NZ TRANSPORT AGENCY
WAKA KOTAHI

Roads of national significance

16 20

Western Ring Route – Waterview Connection

Erosion and Sediment Control Plan

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1. Introduction and Project Description

The purpose of this report is to describe the methods and practices to be implemented to minimise the effects of sediment generation on the aquatic receiving environments associated with the Waterview Connection Project (the "Project"). This erosion and sediment Control Plan (ESCP) is prepared to support the assessment of environmental effects and to provide guidance to construction contractors.

The Project is the key project to complete the Western Ring Route (WRR), providing for works on both State Highway 16 (SH16) and State Highway 20 (SH20) to establish a high-quality motorway link that will deliver the WRR as a Road of National Significance (RoNS).

The recent completion of the Manukau and Mount Roskill Extension Projects on SH20 means that this highway now extends from Manukau in the south to New Windsor in the north, terminating at an interchange with Maioro Street and Sandringham Road. Through the Project, the NZTA proposes to designate land and obtain resource consents in order to construct, operate and maintain the motorway extension of SH20 from Maioro Street (New Windsor) to connect with State Highway 16 (SH16) at the Great North Road Interchange (Waterview).

In addition, the Project provides for work on SH16. This includes works to improve the resilience of the WRR; raising the Causeway on SH16 between Great North Road and Rosebank Interchanges, which will respond to historic subsidence of the Causeway and "future proof" it against sea level rise. In addition, the Project provides for increased capacity on the SH16 corridor; with additional lanes provided on the state highway between St Lukes and Te Atatu Interchanges, and works to improve the functioning and capacity of the Te Atatu Interchange.

The Waterview Connection will be the largest roading project ever undertaken in New Zealand. The Project includes construction of new surface motorway, tunnelling and works on the existing SH16 (Northwestern Motorway) as well as a cycleway that will contribute to the connection between the Northwestern and SH20 Cycleways.

The Project has two (2) separate components being:

- The SH20 Waterview Connection – this section comprises a new state highway link between SH20 and SH16 and capacity improvements on SH16 between the Great North Road and the St Lukes Interchanges, with connection to SH16 at the Great North Road Interchange and completion of 'north facing' ramps at the Maioro Street Interchange; and

- The SH16 Causeway – this section comprises capacity enhancements and raising of the SH16 Causeway to improve the resilience of the state highway network, as well as improvements to the Te Atatu Interchange.

The Project sector diagram as included in Appendix A provides an overview of the extent and works for the Project. This Erosion and Sediment Control Plan (ESCP) covers all sectors of the Project.

The construction methodology for the Project is intended as a realistic and feasible methodology from which the anticipated effects on the environment of these activities can be identified. It is recognised that once the

Project has been awarded and a contractor (or contractors) is in place, the methodology will be further refined and developed. It is acknowledged that this must be done within the scope of the conditions which will be in place to manage the environmental effects of the construction activities.

The Project is anticipated to take between 5 and 7 years to complete, and will able to be undertaken on a number of fronts or work faces, such that many elements of the Project will be undertaken concurrently. It is currently anticipated that the Project will be undertaken in the following main construction activities:

1. Te Atatu Interchange (Sector 1);
2. Causeway and Whau Bridges (Sector 2, 3 and 4);
3. Great North Road Interchange (Sector 5);
4. SH16 Great North Road to St Lukes (Sector 6);
5. Tunnel (Sector 7 and 8);
6. SH20 from tunnel to Maioro Interchange (Sector 9).

During construction, erosion and sediment control measures will be put in place to minimise potential adverse effects by utilising measures which meet industry best practice guidelines such as reflected by Auckland Regional Council's Technical Publication Number 90 Erosion and Sediment Control Guidelines for Land Disturbing Activities (TP 90). However, as expected with projects of this size and nature, it is expected that site and activity specific erosion and sediment control plans will be developed which will follow the general principles of this ESCP. These are referred to as Contractors Erosion and Sediment Control Plans (CESCPs). This will enable the contractor and Auckland Council to have further input into the methodologies implemented.

Once the erosion and sediment controls are in place, ongoing site monitoring by the contractor and the NZTA representatives will occur to ensure that the proposed erosion and sediment control measures have been installed correctly, and are functioning effectively throughout the duration of the works.

Stormwater management during the construction phase is a separate and unique stage in the water management of the motorway. It occurs after earthworks activities have ceased in an area, and erosion and sediment controls are no longer appropriate, but before operational stormwater controls are in place. Stormwater management measures are proposed for impervious construction areas and the pavement of the constructed motorway.

There are 12 construction yards proposed along the route of the Project. All yards will be fully fenced and made secure. Site establishment activities will include site clearance, ground preparation, and establishing erosion and sediment control measures prior to any construction activities occurring. Upon completion of the works, it is expected that the construction yards will be disestablished and the areas reinstated.

During construction, a variety of measures will be used to manage construction activities and ensure that construction is being undertaken in a way that avoids, minimises or reduces effects on the environment. This will include specific mitigation measures, environmental monitoring and environmental auditing. To assist this process, and ensure that the Contractor(s) meet both the designation and resource consent requirements and

the NZTAs requirements, a Construction Environmental Management Plan (CEMP) has been prepared for the Project (Technical Report No. G 21 Construction Environmental Management Plan (CEMP).

The CEMP is an overarching document which supports the applications for resource consents and designations and, ultimately, provides a blueprint to be used by the construction contractors to manage the environmental effects of the Project. The principles and general approach to managing the environmental effects are set out in the main body of the document. The management of specific effects (e.g. construction air quality, noise, vibration etc.) are detailed more particularly within a suite of environmental management plans (sub-plans) that form the appendices to the CEMP. This suite of management plans is:

- Construction Noise and Vibration Management Plan (CNVMP)
- Construction Air Quality Management Plan (CAQMP)
- Erosion and Sediment Control Plan (ESCP)
- Temporary Stormwater Management Plan (TSMP)
- Ecological Management Plan (ECOMP)
- Groundwater Management Plan (GWMP)
- Settlement Effects Management Plan (SEMP)
- Contaminated Soils Management Plan (CSMP)
- Hazardous Substances Management Plan (HSMP)
- Archaeological Site Management Plan (ASMP)
- Construction Traffic Management Plan (CTMP)
- Concrete Batching and Crushing Plant Management Plan (CBCPMP)

The contractor(s) will be required to undertake all construction activities on site in accordance with the provisions of the relevant management plans as part of their contractual arrangements.

The CEMP will be reviewed after confirmation of the resource consent and designation conditions and will be revised in accordance with these conditions. The CEMP and the sub-plans will be updated, with the necessary approval, throughout the course of the Project to reflect material changes associated with changes to construction techniques or the natural environment.

Figure 1.1 below illustrates the relationship of the CEMP to other Project management plans and the Assessment of Environmental Effects.

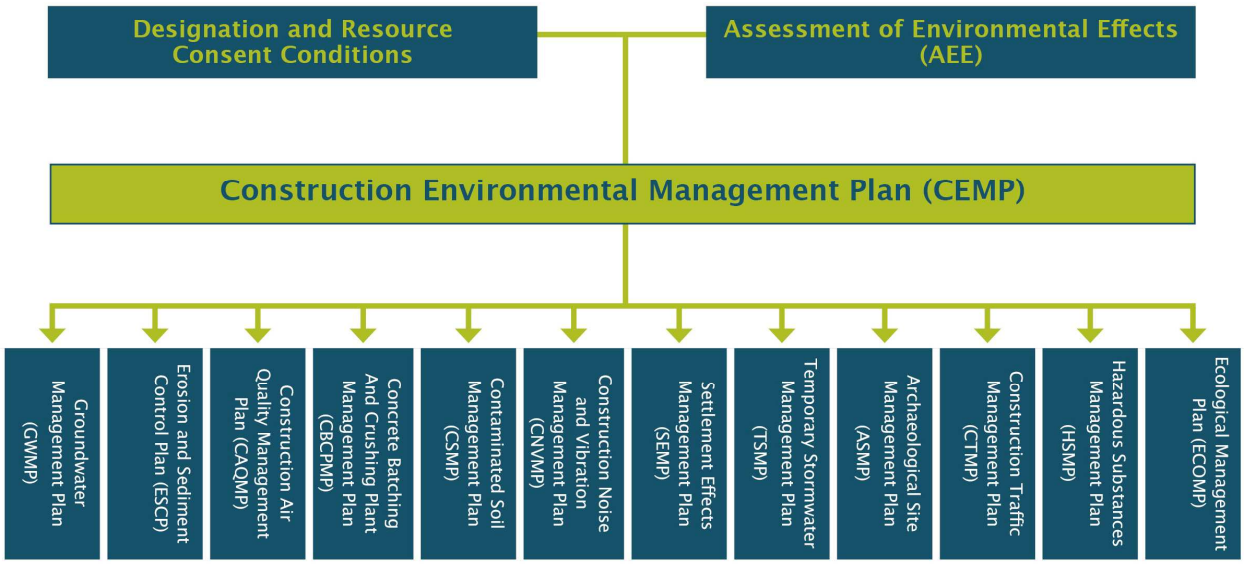

Figure 1.1: Construction Environmental Management Plan

The Contractor will then be required to develop a CESCP for each specific package of work, that is consistent and in accordance with the CEMP, and submit to the NZTA and the Auckland Council for approval prior to undertaking the work.

2. Design Philosophy and Principles

The following provides a generic site description and sets a context for the development of the ESCP. Reference should be made to the *"Project Description (Construction)"* within the AEE documentation which outlines the specific sector by sector details.

The site generally has gentle slopes and therefore a relatively lower erosion risk than sites with steep catchments and earthworks slopes.

The receiving environment values associated with the site include a range of both fresh water and coastal ecological and amenity values. It is important that erosion and sediment control options recognise these values and manage the discharge of sediment accordingly. This ESCP builds on the areas of significance as identified within Technical Report No. G 6 Assessment of Freshwater Ecological Effects, and Technical Report No. G 11 Assessment of Marine Ecological Effects,

- and refers to these as higher risk areas providing for protection of these areas through avoidance of discharges and implementation of erosion and sediment control measures.

The Oakley Creek is defined in detail within Technical Report No. G 6 Assessment of Freshwater Ecological Effects and is summarised as follows within that report:

- Oakley Creek is a significant watercourse (11.3km long) in Auckland City. Parts are substantially modified and the entire creek receives urban stormwater runoff from the surrounding catchment. A 6m high natural waterfall located approximately 900m upstream of its mouth prevents passage of most native fish species, with the exception of longfin and shortfin eels.

- Ecological investigations indicated that environmental conditions within Oakley Creek are poor, probably due to low water quality. The primary indicators of this poor water quality were the macro-invertebrate communities, which were characterised by low numbers of taxa and the absence of pollution-sensitive taxa. Of note in this regard, Oakley Creek near New North Road provided physical habitat conditions favourable to a range of sensitive species (eg. stony substrate and oxygenated water), and their absence in this area therefore suggests that water quality was the main limiting factor. The other sites also lacked pollution-sensitive taxa, and generally had few insect taxa of any sort.

- Relatively high abundance of midge larvae and axehead caddis larvae at the Oakley Creek sites suggested the presence of productive algal slimes on the rocky substrate, which indicates nutrient enrichment.

- In terms of physical habitat, Oakley Creek is a large stream with a large volume of habitat, deep pools suitable for large eels and permanent flows. Below New North Road it has a relatively low level of channel modification, although hydrological changes resulting from urbanization have probably affected channel form.

