assessment*)

In the first instance, construction vibration should be managed to comply with Category A as far as practicable, and then Category B as far as practicable. If levels exceed those of Category B, management of vibration effects may still be possible, but will require vibration monitoring of levels and effects.

Blasting noise and vibration criteria

There are no New Zealand standards specifically for blasting noise and vibration. Noise and vibration associated with blasting have been assessed against the criteria in the Transport Agency Construction Noise and Vibration Guide, as presented in Table 9-16.

Table 9-16: Blasting noise and vibration criteria

Receiver	Location	Details	Category A	Category B
Occupied PPFs	Inside the building	Blasting – vibration	5mm/s PPV	10 mm/s ppv
	Free-field	Blasting – air blast	120 dBL_{Zpeak}	-
All other buildings	Building foundation	Vibration transient	5mm/s PPV	BS 5228-2[74] – Table 4 of *Construction Noise and Vibration Assessment*
	Free-field	Blasting – air blast	-	133 dBL_{Zpeak}

Location of PPFs

For the purposes of the construction noise assessment, PPFs which fall within the Project area (apart from one noted below at 161 Kraack Road) have been excluded from the assessment as they will be unoccupied or demolished as part of the Project. All PPFs within 200 m of the proposed designation boundary were considered in the construction noise assessment. In addition, one residential property within the Project area was included in the assessment at 161 Kraack Road where the Indicative Alignment passes through tunnels below the property. As such the dwelling could

[73] British Standard BS5228-2:2009 Code of practice for noise and vibration on construction and open sites – Part 2 Vibration

[74] British Standard BS5228-2:2009 Code of practice for noise and vibration on construction and open sites – Part 2 Vibration

remain occupied as it is largely unaffected by construction of the Project. In total 60 PPFs were identified.

Construction noise effects are noted as potentially extending beyond 200 m of the proposed designation boundary. However, those PPFs located within 200 m of the proposed designation boundary are the most at risk of exceedances. Any measures and mitigation proposed to address exceedances at these PPFs would also manage effects in the wider area, including those PPFs located more than 200 m from the proposed designation boundary.

Noise level predictions

Noise level predictions have been undertaken based on the indicative construction methodology outlined in *Section 5* of the AEE. The final construction methodology will be determined by the contractor once appointed.

Noise level predictions generally consider:

- Source sound power levels of each item of equipment;
- Noise propagation characteristics over distance;
- Effects of ground and air absorption;
- Meteorological conditions; and
- Terrain (including shielding).

The noise level predictions undertaken for the assessment are considered conservative whereby weather conditions, shielding due to terrain (including buildings or hills/cutting) and absorption from the ground and air were not considered.

Vibration predictions

Vibration predictions need to take the following into consideration:

- Propagation through non-uniform ground types;
- Coupling between the vibration source and the ground; and
- Coupling between the ground and the vibration sensitive receiver.

Vibration calculations were based upon ground type. All construction activities occur within the Category III Soil Classification as defined in the Transport Agency Construction Noise and Vibration Guide: Hard soils (cannot dig with shovel, must use pick to break up); dense compacted sand, dry consolidated clay, consolidated glacial till and some exposed rock.

Blasting predictions

No predictions were undertaken for blasting as sufficient details are not available at this stage. The Construction Noise and Vibration Assessment has assumed that if blasting is required, the contractor will undertake initial trials (using smaller charge sizes) to determine the site specific blast response characteristics to define allowable blast sizes to maintain compliance with the criteria outlined earlier in this section.

9.8.4. Assessment of construction noise and vibration effects

Construction is inherently noisy and generally results in a large noise level increase above existing levels for a defined period. The increase is particularly apparent in low noise environments where construction noise is introduced.

Ambient noise levels within and in proximity to the Project area are generally low due to the surrounding primarily rural nature. Therefore, even when achieving compliance with the criteria of NZS 6803 there will be a significant increase in overall noise level during the construction phase.

The assessment within this section considers the effects of an Indicative Alignment and other potential effects that could occur if that alignment shifts within the proposed designation boundary when the design is finalised in the future.

Construction noise predictions

Construction equipment will be working in clusters along the Indicative Alignment, and would undertake the following general activities:

- Bulk earthworks;
- Earthworks fills, soil disposal areas and compaction;
- Rock breaking;
- Drilling (for blasting if required);
- Piling for bridges;
- Construction of bridge/viaduct structures;
- Pavement construction;
- Staging areas;
- Mineral extraction; and
- Rock crushing.

A list of likely equipment required for the above activities was completed based on similar roading projects throughout New Zealand. The 'time weighted activity sound power levels and compliance distances' were determined from the estimated equipment used for undertaking the above activities and the estimated time periods each of the equipment is used for. The distance the activity would need to be from the sensitive receiver to comply with the criteria (without mitigation) was calculated using the sound power level (see Table 9-17).

Table 9-17: Time weighted activity sound power levels and compliance distances

Activity (all equipment)	Time Weighted Activity Sound Power Levels dB L_{AW}	Distance beyond which compliance is achieved without additional mitigation (m)		
		Monday to Saturday 0730h to 1800h	Weekdays 1800 to 2000 hours	Sundays and Public Holidays 0730h to 1800h Limit 45 dB L_{Aeq}
		Limit 70 dB L_{Aeq}	Limit 65 dB L_{Aeq}	
Large bulk cuts	117	84	150	1497
Small bulk cuts	118	98	175	1748
Earthworks fills, spoil areas/ compaction	114	64	114	1142
Rock breaking	108	31	55	548
Drill rigs for blasting	116	80	142	1416
Bridges – piling	100	12	22	218
Bridges – super structure	107	30	53	526
Bridges – viaduct	107	30	53	526
Pavement construction	111	44	78	776
Staging area	109	34	60	603
Mineral extraction	108	31	55	548
Rock crushing	120	123	218	2181

The number of PPFs within 200m of the proposed designation boundary are set out in Table 9 of the *Construction Noise and Vibration Assessment.* The mitigation approach proposed to be adopted for construction of the Project will include techniques such as site hoardings/temporary noise walls, communication with PPFs and wider community, avoidance of working in close proximity to PPFs where practicable and using stock piling for screening. At times during the construction of the Project, construction activities will occur in close proximity to PPFs and in some instances there is the potential for noise and/or vibration levels to temporarily exceed the criteria, after best practicable option for mitigation has been implemented. For large scale projects such as this, minor temporary exceedances of the noise and vibration criteria are common, and practices are in place to address adverse effects of those exceedances. 16 PPFs were located within 50m of the proposed designation boundary and therefore required specific attention with respect to mitigation. These are located as follows:

Table 9-18: PPFs within 50 metres of proposed designation

Location	Number of PPFs affected
Southern section	
74 Wylie Road	1
Kaipara Flats Road	4
Central Secton	
Kraack Road	2
Northern Section	
Rustybrook Road	1
SH1	2
129/139 Vipond Road	2
Northern tie -in	4
Total	**16**

While there will be adverse construction noise effects, the *Construction Noise and Vibration Assessment* concludes it is practicable for noise levels to be controlled to comply with appropriate NZS 6803 criteria most of the time. On this basis people should be able to continue their normal activities with temporary alterations to their amenity. This temporary disturbance is considered acceptable and minor.

9.8.5. Measures to avoid, remedy or mitigate actual or potential adverse effects

Construction activities throughout the extent of the proposed designation will occur in the vicinity of some PPFs. As outlined above, there is potential for specific construction related activity to temporarily exceed applicable construction noise and vibration criteria at PPFs located within 200 m of the proposed designation boundary, and more specifically identified for 16 PPFs located within 50 m of the proposed designation boundary.

The proposed mitigation measures applied on Transport Agency projects are well established processes and are currently being implemented on the current P2Wk construction. Although exceedances at times during construction for large scale infrastructure projects are expected, measures can be implemented to manage or mitigate noise generation as far as practicable. The BPO will be applied to the management and mitigation of construction noise and vibration. The contractor will need to develop the BPO for the mitigating of noise and vibration generating construction activities. The mitigation measures detailed below are considered to be the baseline mitigation for most circumstances.

Recommendations to mitigate effects are as follows:

- Construction should be undertaken in accordance with a CNVMP which provides a framework to manage and mitigate noise and vibration effects.
- Long term construction staging areas should be separated from PPFs as much as practicable and should not be located in the vicinity of occupied PPFs on Kaipara Flats Road
- Kraack Road should not be used as a haulage route.

The potential risk of exceedances of the recommended criteria can be managed and mitigated through a CNVMP which will be prepared by the contractor prior to construction when details of the design, construction method and programme are finalised. The CNVMP will provide overall direction for management and mitigation of potential impacts during construction for both on-site and off-site measures and will outline a process for development of activity specific or area specific schedules to the CNVMP where exceedances of the criteria are likely. The CNVMP will be prepared in accordance with NZS 6803 and the Transport Agency Construction Noise and Vibration Guide.

The CNVMP will set out measures to manage construction noise and vibration effects. These will include general noise management and mitigation measures to be adopted throughout construction, such as considerate operating procedures on and off-site and appropriate communication with affected residents. Examples of on-site measures include training of personnel, maintenance of equipment, noise barriers and enclosures and considerate behaviour and use of equipment. Examples of off-site measures include public liaison and communication, temporary barriers, and noise level monitoring. Temporary relocation should also be offered where all other practicable mitigation measures have been implemented. In addition, targeted management approaches such as individual engagement with residents should be undertaken for 'at risk' receivers.

9.8.6. Conclusion

The Project will introduce construction related noise and vibration generating activities to an area with a generally low ambient noise environment. Therefore, even noise increases within the applicable standards may be noticeable at nearby PPFs when compared to the existing situation.

The assessment has determined that daytime compliance with applicable noise and vibration criteria is likely in most cases, but there could be localised exceedances at specific PPFs and in conjunction with specific construction activities.

Measures to manage noise and vibration effects during construction are recommended through the preparation of a CNVMP. The development and implementation of a CNVMP should be able to mitigate significant adverse effects of construction noise and vibration with the BPO followed in terms of mitigation. Even if compliance cannot be achieved, the CNVMP will provide methods to minimise the overall effect of the exceedances to the noise and vibration criteria.

Additional measures have been recommended for PPFs located on Kaipara Flats Road and Kraack Road.

Based on the findings of the *Construction Noise and Vibration Assessment*, and with adherence to relevant construction noise and vibration criteria (where practicable) and the implementation of the CNVMP, it is considered that noise effects from construction of the Project will be more than minor and vibration effects from construction of the Project will be minor.

9.9. Construction air quality

Overview

The construction phase of the Project has the potential to generate dust, particularly from earthworks, topsoil removal and spread, cut and fill operations, vehicle movements on unsealed roads, rock crushing and other activities in road construction such as trackout (the transport of dust and dirt on the road network where it may be deposited and re-suspended by vehicles).

There are some specific receivers in the vicinity of the Project with higher sensitivity to air quality effects from construction dust. The locations at risk to air quality effects include highly sensitive receivers (HSRs), such as dwellings, within 200 m of the proposed designation boundary, and within close proximity to both sealed and unsealed access roads which extend outside of the proposed designation boundary. The HSRs which are most at risk to air quality effects are located:

- downwind of and within 50 m of the proposed designation boundary;
- within 100 m of any proposed mobile rock crushing machine;
- within 50 m of sealed access roads, up to 500 m from the proposed designation boundary where trackout is proposed; and
- within 100 m of all unsealed access roads and local roads.

Dust generation can be reduced by implementing mitigation 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. Several access roads are recommended to be sealed, should these be utilised for construction access. Suitable separation distances for the rock crushing plant operation from HSRs can be implemented.

It is recommended that a Construction Air Quality Management Plan (CAQMP) be developed and implemented to manage effects of dust from construction of the Project. The CAQMP will outline a range of general mitigation measures, and procedures for implementing site dust controls.

Through the implementation of the CAQMP, dust effects during construction are considered to be manageable and minor.

9.9.1. Introduction

This section summarises the findings of the assessment of the actual and potential effects on air quality arising from construction of the Project outlined in the *Air Quality Assessment*, contained in *Volume 2* of this Application. Air quality effects in relation to the operational phase of the Project are also the subject of that assessment report and are summarised in section 9.16 of this AEE.

The existing air quality environment, identification of highly sensitive receivers (HSRs) in proximity to the Project area, and potential construction air quality effects at specific locations are described in detail in the *Air Quality Assessment*. Whilst undertaking this assessment, reference has been made to the Ministry for the Environment *Good Practice Guide for Assessing and Managing Dust 2016* (MfE Dust Guide) and the *Transport Agency Assessment Guide to assessing air quality impacts*

from State highway projects (2015) (Transport Agency Air Quality Assessment Guide). Based on the guidance, the *Air Quality Assessment* outlines the potential air quality effects arising from the construction of the Project. This section of the AEE presents the findings of that assessment, namely the potential effects on air quality associated with the construction of the Project.

9.9.2. Existing air quality environment

Background ambient air contaminant concentrations for the Project area are low given the rural nature of the area.

The Project area environment is characterised by:

- Hilly terrain requiring a series of cuts and fills for road construction;
- Prevailing winds from the west to south-west sector, with winds above 5 m/s likely around 30% of the time; and strong winds are predominant from that direction; and
- Strong winds over 10 m/s which are likely to be infrequent at around 2.5% of the time.

9.9.3. Construction air quality assessment methodology

Overview

Construction dust effects were assessed by considering the separation distance of the construction areas and potential access roads to HSRs, and the nature and extent of the construction activities. Potential air quality effects from construction access roads were assessed by evaluating trackout dust from construction areas and dust suspension from unsealed roads.

Highly sensitive receivers (HSRs)

The Transport Agency Air Quality Assessment Guide defines a HSR as a location where people or surroundings may be particularly sensitive to the effects of air pollution. For the Project, HSRs identified are dwellings.

Proximity of HSRs to the Project is a determining factor when assessing construction dust effects. HSRs for the assessment of construction air quality effects were identified based on the following criteria:

- HSRs located 200 m from the proposed designation boundary;
- HSRs within 50 m of sealed access roads, up to 500 m from the proposed designation boundary; or
- HSRs within 100 m of unsealed local roads used for access outside of the proposed designation boundary.

One HSR is located within the proposed designation boundary (located above the proposed tunnels). It is assumed that this HSR can remain occupied during the construction of the Project. All other HSRs located within the Project area were considered to be unoccupied at the time of construction, and therefore were excluded from the assessment. Table 9-19 outlines the number and proximity of HSRs to the proposed designation boundary and Indicative Alignment for the South, Central and North sections of the Project.

Table 9-19: HSRs near the Indicative Alignment proposed designation boundary

Section	Number of HSRs within 200 m of proposed designation boundary	Approx. distance of nearest HSR to proposed designation boundary (m)	Distance of nearest HSR (outside of the proposed designation boundary) to Indicative Alignment road edge (m)
South	20	5	40
Central	2	1	112
North	41	8	11
Total	63[75]		

The transport of dust and dirt from the Project construction activities on the public road network, where it may be deposited and re-suspended by vehicles using the network, is referred to as trackout. Construction dust originating from trackout is relevant for HSRs located within 50 m of sealed roads, up to 500 m from the proposed designation boundary[76]. Dust from unsealed roads are relevant for HSRs located within 100 m of the entire length of unsealed road. The specific roads and number of HSRs potentially impacted by dust from trackout and vehicle movements along sealed and unsealed roads are summarised in Table 9-20. There are seven HSRs within 50 m of the sections of sealed access roads with potential to have elevated dust from construction trackout, with the nearest HSR being 20 m from SH1, North of Maeneene Road. There are two HSRs within 100m of unsealed roads being used for construction site access, with the nearest being 42 m at Silver Hill Road.

Table 9-20: HSRs with potential for dust effects from access roads

Construction dust trackout from sealed access roads, up to 500 m from proposed designation boundary edge			
Road	**Section**	**Number of HSRs within 50 m**	**Distance of nearest HSR to access road (m)**
Kaipara Flats Road – Carran Road to SH1	South	2	37
Carran Road	South	0	200+
Woodcocks Road	South	1	45
SH1, south of Hōteo Bridge, to Warkworth	Central/South	1	30
SH1, north of Maeneene Road	North	2	20
Mangawhai Road	North	1	50

[75] This excludes the one HSR located within the proposed designation boundary also assessed.
[76] *Institute of Air Quality Management Guidance on the assessment of dust from demolition and construction (2014)*

Whangaripo Valley Road	North	0	98
Wayby Valley Road	North	0	200+
Dust from unsealed access roads			
Road	**Section**	**Number of HSRs within 100 m**	**Distance of nearest HSR to access road (m)**
Lower Silver Hill Road	North	0	-
Silver Hill Road	North	2	42
Farmers Lime Road	North	0	-

In summary, the following have been identified as being potentially affected by dust associated with the Project:

- 64 residential properties within 200 m of the proposed designation boundary. This is made up of:
  - 63 residential properties within 200 m of the proposed designation boundary, and
  - one residential property within the proposed designation boundary.
- An additional nine residential properties outside of the proposed designation boundary. This is made up of:
  - seven residential properties within 50 m of sealed access roads up to 500 m from the proposed designation boundary (for construction dust trackout assessment purposes); and
  - two residential properties within 100 m of unsealed access roads.

Assessment methodology

Dust is the primary contaminant of concern for the construction phase of the Project. The assessment of construction effects on air quality was based on a qualitative assessment and "Frequency, Intensity, Duration, Offensiveness and Location" (FIDOL) factors, see Table 9-21.

Table 9-21: Description of FIDOL Factors

Frequency	How often an individual is exposed to the dust
Intensity	The concentration of the dust
Duration	The length of exposure
Offensiveness/character	The type of dust
Location	The type of land use and nature of human activities in the vicinity of the dust source

For construction dust, the relevant assessment criterion in line with the MfE Dust Guide 2016 and Standard E14.6.1.1 of the AUP(OP) aims for no adverse effects on health or dust nuisance predicted beyond the site boundary i.e. no noxious, dangerous, offensive or objectionable dust or odour from dust deposition. Construction dust effects are influenced by the location and separation distance

between the construction activities and HSRs around the Project, and the nature and extent of the construction activities.

Sensitivity assessment

The assessment considered the location of construction activities within the proposed designation boundary, allowing for the possibility of the alignment being constructed anywhere within the proposed designation boundary. However, it is noted that it is unlikely construction works will occur immediately adjacent to the proposed designation boundary for the entire length of the Project and therefore the approach adopted is conservative.

9.9.4. Assessment of construction air quality effects

The potential effects of dust from construction are dependent on multiple variables including wind direction and strength, rainfall, the distance from the earthworks activity to potentially affected properties, the size and scale of earthworks and other activities, the number of vehicle movements and the nature of the surface material, including moisture content.

The construction phase of the Project has the potential to generate dust, particularly from earthworks, topsoil removal and spread, cut and fill operations and other activities in road construction such as blasting, rock crushing and trackout to access roads (construction traffic on sealed and unsealed roads) from construction areas. These activities have been assumed to be able to be located anywhere within the proposed designation boundary with the exception of the mobile crushing plant which has been assessed based on where the activity will be reasonably expected to be located (see below).

Dust will be generated as a result of vehicle movements and wind on exposed or unsealed surfaces. The cut volumes for the Project have been estimated at approximately 1.9 million m^3 in the South section, 6 million m^3 in the Central section, and 4.5 million m^3 in the North section. Haulage by heavy vehicles will largely be determined by cut/fill balances. Current estimates show a shortfall of fill in the South section, an excess of material in the Central section and a cut/fill balance in the North section. Therefore, construction dust may be generated through vehicle movements, transporting of material between the Central and South sections, and from nearby quarry sources along roads and through the importing of other materials such as those required for pavements. The construction routes are described in more detail in section 9.7 in this AEE.