- Freshwater fish communities within Oakley Creek above the waterfall are of very low diversity, with only shortfin eels (in super-abundance) and (less commonly) longfin eels, and the introduced goldfish and mosquitofish being recorded. Given this it is evident that the waterfall on the Oakley Creek near UNITEC (downstream of the Phyllis Street Reserve) is a significant barrier to migrating native fish.

- Overall the sections of Oakley Creek within the Project area have relatively low ecological health, in terms of physical habitat modification and diversity and sensitivity of macroinvertebrates. Water quality is low but is similar to other urban catchments.

- Because of the existing ecological condition, the Creek has a relatively low sensitivity to impacts, and a relatively large impact would be required to significantly affect aquatic ecological values.

Given the inherent high variability with respect to marine invertebrates, it is clear that the intertidal areas north of the Causeway, and drier more coarse grained patches within the Waterview Estuary, have higher ecological values due to higher diversity of organisms and presence of less tolerant species such as bivalves and gastropods.

Of specific interest to the Project is the tidal influence of the harbour environment associated with the SH16 component of the Project. There are particular practical and environmental issues associated with working in this area which results in methodologies and control measures of a higher standard than that typically expected for earthworks operations in the Auckland region.

This document is referred to as an Erosion and Sediment Control Plan which forms part of the overall assessment and the Construction Environmental Management Plan. More specific erosion and sediment control plans, CESCPs, will be developed for each specific area and activity prior to construction.

On most earthwork sites, most sediment generally arises from the bulk earthworks phase of operations because of the area exposed by these works and the time required to undertake the works. For this Project, slope is considered more influential on sediment yield than site area due to the fact that the Project does not feature significant bulk earthwork operations involving large volumes of earth being worked over long periods of time. Approximately 70% of the Project is involved with either the creation of additional lanes either side of existing carriageways, or reworking existing road surfaces. Such works, particularly lane widening works, typically involve small catchments, have low slope angles and small exposure periods, and use granular fill that has low erodibility. A further 20% of the route will be cut and cover or tunnel works and the excavation nature of this work will result in ponded water rather than discharged water. These works are typically low sediment generators and total control can be exerted over ponded water. In all, only about 10% of the actual length of carriageway comprises the usual type of bulk earthworks. The numerous construction yards add to the overall area but low sediment loads are expected from them because of their short construction time and efficient sediment control measures.

There are however other land disturbing activities proposed by the Project that need to be taken into account when considering the potential generation and discharge of sediment from the Project. These include stream works and coastal reclamation. Because of the extent of these works on this Project, and because of the immediate delivery of any sediment yield into the aquatic environment, these works could be considered to be higher risk than the works confined directly to the land, from an environmental perspective.

Erosion is the process whereby the land surface is worn away by the action of water, wind, ice or other geological processes. The resultant displaced material is known as sediment with sediment yields being the sediment which leaves a particular control measure. Sedimentation is the deposition of this eroded material. Accelerated erosion is primarily caused by human activities and is a much more rapid process then natural erosion.

Through the erosion process, soil particles are dislodged, generally by rainfall. As rain falls, water droplets concentrate and form small flows. The combined energy of the rain droplets and the concentrated flows has the potential to dislodge soil particles. The amount of sediment generated depends on the erodibility of the soil, the amount of energy created by the intensity of the rainfall event and the site conditions, for example the slope and the slope length of the site. In general, the steeper the site and the longer the flow lengths, the more energy will be created. Any reduction of erosion will reduce the erosion and sediment generation.

Erosion and sediment control measures are used to minimise the effects of earthworks on receiving environments.

Erosion control is based on the practical prevention of sediment generation in the first instance. If erosion control is effective and sediment generation is consequently minimised, then the reliance on the sediment control process is not as significant.

Sediment control, on the other hand, refers to management of the sediment *after* it is generated. It is inevitable that some sediment will be generated through earthworks, even with erosion control measures in place. Sediment control is designed to capture this sediment and minimise any resultant discharge.

A significant reduction in erosion on a site will lead to far less sediment being generated, treated and ultimately lost through the control measures as opposed to full reliance on sediment control measures.

The erosion and sediment control measures for the Project are designed to minimise the extent of soil erosion and any resultant sediment yield from the Project site. The proposed erosion and sediment control measures have been designed in accordance with TP90 and are detailed later within this report. In some circumstances measures exceeding TP90 Guidelines are proposed where there is a greater risk of undertaking the works.

The following erosion and sediment control principles will apply.

1. Erosion and sediment control measures will be undertaken and implemented with a hierarchy and priority order as follows:

    a. Avoidance of effects will be the first priority. Discharge locations will be carefully selected; streamworks will only be undertaken where they are a necessary component of the Project construction and temporary stream crossings will be based on bridge structures, where at all possible, to avoid direct stream disturbance activities.

    b. Erosion control will be a priority in all circumstances by preventing sediment generation through a range of structural (physical measures) and non structural (methodologies and construction sequencing) means.

    c. Sediment Retention Ponds (SRPs) including chemical treatment are the primary control method to be utilised in all cases based on the Ridley Dunphy Environmental Limited Chemical

Treatment Plan (CTP) dated August 2008 (updated May 2010) and the Orica Chemnet Report dated March 2010 (attached in Appendix B). These reports show the variability in the soils encountered and confirm the ability to chemically treat sediment laden water to achieve the necessary water quality. Priority of controls will then be decanting earth bunds, super silt fences and silt fences. Various innovative products may also be used and could include measures such as filter socks and portable cofferdams. Approval is expected to be required for these products, with approval based upon the expected effectiveness of the products and the suitability of alternatives to achieve the same environmental objectives. The selected innovative measures may move in the priority ranking with this dependent upon their suitability.

2. All SRPs will be based on TP90 design with the 3% volume criterion applied in relationship to catchment size (i.e. $3m^3$ SRP volume per $100m^2$ of contributing catchment).

3. Pumping of sediment laden runoff and groundwater during construction will be required from both the northern and southern tunnel portals. These flows will be pumped to SRPs or to temporary stormwater treatment devices with the volume of the SRPs, in addition to other detention structures, being sufficient to treat both surface runoff and groundwater flows.

4. SRPs for the treatment of construction related sediment laden runoff will be established as independent devices. The Project also includes the installation of a number of stormwater wetland and pond features (for both temporary and permanent stormwater treatment from impervious surfaces) as detailed within Technical Report No. G 15 Assessment of Stormwater and Streamworks Effects. Where it is not practical to install separate SRPs they will be installed in the same location as the stormwater devices. SRPs will be installed early in the Project, and designed in accordance with TP90. Consideration will be given to pond depth and configuration to ensure that the eventual conversion of these temporary SRPs to long term stormwater features can be undertaken appropriately. For example, the outlet pipe location and sizing will be based on the long term stormwater device to minimise further rework of such areas.

5. Chemical treatment will be based upon the chemical treatment tests detailed in the CTP. The flocculant polyaluminium chloride (PAC) was tested, with initial bench test results indicating a dose rate of 4 milligrams of aluminium per litre of runoff volume. Rainfall activated systems will be utilised in all SRPs where surface flows can directly enter the SRPs. However where pumping of sediment laden flows to SRPs is required then a manual batch chemical dosing regime will also be implemented. This is also to be based on the CTP. The CTP will be updated immediately before works are undertaken to ensure that the site-specific issues such as specific roof size, header tank design and other chemical details for each work area and activity are accurate. The CTP is based on sampling undertaken in 2008, however represents soils that are expected to be encountered within both the northern and southern tunnel portal areas. The Orica report is based on more recent soil samples from locations as identified within the Orica report and as outlined in the associated geotechnical investigation report.

   The standard of discharge quality aimed at from the Project will be 100mm clarity from all chemically treated detention structures prior to any discharge.

6. All decanting earth bunds will be based on a volume of 2% of the contributing catchment area with an ideal length to width ratio of 1:3. Further, chemical treatment will be applied to all decanting earth

bunds through the provision of rainfall activated systems as defined within the CTP. Where contributing catchment areas are less than 500 m^2, manual batch dosing will be implemented as an alternative. This design exceeds TP90 guidelines. All spillways from the decanting earth bunds will be installed as per TP90 guidance which ensures that they safely pass the 1% AEP rain event with low velocity and therefore minimal scour potential.

7. All SRPs and decanting earth bunds will be fitted with floating decants and a mechanism to control outflow; e.g. a manual decant pulley system, to be used during pumping activities to these structures. In this circumstance, discharge will cease, manual batch dosing will occur, and only once the standard of discharge quality can be achieved will the decants again be lowered. Pumping will be such that pump volumes will only be to the same level as that able to be fully captured within the retention structure.

8. It is recognised that some of the soil material within which the SRPs will be constructed, such as basalt, may lead to difficulties with achieving a fully sealed structure. As a result all SRPs will be over excavated, lined with an impermeable layer, and fill material placed over the impermeable layer to achieve the correct SRP volume. This will ensure that no leakage from these structures occurs.

9. All super silt fences and silt fences will be based upon the design criteria within TP90. The fabric will be installed with a minimum 200mm of fabric placed upslope at the base of the trench. In circumstances where silt fences or super silt fences are proposed next to active roads, they will be installed only after traffic barriers have been installed, to ensure safe installation and also to provide further protection of the silt fence or super silt fence material from accidental damage.

10. Dirtywater runoff diversion channels will be sized to cater for the 1% AEP rainfall event which will ensure that all storm events up to this design will be diverted to control measures without overtopping. This will prevent uncontrolled runoff within the site boundaries. The design for all dirtywater runoff diversion channels will be based on the largest catchment areas within the Project and accordingly will result in overdesign in relation to TP 90 requirements. Dirtywater runoff diversion channels sizes will be based on the tables provided within Section 5.0 of this ESCP. While these dirtywater runoff diversion channels are "oversized", there remains the potential for deposition within them, and where this is noted to be an ongoing issue, excavated pits or sumps will be positioned along the channels to retain sediment bed load.

11. Cleanwater diversion channels designed to cater for the 1% AEP rainfall event, will be installed to divert all possible upslope cleanwater away from the earthworks areas. Where this cannot occur in practice, SRP volumes will be increased in volume to allow for the further cleanwater catchment. Cleanwater runoff diversion channel sizes will be based on the tables provided within Section 5.0 of this ESCP.

12. Progressive and rapid stabilisation of disturbed areas utilising mulch and geotextiles will be ongoing throughout the Project. A mulching contractor will form part of the Project team with availability on site at all times.

13. Stockpiles of spoil from the tunnel construction activity will be developed in specific locations within the construction yard areas. The spoil material will be transported to these stockpiles via a fully enclosed conveyor system which is designed to minimise both dust discharge and also potential

sediment discharge. The stockpiles of material from the tunnel spoil will be located within covered building structures and as a result will not contribute to sediment discharge.

14. Stabilised entrance ways and wheel wash will be established at all ingress and egress points of the site. No vehicles will leave the site unless having been through the wheel wash facility. These wheel wash facilities will be based on recycling of wash water with any discharge from these systems to an independent detention treatment measure or a sediment retention pond already installed on the site.

15. The erosion and sediment control methodologies and drawings provided within this ESCP are based upon methodologies and measures using TP 90 as a minimum standard, but also incorporating some procedures and facilities that surpass the TP 90 standard. Through the implementation phase of the Project it is recognised that there will be room for innovation and alternative means of achieving the same environmental objectives. As detailed above in this circumstance, prior to utilisation of such innovative measures, the full set of alternatives will be explored and approval of the Auckland Council will be sought as necessary.

16. All SRPs and decanting earth bunds will be installed outside the 1% AEP flood levels where at all possible. Where other sediment control measures are installed within the 1% AEP flood plain area this will be undertaken with specific emphasis on maintenance, removal of any accumulated sediment and minimisation of the duration of works in these areas such that the sediment control measure will be removed as soon as possible with a fully stabilised surface remaining. Particular attention will be given to the nature of the stabilisation cover to ensure that the surface is not remobilised by flood flows. This will include, but not be limited to, techniques such as rock stabilisation and geotextile placement.

17. The tunnel construction operations will discharge at the two tunnel portal areas, and due to the cut nature of these locations, will discharge via a pumping regime. There are likely to be high pH levels within the tunnel water due to cement related activities within the tunnel structure. The tunnel discharge from these portal locations will be treated by shipping containers with baffles installed and bark/mulch filter systems[1] incorporated within the baffles (as shown in Plan Number 20.1.11-3-D-EN-740-205 Appendix F). The discharge from these devices will be to one of two locations as follows:

    a. Direct to Wastewater network. Where contamination levels within the discharge water is such that it is not acceptable to discharge to surface water, then discharge will be direct to wastewater network with appropriate authorisation sought at that time.

    b. Interim Stormwater Treatment Device. A continuous turbidity and pH meter will be installed at the discharge from the tunnel portal location after treatment through the container systems. A turbidity discharge standard will be established based on receiving environment values, determined through the monitoring programme however will be set at an initial 50 NTU. A pH standard will be established based on a pH of 7.5 which will also be subject to some change as a result of the monitoring programme outlined in Section 5.3 of this ESCP.

    Provided these standards can be achieved pumping will continue to the interim stormwater device, which will subsequently discharge to surface water. Where the turbidity level is exceeded, or pH is

[1] Fletcher Construction experience at New Lynn Rail Trench, 2009, demonstrated a high success rate of reduction of pH from concrete related discharges when treated through bark or mulch within containers and/or filter socks.

greater than 7.5, the pump will be automatically shut off and no discharge occurs. This will effectively lead to surface ponding at the portal location and will allow for further treatment to be achieved via chemical treatment and or pH management prior to discharge. The further treatment could include treatment through SRPs, removal of the material off site via sucker truck to an appropriate location or discharge directly into the wastewater network can occur. As an example if, after treatment, pH levels are such that further treatment is required, acid dosing can be implemented. It is noted that treatment with polyalluminium chloride will have the effect of reducing pH and may, in itself, provide the necessary pH adjustment.

18. Reclamation and stream works activities are highly prone to the risk of sediment generation and will be undertaken in a manner that recognises this risk and the sensitivity of the receiving environment. At all times these activities, and any associated works within these environments, such as ground improvement works will be undertaken in a "dry" environment. This will be based upon diversion of flows around the area of works or, in the case of the reclamation activity, measures to ensure works are not tidally inundated. Portable cofferdams form the primary methodology in this regard.

19. This ESCP provides the general principles and methodology for undertaking the necessary earthworks associated with the Project construction and ensures that environmental objectives as outlined in Technical Report No. G 6 Assessment of Freshwater Ecological Effects and Technical Report No. G 11 Assessment of Marine Ecological Effects, can be achieved. Development of specific site and activity erosion and sediment control plans will be prepared and submitted for endorsement immediately prior to construction.

20. Design drawings are provided within this ESCP in Appendix F. These are based on TP90 with those measures that go beyond the TP90 design also shown. As mentioned in Section 1.0 of this ESCP, it is expected that site and activity specific erosion and sediment control plans will be developed which will follow the general principles of this ESCP which will include erosion and sediment control drawings.

21. Erosion and sediment control measures will be implemented in accordance with this Erosion and Sediment Control Plan (ESCP) and are based upon the appropriate approval of site specific erosion and sediment control measures referred to as CESCPs throughout the Project implementation. The principles and practices detailed within this ESCP will be reflected within the CESCPs and as a result will ensure that any sediment yields, and associated effects, of the earthworks activities are less than minor and are all managed within the earthworks footprint of the project. Discharge standards will be achieved through the implementation of control measures, specific turbidity and pH standards associated with pumping tunnel discharge and ongoing environmental monitoring. Further the implementation of CESCPs will allow for contractor innovation, flexibility and practicality of approach to erosion and sediment control and in doing this will ensure that the Project continues to adapt appropriately to changing conditions.

The NZTA has a proven track record with respect to erosion and sediment control associated with large infrastructure projects. Many of these, such as the ALPURT alignment and the Northern Busway demonstrate the effectiveness of the approach taken which is based on the ongoing approval of CESCPs, or the equivalent of, throughout the project. The erosion and sediment control approach taken within this ESCP, while providing much more detail and design than for previous NZTA projects, is consistent with the approach taken by other consenting authorities for large scale projects throughout New Zealand.

3. Planning Framework

It is recognised that a range of earthworks and streamworks activities that will be undertaken as part of the Project have numerous requirements under the regional policy and planning documents. The detail of these is discussed within the Assessment of Environmental Effects (AEE) that supports this Project. When considering these requirements however, several key features of the Project are of importance in terms of erosion and sediment control:

- Proximity to sensitive waterbodies including the Coastal Marine Area (CMA),
- Values of the receiving environments adjacent to, or downstream of, the Project,
- Site topography,
- Areas of exposed soils or geotechnically unstable areas, and
- Loss of terrestrial and stream habitat that may occur as a result of the Project implementation.

These items have been considered in full in developing this ESCP and are reflected in the overall approach taken. Consents have been applied for which will authorise the necessary activities and associated discharges. Where activities are recognised as permitted activities, the conditions of these permitted activities have been taken into consideration. An example of this is vegetation removal which is a permitted activity under the Auckland Regional Plan: Sediment Control. Where vegetation is to be removed the permitted activity conditions have been assessed and methodologies incorporated to ensure the conditions can be achieved.

In addition, the NZTA has adopted as part of its wider national Environmental Management Plan (NZTA EMP), a series of erosion and sediment control objectives for roading projects. This part of the NZTA EMP is attached as Appendix C of this document with the six erosion and sediment management objectives outlined below:

1. Understand the potential impacts that erosion and sedimentation can have on receiving environments and the operation of the State Highway network.
2. Manage construction and maintenance activities to avoid, minimise or mitigate soil erosion, sediment runoff and sediment deposition.
3. Identify areas susceptible to erosion and sediment deposition and implement appropriate erosion and sediment control measures accordingly.
4. Identify erosion and sediment control measures appropriate to each situation with particular emphasis on identified areas of high risk. Use bioengineering practices where practical and possible.
5. Implement and maintain erosion and sediment control measures whilst adhering to the standard of best practice and complying with RMA and resource consent requirements.

6. For revegetation purposes use low cost measures such as planting native plant species that will allow for low long term maintenance costs.

These objectives have been fully considered and are reflected within this ESCP.

Further planning considerations associated with the Project are outlined in Section 8.0 of this ESCP.

4. Assessment of Risk

Estimating sediment yields for the Project has generally followed the process outlined in TP90 specifically the procedures for calculating the sediment yield within the Universal Soil Loss Equation (USLE). The primary purpose of the USLE is to provide a measure of the risk of sediment generation and yields, and to assist in identifying controls required for managing this risk to the environment from sediment discharges from earthworks sites.

Three key aspects of erosion and sediment control are related to the risk:

1. Sediment generating potential - this highlights the generation potential of the area in question and is based on slope, slope length, soils, rainfall and erosion control factors.

2. Sediment delivery – this relates to the amount of eroded material that is retained on site in depressions and within the site's natural contours prior to it entering any sediment treatment devices.

3. Sediment yields – the amount of sediment that actually leaves the site and enters the receiving environment. It is well recognised that this is the key area of interest.

The USLE allows for greater consideration to be given to the areas of higher sediment yields and for these areas to be targeted with more comprehensive control methodologies to reduce this potential.

While the USLE can provide for this risk assessment, a separate modelling exercise has been undertaken by the National Institute of Water and Atmospheric Research (NIWA) to determine more accurate sediment yields from the construction phase of the Project. The results and analysis of this modelling exercise are presented in a separate report titled Technical Report G.30 Assessment of Associated Sediment and Contaminant Loads, which supports the overall earthworks activity associated with the Project. No separate USLE calculations have been included within this ESCP.

The Project includes a number of sectors within which a range of earthworks activities are to occur. The predominant earthworks will however be from works within Sector 1 to Sector 7 (State Highway 16, Waterview Interchange and Northern Tunnel Portal) and works within Sector 9 (surface earthworks and Southern Tunnel Portal). Other works, including the tunnel excavation itself, will also involve earthworks, however these works are largely protected from surface runoff. It is noted that the excavation associated with the tunnels will involve all excavated material to be temporarily stockpiled within covered stockpile buildings and removed off site to approved fill locations or reused as part of the Causeway construction.

A GLEAMS model has been undertaken for the construction phase of the Project which estimates the sediment yields that will result from the construction activity. The yields modelled are based on the assumption that construction will take place over a 12 month period, and therefore are considered an estimate only. 12 months was considered an appropriate period for modelling purposes which recognises that while actual construction timeframes will be longer, staging and progressive stabilisation will occur which will result in the

actual duration of earthworks remaining the same. In terms of erosion and sediment control this is particularly useful in providing an indication of the higher risk areas of the Project. The yields show that works within Sectors 1, 6 and 9 produce the highest amount of sediment yield (yielding approx 70% of the total sediment yield from the Project) and therefore need to be carefully managed to assist in the minimisation of this yield.

The erosion and sediment controls developed for works within Sector 1 utilise a range of erosion and sediment control measures that represents the best practicable option for this sector. Progressive stabilisation will also be undertaken to ensure that areas that are completed from an earthworks perspective will not be subject to erosion.

Works within Sector 6 involve the widening and lane addition works. These works will be progressively stabilised as works progress. This sector relies on silt fences as the primary control measure which it is recognised has a lesser efficiency than other sediment control measures. Practical alternatives are however not available and it is considered that with the progressive stabilisation of this area as works proceed that sediment yields will be greatly reduced.

The construction area within Sector 9 is largely associated with the Southern Tunnel Portal and a large portion of the works area will discharge into this location. This runoff is then pumped to a SRP for treatment. With this method of control, and the other erosion and sediment controls to be employed in this sector, including chemical treatment, it is assessed that sediment yields can be further reduced.

In all of the above three sectors, as with the other sectors, emphasis will be placed upon the monitoring and maintenance of all controls, and particular attention will be paid to these areas prior to, during and after rain events.

It is considered that the key elements of risk for this Project are the exposure of bare land, the receiving environment locations and the value of these receiving environments.

Oakley Creek, which is located at both the southern and northern extent of the Project, and the coastal environment in the northern location, are widely recognised as containing a range of important values and emphasis needs to be placed on the Project to minimise any sediment discharge to these environments. From a risk perspective, the Project will place significant emphasis on those works within the Oakley Creek in addition to earthworks in the northern location adjacent to the coastal environment. Details of these measures are discussed in Section 6.0 and 7.0 of this report. Reference to Technical Report No. G 6 Assessment of Freshwater Ecological Effects and Technical Report No. G 11 Assessment of Marine Ecological Effects, should be made to gain an understanding of the risks that exist and essentially are focused on the coastal and freshwater systems identified above. Of particular note is the avoidance of discharges directly to sandy substrate within the coastal marine area.