Other discharges to air include emissions from vehicle and equipment exhausts. However, these were not specifically assessed as the associated effects are considered to be less than those for vehicle travel from the operational phase of the Project.

The primary potential construction air quality effects resulting from the Project are considered to be health effects from exposure to inhalable particular matter, and dust nuisance. The Project area is located in a rural location, and therefore dwellings are assumed to rely on roof water collection for their water supply. Dust deposition on roofs of dwellings has the potential to cause increased suspended solids in the water

supply, although it is noted that this is more of an aesthetic issue than a health concern.

Rock crushing activities have the potential for adverse dust effects, however, this is largely dependent on the moisture content of the materials being crushed and the amount of fine particulate matter present. The mobile crushing plant could be operated at locations where excavated materials require crushing in order to be used as fill. Consequently, areas of the Project where the mobile crushing plant could be located have been identified as:

- South section: anywhere in cut areas between the southern portal of the tunnel and Bridge 22 as Pakiri Formation rock will be encountered in these cuts.
- Central section: anywhere in cut areas as Pakiri Formation rock will be encountered in all cuts.
- North section: anywhere in cut areas as several cuts are in limestone and other cuts may have bands of stronger mudstone.

Effects on HSRs

All HSRs are susceptible to dust effects from construction. However, those located more than 50 m from construction areas are less likely to be impacted by dust deposition given the likely mitigation measures in place following industry good practice. Properties located more than 200 m from the proposed designation boundary will likely experience less than minor impacts, even without mitigation measures for dust management in place.

The effects from construction dust will be greatest immediately downwind of earthwork activities or exposed surfaces, when conditions are dry and there are strong winds. In the South section there are four properties located within 50 m of the proposed designation boundary. The HSRs identified as being nearby (i.e. within 50 m) and downwind of potential dust producing activities are residential properties 74 Wyllie Road, 130, 131 and 211 Kaipara Flats Road.

In the Central section there is one residential property located within 20 m of the proposed designation boundary. This residence is located at 145 Kraack Road and is relatively far from the likely location of the majority of dust producing construction activities within the proposed designation boundary. Dust effects to this property will have a no more than minor effect.

In the North section there are ten residential properties located within 50 m of potential dust producing activities, with six of these being closer than 20 m. Of these properties, 177 Rustybrook Road, 47 Borrows Road, 35 Vipond Road, 704 SH-1, Wellsford, 542 SH-1, Topuni, 490 SH-1, Wellsford, 139 Vipond Road, 129 Vipond Road, 17 Maeneene Road and 33 Maeneene Road are identified as being both within 50 m and located downwind of the prevailing wind in-line with potential dust producing activities.

There is potential dust from trackout activities and for construction traffic on unsealed access roads to adversely affect specific dwellings and as such mitigation is recommended.

The HSRs within 200 m of potential rock borrow and mobile rock crushing operations are as follows:

- South section: there are eleven HSRs within 200 m and one HSR within 50 m of the proposed cut/fill areas where a mobile rock crusher has potential to be used.
- Central section: there are no HSRs within 200 m of the proposed cut/fill areas where a mobile rock crusher has potential to be used.
- North section: there are 25 HSRs within 200 m and three HSRs within 50 m and two HSRs within 20m of the proposed cut/fill areas where a mobile rock crusher has potential to be used.

There is potential that these properties will be impacted by construction dust associated with potential mobile rock crushing operations. However, these potential impacts can be effectively managed through the implementation of mitigation measures and through following good industry practice as outlined in section 9.9.5 below.

Based on the potential number of HSRs that may be affected by construction dust, the effects of construction on air quality is assessed as being potentially significant and mitigation is recommended.

Effects on electricity transmission lines

There is one existing transmission line located within the Project area which is a 110 kV Line owned and operated by Transpower. The Indicative Alignment is proposed to cross beneath this transmission line in the vicinity of the Te Hana interchange. Construction dust has the potential to cause a line to flashover/fault from dust deposition if dust mitigation measures are inadequate. 'Flashover' is the term used to describe a momentary, but major electric arc; a flashover or contact with the electricity transmission lines, may result in an outage of electricity supply to communities, people and industry[77]. Effects on transmission lines will be managed through the implementation of dust mitigation measures and through consultation with Transpower as outlined below.

9.9.5. Measures to avoid, remedy or mitigate actual or potential adverse effects

It is recommended that a comprehensive Construction Air Quality Management Plan (CAQMP) be developed for the Project once the construction activities and associated areas are at the detailed design stage. The full list of likely mitigation measures is outlined in the *Air Quality Assessment*, and includes measures such as:

- Sealing of access roads near HSRs (where dwellings are located closer than 50 m);
- Maintenance of construction areas, haul roads and site accesses with an appropriate base material;
- Watering/dampening and covering as necessary for truck loads, haul roads, stockpiles or other exposed surfaces;
- Limiting of vehicle speeds;

[77] Ministry for the Environment (2010) *National Policy Statement of Electricity Transmission: further guidance on risks of development near high-voltage transmission lines* publication. Relevant text *The Problems with Development near High-voltage Transmission Lines* available at: http://www.mfe.govt.nz/publications/rma/national-policy-statement-electricity-transmission-further-guidance-risks

- Staging of earthworks as much as practicable to limit the exposed surface area at any one time;
- Limiting earthworks activities in close proximity to HSRs during windy conditions;
- Installation of wind fencing where appropriate; and
- Revegetating of exposed surfaces where practicable.

In addition to the management and mitigation of construction dust effects, the CAQMP will identify procedures for implementing site dust controls, including identifying responsibilities for monitoring, as follows:

- What has to be done and why;
- Who has to do it and/or see that it is done;
- How it will be done;
- The desired outcomes;
- How these outcomes will be monitored; and
- Procedures for acting on any issues identified.

In the event of an exceptional weather event where the controls fail, additional mitigation of adverse effects from dust deposition onto neighbouring properties should include consideration of the need for external house cleaning services and supply of drinking water for residences in the event that drinking water supplies are affected.

Specific mitigation measures are proposed to be adopted to minimise dust in areas where HSRs are located within 50 m and downwind of earthworks activities. The measures to be implemented will be adaptively managed in response to the level and cause of effect and taken from the full list in section 6.1.1 of the *Air Quality Assessment*. Properties requiring this adaptive and specific mitigation are:

- 74 Wyllie Road;
- 211 Kaipara Flats Road;
- 177 Rustybrook Road;
- 47 Borrows Road;
- 490 and 704 SH-1, Wellsford;
- 542 SH-1, Topuni;
- 17 and 33 Maeneene Road;
- 130 and 131 Kaipara Flats Road;
- 127, 145 and 161 Kraack Road; and
- 35, 129 and 139 Vipond Road.

Sealing of some extents of Silver Hill Road and Lower Silver Hill Road is recommended if these roads are confirmed to be used for the construction phase access road network within proximity to PPFs. Provision of vehicle wheel wash facilities for construction vehicles accessing the site off sealed roads should be provided (when departing the construction area), particularly when construction traffic is using:

- Woodcocks Road;
- Kaipara Flats Road;
- SH1, south of Hōteo Bridge;
- Mangawhai Road; and

- SH1, north of Maeneene Road.

Systems for dust suppression will need to be incorporated into the design and management of the crushing plant. These systems could include enclosure of dust sources and extraction to control equipment or water suppression. The *Air Quality Assessment* also recommends a minimum 100 m separation distance from HSRs for rock crushing machines.

Monitoring will be undertaken to ensure dust is kept to an acceptable level and that mitigation measures are having the required effect. Three methods are recommended for dust monitoring during the construction phase:

- Visual inspection and record keeping on a daily basis;
- Weather observations; and
- Dust complaint investigation and reporting.

The above recommended mitigation measures are considered to be sufficient to manage the effects on HSRs and the transmission line. However, if additional measures are necessary, these will be developed and implemented in consultation with the residential occupants and Transpower.

Good practice measures for dust control via a CAQMP will be sufficient to avoid significant adverse effects for the majority of the time and the majority of the route. There are, however, many variables, in particular wind direction and strength, sunshine or rainfall, and the management methods that may be applied. In the unlikely event that significant adverse effects occur, the recommended additional measures are considered sufficient to remedy these.

9.9.6. Conclusion

Construction activities will generate dust which has the potential to impact HSRs in close proximity to the construction areas and access roads. Specific activities such as mobile rock crushing operations also have potential to generate high dust levels. To manage construction dust effects, a suite of control measures, monitoring and mitigation controls are recommended to be put in place and implemented throughout construction of the Project.

A CAQMP will outline the requirements for minimising potential for adverse effects associated with dust generation from construction activities. For mobile rock crushing plant, good industry practice for dust control should be applied and in addition a separation distance of a minimum of 100 m from HSRs is recommended. The CAQMP will be developed prior to the commencement of construction and earthwork activities.

Overall, it is considered the recommendations outlined in the *Air Quality Assessment* are industry good practice, and the assessment has concluded that with these mitigation measures in place significant adverse effects on air quality arising from construction of the Project will be avoided. The recommendations include the preparation of a CAQMP including sufficient setback distances for rock crushing operations. It is considered that air quality effects from construction of the Project with the recommended mitigation in place, will be minor.

9.10. Heritage / archaeology

Overview

The Project is located in an area associated with both Māori and early European settlement. Māori history in the area was largely one of transient settlement, with pathways and tracks recorded in traditional histories and other notable events, particularly in the Hōteo River and Te Hana areas. In the Hōteo South area within the Project area, the archaeological and historic heritage sites relate to 19th century European settlement around Phillips and Carran Roads and include four US Military camp sites related to World War II. In the Hōteo North area, no archaeological and historic heritage sites have been identified within the proposed designation, however there is potential for unrecorded Māori sites to be found in this area. There is one site within the Project area which is identified on the AUP(OP) Historic Heritage Overlay and Schedule of Historic Heritage. However, it is outside the proposed designation boundary and will not be affected.

The Indicative Alignment has avoided some known archaeological and historic heritage sites. The Project where possible by early identification of historic heritage values through the design and alternatives assessment stages of the Project and avoidance of the main towns and centres, which have a higher number of sites of heritage significance.

There are nine known archaeological and built heritage sites located within the proposed designation and seven sites will be affected by the Indicative Alignment with two being destroyed, and five being modified or partially modified. These sites have low to moderate significance as they are either demolished, are only subsurface remains or are in a dilapidated state. Two other sites may also be directly affected by the Project should the Indicative Alignment or the design and location of ancillary components be altered. There is also potential for unrecorded archaeological sites to be affected in the Warkworth, Hōteo River and Te Hana areas.

The historic heritage significance of the identified archaeological sites has been evaluated, and none of the affected or potentially affected sites within the Project area are of more than moderate historic heritage significance. Work will be carried out in accordance with an Archaeological Authority and a range of measures have been recommended to mitigate the adverse effects of the Project on historic heritage values, including a Heritage and Archaeological Management Plan (HAMP) to ensure that archaeological issues are managed appropriately to be minor.

9.10.1. Introduction

This section outlines the actual and potential effects associated with the construction and operation of the Project on archaeology and built heritage. It identifies archaeological and historic heritage sites in the vicinity of the Project area and identifies potential effects from a historic heritage perspective.

The *Historic Heritage Assessment* in *Volume 2* of this Application identifies archaeological and built heritage sites within 200 m of the proposed designation boundary, identifies any areas of archaeological sensitivity where unrecorded archaeological sites are likely to be located, describes the archaeological and historic

heritage sites with the potential to be affected by the Project and assesses the potential effects of the Project on historic heritage.

This section does not provide an assessment of potential effects on Māori cultural values. That assessment is contained in Section 9.18 this AEE.

9.10.2. Existing historic heritage and archaeological environment

The assessments undertaken in the preparation of the *Historic Heritage Assessment* involved background research, field surveys and mapping the locations of identified archaeological and historic heritage sites.

The research approach focused on the wider area surrounding the Project (including 200 m beyond the proposed designation boundary), rather than just within the Project area, in accordance with standard heritage assessment procedure. This assessment of effects section only discusses the archaeological and historic heritage sites within the Project area.

The research involved a review of archaeological and heritage databases including New Zealand Archaeological Association (NZAA) site record file (ArchSite), the Heritage New Zealand Pouhere Taonga (HNZPT) New Zealand Heritage List/Rārangi Kōrero archaeological reports, Land Information New Zealand (LINZ) plans, the Auckland Council's Cultural Heritage Inventory (CHI) database and the AUP(OP) Historic Heritage Overlay and Schedule of Historic Heritage, and other relevant plans, and historical research using general and archival sources.

Following the background research, a series of field surveys were undertaken to examine sections of the Project area considered to have archaeological potential based on the known distribution of archaeological and historic heritage sites and topographic analysis, and to visit recorded archaeological and historic heritage sites. This field survey included examining the ground surface for evidence of former occupation (in the form of middens, depressions, terracing or other unusual formations within the landscape, or indications of 19th century or early 20th century European settlement or other remains). This examination included an inspection of exposed and disturbed soils, where encountered, for evidence of earlier modification and to gain an understanding of the local stratigraphy.

Subsurface probing and test pitting with a spade at points across the Project area was undertaken as part of the *Historic Heritage Assessment* to determine archaeological potential. New or updated site record forms relevant to the Project were prepared and filed in the New Zealand Archaeological Association (NZAA) database.

Twelve known archaeological and/or historic heritage sites have been identified within the Project area, nine of these are located within the proposed designation[78], and seven of these are crossed by the Indicative Alignment (refer Table 9-22 below). These sites are all within the Hōteo South area and relate to 19th century European settlement around Phillips and Carran Roads and four 20th century United States military camp sites related to World War II.

[78] NB Whitson's house and stockyard are two sites on the same archaeological reference as shown in Figure 9-5

The nine sites within the proposed designation are listed in Table 9-22, whilst Figure 9-5 and Figure 9-6 show sites within the proposed designation and within proximity to it.

In the Hōteo North area there are no archaeological or historic heritage sites within the Project area. However, given the watercourses in the Te Hana area provide a direct link to the Kaipara Harbour, there is potential for unrecorded Māori sites to be found in this area, where the proposed designation crosses the hills to the east of Te Hana and at Maeneene Road where the land surrounding the stream holds potential for sites.

Table 9-22: List of recorded archaeological and historic heritage sites within the proposed designation

CHI No.	NZAA No.	Site type	Site Name	Category	Condition	Significance	Intercepts Indicative Alignment?
16996	N/A	US Military Camp	Dome Camp M6	Historic Structure	Demolished but subsurface remains	Low/Moderate	Yes
17005	N/A	US Military Camp	Carran Road Camp H2	Historic Structure	Demolished but subsurface remains	Low/Moderate	Yes
17006	N/A	US Military Camp	Wyllies Road Camp E	Historic Structure	Demolished but subsurface remains and impacted by P2Wk	Low/Moderate	Yes
17007	N/A	US Military Camp	Wyllies Road Camp F and G	Historic Structure	Demolished but subsurface remains and impacted by P2Wk	Low/Moderate	Yes
N/A	R09/2064	Historic Building	Woodthorpe	Historic Structure/ Archaeological Site	Extant poor condition	Moderate	Yes
N/A	R09/2224	Site of Building and structure	Whitson's House and Stockyard	Archaeological Site	Demolished. Potential for archaeological remains	Low/Moderate	Yes
N/A	R09/2226	Site of Building	Dome Valley Teacher's Residence	Archaeological Site	Unknown. Potential for archaeological remains	Moderate	Yes
N/A	R09/2225	Site of Building	Dome Valley School	Archaeological Site	Structure removed and built over. Potential for archaeological remains	Moderate	No
19027	R09/2063	Historic Building	Site of Phillips Cottage	Archaeological Site	Extant good condition	Low/Moderate	No

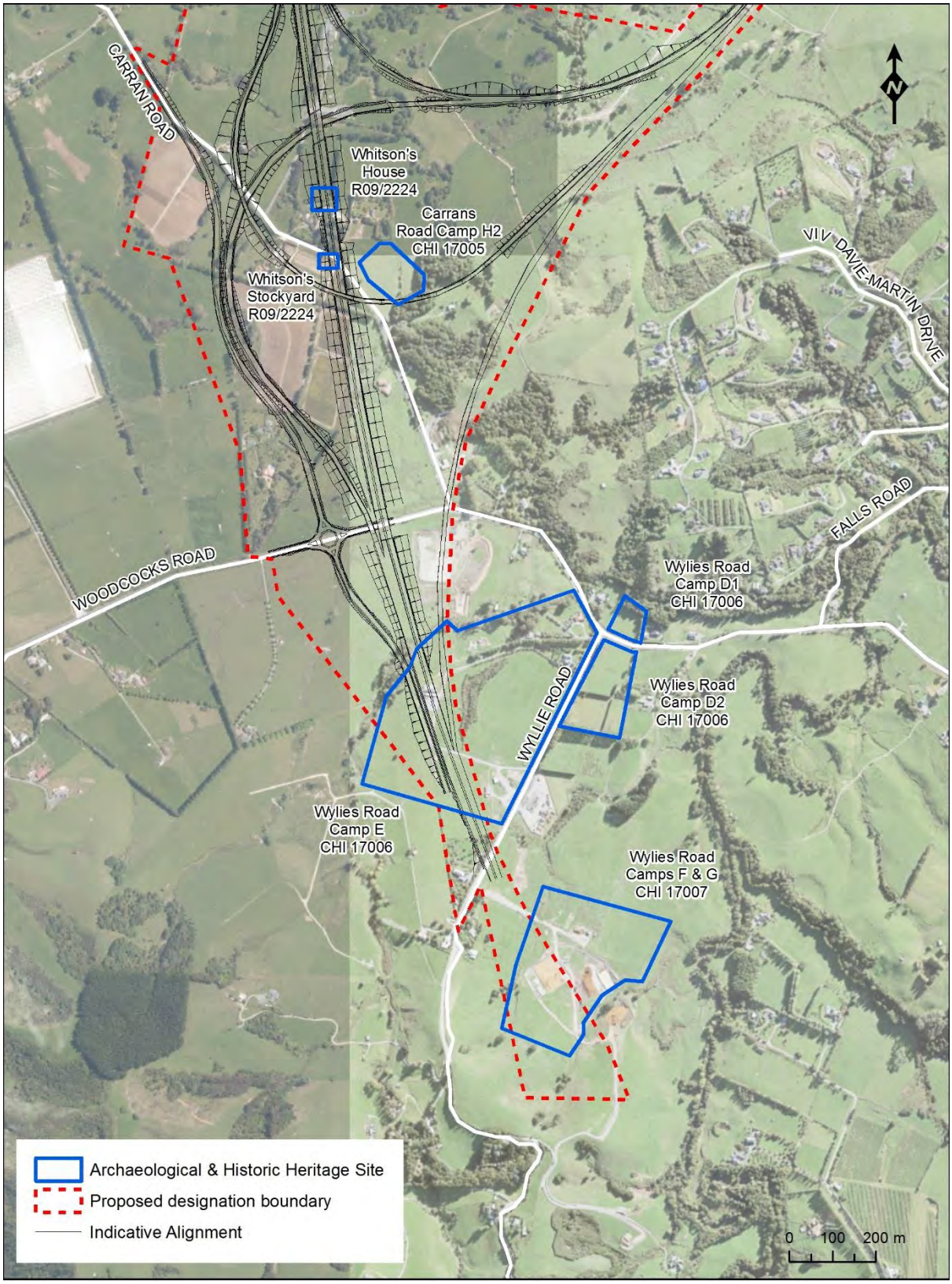

Figure 9-5: Location of archaeological and historic heritage sites within the Project area at Carran, Woodcocks and Wyllie Roads