Further recognised risks are:

- works within watercourse such as culvert extensions and diversions
- works undertaken within the identified 1% AEP flood plain area

- potential failure of the pump system associated with the tunnel portal excavations

These risks are all further discussed in Section 6.0 and 7.0 of this ESCP.

In recognition of the risks that exist, progressive stabilisation of bare earth will be implemented. Some areas will be open for only very short periods of time, for example construction of project offices and car park areas.

The ESCP has accounted for risk by identifying certain sectors in the Project as being 'hotspots' for potential elevated sediment generation. These areas are identified above.

With recognition of the relatively gentle slopes in these areas, utilising contour drains, implementation of chemical treatment for all sediment retention devices, rapid stabilisation, and ensuring these measures are given high priority will reduce the estimated sediment yield. With respect to the streamworks and coastal activities, the methodologies have taken risk into account and this is reflected in all works being undertaken in a "dry" environment wherever practicable, careful consideration of weather patterns prior to and during the works period, and also a relatively intense monitoring and audit programme of these activities. With the above in mind it is assessed that associated risk of these activities will be reduced.

5. Overall Erosion and Sediment Control Approach

The following section outlines the measures that will be implemented as part of the ESCP and builds on the principles outlined in Section 2.0 of this ESCP. There will be further detail and design required, which will be within the specific erosion and sediment control plans developed, through the Project lifetime which will result in a "fine tuning" of the methodologies shown. The aim of this ESCP is to demonstrate, in association with Technical Report No. G 6 Assessment of Freshwater Ecological Effects and Technical Report No. G 11 Assessment of Marine Ecological Effects, that less than minor sediment-related effects will result from construction activities with appropriate measures put in place.

The focus on the erosion and sediment control measures is based on:

1. Viewing the proposed Project works holistically, such that all construction activities, and the full effects of these construction activities, are considered as a package.

2. Minimising potential adverse effects by utilising measures which meet or exceed industry best practice guidelines such as reflected by (TP 90),

3. Implementation of a team approach (as outlined in Section 5.1 below) for design, implementation, maintenance and dis-establishment of erosion and sediment control measures. This will ensure "ownership" of the erosion and sediment control measures and therefore better implementation and maintenance.

4. Undertaking pre-construction meetings for each specific package of works and having regular weekly meetings (toolbox meetings) on site with relevant personnel as part of the construction phase,

5. Maintaining a register of control measures and "As Built" information to allow for quick referencing and understanding of erosion and sediment control measures.

6. Including both structural and non-structural elements within the methodologies to be employed such as:

    - Manually raised decant devices on SRPs;
    - Chemical treatment of decanting earth bunds and SRPs;
    - Proactive monitoring programme;
    - Risk identification and management in accordance with the high risk areas;
    - On-site mulching (erosion control) facility;
    - Weather response; and

- Ensuring contractors are aware of the erosion and sediment controls employed and do not remove them without seeking appropriate approval.

The detailed methodology and supporting plans outlined in Section 6.0 and 7.0 of this report allow for an understanding of the approach that will be taken. The details are based on the construction work sequence as outlined within Chapter 5 of the AEE, albeit that some of this sequence may well change. It is expected that the specific erosion and sediment control plans will follow the principles and details outlined within this report. This enables the contractor and consent authority to have further input into the methodologies implemented.

The proposed methodology for the construction works will take a four step approach to the erosion and sediment control process to be implemented, and will ensure that potential land disturbing related effects of the works are avoided. Broadly speaking the four steps comprise of:

- Team Approach;
- Erosion and Sediment Control Measures;
- Monitoring; and
- Miscellaneous Activities.

5.1 Team Approach

The team approach is a concept whereby planning and implementation of all the erosion and sediment control methodologies and measures are undertaken by an experienced and involved team to ensure that all relevant aspects of the Project are taken into consideration as part of these decisions. This will ensure that adequate resources, commitment and expertise are provided to erosion and sediment controls from start to finish of the Project (design through to dis-establishment). This will also ensure that all key stakeholders are involved and communicated with throughout the Project. The team is expected to consist of representatives from the NZTA, an Erosion and Sediment Control Specialist(s), Contractor(s) and the Auckland Council.

Table 5.1: Erosion and Sediment Control Responsibilities

Organisation	Responsibilities
NZTA	• Ongoing Preparation of CESCPs for specific sectors and activities • Ensuring CESCPs are included in contract documentation • Reviews of CESCPs • Inspections E&SC devices • Certification of E&SC devices • Record keeping
Principal Civil Contractor	• Preparation with NZTA of CESCPs • Implementation of CESCPs. • Installation of E&SC devices • Inspection and Maintenance of E&SC devices • Stabilisation activities • Training • Reporting
Consent Authority	• Endorsements of CESCPs • Approvals of revised CESCPs • Auditing to ensure compliance with CESCPs

All people working on site, or with site responsibilities, will be required to undertake a formal induction process. No one will be permitted to work on the site until they have completed the induction process. Part of this induction process will be based on environmental management including erosion and sediment control.

For those directly involved in earth works activities, specific training sessions on erosion and sediment control activities will be provided. These will be coordinated by the NZTA and shall include;

- Understanding the resource consent conditions;
- Construction and maintenance of erosion and sediment control devices;
- Inspections; and
- Contingencies.

In addition, regular tool box meetings will be conducted on site by the principal civil contractor or sub contractor with erosion and sediment control as a standard agenda item. A record shall be kept of all training including the information presented and a list of attendees.

It is recognised that this ESCP may be administered over various contracts across the Project and it is important that the "ownership" of the ESCP and associated control measures is clear in terms of implementation and maintenance requirements. Table 5.1 above outlines the responsibilities associated with the ESCP and the associated contract documentation will include specific reference to these requirements.

5.2 Erosion and Sediment Control Measures

The erosion and sediment control measures are designed to minimise the extent of soil erosion and sediment yield from the Project site. The proposed erosion and sediment control measures have been designed with TP90 as the minimum standard.

Furthermore it is proposed to implement design elements of the structural sediment control devices that exceed TP90 requirements, specifically:

- Manual decant raising devices utilising pulley systems, within the proposed SRPs and decanting earth bunds to allow pumped water volumes to be fully captured, and chemical batch dosing to be undertaken as necessary during pumping activities,
- The provision of a structured forebay for all SRPs, ensuring that the coarse sediment particles settled through the chemical treatment process are captured and readily removed before entering the pond while also providing for ease of maintenance, and
- To avoid the blocking of the decant structures within the SRPs, it is proposed that a floating novacoil boom be established across the pond width to trap any floating mulch material that may result in the pond and ensure this does not reach, and block, the decant structures.

It is assumed that any modifications to the erosion and sediment control drawings originally approved as part of the consent, may require further approval by the consent authority prior to implementation in the construction phase. This will take place through preparation of site and activity specific ESCPs and a pre-construction meeting on site with the consent authority as a precursor to installing any erosion and sediment controls prior to bulk earthworks activity.

Upon completion of the installation of all approved erosion and sediment controls, another meeting on site will be undertaken with the consent authority for verification and to obtain approval to proceed with works. As-Built certification plans will also be provided to the council at this time.

5.3 Monitoring

As part of the erosion and sediment control methodology, ongoing site monitoring by the contractor and the NZTA representative will occur to ensure that the proposed erosion and sediment control measures have been installed correctly, and are functioning effectively throughout the duration of the works. Any measures requiring attention will be identified, and if necessary, relevant team members consulted to ensure continual improvement is sought. This may include undertaking detailed USLE calculations if risks, including sediment yields, need further assessment and clarification. In the circumstance of higher risk areas being identified more stringent controls will be considered, in particular more progressive stabilisation.

An important aspect of the monitoring is the automated pH and turbidity meter for all discharges of pumped water from the tunnel dewatering. This activity in itself acts as a self regulating monitoring programme whereby any discharge with a turbidity of 50 NTU or higher and/or a pH of greater than 7.5 will not be discharged to the Oakley Creek and will trigger the pump to shut down, and further treatment prior to any discharge.

In addition, visual assessments of the receiving environment will continue to be undertaken during the works period by the contractor with particular attention during and after periods of rainfall. Any noticeable change in water clarity from that previous to the rainfall event as a result of the earthworks activity will result in a review of the erosion and sediment control measures implemented and changes made as necessary.

Weather forecast monitoring will also ensure that critical works such as those associated with the stream diversion works only occur during a suitable weather window.

In the Ecological Management Plan (ECOMP) which forms a sub plan within Appendix H of the CEMP, a proposed monitoring programme is outlined which it is considered provides a comprehensive monitoring regime for both the freshwater and coastal marine receiving environments. The ECOMP focuses on the activities of higher identified risk and will ensure that any effects are quickly detected and the appropriate response and actions put in place to address the effects while also ensuring that the circumstance is not repeated. This ECOMP will form the basis of a detailed monitoring programme, which will require more specific design parameters to be submitted to Auckland Council prior to works commencing and includes pre-construction, during construction and post-construction monitoring activities.

5.3.1 Freshwater Monitoring

The freshwater monitoring programme has two essential components, being “devices” monitoring and “habitat” monitoring. In addition baseline monitoring, scheduled monitoring and triggered monitoring will occur throughout the Project implementation.

Baseline surveys will define the antecedent conditions in the Project area by measuring pre-construction environmental (including ecological) variables. Scheduled monitoring will be undertaken according to a pre-determined schedule during the construction period. Triggered monitoring will occur when pre-determined thresholds are exceeded. Post-construction surveys will assess the medium term effects of the Project on the freshwater environments, and will be used to determine any need for remediation measures to counter adverse environmental effects.

Triggered monitoring for devices will involve an immediate re-check of the devices upstream of where the event occurred. If damage or malfunction of the device is observed, then it will be rectified immediately. Should the likely adverse effects have a reasonably high probability of being significant (ie. more than short-term, localised and/or minor), then ecological monitoring will be undertaken in order to determine the actual magnitude of these effects. Should significant adverse effects be detected as a result, the contractor will discuss appropriate changes to work practices and methodologies to prevent further similar events and will also consider appropriate mitigation for that particular event.

5.3.1.1 Devices Monitoring

Environmental compliance for the Project during the construction period is based upon the appropriate installation, location, maintenance, and monitoring of control devices. The devices are not restricted to structures and may include work practices and methodologies. The design, installation, monitoring and maintenance of these devices are the responsibility of the Erosion and Sediment Control Team.

'Devices' monitoring comprises the monitoring of on-site construction activities, but more particularly the monitoring of on-site structures and devices designed to control the potential adverse effects of those site activities (in particular erosion and subsequent sedimentation events within receiving environments).

The purpose of this monitoring is to ensure that all practices, control measures and devices are constructed, operated and maintained so they remain fully effective at all times. The devices monitoring will largely target erosion and sediment control activities as well as structures such as silt fences, erosion control mulching and sediment retention ponds.

This monitoring is aimed at the early detection of activities or problems that have the potential to result in a significant adverse environmental effect. Devices monitoring will be the main component of scheduled construction monitoring undertaken on-site. The devices monitoring will act as a trigger, together with the scheduled ecological monitoring, for more detailed ("trigger event") monitoring should this be required.

The frequency of the devices monitoring will vary throughout the year and will reflect areas of changing activity and risk along the Project. However, during the undertaking of high risk activities in any catchment the monitoring of devices will be undertaken on a daily basis and more frequently during heavy rainfall. These inspections will take the form of a check-list (to be developed by the Contractor) and any subsequent required actions noted. Any devices problems will be recorded in the monthly compliance reports to the consent authority. The information generated by the devices monitoring will help to determine whether any further action is necessary over and above that which is already implanted at that time.

It is essential that the monitoring of devices include inspections during storm events so that the success of the devices and controls can be reviewed and improved if appropriate.

Visual inspections of the integrity and efficiency of the erosion and sediment control devices will be the responsibility of the Erosion and Sediment Control Team. Qualitative inspections of the installation, operation and maintenance of the sediment controls will occur daily throughout the duration the devices are in place.

The visual inspections will include qualitative monitoring of the following:

- the integrity and effectiveness of all erosion control and sediment treatment devices,
- activities on site,
- general site conditions and other activities occurring within the catchment,
- general status of the immediate receiving environment.

The details of these visual (qualitative) inspections will be recorded on the check lists.

In addition to these qualitative visual inspections, the Erosion and Sediment Control Team will take daily records of the pH and turbidity reading from the portal tunnel pumping operations.

Prior to construction commencing photographs will be taken in the vicinity of the proposed discharge outlet points. These records will show the visual state of the receiving environment at and within the vicinity of the discharge point. This photographic record will be compiled into a log book and will allow a visual comparison of before, during and at completion of the construction of the alignment. Visual inspections of the discharge points and general stream conditions in the vicinity are part of the requirements of the devices monitoring.

Where actual problems with the integrity and/or effectiveness of the devices (ie. for both erosion & sediment control and other on-site activities) are observed these shall be rectified immediately. In addition, there will be more detailed inspections of devices, on-site practices and other catchment activities that will be undertaken in response to certain "triggers" identified over the course of the routine devices monitoring programme. The triggers for these more intensive / repeat investigations include observations such as:

- Activities observed to be happening on-site that are likely to compromise the effectiveness or integrity of that site's erosion and sediment controls.
- Bearing in mind antecedent climatic conditions, a conspicuous change of water colour at the downstream monitoring sites that is very different to the colour that is normally associated with stream conditions at the same site, and with such change in colour not evident at the upstream monitoring sites (ie. above the construction zone).
- Turbidity and/or pH threshold exceedances at the tunnel pumping locations

- Obvious accumulation of sediment in the vicinity of the pond discharge points, or anywhere else within or in proximity to the active construction zones.

- Streambank collapse or obvious signs of channel erosion / instability.

- Visual reports / evidence of changes to downstream community structure (eg. fish kills, death or discolouration of instream plant communities, increased weed growth).

- Spillage / accident reports by construction workers.

- Police / fire reports of vehicles in the vicinity which required clean up procedures for chemical / hydrocarbon spillages.

If the results of any devices monitoring suggest that adverse effects are likely to have occurred then "triggered" responses will be implemented. A Triggered response is in recognition that an event associated with the Project has occurred that may result in a significant adverse effect. A Triggered response follows the process below:

- ascertain that in all probability the issue is associated with the Project;

- inform and liaise with the consent authority;

- ascertain the magnitude of the adverse effects (this may involve undertaking immediate monitoring of the ecological variables;

- if the effects have been more than minor, ascertain what response is necessary;

- determine how to monitor the effectiveness of the response(s);

- implement and monitor the response.

A continual feedback loop is included in this process until it has been verified that the implemented responses have been successful. Changes to construction site practices or to specific devices may also need to be implemented to avoid any future similar events.

Flocculation Monitoring

Chemical treatment is required in all of the sediment retention ponds and some decanting earth bunds. The application of flocculants will be carried out in strict accordance with best practice principles, and will be undertaken in accordance with the CTP attached to this ESCP.

A core part of flocculation management will be monitoring, in order to check that the systems are all working as anticipated and to provide data to facilitate management of the automatic systems. The monitoring that will be carried out is as follows:

- Discharge and receiving environment pH levels at weekly intervals and during nominated storm events;
- Periodic checks of final discharge suspended solids concentration, particularly during storm flows.

This monitoring will be undertaken by suitably trained members of the Erosion and Sediment Control Team.

Other Checks and Inspections

In addition to the devices and flocculation monitoring the other on-site activities such as storage of hazardous chemicals, refuelling facilities and practices, site offices, haul roads, stock-piles, dust control, noise control, etc will also all need to be regularly checked and inspected. The intention underlying these checks is to ensure that they are being properly maintained at all times, and that they remain within the specified standards including consent conditions.

5.3.1.2 Freshwater Habitat Monitoring

The freshwater habitat monitoring programme is intended to:

- identify and quantify any adverse effects resulting from the high risk activities, and
- identify and evaluate corrective measures which may be required in the event of adverse ecological effects arising from these activities.

These high risk activities are focused around the proposed stream realignments and the stream habitats in Sector 9 and in this regard will be monitored by use of a Before-After Control-Impact (BACI) methodology. This refers to undertaking pre-construction (ie. baseline) surveys at selected sampling sites within the location of the realignments, and then periodically re-surveying these same sites following the start of realignment activities, and continuing for a set period after their completion and comparing the results. It also utilises fixed sampling sites stationed outside and within the likely zones of impact.

Baseline data will provide a bench-mark against which to measure the construction and operational phase data sets. The scheduled monitoring will involve routine annual studies of prescribed ecological parameters. The triggered monitoring will be in response to potential adverse effects having happened, as identified by pre-determined “triggers” having occurred.

Section 4.5 of the ECOMP provides further details of freshwater habitat monitoring to be implemented.

5.3.2 Coastal Marine Monitoring

It addition to the devices monitoring as outlined in 5.3.1.1 above, which is critical within the coastal area, it is recognised that the activities in, or immediately adjacent to, the coastal marine environment are higher risk activities, and from an effects perspective monitoring of the activities in these locations is critical.

The following outlines the proposed monitoring programme for activities in these locations.

Suspended Solids Monitoring

Suspended Sediment (three samples at each location per sampling time) will take place adjacent to the construction phase discharge points including:

- Oakley Inlet
- Within Waterview Estuary
- Northern side of the Causeway
- Whau Bridge
- Pixie Stream

Monitoring will take place at the above sites during a rainfall event that equates to over 25mm within a 24 hour period or an intensity of over 15mm per hour. In addition monitoring will take place daily (two hourly samples during the construction time) during excavations of the channel within Waterview Estuary and Oakley Inlet.

If an agreed trigger level is exceeded for excavations and other disturbance of the CMA, follow up actions and further monitoring must be undertaken as agreed at that time with the consent authority. This will include an appropriately qualified ecologist visiting the site to visually inspect the relevant receiving environment and determine whether deposition of sediment has occurred within the intertidal mudflat/sandflat areas. If determined necessary by the ecologist at that time, monitoring of benthic invertebrate community will commence and continue on a weekly basis until the ecologist is satisfied that there are no adverse effects occurring.

pH Monitoring

Monitoring of pH is to take place adjacent to works involving the use of cement within or adjacent to the CMA.

The appropriate frequency includes:

- Intensive sampling for the first two coffer dams (or coffer dam and mudcrete trial), including the installation and removal process, and then if the data supports, reduce monitoring for the ongoing coffer dam use.
- Intensive sampling would comprise weekly replicate sampling during concreting works of pH at set distances from the coffer dam e.g. at dam edge, 5m, 10m, 20m and 50m from the works area into the coastal environment.

If pH in any of the samples increases above 8.5, the resultant action would be to cease works and implement hourly water quality sampling for at least 6 hours post trigger the trigger event. After three consecutive

samples return a pH below 8.5, works could recommence. If pH remains above 8.5 for 6 hours post trigger, a sampling programme for benthic invertebrate community composition would be implemented and repeated on a weekly basis until an ecologist is satisfied that there are no adverse effects occurring. At all times when sampling returns a pH of higher than 8.5 into the CMA reporting will occur and the erosion and sediment control team will consider the methodologies and measures in place in an attempt to address the high pH issue

Section 4.6 of the ECOMP outlines the Invertebrate Community Composition (Sediment Grain Size and Sediment Quality) which is proposed to be undertaken within the coastal environment.

5.3.3 Response to Indicators of Significant Effects

In the event that adverse impacts on the receiving environments are detected by the freshwater and marine ecology monitoring programme, a possible (cause-effect) association with the Project will be investigated in the first instance. Should this prove to establish linkages between the adverse effect and on-site practices then alterations to the operational methods (including modifications to environmental control measures and methodologies) will be investigated as a first order response. The Auckland Council will be consulted in regard to any proposed changes to the on-site practices. Further monitoring would then be used to assess the effectiveness of the alterations in operational methods to alleviate / avoid adverse effects on the environment.

Factors to be considered in the decision chain relating to the above would include:

- the assessed likely cause(s) of the effect;
- whether the effect is on-going;
- the magnitude of the event;
- the sensitivity of the receiving environment; and
- the need for, and nature of, any remedial action.

The most likely cause of a significant adverse effect would be the incorrect installation of devices or sub-optimal performance of the measures and methodologies designed to avoid or minimise adverse environmental effects. The Erosion and Sediment Control Team are responsible for ensuring adequate provision for such devices, and the routine environmental inspections are aimed at minimising their incorrect installation or failure to repair any observed damage.

This ESCP outlines a number of preventative measures that will prevent an adverse effect from occurring in the first instance. In addition to the ESCP the contractor will be preparing CESCPs which will be lodged with the Auckland Council prior to construction activities, within each of the development sectors within the Project area.

Contingency measures (such as the requirement for spill kits to be present in re-fuelling areas) are also detailed in the CEMP and form part of the responsibility of the contractor.

5.4 Miscellaneous Activities

Earthworking activities on the Project have the potential to generate dust that may be considered to be a nuisance in times of dry and windy weather. To manage the potential dust nuisance the standard procedure of minimise, identify and acknowledge, implement measures and ongoing monitoring will occur at all times during construction.

As an example, it is expected that undertaking measures such as having the conveyor from the tunnel operation sealed to prevent dust escaping from excavated material to the environment will achieve the necessary dust management regime.

Stabilised haul roads will be installed where construction traffic is likely to damage existing stabilised areas. These haul roads will be constructed by excavation of topsoil and placement of suitable geotextile and aggregate hard fill.

5.5 Erosion and Sediment Control Devices

As detailed, above this ESCP provides the general principles and methodology for undertaking the necessary earthworks associated with the Project construction and ensures that environmental objectives can be achieved with no effects from earthworks. With innovation and more detailed design as the Project progresses, development of specific site and activity erosion and sediment control plans will be prepared and submitted for endorsement prior to construction.