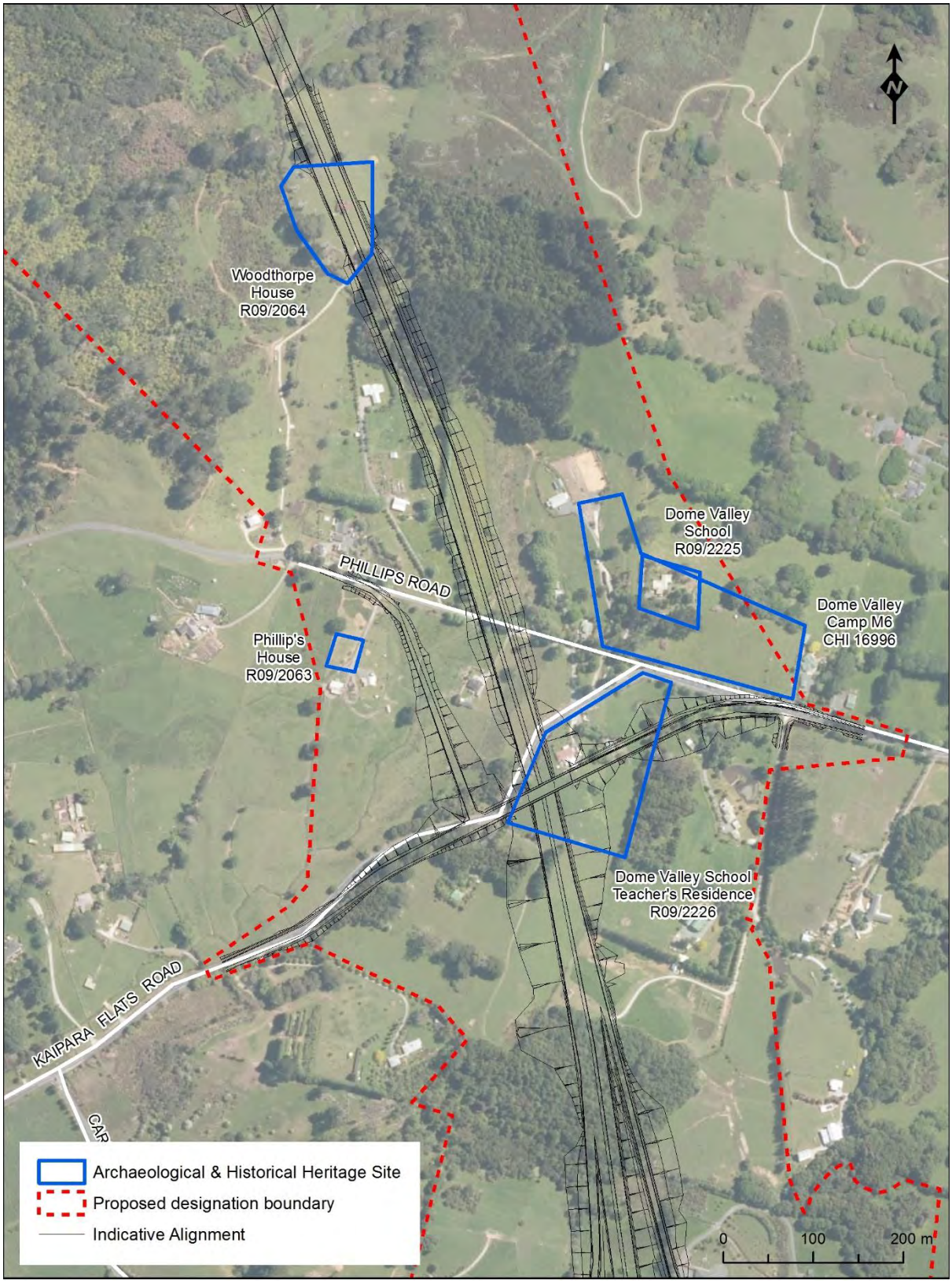

Figure 9-6: Location of archaeological and historic heritage sites within the Project area at Phillips Road

9.10.3. Assessment of effects on archaeological sites and built heritage

Heritage significance

There is one site located within the Project area which is identified in the AUP(OP) Historic Heritage Overlay and Schedule of Historic Heritage within the Project area. However, it is outside of the proposed designation and will not be affected. The evaluation of the historic heritage significance of the identified archaeological sites located within the Project area has been undertaken with reference to the AUP(OP) criteria. The evaluation did not identify any sites of high significance within the Project area.

Woodthorpe House (R09/2064) has moderate significance, but the building is in a poor state of repair, and beyond the scope of restoration/conservation works.

The Dome Valley School site R09/2225 and the Dome Valley School Teacher's residence site R09/2226 have moderate significance but at this time cannot be accessed to confirm their significance.

Whitson's House and Stockyards (R09/2224) has low/moderate significance.

The site of Phillips Cottage (R09/2063; CHI 19027) had low/moderate significance, but the house was relocated in 2011 so no longer has any significance. The site still retains low/moderate significance.

The military camps in the Hōteo South area are of some historical significance but have low physical heritage value. They are part of a wider group of military encampments in the Warkworth area, but with few visible remains they have no significant heritage landscape value. The two Wyllie Road camps are affected by construction works for P2Wk.

Heritage and archaeological effects

Potential adverse effects on known archaeological and historic heritage sites will be confined to the Hōteo South area, where all nine of the historic heritage and archaeological sites recorded in the proposed designation boundary are located. The Indicative Alignment will directly adversely affect seven of the nine heritage sites and may affect the remaining two sites should the Indicative Alignment or the design and location of ancillary components be altered. The sites will be affected as follows:

- R09/2064 Woodthorpe House: the house and surrounds will be destroyed.
- R09/2224 Whitson's House and Stockyards: any surviving subsurface remains will be destroyed.
- R09/2226 Dome Valley Teacher's Residence: any above ground structural remains and subsurface remains will be destroyed where they are under the Indicative Alignment or potentially modified where they are outside the Indicative Alignment.
- Dome Valley Military Camp M6, CHI16996: will be partially modified due to most of the site being within the Project area and a small area in the south east being adjacent to the Indicative Alignment relating to the Phillips Road re-alignment.
- Carran Road Military Camp H2, CHI 17005: will be partially modified due to parts of the site being within and adjoining the Indicative Alignment.
- Wyllie Road Camp E, CHI 17006: will be partially modified where the site is under the Indicative Alignment (already affected by P2Wk construction works).

- Wyllie Rd Camp F and G, CHI 17007: will be partially modified where the site is under the Indicative Alignment (already affected by P2Wk construction works).

The two sites that may be affected by the Project should the Indicative Alignment or the design and location of ancillary components be altered are:

- R09/2225 Dome Valley School: possible adverse effects on any buildings/structural remains, through a change in use of the structures (as a result of potential relocation).
- R09/2063 Site of Phillip's House – possible adverse effects through change in land use (currently a paddock on a residential lifestyle block, noting this could change as a result of the Project to a yard, parking area or other uses).

There is potential for unrecorded sites to be affected in the Warkworth, Hōteo River and Te Hana areas and for effects on unidentified subsurface archaeological remains exposed during construction.

Potential effects on unrecorded archaeological sites

In any area where archaeological sites have been recorded in the general vicinity it is possible that unrecorded subsurface remains may be exposed during earthworks. If not managed appropriately, earthworks can destroy such sites without investigation and recording taking place.

The *Historic Heritage Assessment* has concluded that there is little potential for unrecorded archaeological remains over most of the central part of the Project area (through the Dome Valley). The key areas with historic heritage potential are the Warkworth area up to the pine plantations north of Phillips Road, the Hōteo River area, the hill range to the east of Te Hana, and the Maeneene Road area.

9.10.4. Measures to avoid, remedy or mitigate actual or potential adverse effects

The *Historic Heritage Assessment* proposes various measures to manage and mitigate the actual or potential effects of the Project on archaeological and other historic heritage values and concluded that effects on recorded and unrecorded archaeological sites should be mitigated by detailed investigation and recording to recover information that will contribute to knowledge of the history of the Project area.

Where historic heritage or archaeological sites cannot be avoided by the Project, the appropriate for of mitigation is minimising adverse effects on heritage and archaeological sites. Where practicable, archaeological investigation and recording of any affected pre-1900 heritage and archaeological sites and post-1900 heritage sites within the designation should be undertaken in order to obtain information which will contribute to our knowledge of the history and archaeology of the area. Modification of pre-1900 archaeological sites and any investigations will require an Archaeological Authority under the HNZPTA.

The Project has the potential to affect unidentified subsurface archaeological remains during earthworks. All earthworks or other activities involving soil disturbance in the general vicinity of recorded archaeological sites, United States military camps, the surrounds of heritage buildings and in the identified areas of archaeological potential

should be monitored by an archaeologist to establish whether subsurface archaeological remains are present and to record any remains.

An Accidental Discovery Protocol (ADP) consistent with The Transport Agency Minimum Standard P45 – Accidental Archaeological Discovery Specification or subsequent version will be prepared in consultation with mana whenua for any accidental archaeological discoveries which occur during Project works and modified as necessary to reflect the site specific Project detail.

A HAMP will be prepared by a Suitably Qualified Person (e.g. an archaeologist) in consultation with HNZPT and Council. The purpose of the HAMP will be to manage and mitigate potential adverse effects on heritage and archaeological sites. The HAMP will identify:

- Known historic heritage and archaeological sites within the proposed designation boundary;
- The pre-1900 archaeological sites which will be covered by an Archaeological Authority under the HNZPTA;
- Roles, responsibilities and contact details of Project personnel, Mana Whenua representatives, and relevant agencies involved with heritage and archaeological matters including surveys, monitoring of construction works and monitoring of conditions;
- Specific areas to be investigated, monitored and recorded to the extent these areas will be affected by Project works; and provide the proposed methodology for assessment, monitoring and documentation, including, but not limited to the following areas:
  i. Recorded archaeological sites;
  ii. Identified areas of archaeological potential in Warkworth, Hōteo and Te Hana, including Maeneene Stream; and
  iii. WWII US military camps.
- Methods for protecting or minimising adverse effects on heritage and archaeological sites within the designation during Project works where practicable (for example the fencing off of heritage and archaeological sites to protect them from damage during construction);
- Training requirements for contractors and subcontractors on heritage and archaeological sites within the designation, legal requirements relating to accidental discoveries, and ADP's. The training should be undertaken under the guidance of a Suitably Qualified Person and Mana Whenua representatives, and should include a pre-construction briefing to contractors; and
- For heritage buildings to be demolished or relocated, a methodology for investigating and recording heritage buildings, their condition, measures to mitigate any adverse effects and timeframe for implementing the preferred methodology, in accordance with HNZPT Guideline *AGS 1A: Investigation and Recording of Buildings and Standing Structures dated 4 July 2014* (or any subsequent revision).

9.10.5. Conclusion

There are twelve known archaeological and historic heritage sites within the Project area. Nine of those are located within the proposed designation, and of those, seven are within the Indicative Alignment. Two further sites in the Hōteo South Sector may be affected by the Project should the Indicative Alignment or the design and location

of ancillary components be altered. There is also potential for unrecorded archaeological sites to be located in the Warkworth, Hōteo River and Te Hana areas.

None of the affected or potentially affected sites within the Project area have a high historic heritage significance. A range of measures to mitigate the adverse effects of the Project on historic heritage values, including a HAMP to ensure that archaeological issues are managed appropriately during the construction phase are recommended to be adopted.

The mitigation measures recommended above are considered appropriate, and as concluded in the *Historic Heritage Assessment*, it is considered that the adverse effects of the Project on archaeological and historic heritage values will be minor in view of the limited number of heritage sites affected, and the low to moderate heritage significance of the affected sites. While there is potential for new sites to be uncovered during construction, it is considered that the effects on potential sites can be managed with adoption of the recommended mitigation measures, and within the provisions of the HNZPTA.

9.11. Land contamination

Overview

There are a number of properties within and surrounding the Project area that are, have previously been or may have been subject to land uses listed on the Ministry for the Environment's (MfE) Hazardous Activities and Industries List (HAIL).

The actual and potential adverse environmental effects posed by soil contamination relate to the level of contamination present and the construction activities proposed which result in land disturbance of contaminated sites. An interim Preliminary Site Investigation (PSI) has been undertaken which identifies existing areas of known and potentially contaminated land within the Project area and outlines the typical contaminants likely to be present.

Additional contamination investigations prior to any soil disturbance are recommended to determine the actual levels of contamination within the Project area. On completion of that more comprehensive investigation and when the detailed design is known, appropriate consents will be sought if necessary.

Overall, based on a preliminary PSI, the effects related to contaminated land are able to be managed and are assessed as minor. This will be confirmed prior to construction.

9.11.1. Introduction

This section provides a preliminary assessment of the actual and potential effects arising from disturbance of contaminated land associated with the construction and maintenance of the Project.This section is based on the findings of an interim PSI and Land Contamination Assessment given access to properties was limited.

This section identifies existing areas of known and potentially contaminated land within the Project area and outlines the typical contaminants likely to be present informing a qualitative risk assessment of effects of contamination.

Given that the assessment is based on an Indicative Alignment, and detailed design is yet to be undertaken, works on or in proximity to potentially contaminated sites will be identified, assessed and managed through updating the interim PSI to reflect the final alignment and include the results of future site walkover inspections, information obtained from landowners and geotechnical investigations. The Transport Agency will apply for any consent under the NES Soil and AUP(OP) if required prior to construction commencing. No consents relating to contaminated land disturbance or discharges are sought as part of this Application.

9.11.2. Existing areas of known and potentially contaminated land

To identify known and potentially contaminated sites, an interim PSI was conducted within the Project area in accordance with the Ministry for the Environment's "Contaminated Land Management Guidelines No.1, Reporting on Contaminated Sites in NZ (Revised 2011)" and the NES Soil.

The Project is located in a predominantly pastoral farming and forestry environment. These two land uses have been present for the past 50 plus years based on a review of historical aerial photographs.

The HAIL is produced by MfE and is a compilation of activities and industries that have the potential to cause land contamination resulting from hazardous substance use, storage or disposal. Land used for pasture and forestry is not identified on the HAIL and, therefore, no widespread areas of contaminated land are anticipated. However, there is the potential for discrete HAIL sites in rural and forestry land. Examples of discrete rural HAIL sites include sheep dips, farm dumps and small timber treatment sites. The interim PSI concludes that it is unlikely that discrete HAIL sites are present on every rural property or within every forestry block.

Known and potentially contaminated sites were identified using a combination of the following:

a) A review of historical aerial photographs into land uses or activities that had the potential to cause ground contamination within or adjacent to the proposed designation; and

b) A search of the Council Contaminated Sites Register/information held on file.

A PSI typically includes a site walk-over inspection to assess if a HAIL activity occurs or has occurred at a property. However, access was not available to all of the privately wned land. Therefore, site walk-over inspections were not undertaken.

For the purposes of ranking the risk profile of the potentially contaminated sites identified through the PSI process, a qualitative risk assessment process was adopted, which assesses probability and consequence of contaminants being present. In accordance with the NES Soil the interim PSI utilised the “more likely than not” test which helps inform whether the activity is more likely than not to have occurred. This test identifies sites with greater than 50% chance of soil contamination being present. The qualitative risk assessment classifies sites into three relative levels of risk: low, moderate and high.

48 properties within the Project area have had or currently have actual or potential HAIL activities on them. Of these properties, 37 are categorised as having a low risk of ground contamination and 11 properties as having a moderate risk. There are no properties with a high risk of ground contamination. The low risk ranked properties are those with typically agricultural activities which may have led to relatively low levels of contamination of the land. Table 9-23 identifies the 11 potentially contaminated pieces of land within the Project area with a moderate risk ranking from the interim PSI.

Table 9-23: Potentially contaminated properties identified as having a moderate risk ranking

Address	Comments
156 Kaipara Flats Road	Farm dumps containing "old treated timber posts".
173 Carran Road	Vehicle workshop (Gary Barber Auto Services), hydrocarbon and chemical storage likely
1207 SH1 Wayby Valley	Stock yards or possible timber storage and outbuildings
199 Rustybrook Road	Commercial (2008 -2010) car dump site Outbuildings predate 1953
200 Rustybrook Road	Scrap metal (2008-2010) Outbuildings predate 1953
37 Borrows Road	Quarrying activities and outbuildings Wintering barn discharge Dairy washwater discharge
50 Farmers Lime Road	Cluster of outbuildings, ground disturbance
200 m north of Worthington Road and Farmers Lime Road	Pump station for First Gas Ltd, formerly Vector Gas Anticipate fuel tanks present on site
18 Hindle Road (various properties)	Stock yards in corner of Farmers Lime Road and Worthington Road. Outbuildings, quarry Dairy discharge
Hindle Road (approx. 500 m North of Farmers Lime Road)	Commercial shed
200 Mangawhai Road	Outbuildings, quarry

9.11.3. Assessment of effects from contaminated land disturbance

The disturbance of and discharges from contaminated land can impact:

- Human health, including site workers and/or the public from the discharge of contaminants (as a matter covered by the NES Soil); and
- The environment from the disturbance of contaminants and associated discharge of contaminants to air, land and water (surface and groundwater).

The potential contaminants of concern that may be associated with the moderate risk ranked properties are:

a) Arsenic, lead, copper, mercury – associated with wood treatment, bulk storage of treated timber, scrap yards and motor vehicle workshops;

b) Organochlorine and organophosphate pesticides – associated with wood treatment, bulk storage of treated timber;

c) Herbicides, fungicides– associated with wood treatment, bulk storage of treated timber;

d) Carbamates, and synthetic pyrethroids – associated with sheep dips or spray race operations;

e) Asbestos – associated with buildings constructed pre 1990's; and

f) Hydrocarbons – associated with wood treatment, bulk storage of treated timber, fuel storage, scrap yards and motor vehicle workshops.

Effects on human health

The potential effects posed by soil contamination as a result of historic activities relate to the level of residual contamination present and the construction activities proposed which result in land disturbance of the sites identified as having the potential to be contaminated.

Given the construction works will be over approximately 7 years the potential exposure duration for the Project is likely to be a few weeks at most. The actual risk to construction workers is therefore likely to be minimal. Worker exposure to contaminated soils would only occur at the sites where contaminated soils occur. The opportunity for residents to be exposed to soil contamination during construction is very limited. Therefore, the risk to human health is considered to be minimal.

Effects on the environment

The risk of actual or potential contaminated land to the environment will be minor for the following reasons:

a) The potential contaminants of concern are generally not very mobile within the soil environment as metals tend to bind to the mineral/clay fraction of the soil and pesticides will tend to bind to the organic fraction of the soil;

b) A portion of these contaminants will not be bioavailable (available for organism uptake);

c) The potential for groundwater contamination is low as there are no high risk sites, and the medium risk sites are not located near known groundwater abstraction bores and existing and potentially future groundwater takes are from deep bores, with limited yield for shallow abstraction;

d) If future DSIs encounter elevated levels of contaminants, these will be managed through the contaminated land consenting process, including through using a Contamination Land Management Plan (CLMP); and

e) Unforeseen ground contamination that may be discovered during future Project earthworks will be appropriately and safely managed using a CLMP.

9.11.4. Conclusion

An interim PSI has identified 48 properties within the Project area that are, have previously been or may have been subject to land uses listed on the HAIL and are subject to the requirements of the NES Soil. The majority of the properties in the Project area are likely to have a low risk of contamination. There are 11 sites within the Project area which are classified as having a moderate risk of contamination. The interim PSI will be updated once the Transport Agency takes ownership of the properties within the proposed designation and the detailed design is completed. Any consents required under the AUP(OP) and/or NES Soil will be submitted prior to construction commencing. Overall, the effects are assessed as likely to be minor, but this will be confirmed prior to construction.

9.12. Operational water assessment

Overview

The design of the Project's operational drainage and stormwater management systems will be in accordance with best practice guidelines.

The Project has the potential for the following effects:

- Reduction in water quality arising from stormwater discharges generated from the mainline alignment and local roads (contaminants and sediment) and spill events;
- Impacts on Watercare's surface water take as a result of reduced water quality in the event of a spill;
- Loss of baseflow, increased stream flow, and channel erosion in streams and impacts on water levels in wetlands arising from changes in hydrology (increased impervious areas and catchment area, and change in drainage patterns); and
- Increased flood risk, reduced flood conveyance and reduced flood storage through changes in flood volume and pathways.

The following approaches for operational water management are proposed to mitigate the potential effects of the Project:

Water quality

- Stormwater quality treatment is proposed for the mainline carriageway surface and rock cuts.
- Stormwater treatment design will be based on GD01 and includes the removal of 75% Total Suspended Solids (TSS) on a long-term average basis, which includes the removal of contaminants associated with sediment such as particulate trace metals, particulate nutrients, oil, grease and bacteria; and;
- Removal of gross litter and floatables such as oil and volatile hydrocarbons by stormwater treatment devices.

Water quantity

- Stormwater collection and conveyance systems to provide a safe road and collect stormwater for treatment;
- Provision of stream diversions either around the Project or through the Project via culverts;
- Provide for the hydrology mitigation requirements of the AUP(OP) by providing detention and controlled release over a 24-hour period for the rainfall generated by the 95 percentile rainfall event on the Project's impervious surfaces.

The proposed stormwater treatment will be effective in reducing contaminant and sediment discharges, with predicted increases in contaminants associated with the Project not expected to result in freshwater quality exceeding guideline values.

The hydrology mitigation requirements and design of the stream diversions, culverts and bridges will mitigate the impacts of the Project on stream and wetland hydrology and flooding.

Overall, the effects associated with operational water management, with mitigation to be incorporated into design of the Project as proposed, are considered to be minor with a moderate level of effects on the hydrology of natural wetlands. The ecological effect of these changes are addressed in the *Ecology Assessment*.

9.12.1. Introduction

This section summarises the findings of the assessment of the actual and potential effects associated with water during the operation of the Project outlined in the *Water Assessment* in Volume 2 of this Application. Water effects in relation to the construction of the Project (also outlined in the *Water Assessment*) are summarised in section 9.2 of this AEE. The *Water Assessment* is supported by a number of technical reports and in referencing the *Water Assessment* here, it is inferred to be the whole suite of reports, and specifically those relating to operational water management[79].

The *Water Assessment* provides an assessment of the environmental effects arising from water during the operation of the Project, including effects of stormwater derived from the Project on the receiving environment as well as the impacts of the Project on the existing hydrological environment.

The *Water Assessment* describes the Project's operational water systems, including the stormwater management devices and modifications to streams and floodplains necessary for the operation of the Project. The approach to operational water management has been to minimise effects by designing mitigation measures into the Project based on a BPO approach. The extent of the mitigation measures discussed in the *Water Assessment Report* is based on consideration of the sensitivity of the receiving environment.

9.12.2. Existing hydrological environment

Catchment description and values

The Project traverses the Mahurangi, Hōteo and Oruawharo river catchments, draining into two coastal waterbodies (Mahurangi Estuary and Kaipara Harbour) as described in section 3 and summarised in section 9.2.

Water quality

Water quality within the Project catchments is discussed in section 9.2. In summary, the water quality in the Mahurangi River and Oruawharo River is generally assessed as good, while the Hōteo is fair to good. All catchments have slightly elevated suspended solid levels, turbidity and phosphorus. Metals are low within all three catchments. During rainfall events, water quality within these environmentsdeclines.

Flooding

Flooding is an issue in the lower Mahurangi catchment. The Council River Flood Hazard Assessment (RFHA) 100 year ARI event floodplain extends into some areas of Warkworth, across farmland and inundates a number of local roads, including Kaipara Flats Road, Carran Road, Woodcocks Road and Goatley Road.

Flooding is also known to be an issue in the Hōteo River catchment. The Council RFHA shows that there is an extensive floodplain to the east of Wellsford, north of the existing SH1, which extends across Wayby Valley Road, farmland and properties within Wayby Valley. Downstream of the Project area the Hōteo River floodplain is generally confined within the river valley, however extends across Hōteo. The

[79] Water Quality technical report, Motorway Runoff technical report, Hydraulic Modelling technical report, Hydrological Assessment technical report and Operational Water Design Report.

Kourawhero Stream floodplain is also extensive and runs along Kaipara Flats Road and impacts on properties including at Streamlands and Kaipara Flats.

Within the Oruawharo catchment, the Council RFHA floodplain is generally confined to the stream valleys in the vicinity of the Project area. For Te Hana Creek the flooding is generally confined to the river channels, however farmland and some properties are located within the RFHA floodplain. Maeneene Creek has an extensive floodplain upstream of the Project area across farmland.

Existing flooding within the Project is shown in Figure 9-7, with high risk flood areas identified as follows:

1. Crossings of Mahurangi River and its tributaries;
2. Crossings of Kourawhero Stream tributary of the Hōteo to the south of the proposed tunnel;
3. Inundation of areas along Wayby Valley Road due to flood water from the Hōteo River.

The figure below shows flooding already occurs at many different locations along the Project area.

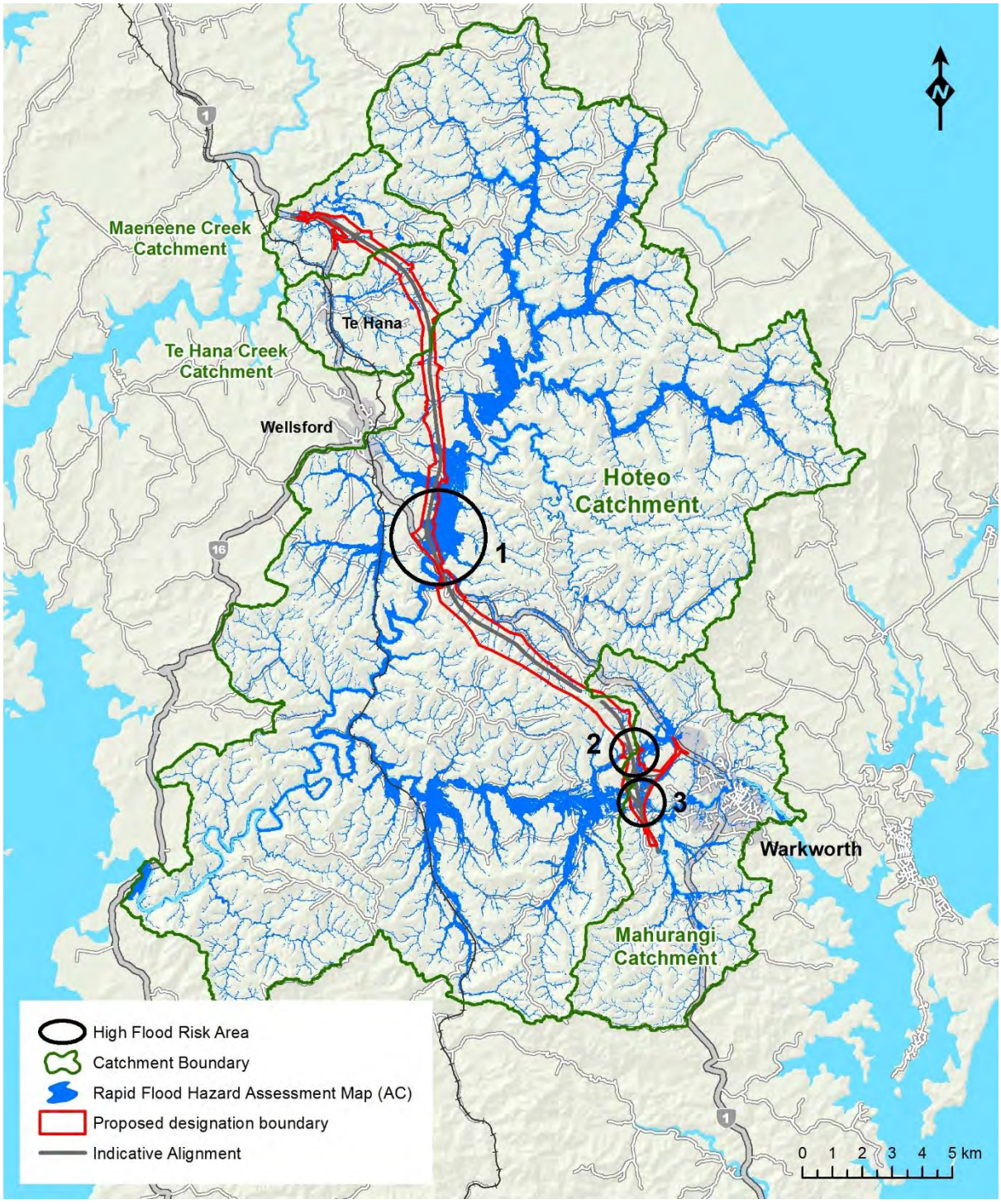

Figure 9-7: 100 year ARI event floodplain extent for the Mahurangi, Hōteo and Oruawharo catchments

Existing consents

The existing consents held for water takes and discharges from and to the Mahurangi and Hōteo Rivers are outlined in section 3.

9.12.3. Operational water assessment methodology

The potential changes to the water environment due to the operation of the Project relate to:

- water quality: these effects include changes to water quality arising from the discharge of stormwater and associated contaminants from the mainline carriageway and effects on stream and marine environmental and potential human impacts;
- hydrology: these effects include changes to stream flow, and changes to stream channel and stream bed morphology; and
- flooding: these effects include changes to flood risk arising from changes to impermeable area, flood conveyance systems (bridges/culverts/stream diversions) and construction activities, permanent works (e.g. embankments) and mitigation planting in floodplains.

Operational water systems

Rainfall onto rock cuts and the mainline carriageway will be collected and conveyed via stormwater treatment devices prior to discharge to streams, which then drain to the estuary and harbours. Rainfall onto local roads will be managed in rock and grass lined swales. Rainfall adjacent areas will be diverted away from cuts and the road carriageways. Rivers and streams, and overland flow paths that intersect the Project alignment will be conveyed via a culvert or crossed by a bridge/viaduct or stream diversions. In some circumstances, the Project fills and soil disposal areas or other elements of the Project will occupy existing floodplains.

A summary of the operational drainage and stormwater management devices proposed for the Project is outlined in section 4 of this AEE.

Methodology to identify changes to water quality

The operational phase of the Project has the potential to result in changes to water quality, these changes may be associated with:

- discharge of contaminants, such as heavy metals, fuels and oils that are generated from vehicles, from the road carriageway;
- discharge of sediment from eroded cut faces along the road carriageway; and
- discharge of gross pollutants (litter) from the road corridor.

Two models were used to assess water quality in the receiving environment during the operational phase, accounting for changes due to the road carriageway runoff, which modelled contaminant loads and contaminant concentrations associated with the Project.

The Contaminant Load Model (CLM) estimates contaminant loads to predict the relative change in contaminant loads on a catchment scale. This information is useful to understand any potential effects on the marine receiving environments.

The CLM model enables the water quality in the existing environment to be compared to water quality guideline values, and for the predicted change in the water quality to also be assessed against those guideline values.

The second model (contaminant concentration method) provides site specific estimates of the predicted change in contaminant concentrations in freshwater due to Project runoff. The model uses 2017 monitoring data for surface water and the average (median) motorway runoff water quality data from existing New Zealand motorways applied on a weighted catchment basis to estimate contaminant concentrations in receiving environments. The water quality in the existing

environment is compared to water quality guideline values, and the predicted change in the water quality is also assessed against those guideline values.

Methodology to identify changes in hydrology

The Project has the potential to cause changes to catchment runoff and changes to catchments boundaries that may result in changes to stream flow, and changes to stream channel and stream bed morphology. These changes may arise from the Project due to:

- alteration of catchment areas as a result of the introduction of the road with high and low points, road embankments, culverts, stream diversions and cut-off drains;
- alteration of flow pathways and altered runoff regime (drainage features, impermeable area and slope change); and
- changes to stream channel and stream bed morphology due to stream diversions, culverts, bridges and other instream structures.

A hydrology analysis was applied to assess the following changes in catchment characteristics:

- changes in catchment area; and
- changes in impervious cover.

Catchment area influences runoff flows because it defines the maximum flow and volume of runoff that drains to a specific point. Impervious cover influences runoff flow, because increases in imperviousness increase the amount of runoff, correspondingly reducing the amount of rainfall that is infiltrated into the ground and potentially baseflow into streams.

The existing sub-catchments were defined using the River Environment Classification (REC) GIS layer. The operational drainage and stormwater management design was analysed to determine where proposed alterations to flow pathways and runoff regime would result in changes to catchment areas at the downstream limit of the affected REC sub-catchments.

Methodology to identify changes to flooding

The Project may result in changes to flood risk in the rivers/streams upstream and downstream of the Project. These changes may occur due to:

- alteration of flow pathways due to culverts and stream diversions;
- change in flows and flood depths due to culverts and bridges;
- changes in flood depths or extent due to planting in the flood plain and
- change in flows and flood depths due to embankments located in the floodplain.

Three hydraulic models were developed for three areas of the Project that were identified in the *Water Assessment Report* as having a high flood risk. These areas are identified in Figure 9-7 of this AEE and summarised below:

- Mahurangi River in the vicinity of Kaipara Flats and Carran Road;
- Kourawhero Stream (a tributary of the Hōteo River to the south of the proposed tunnel); and
- Hōteo River along Wayby Valley Road.

All three models were run with the 2, 10, 20 and 100 Year ARI floods, including an allowance for climate change, to 2130. Each model was run for the 'without Project' scenario and 'with Project' scenario. A comparison was made between the scenarios to understand the effects of the Project on flooding.

Methodology assessment criteria

The assessment of effects arising from water during operation has been based on the requirements of the RMA, AUP(OP), relevant Auckland Council guidelines and Transport Agency policy, standards and guidelines.

9.12.4. Project approach to the management of operational water

The Project design will integrate the stormwater system collection and conveyance network, treatment systems, culverts and stream diversions and consideration of the floodplain, and will include full consideration of the implications of stormwater management through the design life of the asset. The design will include a range of water sensitive design solutions including stormwater treatment wetlands and swales to deliver stormwater quality (treatment) and stormwater hydrology (flows) mitigation.

A summary of the specific design criteria for stormwater components is outlined in section 4 of this AEE.

The following stormwater management measures are included as the BPO and are designed to release water slowly into streams to maintain baseflow and to minimise stream bank erosion resulting from change in peak-flow:

- Diversion of clean runoff to prevent it flowing down cuts or mixing with runoff from the road;
- Stormwater treatment wetlands, which were selected as the preferred treatment for the main alignment carriageway through the BPO assessment, these will include the AUP(OP) hydrological mitigation requirements;
- Vegetated or rock lined road side drains are preferred on ancillary/local roads;
- Sediment traps are proposed along the base of rock cuts;
- Erosion protection at outfalls.

In terms of flood management, the Project comprises an integrated design of road, bridge/culverts, stream diversions and stormwater management elements.

9.12.5. Assessment of effects arising from water during operation

The effects of the Project resulting from management of water during operation has been assessed based on a design that incorporates the BPO measures identified above to avoid, remedy and mitigate effects. Criteria from the AUP(OP) have been relied on to assess potential effects.

Effects on water quality of receiving environments

The existing water quality at all the freshwater sites is considered to be good in relation to metals, with dissolved concentrations all below the default trigger values, with the exception of copper at the Mahurangi river mouth.

The assessment predicts small increases in concentrations at all sites for "2046 traffic with Project, with treatment" compared to existing. This is a conservative assessment as the modelling methodology does not account for the expected transfer of traffic

from the existing SH1 (no formal stormwater treatment) and on to the Project (with improved stormwater treatment).

The largest proportional increases of contaminant concentrations arising from the Project occur in the catchments where the road footprint makes up a larger proportion of the overall catchment. It is noted that prior to this Project being constructed the Safe Roads Alliance will have implemented plans for safety upgrades to the existing SH1 which will include some treatment of stormwater, arising from 25,500m^2 of additional highway pavement. Stormwater treatment for the additional impervious areas is proposed as part of those proposed safety improvement works. This assessment is conservative, as it does not account for the reduction of traffic on the existing SH1 (with limited stormwater treatment) by its transfer to the Project (with full stormwater treatment).

The predicted increase in metal contaminant concentrations associated with the Project is not expected to result in the freshwater quality exceeding the Australia and New Zealand Environment Conservation Council (ANZECC/ARMCANZ) (2000) guideline trigger values for 95% level of species protection in freshwaters, provided stormwater runoff is treated to the standard assumed in the assessment. The exception is copper at the Mahurangi River mouth, which already exceeds the guideline value and will increase to a small extent. There will be no change in total petroleum hydrocarbons (TPH) concentrations as a result of the Project.

The decrease in contaminant loads predicted by the modelling at the mouths of the Hōteo and Mahurangi Rivers and at Te Hana Estuary downstream of the confluence of Te Hana Creek and Maeneene Creek when considered in conjunction with the existing sediment quality within the Mahurangi and Kaipara Harbours suggest an expected negligible change in the long term estuarine sediment quality as a result of the Project with treatment accounted for.

With the proposed design criteria and a suitable maintenance regime, the Water Assessment has assessed the contaminant effects on freshwater quality to be minor or negligible and on the long term marine sediment in the sensitive receiving environments of the harbours, and a negligible or slight minor contaminant effect on freshwater and estuarine water quality. With the proposed design criteria and a suitable maintenance regime, the effect of the stormwater treatment wetlands, permanent diversions and changes in hydrology, on the development of excessive growths of aquatic plants (algal blooms) in receiving freshwater is considered to be minor.

With respect to the recreational use, overall the predicted change in bacteria associated with the Project is assessed as having negligible effect on contact recreation. Similarly, the predicted change in metals associated with the Project is assessed as having negligible effect on contact recreation.

The effects of the state highway operation on the drinking water supply is considered to be negligible. It is recommended that Watercare is informed if an event resulting in a pollution spill occurs (such as a collision involving a truck), so that Watercare is able to determine what action, if any, is required. With conditions to alert Watercare about spills, the effect on drinking water is considered to be minor.

Hydrological effects

The impervious land cover introduced by the new road surfaces of the Project prevents natural infiltration of rainfall into the ground surface. This has two potential hydrological outcomes, a loss of baseflow and an increase in storm flow in streams. This can result in changes in stream health related in dry weather to less water and in wet weather to erosion of the stream that modifies habitats and increases suspended sediment.

The catchments that the road passes through are predominately rural with very low levels of imperviousness. The cumulative effects of the increased imperviousness of the road on stream flows is likely to be negligible (at the catchment scale) to minor (at the local sub-catchment scale), given that for the majority of catchment the impervious road will occupy less than 5% of the catchment, and hydrological mitigation is provided in the stormwater treatment wetlands. The hydrological mitigation involves the detention (temporary storage) of the difference between the existing and operational phase stormwater runoff, and slow release of this water over 24 hours. This will reduce peak flows in the receiving watercourses. Hydrological mitigation by retention (infiltration to ground) is not provided for in the design, due to assumed geotechnical constraints (poor infiltration rates) and because of the challenging operating environment (high sediment loads and safety issues with maintenance).

Changes in catchment area once the Project is constructed and operational compared with the existing environment, arise from the proposed stream diversions and changes in flow paths due to the road catchments draining to adjacent catchments. These changes in drainage patterns can impact on stream flows, stream erosion, and natural wetlands.