As detailed within Section 6.0 and 7.0 of this ESCP the Project includes the implementation of a range of erosion and sediment control measures. With respect to the SRPs, a total of 17 SRPs will be established. These SRPs are all sized based on a length to width ratio of 3:1, side slopes of 2:1 and a depth of 1.5m as follows:

Table 5.2: Sediment Retention Pond Volume and Size Analysis Refer to Drawings in Appendix F

Sediment Retention Pond Name	Catchment Area (ha)	Minimum Pond Volume (m^3)	Forebay Volume (m^3)	Top Dimensions (m)	Number of Decants	Side slopes	Inlet Slope	Drawing Reference
Sediment Retention Pond 1A	0.26	78	4	18.0 by 8.0	1	2:1	3:1	20.1.11-3-D-EN-740-101
Sediment Retention Pond 1B	0.94	282	14	31.0 by 12.5	1	2:1	3:1	20.1.11-3-D-EN-740-101
Sediment Retention Pond 1C	1.34	402	20	36.0 by 14.0	1	2:1	3:1	20.1.11-3-D-EN-740-101
Sediment Retention Pond 1D	0.97	291	15	31.0 by 13.0	1	2:1	3:1	20.1.11-3-D-EN-740-102
Sediment Retention Pond 1E	0.87	261	13	30.0 by 12.0	1	2:1	3:1	20.1.11-3-D-EN-740-102
Sediment Retention Pond 1F	4.20	1260	63	60.0 by 22.0	3	2:1	3:1	20.1.11-3-D-EN-740-102
Sediment Retention Pond 3A	1.18	354	18	34.0 by 13.5	1	2:1	3:1	20.1.11-3-D-EN-740-104
Sediment Retention Pond 3B	1.03	308	15	32.0 by 13.0	1	2:1	3:1	20.1.11-3-D-EN-740-104
Sediment Retention Pond 5A	4.19	1257	63	60.5 by 22.5	3	2:1	3:1	20.1.11-3-D-EN-740-113

Sediment Retention Pond Name	Catchment Area (ha)	Minimum Pond Volume (m^3)	Forebay Volume (m^3)	Top Dimensions (m)	Number of Decants	Side slopes	Inlet Slope	Drawing Reference
Sediment Retention Pond 5B	1.46	438	22	37.5 by 15.0	1	2:1	3:1	20.1.11-3-D-EN-740-109
Sediment Retention Pond 5C	0.48	144	7	23.0 by 10.0	1	2:1	3:1	20.1.11-3-D-EN-740-113
Sediment Retention Pond 5D	2.08	624	31	44.0 by 16.5	2	2:1	3:1	20.1.11-3-D-EN-740-109
Sediment Retention Pond 7A	1.49	447	22	38.0 by 15.0	1	2:1	3:1	20.1.11-3-D-EN-740-114
Sediment Retention Pond 9A	4.89	1467	73	65.0 by 24.0	3	2:1	3:1	20.1.11-3-D-EN-740-118
Sediment Retention Pond 9B	2.72	816	40	50.0 by 19.0	2	2:1	3:1	20.1.11-3-D-EN-740-117
Sediment Retention Pond 9C	2.36	708	35	46.5 by 18.0	2	2:1	3:1	20.1.11-3-D-EN-740-119
Sediment Retention Pond 9D	0.95	285	14	31.0 by 12.5	1	2:1	3:1	20.1.11-3-D-EN-740-117

The details of the specific erosion and sediment controls to be implemented in each sector are detailed in Section 6 of this ESCP. These plans also show the catchment areas which apply to the Project, and are related to the specific erosion and sediment control measures. These plans are contained within Appendix F of this ESCP.

Further to the above, it is recognised that the sizing of the various erosion and sediment control measures is critical in achieving an overall effective approach to the Project. SRPs are sized based on TP90 and have been calculated as shown in Table 5.2 above. With respect to cleanwater diversion channels and dirtywater runoff diversion channels, it is recognised that within the Project there are a wide range of catchment sizes and characteristics that will require specific design for each area. Within this ESCP the approach taken for sizing diversion channels is based on provision of a conveyance system that will transfer up to the 100 year ARI storm event to the treatment device or to a stable area (in the case of cleanwater diversion channels). Figures 5.1 and 5.2 below provide an example of the sizing guidance which will be utilised within the Project. As earthworks commence in each catchment area, the specific as built catchment will be determined and the diversion channel sizing calculated from this figure accordingly. Appendix D of this ESCP provides the full set of figures for both dirtywater runoff diversion channel and cleanwater diversion channel sizing.

No house demolition or vegetation clearing methodologies are specifically discussed in this ESCP, and while these activities are essentially considered as permitted activities in accordance with the relevant statutory framework, they will be covered by the principles within this ESCP. In this regard, in addition to methodologies such the placement of mulched vegetation on recently cleared areas, the erosion and sediment control measures outlined in this ESCP will be established as one of the first steps in the construction programme.

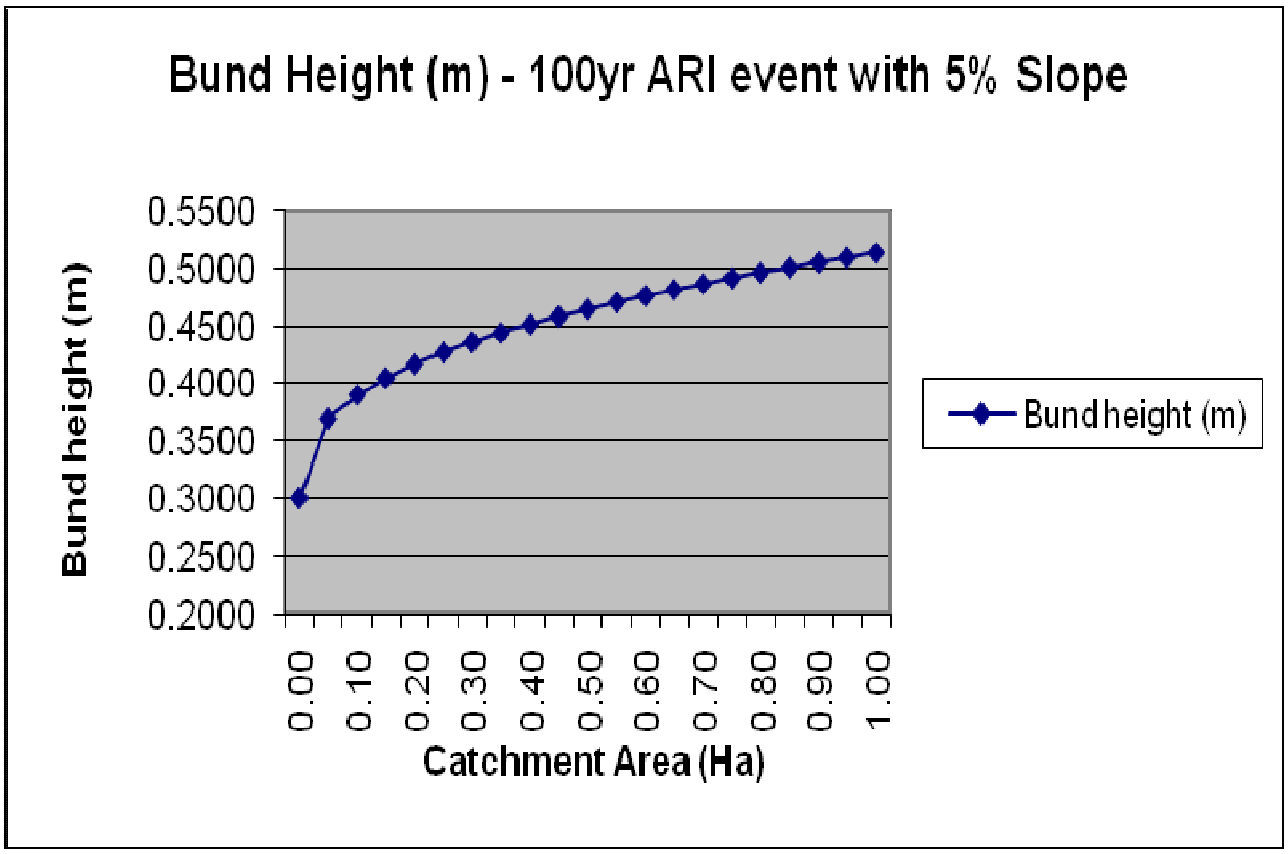

Figure 5.1: Example Dirtywater Diversion Bund Height

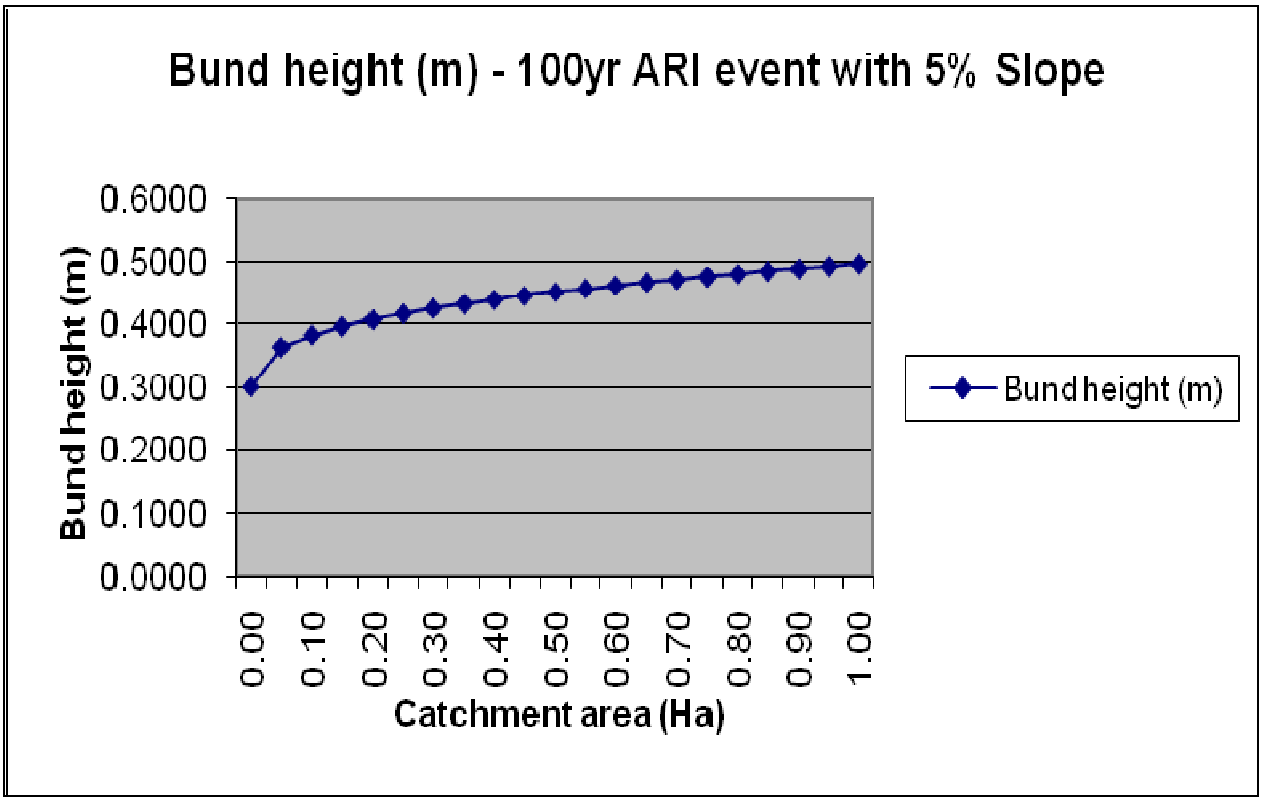

Figure 5.2: Example Cleanwater Diversion Bund Height

6. Specific Erosion and Sediment Control Methodology for each Sector

When considering this section of the ESCP, reference should be made to Appendix F of the ESCP which contains all the erosion and sediment control plans and design drawings which relate to the specific sectors.

6.1 Sector One

This sector is situated between the western embankment of the Whau River and the eastern abutment of the Henderson Creek bridges, and includes the Te Atatu Interchange. SRPs, decanting earth bunds, super silt fences, rock toe with embedded geotextile (further referred to as rock toe silt fences), dirtywater runoff diversion channels and cleanwater diversion channels will be used in this section of motorway.

In this section of motorway, the main erosion and sediment control philosophy is to:

- prevent clean water runoff (from catchments discharging into the site) from entering the site by the use of cleanwater diversion channels;
- capture the sediment in any sediment laden runoff leaving the site by use of silt fences;
- divert, using dirtywater runoff diversion channels, sediment laden runoff into decanting earth bunds; and
- provide stormwater inlet protection along Te Atatu Road where required.

Erosion and Sediment Control Plans 20.1.11-3-D-EN-740-101 to 103 show preliminary plans locating these measures throughout this area of work. This sector and stage of works can be considered in discrete separate stages as follows:

<u>Te Atatu Road overbridge westward along the existing State Highway 16 to the eastern bank of Henderson Creek</u>

The works west of the Te Atatu interchange from Chainage 5400 along the existing State Highway 16 up to the Henderson Creek bridges at Chainage 6500 have a constraint in terms of availability of space for the construction of significant (large volume) controls. The works are, however, relatively minor in this area and essentially include shoulder widening activities with the new road construction consisting largely of re-alignment of the eastbound off-ramp. The surface works can be easily managed through the use of dirtywater runoff diversion channels and super silt fences channelling dirty water to SRPs and decanting earth bunds.

Due to larger catchment areas on the western side of the Te Atatu interchange and available space on the northern side of the motorway from Henderson Creek to Te Atatu interchange, SRPs will be constructed. The dimensions of these ponds are detailed in Table 5.2 of this ESCP. SRPs to be constructed will be:

- SRP-1A at Chainage 6320 EB at Jack Colvin Park (referred to as Jack Colvin Park Sediment Retention Pond) on the northern side of the motorway.

- SRP-1B at Chainage 6230 EB just east of Jack Colvin Park (referred to as Rugby Club Sediment Retention Pond) on the northern side of the motorway.

- SRP-1C at Chainage 5820 EB upstream of the Pixie Stream (referred to as Pixie Stream North Sediment Retention Pond) on the northern side of the motorway.

- SRP-1D at Chainage 5640 WB south of the Te Atatu westbound on-ramp (referred to as Pixie Stream South Sediment Retention Pond).

- SRP-1E at Chainage 5320 EB north of the Te Atatu eastbound on-ramp (referred to as Te Atatu Sediment Retention Pond).

- SRP-1F will be located within the Construction Yard 1 situated in Orangahina Park to the north of the Pony Club and the Te Atatu eastbound on-ramp (referred to as Construction Yard 1).

On the southern side of SH16 decanting earth bunds have been located at approximately 150m to 180m intervals discharging into the Henderson Creek and existing culverts under the motorway. The decanting earth bund catchment areas are up to 3000m^2 (as per TP90 guidance) and have been sized on this basis to ensure that adequate volume exists to allow for the space constraint between the edge of the motorway and the property boundaries / construction demarcation area. Decanting Earth Bunds-1A to 1G will have volumes ranging from 30m^3 to 60m^3 based on catchments up to 3000m^2.

These decanting earth bunds will be chemically treated in accordance with the CTP. Dirtywater runoff diversion channels will be established that will direct flows to these devices.

In recognition of the values of the receiving environment, super silt fences will also be placed along the contour to act as a “back up” in the unexpected event of a sediment control failure.

A higher risk component of the sector is that associated with a culvert extension within the Pixie Stream. It is recognised that this is a relatively significant watercourse from both a value and amenity perspective and will be managed accordingly. The key aspect of this will be undertaking these culvert works during a period of dry weather when a minimum 3 day weather window indicates no significant rainfall. Once the culvert works are completed the culvert outlet area will be fully protected with a super silt fence.

Flows through the other culverts are ephemeral and the culvert outlet areas will be fully protected with super silt fences.

The Erosion and Sediment Control measures at the extension of the culverts in this section will be in accordance with the methodology described in Section 7.0 of this report.

Reclamation to construct the permanent stormwater treatment device - Jack Colvin Park Wetland (TD1A)

A wetland will be constructed at Jack Colvin Park on the northern side of the SH16 motorway between Ch6200 and Ch6350 to provide water quality treatment to the above section during the operational phase of the Project. The construction of the wetland will require reclamation of approximately 1880m² of the Coastal Marine Area (CMA) to the east of the Henderson Creek. The reclamation area consists of mangrove covered tidal mudflats generally above 1.0m RL. Erosion and sediment control measures during the reclamation and construction of the wetland will consist of a rock toe silt fence installed at the toe of the fill embankment on the mudflats. Super silt fences will be used on the land based work areas.

Reclamation will be done by foundation undercut and removal of the in-situ material to a depth of approximately 2m and building up the wetland embankments using cohesive material. Due to the elevation of the mudflats, this area will only be inundated by tides for short periods to a depth of up to 0.6m. With the works programmed to correspond with the tidal cycle, the rock toe silt fence will provide adequate protection.

This methodology is summarised as follows:

Example of Reclamation and Embankment Staging based upon 'Undercut and Cohesive Backfilled Embankment'

1. Install erosion and sediment control silt fence immediately landward of the CMA.

2. Strip off and remove existing top soil between motorway and silt fence.

3. Clear mangroves utilising low impact methods such as hand removal where possible within the construction and reclamation zone during low tide.

4. Prepare a smooth footprint area surface (i.e. remove rocks, mangrove roots, etc.) for the rock toe silt fence approximately 3 to 5 metres clear of the works area.

5. Hand lay 3m wide geotextile / combigrid directly on marine mud during low tide along the toe of the embankment.

6. Place new AP300 rock armour toe directly upon geotextiles using a long reach excavator in layers and embed geotextile filter blanket (e.g. Bidim A29 or similar approved) into the rock to form a silt fence as shown on the detail on drawing 20.1.11-3-D-EN-740-203 in Appendix F on the tidal mud flats with returns back onto land. The rock toe must have a minimum freeboard of 500mm above MHWS level of 1.63m RL. Super silt fences should be joined to the rock toe silt fence and continued on land to along the downstream perimeter of the works area.

7. Form pump sumps along the inside of the rock toe silt fence to frequently remove seepage water. Contaminated water (i.e. sediment or cement laden runoff) should be pumped to the SRPs or to sucker trucks and removed from site.

8. Excavate and remove the virgin Holocene Alluvium (marine mud) approximately 2m deep down to the East Coast Bays Formation founding level.

9. Commence the construction of the embankment shoulders then proceed with bulk earthwork filling. Place selected cohesive fill in layers and compact to form pond floor and embankments.

10. Carry out earthworks to form wetland. The size, type and exact location of the wetland are shown on drawings which form part of the Technical Report No. G 15 Assessment of Stormwater and Streamworks Effects.

11. Install a silt fence on top of the embankment fill next to the rock armour once backfill level is above MHWS.

12. As bulk back filling progresses, the rock armour from the rock toe silt fence can be used to clad the outer surface of the embankment and provide erosion protection.

Te Atatu Interchange and eastwards to the western bank of the Whau River

The interchange itself will involve the construction of a SRP (referred to as Te Atatu Sediment Retention Pond SRP-1E) during the construction phase of the Project. SRP-1E will have a catchment area of 0.87 hectares (including some clean water areas which cannot be practically diverted away from the catchment area) and will be chemically treated in accordance with the CTP. Dirtywater runoff diversion channels will be established that will direct flows to this device.

As shown on Plan 20.1.11-3-D-EN-740-102 the swale along the eastbound on-ramp currently treating runoff from parts of Te Atatu Road and the on-ramp will be removed due to the re-alignment of the on-ramp. Run-off from this area will be treated through the SRP-1E which will be located at the low point at approximately Chainage 5300 with a capacity of 261m³.

On the eastern side of the Te Atatu interchange the on- and off ramps and east- and westbound lanes from Chainage 5100 to 5400 will be treated using decanting earth bunds. The decanting earth bunds have been located at approximately 50m to 100m intervals discharging to a carrier pipe outfalling into the Whau River on both sides of the western abutment of the Whau River bridges. Due to space constraints, the decanting earth bunds will have to be established within the swale area along the eastbound lanes, with the outlets connected to the carrier pipe with a capacity to convey the 20 year ARI storm event. Along the westbound lanes the decanting earth bunds can be established within the proposed swale as for the eastbound side, or within the widening for the cycle lane / off ramp area with a temporary carrier pipe until the permanent swale with under drain is established. An alternative measure would be to establish a SRP which could be located within the new off ramp widening area at approximately Chainage 4950.

Contour drains will be formed along the cut embankments to divert clean water from the decanting earth bunds.

The SRP and decanting earth bunds will be chemically treated in accordance with the CTP. Dirtywater runoff diversion channels will be established that will direct flows to these devices. In recognition of the values of the

receiving environment, super silt fences will also be placed along the contour to act as a "back up" in the unexpected event of a sediment control failure.

Areas within the interchange that cannot be diverted to SRP-1E will be treated via super silt fences and silt fences.

Construction Yard 1

The portion of land (Pt Lot 2 DP370) belonging to the Waitakere City Council to the north east of the Te Atatu interchange adjacent to Te Atatu Road and on the northern side of the Pony Club, and will be used as a Construction Yard. This is shown on Plan 20.1.11-3-D-EN-740-120. The facilities associated with the Construction Yard 1 (Orangihina Park) may include site offices, construction plant and equipment parking, material storage and lay down areas, a workshop, waste management/storage, refuelling facility and associated building structures. The development of the Construction Yard will involve the installation of a super silt fence around the downstream perimeter of the associated earthworks activity and on completion of the earthworks the stabilisation of the area with clean metal. It is expected that the yard areas will be stabilised in metal over a period not exceeding one month. Further to this the super silt fence will remain in place throughout the utilisation of the yard area.

This area has a natural slope that falls towards the south west corner, to a low point which will in itself create a natural collection point for sediment laden runoff. Before commencement with any construction works occurring, and prior to the establishment of the Construction yard, a SRP-1F will be established. This SRP with a capacity of 1260m³ will have water diverted to it via dirty water diversion channels and has a contributing surface water catchment of 4.2 hectares.

The entrance to the Construction Yard 1 (Orangihina Park) off Te Atatu Road will be provided with a stabilised entrance and wheel wash facility.

In recognition of the values of the receiving environment, super silt fences will also be placed along the contour to act as a "back up" in the unexpected event of a sediment control failure.

6.2 Sector Two

Sector Two is located from the western side of the Rosebank Domain to the western abutment of the Whau River bridges. Works to the motorway in this sector mainly consists of widening the Whau River Bridges, construction of a separate new bridge structure accommodating the cycleway/footpath over the river on the southern side of the current bridges and widening the existing motorway to four traffic lanes plus a bus lane in both directions. Between the Rosebank Park Domain to the bridge abutments the motorway traverses the Motu Manawa Marine Reserve and other areas of the CMA. The interfaces between these areas and the proposed motorway widening are typically above high tide level and as such are only expected to be inundated, if at all, on an infrequent basis. In this section of the motorway where there are some works proposed below MHWS, (e.g. the approach to Whau River Bridge), then the reclamation works will proceed as per the indicative methodologies using light weight fill as described in *Technical Report No. G 23 Coastal Works, Western Ring Route Waterview Connection, Aurecon 2010* and Section 6.4 of this report.