The stormwater design has avoided most changes in flows by locating culvert crossings to maintain the existing natural drainage patterns of the contributing catchment where possible. This means that there are a limited number of stream diversions. Where they do occur, the stream diversions are located within first order catchments (headwaters with small upstream catchments). The stormwater design has also avoided effects of stormwater routing by directing flow to the proposed stormwater treatment wetlands, generally located in the same sub-catchment as where the stormwater originated. However, increased localised changes in stream flows will occur where flow is routed from one sub-catchment to another, but effects are likely to be localised and similar to those assessed.

The *Water Assessment* assesses the effect of changes in flows related to the diversion of stormwater as minor because for most freshwater catchments the changes in stream flow are less than 10% at the REC catchment scale. There a limited number of catchments with increases larger than 10%, however these are localised and generally affect streams with catchments of less than 1 km^2. As such the change to the flow within streams and rivers due to diversions is small.

Tributary streams where there is an increase in flow may have an increased risk of erosion. This risk can be mitigated by providing stream diversion designs which account for the Project hydrology and provide erosion protection as necessary. In addition, all stormwater outfalls are proposed to incorporate energy dissipation and/or erosion protection measures that will minimise bed scour and bank erosion.

All stream diversions will be stabilised and designed to allow for the 1 in 100-year ARI event.

A number of the wetlands located within the Project area will be impacted by the road embankment and or stream diversions and culverts, likely resulting in loss of wetland area, lowering of water levels in some locations and/or times within the natural wetlands, and increases in water levels in some locations and/or times due to loss of storage and changes in flood patterns. Changes to wetland hydrology, without mitigation, are expected to result in a significant level of effect for a number of wetlands.

Within the Kourawhero Stream catchment there are a number of wetlands that are hydrologically connected to surface water and are located within the floodplain. Adverse effects on the hydrology of the wetlands in this location will be avoided by the bridging of the Kourawhero Stream, which provides for maintenance of the hydrologic connection between the wetland areas east and west of the Indicative Alignment. If a culvert instead of a bridge was proposed in this location, more changes would be expected in the hydrological condition of the wetlands.

The level of ecological effect of these hydrological changes on the aquatic habitats within the natural wetlands is contained in the *Ecology Assessment*.

The Project will minimise and mitigate changes in hydrology and stream erosion as far as practicable. However, post construction monitoring and remediation for erosion prone streams is recommended.

The effects of the imperviousness of the road surface on infiltration and stream baseflows are likely to be negligible to minor, given that for the majority of catchment the impervious road will occupy less than 5% of the catchment. However, in very small subcatchments this proportional increase in impervious area is larger but the level of effect is not considered to be significant.

While the effect of hydrological changes to wetlands is assessed in section 9.5 of this AEE, detailed design can further minimise changes to hydrology to maintain the wetlands to as neutral a state as is practicable this is expected be able to reduce adverse effects to a no more than minor level.

Flooding effects

Changes in flood patterns will occur as result of the Project due to impact on flood storage and conveyance as follows:

- Alteration of flow pathways due to culverts and stream diversions;
- Change in flows and flood depths due to culverts and bridges;
- Change in flood depth due to planting in flood plains; and
- Change in flows and flood depths due to embankments located in the floodplain.

The stormwater design does not provide for flood attenuation as this has not been necessary to mitigate effects.

Culverts and bridges have been designed such that the assessment illustrates that headwater extents are located within the floodplain of the streams and minimal headwater is predicted to extend beyond the proposed designation. The bridges located within floodplains have minimal impact on upstream flood levels. The

culverts and bridges have been designed to maintain existing overland flow paths in most cases. In some locations, stream diversions have been recommended that will alter overland flow paths, in these instances' diversions have been designed to convey the 100 year ARI climate change event.

Complete avoidance of floodplains has not been possible, and parts of the Indicative Alignment are located within the floodplains of the Mahurangi River, the Kourawhero stream and the Hōteo River. Where possible fill areas and stormwater treatment devices have been located out of the 100 year ARI floodplain, however there are locations where these features occupy parts of floodplains especially as the Hōteo River has an extensive floodplain that must be crossed by the Project.

The assessment shows changes to flood levels due to the Indicative Alignment. Most of the increases in flood levels and extents are located within the proposed designation and will not affect properties upstream or downstream of the designation.

In terms of the increases in depth outside of the designation:

- Effects are generally less than 150mm in increase, with one exception where the increase (600mm) is very localised and immediately adjacent to the proposed designation boundary on pasture.
- Effects are generally restricted to land which is already subject to flooding and the current land use is pasture.
- For all local roads, increases in flood levels are localised and do not result in significant changes in the peak flood level or flood durations along the road.
- There is no predicted increase in flood depth or hazard to dwellings or other structures outside of the proposed designation.

Effects on water users

The predicted small increases in sediment, metals, TPH, bacteria and algae are expected to have a very minor effect on the quality of the surface water and are not expected to affect the ability of the treated water to meet NZ drinking water standard values (NZDWS 2008).

There is the potential for an accidental spill of contaminants entering the Mahurangi and Hōteo Rivers, for example due to an accident. If an accidental spill occurs during the operational phase, it is likely that a large proportion of contaminants would be intercepted by the stormwater treatment wetlands, but some residual contaminants may be discharged to the Mahurangi and Hōteo Rivers. The operational water assessment outlines that the effects of the Project on surface water drinking sources in the Mahurangi and Hōteo Rivers will be potentially moderate in the event that a large spill was to occur.

The predicted change in metals, clarity, bacteria and algal growth associated with the Project is assessed as having negligible effects on contact recreation and stock drinking water. Outside a reasonable mixing zone, effects are considered minor on existing water users with permitted water takes.

9.12.6. Measures to avoid, remedy or mitigate actual or potential adverse effects

The Project design includes mitigation measures within the proposed operational water systems. These measures are incorporated into the Project to mitigate any potential adverse environmental effects associated with stormwater management and stream works. The *Water Assessment* details these BPO mitigation measures for avoiding, remedying or mitigating effects. The design of the BPO has focused on managing the water quality and hydrological effects of the operational stormwater discharges. Mitigation measures are also included for key areas of risk. The summary of design mitigation for the Project is outlined below:

Stormwater discharges

- Water quality treatment for the mainline carriageway and rock cuts will be designed to follow GD01 guidelines, recognising that a design to this standard will remove the majority of suspended sediment and vehicle/road derived contaminants;
- Stormwater wetlands with forebays and submerged or baffled low flows outlets so that floatables and litter will be trapped in the wetland;
- Stormwater wetlands discharging to stream environments will achieve the hydrology mitigation requirements specified in the AUP(OP) by providing detention and controlled release over a 24-hour period for the rainfall generated by the 95 percentile rainfall event on the Project's impervious surfaces;
- Stormwater wetlands will have dense, healthy planting in emergent, littoral and riparian zones and vegetation to provide shading;
- Sediment traps or alternative mitigation for sediment eroded off rock cuts;
- Vegetated and rock lined roadside drains for water quality treatment forlocal roads;
- Energy dissipation and erosion protection for stormwater outfalls to minimise bed scour and bank erosion at the point of discharge or downstream;
- Stormwater outfalls design to assess various rainfall and tailwater levels to ensure the critical storm is considered.

Stream diversions

- Stream diversions designed to convey the 100 year ARI rainfall event, with consideration given to the risks of blockage;
- Stream diversions designed to maintain hydrological connectivity with wetlands where hydrological connectivity currently exists;
- Riparian planting of all new diversions and existing watercourses where flow regime is altered by the Project;
- Stream diversions to provide channel stability, in-stream habitat and riparian planting;
- Stream diversions designed in accordance with their type (lowland stream, steep stream, or flow channel).

Works in the beds of streams and wetlands

- Culverts and bridges designed to convey the 100 year ARI rainfall event, with consideration given to the risks of blockage;

- Fish passage in culverts to be provided for all permanent streams and in all instances where there are fish present or there is the potential for fish habitat upstream in intermittent streams;
- Energy dissipation and erosion protection for culverts to minimise bed scour and bank erosion at the point of discharge or downstream;
- Monitoring (and remediation if necessary) over a limited post-construction period for erosion prone streams;
- Provide for a bridge to maintain the hydrological connectivity between the wetlands on the east and west side of the final design alignment in the Kourawhero floodplain;
- Avoid locating stormwater treatment wetlands within natural wetlands that are otherwise avoided by the road embankment.

Flooding

- TP108 hydrology methodology is used for the sizing of culverts;
- Bridge manual hydrological methods are used for hydrological assessment of bridge performance;
- Calibrated hydraulic models are used for assessing flood effects on the Hōteo and Mahurangi floodplains.

In addition to specific design features, the following recommendations are also proposed to mitigate effects:

- Operation and maintenance plans to ensure the ongoing performance of stormwater treatment devices including sediment traps and wetlands;
- Notification to inform Watercare if a spill occurs on the mainline alignment within the Hōteo catchment (upstream of Wilson Road in Wellsford), so that Watercare can take measures to protect their surface water take.

9.12.7. Conclusion

Stormwater runoff from new impermeable surfaces associated with the Project will be treated before discharge to remove the majority of contaminants. The stormwater treatment design of the mainline carriageway and rock cuts will achieve GD01 standards. Increased sediment will be managed through sediment traps. Retention of stormwater flows and erosion control will also be provided. As a result, it is considered that the effects on water quality will be minor.

The effects on water quality at Watercare's water abstraction point in the Hōteo River will be moderate in the event of an accidental spill. As noted earlier, it is recommended that Watercare is notified of any spill event.

Changes in hydrology as a result of the Project will affect stream flows, channel erosion and hydraulic connectivity within streams and wetlands. With the proposed BPO to be achieved through design to mitigate these effects (through hydrological mitigation, design of stream diversions, scour protection and providing a bridge at the Kourawhero wetland), it is considered that the effects associated with the changes in hydrology will be minor.

The Project will be designed to convey flood events. The residual effects of the road embankment and cross drainage on flood levels, are increases in flood depth and extent within the proposed designation. In one location outside of the proposed designation some pasture land is also predicted to experience increased flood levels.

With implementation of the recommended operational water management design elements the effects of the Projects operational water systems are considered to be minor with a moderate level of hydrological effect on a number of natural wetlands.

9.13. Landscape and visual

Overview

The actual and potential landscape and visual amenity effects arising from the Project have been assessed in the *Landscape and Visual Assessment*. The assessment has considered the effects of the Indicative Alignment and the potential effects that could occur if that alignment shifts within the proposed designation boundary when the design is finalised in the future.

The Project has the potential to result in landscape and visual effects including effects on wetlands, rivers and their margins; identified sites of outstanding natural features and significant ecological areas; visual amenity and the quality of the environment, during construction and upon completion of the Project.

Landscape mitigation has been developed with ecology, heritage, Mana Whenua and hydrology factors in mind in order to achieve an integrated approach and to maximise the landscape and ecological outcomes.

A Planning Version ULDF has been developed which identifies landscape and urban design objectives, principles and opportunities for the Project.

Overall, consideration of the landscape context of the Project area and the assessment of the potential landscape and visual effects has identified that the effects can be minimised through design development guided by the ULDF, and the proposed integrated mitigation approach. With mitigation in place the landscape and visual effects of the Project will be less than minor.

9.13.1. Introduction

This section summarises the findings of the assessment of the actual and potential landscape and visual amenity effects of the Indicative Alignment of the Project as well as the effects that could occur if that alignment shifts within the designation boundary, as identified in the *Landscape and Visual Assessment* in Volume 2 of this Application.

The *Landscape and Visual Assessment* provides a description of the landscape character and the context of the Project area and considers the character and quality of the existing environment and landscape and amenity values. It includes an assessment of effects of the Project on the landscape and considers the effects on the visual amenity of potential viewing audiences. The assessment outlines recommended measures to avoid, remedy or mitigate adverse landscape and visual effects.

9.13.2. Existing environment

The existing landscape environment is outlined at a broad level in section 3 of this AEE. Section 9.13.4 provides greater detail of the character and values associated with the landscape through which the Project is located.

9.13.3. Assessment methodology

The methodology used for the identification of landscape values and assessment of the significance and the framework for assessing the magnitude and level of effects on landscape and visual amenity effects included; reviewing relevant literature, site

visits, identifying landscape units (broad types of landscapes found in various places across the Project area) and identifying landscape character areas (LCA's) for description and assessment purposes (discrete areas along the Project area).

Analysis was undertaken to identify the likely extent of visibility of the Project utilising a Zone of Theoretical Visibility (ZTV) analysis and panoramas from 22 public viewpoints. The assessment was not able to access private land and therefore private view points have not been assessed. Visual simulations of the Indicative Alignment from selected viewpoints have been used to inform the assessment of landscape and visual effects. The simulations are included in the *Volume 3: Drawing Set* as the *LS-Series*.
The assessment considered:

a) **landscape effects**; which considers the effects of change and development on landscape as a resource which includes the physical elements and features that make up the landscape such as vegetation, watercourses and landform and the overall character of the landscape, including the physical, sensory and associative aspects; and

b) **visual effects**; which relates to the effects of change and development on the views available to people and the visual amenity that people experience as a result of those views. It considers the visual effects arising from changes to public views and changes to private views.

The assessment used a seven-point scale of ratings (from 'very low' to 'very high') to describe the significance of the landscape and visual effects resulting from the Project. The assessment has also considered the nature of effects; which may be positive (beneficial), neutral (benign), or negative (adverse) in the context within which they occur.

For description and assessment purposes the Project area was divided into five discrete landscape character areas (LCAs) along the Indicative Alignment (south to north) and covering the land within the Project area. The five LCAs (refer Figure 9-8 below) are:

a) Warkworth North;

b) Dome Valley;

c) Upper Hōteo River Valley;

d) Wellsford East; and

e) Te Hana North.

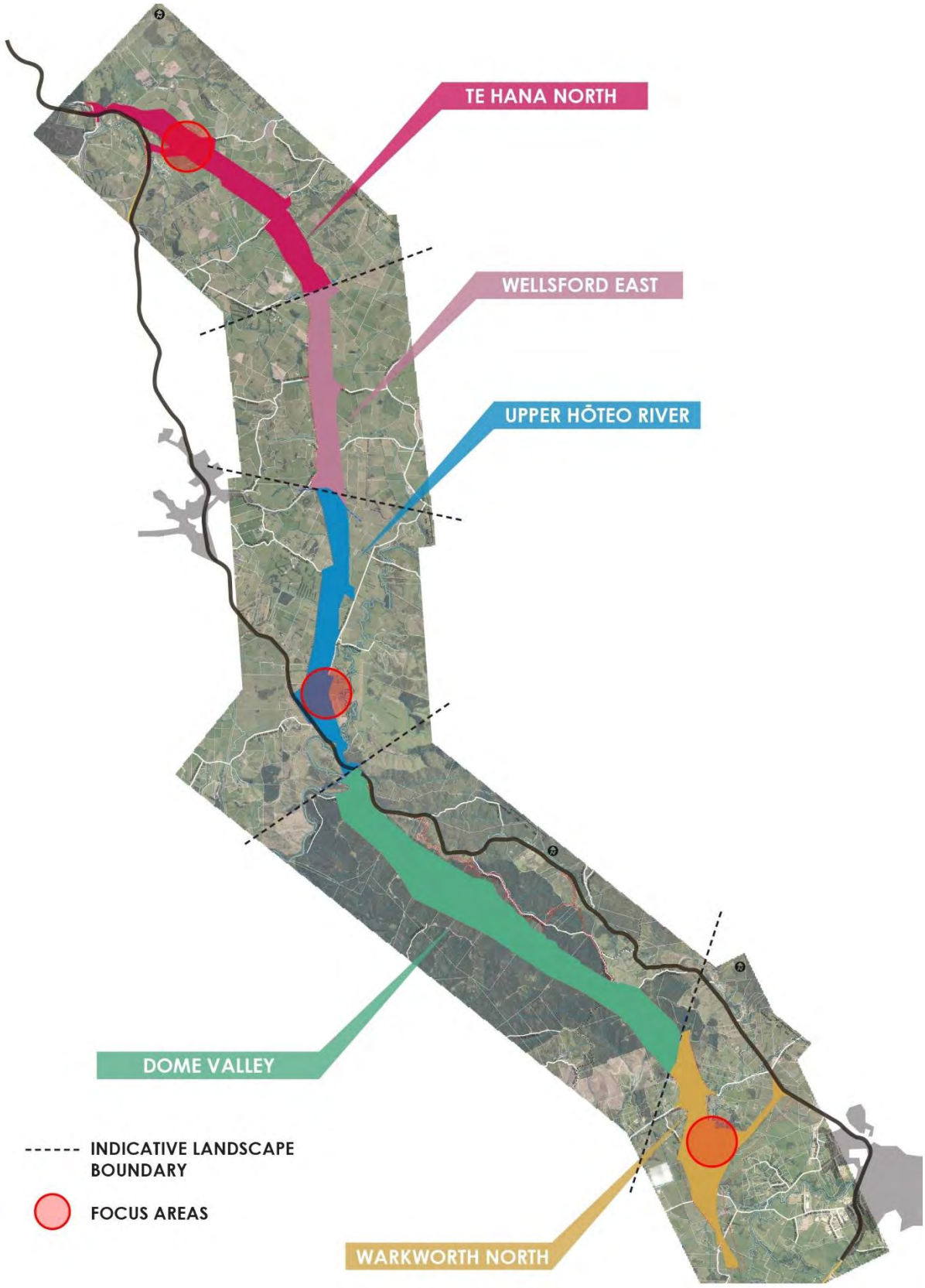

Figure 9-8: Location of each of the five Landscape Character Areas

Following consideration of the Project elements and the impact on landscape character, visual catchment and landscape values for the five LCAs, key areas (worst case scenarios from publicly accessible locations based on the Indicative Alignment) were identified where adverse visual effects would be experienced. Visual simulations for these areas were prepared and show a panorama of the existing view, the proposed view with the state highway at completion and the proposed view with mitigation native planting after 10 years (refer LV 35-LV 39 located in *Landscape and Visual Assessment* Appendix 1: Landscape Figures).

9.13.4. The Urban Landscape Development Framework

The *Landscape and Visual Assessment* is supported by a Planning Version ULDF in *Volume 3: Drawing Set*

The principles of the ULDF are:

- Clean uncluttered highway;
- Stitched together landscape;
- Human landmarks; and
- Celebrate cultural and natural features along the Corridor.

The ULDF provides guidance for the detailed design with respect to:

- Connectivity;
- Wayfinding and highway stopping places;
- Integration of landscape and ecology;
- Place making on the corridor and in relation to urban environments; and
- Integration of Mana Whenua values.

There are project specific mitigation principles and opportunities identified in relation to the bridge and viaduct structures, interchanges, tunnels and associated infrastructure, walking and cycling, retaining walls and earthworks and landscape mitigation.

9.13.5. Landscape and visual effects assessment

The potential landscape and visual effects of the Project are:

- Effects on the natural character of wetlands and rivers and their margins;
- Effects on outstanding natural features and landscapes;
- Effects on visual amenity values;
- Effects on the quality of the environment; and
- Landscape effects during construction.

Warkworth North landscape character area

Figure 9-9: Kaipara Flats Road near Phillips Road, within the Warkworth North character area (showing areas of lower valley pasture, enclosed to the north by the rising land associated with the Dome Valley).

Landscape character and values

The key attributes of the Warkworth North LCA are:

- The landscape is characterised by flat valley land, small rural properties and a predominance of agricultural land uses. These land uses include dry stock grazing (primarily sheep), horticulture, orchards and glasshouses.
- The Mahurangi River and its mature remnant riparian vegetation is a key landscape feature.
- The highest landscape values are attributed to the vegetated stream courses, and particularly those parts of the Mahurangi River (left branch) which features indigenous vegetation cover and are identified within a SEA overlay in the AUP(OP).

Assessment of landscape effects

The main landscape sensitivity for this LCA is associated with the Warkworth Interchange which involves the construction of embankments, several bridges up to 21m above ground level, including three bridges over the Mahurangi River, and the realignment of Carran Road.

The Project will impact several of the key characteristics of this project area with the main effects on the physical landscape during construction resulting from the removal of indigenous vegetation, including within an SEA, in addition to earthworks for the mainline and structures and presence of construction equipment. The Project will change the character of this area to a transport infrastructure dominated landscape, particularly around Woodcocks Road and west along Kaipara Flats Road.

The wider landscape character has a reduced susceptibility to the proposed changes due to the presence of existing infrastructure including large scale developments (e.g. glasshouses along Woodcocks Road) and the P2Wk which is currently under construction. Moreover, the south eastern slopes of the valley including Viv Davie-Martin Drive are zoned Future Urban, which generally indicates that sensitivity to these areas to urbanisation is of a reduced level (compared to the rest of the character area which is zoned rural production).

Assessment of visual effects

The most sensitive areas in terms of visual effects within the Warkworth North LCA are Viv Davie-Martin Drive and Woodcocks Road, the Warkworth Interchange and Kaipara Flats Road which results from these areas including residential properties and therefore, more sensitive receivers than any other character area.

Views of the Indicative Alignment from properties off Kaipara Flats Road will be screened (where possible) by retaining existing shelter belts within the designation and by revegetating a wide strip of land on the eastern side of the Indicative Alignment to buffer the Kaipara Flats Road rural residential area to the east.

Mitigation

The proposed mitigation of the Warkworth Interchange involves extensive native planting between the ramps to visually absorb the various lanes, fill embankments and structures, particularly when viewed from elevated properties off Viv Davie-Martin Drive. Shelter belt type screen planting will screen views of the interchange from properties off Wyllie Road, Woodcocks Road and Carran Road. A shelter belt is proposed on the western side of the Indicative Alignment, by Phillips Road, to screen views from properties to the west off Kaipara Flats Road.

There is an opportunity to retain the existing indigenous riparian vegetation along the Mahurangi River (left branch) except where limited clearance is needed to construct bridges over the river. This along with planting residual land within the interchange will create a distinctive landscape feature that integrates all the lanes and bridge structures of the interchange. Planting at the interchange will connect the Mahurangi River (left branch) with remnants of indigenous vegetation up to Kaipara Flats Road which will filter views of the alignment from the more sensitive residential viewing areas around Warkworth, as well as presenting an opportunity to create a vegetated corridor between the upper Kourawhero Stream and Mahurangi River that links remnant patches of indigenous forest within the two catchments. This will create a buffer between the Indicative Alignment and the Kaipara Flats Road rural residential area as well as assisting to mitigate the change in character to the area reducing the scale and effects of the interchange infrastructure.

Summary of landscape and visual effects in the Warkworth North landscape character area

The *Landscape and Visual Assessment* concludes that landscape effects generated by the Project will have Moderate-High adverse physical landscape effects and High landscape character effects on the Warkworth North LCA. These effects can however be reduced to Low if the mitigation shown on the Landscape and Visual Mitigation plans is implemented. Visual effects are assessed as being low.

Dome Valley character area

Figure 9-10: River Road, within the character area (overlooking the Hōteo River corridor which is enclosed by plantation forestry and smaller pockets of indigenous vegetation around the Hōteo River margins).

Landscape character and values

The key attributes of the Dome Valley character area are:

- The landscape is characterised by elevated hill country and forms a backdrop to views from the northern parts of Warkworth.
- Includes notable peaks such as The Dome (at 336 m above mean sea level), to the east of the character area, and Kraack Hill (at 310 m above mean sea level).
- Vegetation cover, particularly to the west, is almost entirely comprised of exotic plantation forestry.
- Areas of indigenous vegetation are found along the north eastern side of the existing SH1 corridor within an ONL (ID 32, Dome Forest) to the east of the character area, several SEAs and two DOC reserves, all of which are outside of the proposed designation boundary.
- The wider Project area contains a number of public walking trails including the Te Araroa national walkway. The trail crosses the character area on the northern side of the Kraack Hill ridge, where the Project is in a tunnel.

Assessment of landscape effects

The main landscape sensitivity for this LCA is associated with a series of steep cuts before passing through the tunnel beneath Kraack Hill and Kraack Road. These works would likely require the filling of gullies, which include streams/overland flows that flow into the Waiteraire Stream which flows to the Hōteo River. Effects on the physical landscape will result from a wide bench cutting across a series of ridges and valleys.

The cut and fill works would require substantial clearance of pine plantation across much of the character area, however it is assumed that this forestry is harvested prior to construction of the Project. The project area avoids areas of indigenous vegetation on the northern side of SH1 (i.e. around Sunnybrook Reserve) and around the Kraack Hill summit. Apart from the impact on streams, the filling of gullies and clearance of any forestry in this character area will have a low landscape effect. In addition, mitigation will help to blend cut and fill batters with adjacent landform and integrate the state highway into the wider landscape. The Te Araroa national walkway is identified as a valuable landscape feature within this character area. The Indicative Alignment at this location is in the tunnel and completely avoids the walkway. In terms of effects on the wider landscape character, the key characteristic of value within this character area is the high coverage of forest vegetation. However, by

nature the character of the area is dynamic and subject to change and this commercial forest is expected to have been harvested prior to construction of the project. Noting the anticipated harvesting of the forest along with the existing SH1, logging activities and forestry roads, the Project is not incompatible with the landscape character of the Dome Valley.

Assessment of visual effects

This section of the Indicative Alignment passes through the steeply undulating Dome Valley. The Indicative Alignment is proposed to be largely located below the existing grade (i.e. within areas of cut). Due to the limited occurrence of roads or dwellings through this location, this character area has the lowest number of potential viewers, of any character area along the alignment.

Mitigation

To mitigate effects of the twin bore tunnels, consideration will be given to the associated infrastructure (e.g. portals and deluge storage tanks) to ensure that the infrastructure is integrated with the landscape. Whist this detail will be finalised at the detailed design stage of the Project, integration techniques could include sloped portal structures and revegetation works. In addition, as recommended in the *Landscape and Visual Assessment*, tunnel infrastructure will be recessive in design including being located so that they are not visible from the Te Araroa Trail.

To mitigate general effects in this character area:

- The final contour on completion of earthworks will visually and physically transition into the natural landform;
- Cut and fill batters and soil disposal sites will be designed to include slope gradients that can sustain vegetation;
- Some area of exposed rock from cutting/blasting will likely be retained as a feature; and
- Extensive revegetation will be undertaken to integrate infrastructure and soil disposal sites with the adjoining landforms and provide screening.

Summary of landscape and visual effects in the Dome Valley landscape character area

The *Landscape and Visual Assessment* concludes that for the Dome Valley LCA the landscape effects generated by the Project will have Moderate-High physical landscape effects and Moderate landscape character effects which can reduce to Moderate-Low with mitigation. Visual effects are assessed as being low.

Upper Hōteo River landscape character area

Figure 9-11: Wayby Valley Road, within the character area (showing the flat pastoral landscape, and Wayby Valley Road along the valley floor).

Landscape character and values

The key attributes of the Upper Hōteo River LCA are:

- The landscape is characterised by a gently undulating valley landscape featuring the Hōteo River, Auckland's longest river and several of its key tributaries. Some parts of the river and its tributaries feature connected swathes (and pockets) of indigenous vegetation (some of which are recognised in the AUP(OP) as SEAs for their ecological value).
- Land uses in this area are largely pastoral (grazing).
- Infrastructural activities are featured within the character area, including the existing SH1, and in the surrounding environment (i.e. the Springhill Aerodrome and the North Auckland Rail Line).
- The values of the landscape within and surrounding this character area are of moderate/regional importance, primarily as a result of the Hōteo River.
- The Hōteo River contributes (both directly and indirectly) the highest values to the landscape, particularly those parts of the river that feature indigenous vegetation cover and are identified in the AUP(OP) as ONF and SEA overlays.
- The Hōteo River also has significant cultural value to Mana Whenua.

Assessment of landscape effects

The main landscape sensitivity for this LCA is associated with the Hōteo River which is a highly valuable landscape feature and recognised in the AUP(OP) as an ONF. The Project includes the construction of the Wellsford Interchange (likely to be formed on fill embankments) in this LCA, which will include a series of cut and fills through ridges and across valleys to the north.

Areas of riparian indigenous vegetation and the existing tributaries to the Hōteo River are also of value, particularly those which are identified as SEAs. While the Indicative Alignment avoids the SEAs immediately alongside the river, it will intersect with two tributaries and one SEA area and will result in some indigenous vegetation removal, impacting the wider natural values of the Hōteo River.

The Indicative Alignment passes over the Hōteo River via a proposed viaduct. The viaduct is proposed to ensure that there will be no direct impact upon the riverbed or its banks, but the supporting structures are likely to impact an area of native vegetation cover (SEA_T_683) to the south of the river's southern banks. The proposed designation has been narrowed down substantially at this point to minimise

impacts on the SEA and avoid, to the greatest extent practicable, the Hōteo River ONF (ID 48). The indicative design of this area considered several bridge layouts with pier spacings from 35 m centres to 80 m. After careful evaluation, an (approximately) 65 m span was incorporated within the Indicative Alignment as this enabled all piers to be located outside of watercourses and minimises vegetation clearance for construction purposes. The design for the northern bridge abutment retains most of the wetland SEA_T_6854 and with piers located on the northern and southern edge of SEA_T_ 683, enabling the centre of the vegetation to be retained.

Assessment of visual effects

The most sensitive areas in terms of visual effects within the Upper Hōteo River LCA are views of the Indicative Alignment from properties off Wayby Station Road, views of the Hōteo River viaduct, the Wellsford Interchange and from elevated properties in Rustybrook Road.

Views of the Hōteo River viaduct should be partially screened by retaining the existing Poplar shelter belt inside the designation near SH1 and through the design and construction methodology for the viaduct in line with the principles outlined in the ULDF. The visual effects following mitigation will be Low.

Views of the Wellsford Interchange will be screened by retaining existing shelter belts inside the proposed designation beside Wayby Valley Road and planting a shelter belt on the western sloping fill batter of the interchange. The visual effects will be Moderate-Low/Moderate-High following mitigation.

Views of the Project from elevated properties off Rustybrook Road, Whangaripo Valley Road and from Wayby Valley Road will be screened, where necessary by planting shelter belts on any eastern and western fill batter slopes of the final design.

Mitigation

Measures are proposed to mitigate the effects of the Project on the landscape qualities of the upper Hōteo River LCA as follows:

(a) The final design of the Wellsford Interchange should serve as a gateway feature along the Project and provide a feature that connects to Wellsford and the surrounding landscape setting. Native planting and design work at the interchange will promote a sense of place that reflects the destination presented e.g. by using culturally and locally important plant species.

(b) The support structures (piers), abutments and embankments of the Hōteo viaduct will be carefully placed to minimise their physical impact where possible on SEAs. Refer to Section 4.1 Viaducts and Bridge design principles of the Planning Version ULDF.

(c) The design of the Hōteo Viaduct, the hardscape material (e.g. rock rip rap), inspection and maintenance areas/access, and any railings or barriers will be considered holistically as part of the overall urban and landscape design treatment for the corridor and not as an isolated area, as outlined in the design principles of the Planning Version ULDF.

(d) Revegetation and mitigation planting will be undertaken as early as possible to gain maximum benefit. These works should also be reflective of the surrounding landscape character and pasture may be most appropriate in this character area.

(e) Plant the riparian margins of streams in the pastural landscape north of the Hōteo River to help stitch together and enhance the legibility of the landscape.

The *Landscape and Visual Assessment* concludes that the Upper Hōteo River LCA will experience Moderate-High physical landscape effects and High landscape character effects which can be reduced to Moderate or even Moderate-Low depending on the extent of mitigation. The visual effects will be Moderate-Low following mitigation.

Wellsford East landscape character area

Figure 9-12: Whangaripo Valley Road, within the character area (showing areas of undulating and lower valley pasture).

Landscape character and values

The key attributes of the Wellsford East character area are:

- The landscape is characterised by sparsely populated undulating to rolling farmland typified by a sequence of low ridges, which rise and form part of a more elevated ridge to the west of the character area (around Worthington Road).
- The Worthington Road ridge provides a physical separation between the character area and the Wellsford settlement.
- Ridgelines enclose a network of stream courses, which feed into three main catchments, including those of the Hōteo River and Te Hana Creek.
- Land use is predominantly open pastoral, with limited vegetation cover which is typically pockets of exotic vegetation.
- The values of the landscape within and surrounding this character area are primarily recognised and appreciated at a local level. The local population are likely to value the open, undeveloped agricultural character of the landscape in this character area, particularly for the sense of rural tranquillity.

Assessment of landscape effects

The main landscape sensitivity for this LCA is associated with the introduction of substantial infrastructure in a rural landscape and extensive earthworks forming a series of cuts and fills through ridges and across valleys with an elevated bridge proposed across Whangaripo Valley Road.

The impact of the Project upon the landform will be very high due to the physical extent of the earthworks. Minimal vegetation clearance will be required due to the lack of existing trees within the footprint of the Indicative Alignment in the Wellsford East LCA.

The Worthington Road ridge and the rolling topography will contain the Project within the more immediate landscape ensuring the Project does not impact upon the

character or amenity of Wellsford and/or its rural interface. However, the Project will have a significant impact upon the character surrounding Burrows Road, Whangaripo Valley Road and Farmers Lime Road due to the introduction of a new bridge and embankments that will change the character of these rural areas currently characterised by open pasture, shelter belts and agricultural (farming) land use with interspersed residential dwellings.

Assessment of visual effects

The most sensitive areas in terms of visual effects within the Wellsford East LCA are the views from Whangaripo Valley Road looking west and Borrows Road looking south-east. At this location the Indicative Alignment passes through sparsely populated open farmland so has a limited visual catchment in relation to any known public or private viewing audiences. The Hōteo Viaduct and Wellsford Interchange will be visible from properties off Wayby Station Road with the Indicative Alignment also visible from elevated properties off Rustybrook Road.

Mitigation

Measures are proposed to mitigate the effects of the Project on the landscape qualities of the Wellsford East LCA as follows:

(a) Earthworks will be designed and graded out to integrate with the surrounding landscape. This approach will be particularly important for the fill embankments proposed around the Borrows Road area.

(b) Small woodlots and tree belts are common in the wider landscape around Borrows Lane/Whangaripo Valley Road. Similar planting will be used/replicated around the Borrows Road bridge area to soften and visually anchor the proposed bridge and the tall engineered fill embankments.

(c) Appropriate surface treatment of cut slopes will be undertaken, including grassing, revegetation or leaving an exposed rock face. Rock cuttings can provide features within the local landscape, and reflect the local character of the area, in particular the distinctive limestone geology of the area.

(d) The bridge form and design will be considered as part of the overall urban and landscape design for the corridor as outlined in the Planning Version ULDF.

(e) Worked areas, and embankments (outside of the Borrows Road area) will be returned to pasture, to blend with the character of the surrounding open pasture land.

(f) Plant the riparian margins of streams that flow through the proposed designation within the Wellsford East LCA.

Summary of landscape and visual effects in the Wellsford East landscape character area

The *Landscape and Visual Assessment* concludes that the Wellsford East LCA will experience Moderate physical landscape effects and Moderate-High landscape character effects which can reduce to Moderate-Low physical landscape effects and Moderate character effects with mitigation.

Te Hana North landscape character area

Figure 9-13: Lower Silver Hill Road looking from the east (showing areas of undulating pasture and former quarry workings).

Landscape character and values

The key attributes of the Te Hana character area are:

- The landscape is characterised by sparsely populated undulating to rolling farmland typified by a sequence of low ridges, which form part of a more elevated ridge/land to the east of Te Hana.
- The land use is predominantly open pastoral, with limited vegetation cover apart from pockets of indigenous vegetation found around the tributaries and main channel of the Maeneene Stream.
- The values of the landscape within and surrounding this character area are primarily recognised and appreciated at a local level. The local population are likely to value the open, undeveloped agricultural character of the landscape in this character area, particularly for the sense of rural tranquillity that is evident in the wider landscape to the east of Te Hana settlement.

Assessment of landscape effects

The main landscape sensitivity for this LCA is the extensive earthworks forming a series of cuts and fills through ridges and across valleys, a large fill to form the Te Hana Interchange over Mangawhai Road and the landform and land cover modification which will result in a change to the rural character.

The Project passes over several stream/tributaries feeding into the Te Hana Creek catchment and wetlands. The associated earthworks will require the removal of the existing, largely exotic vegetation and indigenous wetland vegetation. Steep cuts through pasture are required to construct this part of the Project impacting the typical rolling contour and occasional boundary vegetation that contribute to the scenic value of the wider landscape. The Indicative Alignment intersects with a prominent ridgeline north of Silver Hill Road, at which point the road is on embankments. These embankments gradually increase in height/scale towards the Te Hana Interchange where the embankments then reduce in scale and continue through relatively flat open fields to the proposed bridge over Maeneene River.

The susceptibility of the wider landscape to effects from the Project is limited due to the enclosing and screening effect of intervening landforms as well as the overall sense of scale.

The impact of the Project will be realised in the smaller pockets of residential development e.g. around Silver Hill Road where the extent of the engineered slopes and the bridge will be most noticeable.

At the northernmost limits of the Project area, the Indicative Alignment will result in a considerable change to the character of the valley to the east of SH1 where a roundabout will be constructed on the existing SH1 and a full north/south interchange straddling Mangawhai Road. This proposed interchange will alter the landform, use and appearance of the ridge slopes surrounding the lower parts of Mangawhai Road, and will impact upon the landscape character of nearby areas, including the subdivision at Charis Lane, and the rural residential areas around Vipond, Maeneene and Waimanu Roads. The Project will change the character of the valley introducing a large engineered structure, I.e. an elevated road with ramps and lighting. However, the character within this area is already influenced by the existing SH1 road, a local subdivision and local roads; so those areas have a relatively low sensitivity to change.

There is opportunity to integrate place making features into the interchanges to assist with this connectivity.

Assessment of visual effects

The most sensitive areas in terms of visual effects within the Te Hana LCA are considered to be from Mangawhai Road looking south-east, Vipond Road looking south and from Charis Lane looking north-east. The Indicative Alignment intersects with Silver Hill Road, the latter which crosses over the mainline carriageway via a bridge and will be visible along nearby parts of Silver Hill Road and a number of nearby private properties. The Te Hana Interchange and the associated roading realignments/connections will be visible across parts of Mangawhai Road, Vipond Road and SH1.

Mitigation

Measures are proposed to mitigate the effects of the Project on the landscape qualities of the Te Hana East LCA as follows:

(a) Earthworks will be designed and graded out to integrate with the surrounding landscape. This approach will be particularly important in relation to the tall fill embankments proposed around Silver Hill Road.

(b) The Silver Hill Road bridge design will be considered as part of the overall corridor approach to bridge architecture and structures, so that it is part of the corridor wide family of structures as outlined in the ULDF.

(c) For the areas of cut proposed, opportunities for rock cuttings will be explored with the aim of providing features within the local landscape, reflecting its local character (e.g. by exposing the underlying limestone).

(d) The Te Hana Interchange will be the northern gateway to Wellsford as well as connecting visitors to the Te Hana Te Ao Marama Cultural Centre and Te Hana. The landscape treatment of the Te Hana Interchange and the Wellsford Interchange to the south will be similar (creating a family of interchanges) to reinforce the connections into and out of Wellsford. Similar native planting will be replicated around the Te Hana Interchange to visually screen local views towards the interchange and the tall engineered fill embankments.

(e) Plant the riparian margins of streams in native species that flow through the proposed designation in the Te Hana East LCA.

(f) Construction compounds will be located a minimum of 200 m from residential properties where practicable and will be screened with grassed mounding and or fast growing shelter belt trees.

Summary of landscape and visual effects in the Te Hana landscape character area

The Landscape and Visual Assessment concludes that the Te Hana North LCA will experience Moderate-High physical landscape effects and High landscape character effects which can reduce to Moderate with mitigation. The visual effects will be Moderate following mitigation

Natural character effects

The Project area crosses a number of watercourses including the Mahurangi and Hōteo Rivers, Kourawhero and Maeneene Streams, and the Te Hana Creek, which feed into the Mahurangi and Kaipara Harbours. Sections of the Kaipara and Mahurangi Harbours are identified as High Natural Character areas in the AUP(OP) and an area in the lower reaches of the Mahurangi Harbour is identified as an Outstanding Natural Character (ONC) area and therefore potential impacts on natural character have been considered. Based on the findings of the *Marine Ecology and Coastal Avifauna Assessment*, and the *Assessment of Coastal Sediment*, it is considered that the potential effects on natural character of the coastal environment would be low, including cumulatively.

Lighting

The only lighting currently anticipated along the Project alignment will be at the interchanges and the tunnel (including the portals) with the remainder of the Indicative Alignment being unlit to preserve rural amenity. The effect of lighting in the interchange areas will add to the urban presence of the interchange infrastructure. Lighting at the interchanges and in the tunnels is required for safety reasons. The lighting will be designed to achieve the lighting category (medium brightness) identified in the AUP(OP) for the Rural Production Zone and the requirements of "AS/NZS 1158:2005: Lighting for roads and public spaces". The lighting design will control the intensity, location and direction of artificial lighting to avoid significant glare and light spill onto adjacent sites, maintain safety for road users and minimise the loss of night sky viewing. Mitigation planting (shelterbelts and woodlots) is proposed in some areas to screen views of the road and interchange lighting.

Potential landscape effects if the alignment shifts within the designation boundary

The assessment undertaken and outlined in detail in the *Landscape and Visual Assessment* is based on the Indicative Alignment. Consideration was also given to the potential landscape and visual effects should the alignment shift within the proposed designation boundary during future design development phases. Particularly sensitive areas identified are:

- The Mahurangi River and its associated riparian vegetation;
- Remnant patches of indigenous vegetation south and north of Kaipara Flats Road;
- Upper reaches of the Kourawhero Stream;

- The Hōteo River and adjoining indigenous forest identified as SEA_T_ 683; and
- A high value wetland SEA_T_6854 and a remnant of indigenous floodplain forest SEA_T_6851 north of the Hōteo River.

The *Landscape and Visual Assessment* identified that the final design has potential to increase the level of landscape effects in two parts of the Warkworth North LCA:

- the Mahurangi River (left branch) running parallel with the Indicative Alignment;
- the wetlands at the headwaters of the Kourawhero Stream.

Provided the current level of impact on these two areas is maintained or reduced, by the following, the *Landscape and Visual Assessment* concludes that future changes to the alignment can be accommodated without an increase in effects on these areas:

- Bridges crossing the Mahurangi River should be perpendicular to the river to minimise the impact on riparian vegetation. The number of bridges associated with the Warkworth Interchange over the river will be restricted to a maximum of three;
- Loss of vegetation from remnant patches of forest will be no greater in area to that shown on the Indicative Alignment;
- The bridge over the upper Kourawhero Stream will be retained in any further designs;
- The designation is very narrow at the Hōteo River crossing so will avoid any change to the impact on the river and SEA_T_ 683;
- The Hōteo River viaduct northern bridge abutment is located on the northern edge of wetland SEA_T_6854. Future designs will not increase the area (i.e. m^2) of the physical works which impact on the wetland area within the Indicative Alignment;
- Future designs will not encroach further into SEA_T_685.

Potential changes to the Indicative Alignment within the designation boundary should have similar effects to the Indicative Alignment on the assumption that the final design gives effect to the mitigation principles and guidelines recommended in the ULDF. The proposed integrated mitigation approach is discussed in detail in section 10.3 of this AEE.

9.13.6. Overall assessment of landscape and visual effects

A project of this nature and scale will inevitably have landscape and visual effects. However, the Project has been through a detailed route selection process involving the assessment of alignment options and environmental effects to avoid significant adverse effects where possible. This process resulted in the avoidance of all scheduled landscape features and minimal impact on a scheduled outstanding natural feature (Hōteo River).

Effects on landscape character and features

The Project will alter the composition of the landform and vegetation cover within the Project area and will introduce changes to the various landscape character areas along the route. The significance of the landscape effects resulting from those changes will range from moderate adverse to high adverse effects during and immediately following the construction works. However, many of these effects can be mitigated to between low adverse to moderate adverse effects through the design development phase being guided by the design principles outlined in the ULDF and over time with

the establishment of the proposed revegetation.The Project will alter existing landscape elements and features within the Project area which will have an effect on the Project area's character, and the wider character outside of the Project area in places. The significance of the landscape effects resulting from those changes will range from moderate adverse to moderate-high adverse effects during and immediately following the construction works. However, many of those effects can be remedied or mitigated to between moderate-low adverse to moderate-high adverse effects.

There is potential for the Project to create positive beneficial effects as a result of landscape ecological mitigation. The proposed mitigation will strengthen existing vegetation frameworks and improve the management of riparian margins in certain locations resulting in positive landscape and ecological effects.

Protected natural landscapes

The Project does not encroach on and therefore does not result in adverse effects on the values of the any scheduled Outstanding Natural Landscapes. The potential effects on the ONF (Hōteo River) that overlaps and adjoins the proposed designation boundary have been minimised to the greatest extent possible with the Indicative Alignment having been designed to ensure that construction works do not encroach on the ONF itself. River Road currently runs through the ONF in this area and the proposed upgrades to this local road as part of this project will not affect the values of the scheduled landform.

Visual effects

The potential effects of the Project on public viewing areas will range from very high to very low adverse effects during and immediately following the construction works and it is considered that many of those effects can be remedied or mitigated over time generally to be moderate-low with the establishment of the proposed mitigation and screen planting.

Post construction, the residual and enduring effects of the Project will be the modification of the rural character and amenity values. Well-considered specific mitigation will assist considerably in ameliorating such effects.

Further design and development

The use of the ULDF as a guiding document to ensure the final design avoids or minimises adverse landscape and urban design effects is a proven mechanism for minimising adverse effects. The development of this document during the detailed design process will ensure that the potential adverse effects are appropriately considered and managed. In addition, the *Landscape and Visual Assessment* identifies areas particularly sensitive to the Project and makes specific recommendations to manage effects in these areas. These are listed in section 9.13.7.

9.13.7. Measures to avoid, remedy or mitigate actual or potential adverse effects

A Planning Version ULDF has been developed which identifies landscape and urban design objectives, principles and opportunities for the Project (see volume 3 drawing set of the AEE). Cultural values have been one of the key drivers in its development. The ULDF will be developed to inform the detailed design and the construction and

implementation phases, and sector specific Urban Design and Landscape Management Plans will also be prepared.

The recommended measures to mitigate potential adverse landscape and visual effects of the Project include:

- Implementation of the *Landscape Mitigation Plans, LM* – Series in Volume 3 of the AEE which depicts locations for planting specifically to address landscape and visual effects;
- Design of structures and highway features as guided by the principles of the Planning Version ULDF and subsequent versions;
- Structures in the Dome Valley area should be recessive in design and not be visible form the Te Araroa Trail;
- The Warkworth Interchange and Te Hana Interchange should serve as a "gateway features";
- Earthworks design and implementation to visually and physically integrate highway batter slopes with adjacent landform and land cover;
- Cut to fill batters and soil disposal sites to include slope gradients that can sustain vegetation;
- Construction mitigation that includes maximising the retention of existing vegetation and locating construction yards to minimise visual effects;
- Planting and revegetation that includes extensive planting at key locations to maximise the opportunity to provide high value and resilient landscape and ecological outcomes;
- Visual screening by planting shelter belts and hedge rows with fast growing species that are common in the area;
- Riparian planting of streams in the pastural landscape north of the Hōteo River;
- Locating construction compounds that are within 200 m of a residential properties so that they are screened from view. This may include visual screening.

9.13.8. Conclusion

Landscape considerations have been an integral component of the design of this Project to date including the process of assessing the alignment options (MCA process) and determining the Indicative Alignment. This has enabled the most significant landscapes and features to be avoided or the effects minimised and landscape and visual considerations to be integrated with other aspects of the Project. The adverse landscape and visual effects of the Project are summarised in Table 9-24 of this AEE.

Landscape mitigation has been considered together with ecological mitigation, hydrology, stormwater treatment and cultural values in order to provide a more effective and resilient environmental outcome overall. The focus for mitigation is to establish large areas of revegetation that provide a strong landscape framework and habitat creation around a few key areas that contain existing high value features.

Overall, consideration of the landscape context of the Project area and the assessment of the potential landscape and visual effects has identified that the effects can be minimised through design development guided by the ULDF, and the recommended mitigation planting. The residual and enduring effects are summarised in Table 9-24 below.

Table 9-24: Summary of adverse landscape and visual effects

LCA	Landscape – character				Landscape – Values				Visual	
	Effect rating									
	Construction	Completion	Once mitigation established	RMA scale of effect	Construction	Completion	Establishment of mitigation	RMA scale of effect	Establishment of mitigation	RMA scale of effect
Warkworth North	Moderate–High	Moderate	Low	Less than Minor	High	Moderate–High	Low	Less than Minor	Low	Less than Minor
Dome Valley	Moderate–High	Moderate	Moderate–Low	Minor	Moderate	Moderate	Moderate–Low	Minor	Moderate – Low	Less than Minor
Hōteo River	Moderate–High	Moderate	Moderate to Moderate–Low	More than Minor	High	Moderate–High	Moderate	More than Minor	Moderate	Less than Minor
Wellsford East	Moderate	Moderate–Low	Moderate–Low	Minor	Moderate–High	Moderate–High	Moderate	More than Minor	Moderate	Less than Minor
Te Hana North	Moderate–High	Moderate–High	Moderate	More than Minor	High	High	Moderate	More than Minor	Moderate	Less than Minor

9.14. Operational Traffic

Overview

The identified problems on the existing SH1 Warkworth to Wellsford route are, in summary:

1. The corridor is substandard for a national strategic route, resulting in a higher number of crashes involving injury and death; and
2. Poor resilience and costly journeys between Northland and Auckland, which is constraining economic growth and investor confidence.

The Project will deliver significant positive transportation and traffic effects (i.e. benefits). The Project will improve road safety, improve resilience and accessibility, reduce journey times, and improve consistency of journey times for general traffic and freight. It will improve route security by providing an alternative route to the current SH1 built to higher standards, which will be safer and more resilient to incidents.

9.14.1. Introduction

This section summarises the findings of the assessment of the actual and potential effects on the transport environment arising from the operation of the Project outlined in the *Operational Transport Assessment* contained in Volume 2 of this Application. Traffic effects in relation to the construction phase of the Project are the subject of a separate report and are summarised in section 9.7 of this AEE.

The *Operational Transport Assessment* establishes a baseline transport environment which was developed by considering the existing transport environment and how the performance of the transport network might change over time, informed by traffic modelling.

This section presents the findings of the assessment of the actual and potential effects of the operation of the Project on the road network and road users, including safety, route quality, resilience and travel time reliability, and predicted changes in travel times.

9.14.2. Existing transport and traffic environment

The description of the existing transport and traffic environment is included in section 3 of this AEE.

In summary:

- SH1 serves the dual purposes of providing the inter-regional transport function between the Auckland and Northland regions for the movement of people and goods, as well as providing access to local areas. As a consequence of this dual function, there is a mix of regional and local traffic on SH1.
- The Warkworth to Te Hana section of SH1 has a single carriageway, with generally one lane each way. The road follows the undulating landform, with restricted sightlines and steep grades in some locations, which present safety, resilience and capacity issues.

The specific objectives for the Project are directly relevant to the problems experienced on the existing corridor. The objectives are identified in section 2.2 of this AEE and the key issues are summarised below.

Safety

The geometric issues associated with the current SH1 alignment has an unsatisfactory safety record. The geometric issues contribute to a number of crashes, particularly through the Dome Valley.

The following sections of the route have a high crash rating (from south to north) as shown in Figure 9-14:

- Between Kraack Road and L Philips Road;
- Near Saunders Road;
- Between Wayby Valley Road and River Road;
- At the Wayby Valley intersection;
- Between School Road and Port Albert Road; and
- Between Mangawhai Road and Whakapirau Road

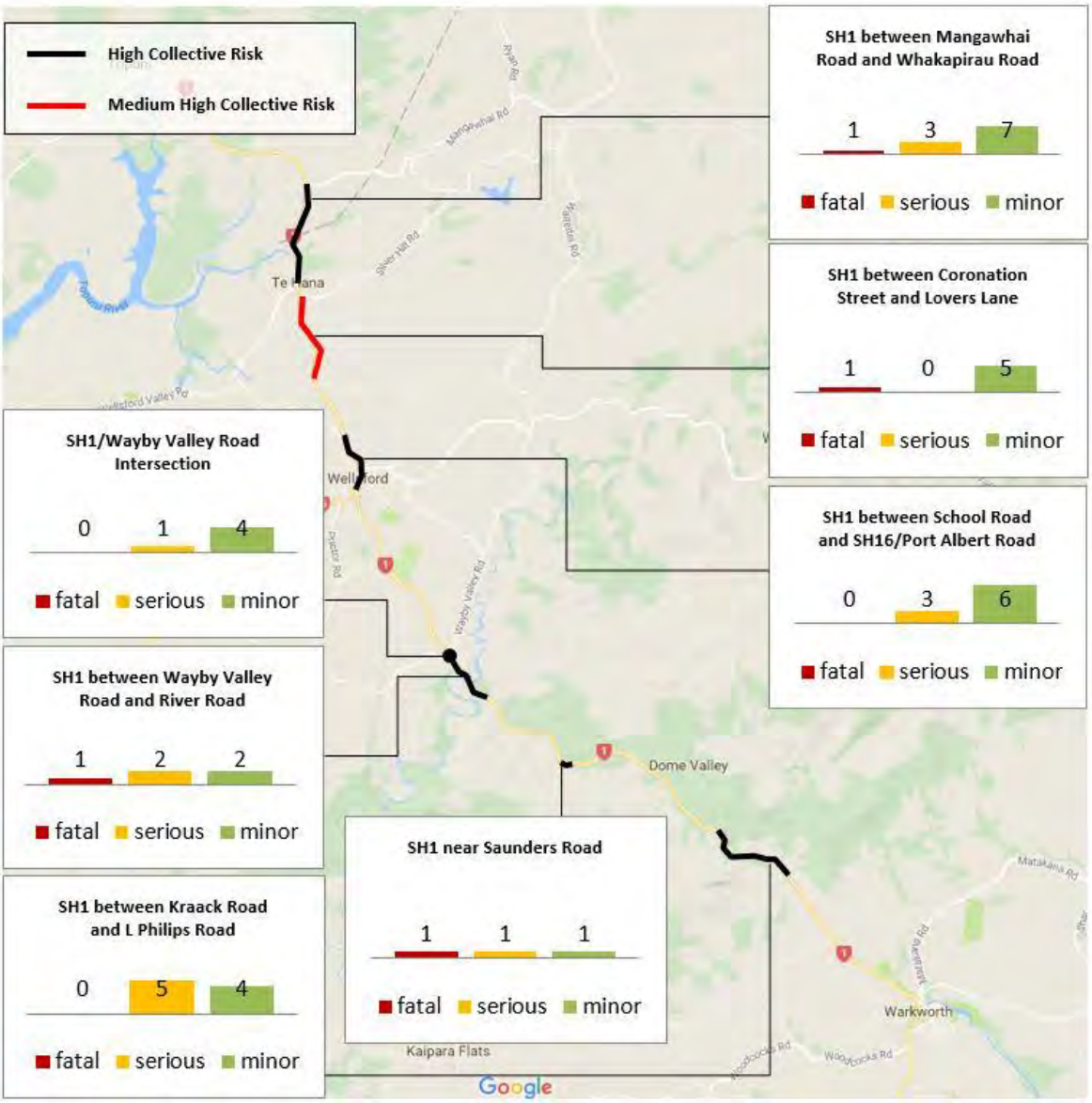

Figure 9-14: Sections of SH1 with a High or Medium High Crash Risk Ranking (2006-2011)

The Dome Valley safety improvements project will improve safety along SH1 through providing improved and widened shoulders and shoulder barriers, providing wider centre medians or median safety barriers, and improvements to the passing lanes[80].

Travel times

The existing Warkworth to Te Hana section of SH1 is currently subject to congestion. The most regular congestion currently occurs through Warkworth, at the southern end of the Project, and southbound queues extend back several kilometres. This congestion results in increased travel times, not only through Warkworth but also through Wellsford and at various locations along the route, such as at the end of passing lanes. Congestion is known to be extensive at peak periods, such as at weekends over the summer, and particularly around weekends which coincide with public holidays. Travel times for northbound traffic are significantly higher at the start of a holiday weekend, and for southbound traffic at the end of a holiday weekend. In addition, severe congestion can occur as a result of unexpected incidents (such as crashes, slips, etc.).

Travel time reliability

Congestion not only results in increased travel times but also increased variability of travel times and reduced reliability. The southbound trip through Wellsford has the most variability in the morning, evening and holiday end peaks. In the morning weekday peak 92% of trips have a journey time between 2 and 5 minutes. However, only about 31% of southbound trips have a journey time between 3 and 5 minutes during the holiday end period. Travel time variability is mainly an issue during holidays, particularly through Wellsford.

Increased variability makes journey planning difficult for individuals and businesses such as freight operators and others who rely on the transport system for the movement of goods and services.

Route resilience

The SH1 corridor between Auckland and Whangārei is of nationally strategic significance as it provides the primary strategic inter-regional transport route between the Auckland and Northland regions. However, the Warkworth to Te Hana section of the existing SH1 route is closed on average five times per year for an average of three hours as a result of events such as crashes, flooding or slips blocking the road. The detour routes for many of these closures are challenging.

Road freight performance

The SH1 corridor has an important freight function, providing freight access between Auckland and Whangārei.

The geometry of the Warkworth to Te Hana section of SH1 presents difficulties for heavy vehicles, particularly through the Dome Valley where SH1 is a single carriageway with tight horizontal curves and steep grades in some locations, both of which force heavy vehicles to lose speed. HCVs were involved in approximately 12% of all injury crashes and 20% of fatal and serious injury crashes on SH1 between

[80] This project will lead to safety improvements along the corridor, but will have minimal effects in terms of the traffic capacity along the route.

Warkworth and Wellsford. In addition, the lack of resilience affects HCVs as many of the detour routes are not able to carry HCVs.

Public transport, pedestrian and cycle network performance

There are currently limited public transport services in the Project area and no pedestrian or cycle facilities along the majority of SH1 between Warkworth and Te Hana, with the exception of Wellsford town centre. Accordingly, the levels of pedestrians and cyclists travelling along or across the route are very low. There is a greater level of pedestrian activity within Wellsford, both along and across SH1. The section of SH1 through the Wellsford township generally has footpaths on both sides, and only one pedestrian crossing within the town centre.

9.14.3. Transport assessment methodology

The assessment of the operational transport effects of the Project has been undertaken by forecasting the performance of the transport network for a "Future Reference Case Scenario" which assumed that the Project was not constructed. The forecast performance of the transport network in the future for a "Project Scenario" was then determined, which assumed that the Project was constructed. A comparison of the performance of the transport network in the two scenarios was undertaken to assess the potential positive and adverse transportation and traffic effects of the Project.

Transport model

The assessment of operational transport effects is based on the outputs of traffic modelling. A SATURN traffic model was developed for the road network from Pūhoi to Te Hana, including the townships of Warkworth and Wellsford. The regional transport demands for the model were sourced from the Auckland Regional Transport (ART) model.

The assessment of transport effects has been undertaken using the forecast years of 2036 and 2046, as the construction of the Project is assumed to be complete and operational by 2036. The traffic model has a base year of 2016. Irrespective of the operational date of the Project the overall outcomes of the traffic assessment are valid.

Definition of scenarios

Future Reference Case Scenario

The Future Reference Case Scenario allows the future transport network performance to be assessed in the absence of the Project. It represents the future transport environment baseline and was forecast for the years 2036 and 2046.

Land use forecasts for the Future Reference Case Scenario were developed from the following sources:

- Auckland Regional Transport (ART) model with I11.4 land use assumptions[81]
- Auckland Transport forecast growth for Warkworth and Wellsford
- Kaipara District Council forecast growth for Mangawhai.

[81] This reflects Auckland Council/ Auckland Transport growth expectations (updated September 2017) and was sourced from the Auckland Forecasting Centre.

The Future Reference Case Scenario assumes a number of changes and improvements relating to the future transport network which are anticipated to take place over time. These transport network changes include the P2Wk section, and new roading around the Warkworth township. These changes and improvements are identified in section 2.5 of the *Operational Transport Assessment*.

Project Scenario

The Project Scenario has the same network, land use and demand assumptions as the Future Reference Case Scenario, but it also includes the Project.

Sensitivity testing

There is a level of uncertainty around the accuracy of future traffic forecasts. Therefore, a series of sensitivity tests were carried out to consider:

- The inclusion of only committed transport projects;
- A lower increase in the rate of growth (slower growth), and
- Increased traffic growth based on a higher number of trips in the local network.

9.14.4. Assessment of operational transport effects

The Project has been developed to address the issues identified with the existing transport environment, i.e. the predicted scenario in the future if the Project is not constructed. Accordingly, as would be expected, there will be significant positive operational transport effects as a result of the Project. In addition, the transport environment that exists at the time of detailed design will be assessed and reflected in the detailed design.

Safety

In the future, if the Project is not constructed, traffic volumes on SH1 between Warkworth and Wellsford are predicted to increase from approximately 14,000 vpd to approximately 29,000 vpd in 2046. The increases in travel times predicted indicate that more congestion and queuing is expected in future. This congestion and queuing is predicted to increase the rate of rear-end crashes and may also increase the number of head-on crashes due to increases in two-way traffic demands. These increased demands will reduce the margin for error (i.e. it will increase the possibility of there being an oncoming vehicle if a vehicle accidentally crosses the centre line) and it will reduce the possibility of safe overtaking manoeuvres.

It is expected however, that the slower travel speeds along the route may reduce the severity of crashes during busy time periods. In addition, improvements are being implemented by the Safe Roads Alliance to the existing SH1 through the Dome Valley.

While volumes in the corridor will increase over time, if the Project is constructed a large proportion of trips between Warkworth and Wellsford will travel along the Project route. The Project route can be expected to have a significantly improved safety performance compared to the existing SH1, as it will be designed to the highway standards which apply at the time of detailed design. As a result, the Project will deliver a range of safety improvements (dual lane carriageway, median, side barriers, removal of local road intersections, and accesses etc.).

The Project is predicted to result in a significant reduction in crashes along the existing SH1, primarily due to the reductions in traffic volumes. The net effect of the

Project is expected to be a reduction in annual injury crashes from 19 crashes to 17 crashes (a 10% reduction), along the existing SH1 and the Project route (i.e. combined), relative to the 2036 Future Reference Case Scenario, in which the Project is not constructed. This 10% reduction significantly underplays the expected effects of the Project, which is expected to lead to a change in the level of injury incurred, namely a significant reduction in serious or fatal crashes in the Project area. The Project may change the severity of crashes occurring on the existing SH1 as the predicted lower volumes may result in higher speeds (due to the reduction in congestion along the route) and therefore a higher proportion of high severity crashes. However, as the vast majority of vehicles are predicted to divert off the existing SH1 and on to the new, safer route, the total number of crashes involving deaths and serious injuries is predicted to reduce significantly. The Project will also provide a safer walking and cycling environment within Wellsford and Te Hana with the shift of vehicles to the new road.

Public transport, pedestrian and cycle networks

In the future if the Project is not constructed, increased traffic on SH1 will cause longer travel times and decreased travel time reliability for the existing bus services between Auckland and Whangārei. These effects will be particularly pronounced during holiday periods, when bus services are likely to be more heavily utilised and traffic flows on SH1 are highest. The increase in traffic will also increase the difficulty for pedestrians of crossing SH1.

With the Project, the performance improvements forecast below for general traffic will be experienced by the regional bus services that run between Auckland and Whangārei, in terms of shorter travel times and increased travel time reliability. The significant reduction in traffic on the existing SH1 will make it easier and safer for pedestrians in Wellsford to cross SH1. The reduction in traffic could also facilitate the addition of more convenient crossings in Wellsford in the future.

Higher levels of traffic along the existing SH1 in the Future Reference Case Scenario could present an increased risk of conflict for recreational cyclists in the Project area, and for pedestrians and cyclists within Wellsford. The lower volumes of traffic along the existing SH1 route between Warkworth and Te Hana with the Project will improve safety and amenity for pedestrians and cyclists using that route. In addition, the Project will significantly reduce traffic flows within Wellsford and Te Hana, which will improve safety and amenity for pedestrians and cyclists within those townships.

Pedestrians and cyclists will be prohibited from using the new state highway through this section. Provisions have been made for pedestrians and cyclists on local roads affected by the Project in the indicative design. These provisions support the potential development of further future walking and cycling infrastructure in the area.

Traffic volumes

Modelling of the Future Reference Case Scenario (that is without the Project) indicates that traffic volumes on the existing SH1 are predicted to grow at a rate of approximately 3.4% per annum between 2016 and 2046 between Warkworth and Wellsford, increasing by 71% between 2016 and 2036, without the Project in place. This growth rate means that daily traffic volumes on SH1 are expected to be in the order of 29,000 vpd in 2046. This forecast growth rate is consistent with the 3.7% per annum growth rate observed over the last five years at this section of SH1. The

evening peak flows are the highest, and there is more traffic in the inter peak than in the morning peak. This pattern is consistent in all three model years, becoming more pronounced as overall volumes increase.

With the Project Scenario, traffic volumes on the existing SH1 are forecast to significantly reduce by 86% to 4,000 vpd in 2046 (refer Figure 9-15). These reduced traffic volumes on SH1, with the shift of the majority of traffic to a four lane dual carriageway, will provide faster and more reliable travel times for vehicles. Traffic volumes on the Project (between Warkworth and Wellsford) are expected to be 24,600 vpd in 2046.

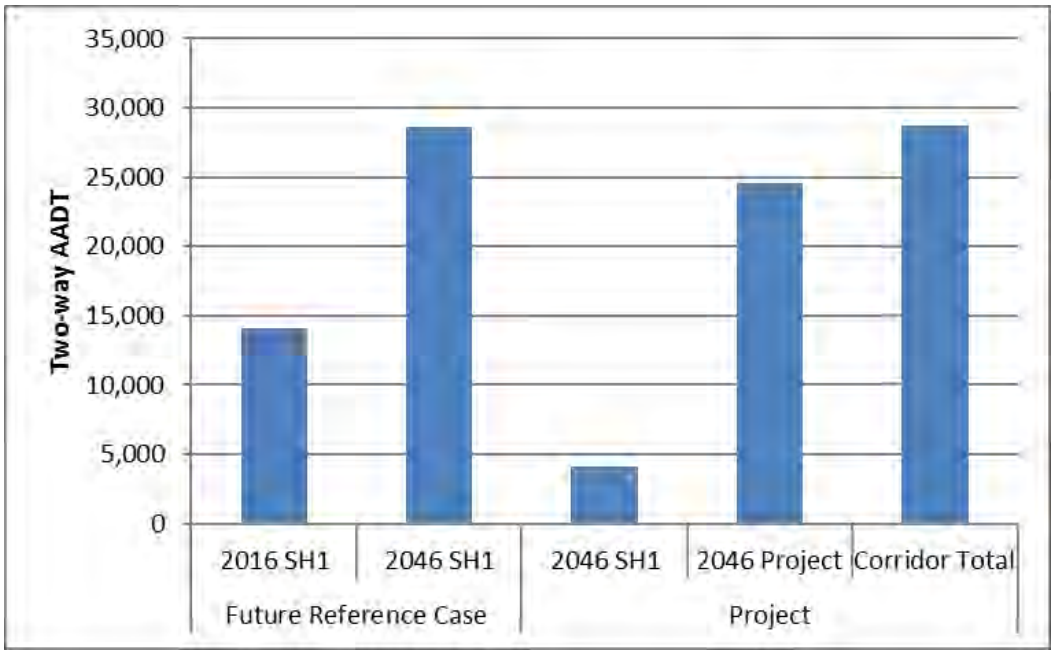

Figure 9-15: Traffic volumes between Warkworth and Wellsford in the Future Reference Case (without Project) and with Project scenarios

Travel times

In the Future Reference Case Scenario, the travel times along SH1 between Warkworth and Wellsford on a normal weekday are not expected to increase significantly between 2016 and 2046 (refer Table 9-25). This is because the improvements proposed to the road network considered in the Future Reference Case Scenario (such as P2Wk project, which will allow traffic to bypass Warkworth centre, or the Sandspit Link which will allow traffic from the eastern beaches to bypass the Hill Street intersection) can be expected to significantly relieve the queues that currently extend north from Warkworth at peak times. With the increase in traffic volumes on SH1, travel time reliability is likely to decrease on the Warkworth to Te Hana section of SH1 in the Future Reference Case Scenario. In summary, the traffic demand will be balanced by provision of new infrastructure, so travel times will not significantly increase, yet there will be more traffic on the road and the network will be closer to capacity overall, resulting in less travel time reliability.

Table 9-25: Travel times on SH1 between Warkworth and Wellsford (minutes)

	Period	2016	2036	2046	Change 2016 to 2046	
					Absolute (minutes)	%
Northbound						
Warkworth to Wellsford	Morning	17	18	18	2	10%
	Inter peak	17	18	19	2	12%
	Evening	18	19	21	3	16%
Southbound						
Wellsford to Warkworth	Morning	18	18	19	1	8%
	Inter peak	17	19	20	2	13%
	Evening	19	19	21	2	10%

The Project's new four lane dual carriageway will reduce travel times and allow journeys to be planned with a greater level of certainty. The modelling results indicate a decrease in travel times for travellers on both the existing SH1 and the Project.

For through traffic (from Pūhoi to Te Hana), travel times on the Project are predicted to be consistent in both directions and all time periods, indicating that it is predicted to operate with free-flow conditions. Travel times via the existing SH1 are predicted to reduce between 6% and 24%, depending on period and direction. Travel times via the Project are predicted to reduce between 36% and 48% (refer Figure 9-16).

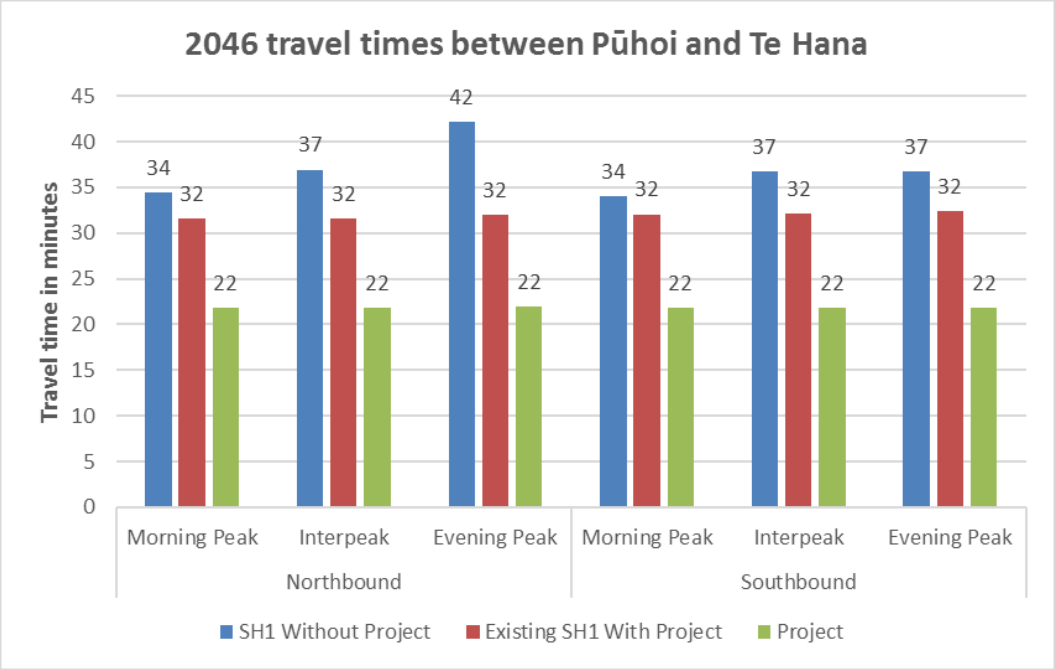

Figure 9-16: Travel times between Pūhoi and Te Hana (through traffic)

For local traffic, the Project is predicted to have the lowest travel times overall, even though it will have a longer distance than the existing SH1 route. Travel times via the Project (when compared to the existing SH1 route) are predicted to reduce between 9% and 19% (refer Figure 9-17). Travel times on the Project are predicted to

be consistent in both directions and all time periods, indicating that it will be operating with free-flow conditions. Travel times via the existing SH1 are also predicted to reduce between 6% and 16%, depending on time period travelled and direction.

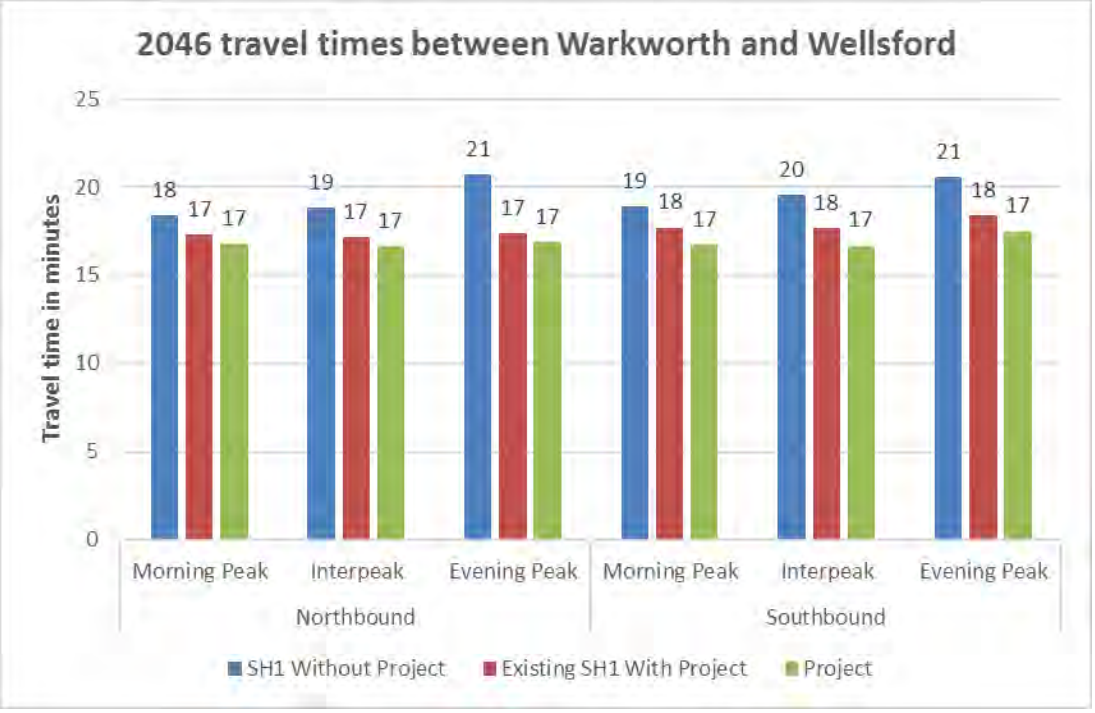

Figure 9-17: Travel times between Warkworth and Wellsford (local traffic)

The proposed interchanges are predicted to operate within their capacity, at level of service[82] B or higher in 2046, with average delays of less than 20 seconds.

Travel time reliability

With the increased traffic volumes on SH1 travel time reliability is likely to decrease on the Warkworth to Te Hana section of SH1 in the Future Reference Case Scenario. In congested conditions, small disturbances in flow are more likely to result in delays and queuing.

Travel time reliability is expected to improve in the future with the Project, given the capacity along the corridor will increase significantly as a result of the Project. Trips to and from locations to the north of Wellsford will be faster along the Project route, while the reduction in traffic along the existing SH1 route will also reduce travel times for vehicles that remain on the existing SH1. With two traffic lanes in each direction along the Project route, plus crawler lanes, more opportunities for passing will be provided than on the existing SH1. Reduced traffic volumes on the existing SH1 corridor will allow light vehicles to be less constrained by slow moving HCVs. A shift of HCVs onto the Project route will provide greater travel time consistency for HCVs due to the improved road geometry along this route.

Although not directly forecast by the models, travel time reliability generally decreases as traffic levels approach capacity. Therefore, the significant increase in

[82] Level of service (LOS) is a qualitative measure used to relate the quality of traffic service

capacity provided by the Project is expected to significantly improve travel time reliability.

This improvement in travel time reliability will be a significant benefit of the Project, enabling individuals and businesses to plan their travel with a much greater degree of certainty and providing for a much more robust network that will be able to cater for some disruption without significant increases in travel time.

Route resilience

The introduction of a high quality, alternative route to the existing SH1 route between Warkworth and Te Hana will reduce the effects of incidents (crashes and natural events such as slips and flooding) on travel between Warkworth and Te Hana – which in turn will mean improved resilience for those travelling between Northland and Auckland. The Project will improve route resilience in the following ways:

- Having two routes will provide a measure of redundancy and a greater level of security and availability of travel routes between Auckland and Northland.
- The Project route will have four traffic lanes. This design will allow the route to be opened sooner following a crash than is currently possible on the existing SH1, which is primarily a single carriageway.
- The number of crashes both on the existing SH1 and in the Project corridor overall is forecast to reduce, which will consequently reduce the number of times the route is closed.
- Improved resilience through the reduction of natural hazards i.e. slips and increased choice for route diversion.

As a result of these factors, the resilience of the wider state highway network will be improved as a result of the Project.

Road freight performance

With the Project in place, the volume of HCVs along the existing SH1 is expected to reduce by 80% as they will be attracted to the Project route, given road freight performance will be improved in the following ways:

- The Project will be designed to the highway standards which apply at the time of detailed design, with grades and alignment favourable to HCVs. The Project will therefore improve travel times and vehicle operating costs for HCVs and increase travel time reliability for HCVs.
- Improved travel times for freight will improve opportunities for trade by effectively bringing freight destinations closer together.
- HCVs will be able to bypass the Dome Valley, which currently presents geometric challenges and safety risks for heavy vehicles.
- The Project route will have four lanes, which will improve safety and travel times by eliminating the need for passing lanes and risky overtaking manoeuvres.
- Travel times and travel time reliability for HCVs will improve in the same way as described for general traffic.
- Safety for HCVs will also improve as described for general traffic.

Overall, the project is expected to have a positive impact on the performance and safety of freight.