Temporary cofferdams rock toe silt fences as described in Sector 1 above, super silt fences and dirtywater runoff diversion channels will be used in this section of motorway.

Erosion and Sediment Control Plans 20.1.11-3-D-EN-740-103 show preliminary locations for these measures throughout the sector. The Contractor will be expected to identify the most appropriate method for applicable locations for any given stage of the construction process.

Whau River Bridges widening and new pedestrian/cycleway bridge.

Widening of the existing bridges and the construction of the new cycleway bridge will require wet concrete work over the waterway. Construction of the bridges utilising pre-cast elements is proposed to minimise the amount of in-situ concrete that will be required. Pre-cast beams are recommended for the main girders and pre-cast piles for the foundations of the motorway widening. The use of Super Tee girders with extended flanges will act as permanent formwork for an in-situ deck. The piles of the cycleway may be cast in-situ to allow consistency of design with the Whau River Cycleway Bridge or precast piles similar to the motorway widening.

In-situ piles are typically cased with steel as they pass through the water and recent Holocene Alluvium stratum. The casing may be unable to prevent the ingress of water into the pile and concrete will be Tremie poured. In the Tremie Concrete method, concrete is placed below water level through a pipe, the lower end of which is kept immersed in fresh concrete so that the rising concrete from the bottom displaces the water without washing out the cement content.

This will still result in cement contaminated water which will require treatment before discharge and this will either be conducted on site using treatment tanks and the water tested before discharge to the receiving environment, or the water removed from site and treated elsewhere through the use of sucker trucks.

Concrete placement will be carefully controlled to ensure no loss to the environment using pumps and skips. Designated concrete truck wash out areas will be required at the Construction Yard and these will contain the water from washing the trucks drums and chutes which can be treated or disposed of offsite.

Rosebank Park Domain to Whau River Bridges

Widening of the existing motorway and the construction of the pedestrian/cycleway will require reclamation of the CMA. The level of the marine tidal flats in this section of motorway is between 0.9m RL and 1.7m RL, which with the MHWS level at 1.63m RL, means that the reclamation area will be inundated by up to 0.73m during high tide. The sediment control measures during the ground improvement and reclamation process are discussed in detail in Sectors 1 and 4, and similar methods will apply on this section of the motorway.

The surface works can be easily managed through the use of temporary cofferdams, rock toe silt fences and super silt fences. These are shown on Plan 20.1.11-3-D-EN-740-103.

Reclamation will be undertaken by foundation undercut and removal of the in-situ material to a depth of approximately 2m and building up the embankments using granular material.

This methodology is summarised as follows:

Example of Reclamation and Embankment Staging based upon 'Undercut and Granular Fill Embankment'

1. Install erosion and sediment control silt fence at edge of existing motorway immediately landward of the CMA.

2. Strip off and remove existing top soil between motorway and silt fence.

3. Clear mangroves utilising low impact methods such as hand removal where possible within the construction and reclamation zone during low tide.

4. Prepare a smooth footprint area surface (i.e. remove rocks, mangrove roots, etc.) for the rock toe silt fence approximately 3m to 5m clear of the works area.

5. Hand lay geotextile / Combigrid directly on marine mud during low tide along the toe of the embankment.

6. Place new AP300 rock armour toe directly upon geotextiles using a long reach excavator in layers and embed geotextile filter blanket (e.g. Bidim A29 or similar approved) into the rock to form a silt fence as shown on the detail on drawing 20.1.11-3-D-EN-740-203 on the tidal mud flats with returns back onto land.

7. Build up the rock toe to a minimum freeboard of 500mm above MHWS level of 1.63mRL.

8. Form pump sumps along the inside of the rock toe silt fence. Contaminated water (i.e. Sediment or cement laden runoff) will be pumped to SRPs or tankers and removed from site.

9. Commence the construction of the embankment shoulders then proceed with bulk earthwork filling in accordance with the ground improvement methodologies and drawings.

10. Install a silt fence on top of the fill embankment next to the rock armour once embankment level is above MHWS.

11. As bulk back filling progresses, the rock armour from the rock toe silt fence can be recovered or incorporated as part of the revetment rock armour.

6.3 Sector Three

Sector Three comprises the westbound (landward) lanes between Rosebank Road westbound off ramp and the Rosebank Park Domain where the motorway borders the Rosebank Peninsula and traverses the CMA only for a short section at the entrance road to the Rosebank Park Domain Go Kart track. The interfaces between these areas and the proposed motorway widening are typically above high tide level and as such are only expected to be inundated, if at all, on an infrequent basis. Therefore traditional erosion and sediment control methods, such as SRPs, decanting earth bunds, super silt fences, rock toe silt fences, cleanwater diversion channels and dirtywater runoff diversion channels, can be used. Erosion and Sediment Control Plans 20.1.11-3-D-EN-740-

103, 104 & 105 show a preliminary plan locating these measures from Traherne Island to Rosebank Park Domain. In this section of motorway the main erosion and sediment control philosophy is to:

- prevent clean runoff from Rosebank Peninsula from entering the site by the use of clean water diversion channels,
- to capture the sediment in any sediment laden runoff leaving the site by use of silt fences, and
- where possible divert, using dirty water diversion bunds, sediment laden runoff into decanting earth bunds before discharge into the CMA.

Patiki Road to Rosebank Park Domain Go Karting Track

The works west of the crest / watershed from approximately Chainage 3420 along the existing State Highway 16 up to the Rosebank Park Domain Go Karting Track at Chainage 4400 have a constraint in terms of availability of space for the construction of controls. The works are however relatively minor in this area and essentially include shoulder widening activities with the new road construction consisting largely of a new cycleway, re-alignment of the Patiki Road westbound on-ramp and new access road to the Go-karting track. The surface works can be managed through the use of cleanwater diversion channels and dirtywater runoff diversion channels and super silt fences channelling dirty water to SRPs. These are shown on Plans 20.1.11-3-D-EN-740-103, 104 & 105.

The only available space to fit SRPs is located between the Patiki Road on-ramp and Go-karting track in the area also allocated for Construction Yard 2. The dimensions of these ponds are detailed in Table 5.2 of this ESCP. SRPs to be constructed will be:

- SRP-3A at Chainage 3920 WB at the entrance to the Go-Karting Track (referred to as Go-Kart Sediment Retention Pond) on the southern side of the motorway; and
- SRP-3B at Chainage 3820 WB south west of Patiki Road On-ramp (referred to as Patiki Sediment Retention Pond) on the southern side of the motorway.

The surface water from the Rosebank Peninsula discharging towards the motorway can be managed through the use of cleanwater diversion channels and super silt fences channelling clean water to the CMA east of SRP-3B. This is shown on Plan 20.1.11-3-D-EN-740-104. This SRP will be chemically treated in accordance with the CTP. Dirtywater runoff diversion channels will be established that will direct flows to this devices.

The same method of erosion and sediment control utilizing a rock toe silt fence, will be applied to the section of works adjoining the CMA from Ch3920 to Ch4100 where reclamation is required.

In recognition of the values of the receiving environment, super silt fences will also be placed along the toe of the embankments and revetments to act as a “back up” in the unexpected event of sediment control failure.

Construction Yard 2 (Patiki)

The portion of land on the southern side between Patiki Road and the Rosebank Park Domain Go Karting Track will be suitable to be utilised as a laydown area. The facilities associated with the Construction Yard 2 (Patiki) may include construction plant and equipment parking, material storage and lay down areas and any associated building structures. The development of the Construction Yard will involve the installation of a super silt fence around the downstream perimeter of the associated earthworks activity and on completion of the earthworks the stabilisation of the area with clean metal. It is expected that the yard areas will be stabilised in metal over a period not exceeding one month. Further to this the super silt fence will remain in place throughout the utilisation of the yard area.

This area has a natural slope that falls towards the south west. Before commencement with any construction works occurring, and prior to the establishment of the construction yard, a SRP-3A will be established as described above and will both serve as a SRP for the works on the motorway and/or to the construction yard. Details of Construction Yard 2 are shown on drawing 20.1.11-3-D-EN-740-121. Table 5.2 provides the design details of this SRP.

The entrance to Construction Yard 2 (Patiki) will be off Patiki Road and will be provided with a stabilised entrance and wheel wash facility.

In recognition of the values of the receiving environment, super silt fences will also be placed along the contour to act as a "back up" in the unexpected event of a sediment control failure.

Rosebank Road Off-ramp to Patiki Road.

The works from the Rosebank Road westbound off ramp at Chainage 2800 westwards to the crest / watershed at approximately Chainage 3420 along the existing State Highway 16 also has a constraint in terms of availability of space for the construction of controls. The works are, however, relatively minor in this area and essentially include shoulder widening activities with the new road construction consisting largely of a new cycleway. The surface works can be managed through the use of cleanwater diversion channels and dirtywater runoff diversion channels and super silt fences channelling dirty water to decanting earth bunds. These are shown on Plan 20.1.11-3-D-EN-740-105.

On the southern side of SH16, decanting earth bunds have been located at approximately 100m intervals discharging into the cleanwater diversion channels which outfalls to the CMA at Rosebank Road Off ramp. The decanting earth bund catchment areas are between 2400 m^2 and 3000m^2 (as per TP90 guidance) and have been sized on this basis to ensure that adequate volume exists. Decanting Earth Bunds DEC-3A to DEC-3D will have volumes of between 50m^3 to 60m^3 based on catchments of 2400 m^2 to 3000m^2.

These decanting earth bunds will be chemically treated in accordance with the CTP. Dirtywater runoff diversion channels will be established that will direct flows to this devices.

6.4 Sector Four

Between Great North Road Interchange and Rosebank Road Off ramp on the westbound lanes, and the Whau River for the eastbound lanes, the motorway traverses the Motu Manawa Marine Reserve and other areas of the CMA, a sensitive and protected marine environment. The interfaces between these areas and the proposed motorway widening are typically below high tide level, and as such will be subjected to twice daily tidal inundation. This creates some challenges to control and capture any sediment that is generated by the works.

Erosion and Sediment Control Plans 20.1.11-3-D-EN-740-103 to 108 shows preliminary plans locating where erosion and sediment control measures are proposed in Sector 4. Further, Appendix E should be referred to provide plans of both construction sequencing and Causeway construction sections for Sector 4.

Eastbound lanes from Rosebank Park Domain to Rosebank Road On-ramp

The works from the Rosebank Road eastbound on-ramp between Ch3200 and Ch3850 westwards along the existing State Highway 16 traverses mainly the Rosebank Peninsula bordering the CMA up to and at the Patiki Road off ramp. This section of SH16 is also constrained by availability of space for the construction of controls. The works are however relatively minor in this area and include shoulder widening activities. The surface works can be managed through the use of dirtywater runoff diversion channels and super silt fences channelling dirty water to decanting earth bunds. These are shown on Plans 20.1.11-3-D-EN-740-103 to 105.

On the northern side of SH16 decanting earth bunds have been located at approximately 100m intervals discharging into the Motu Manawa Marine Reserve and channel between the motorway and Pollen Island. The decanting earth bund catchment areas are between 2000m^2 and up to a maximum of 3000m^2 (as per TP90 guidance) and have been sized on this basis to ensure that adequate volume exists. Decanting Earth Bunds DEC-4A to DEC-4F will have volumes of between 40m^3 to 60m^3 based on catchments of 2040 m^2 to 2940m^2.

The decanting earth bunds in this area will be chemically treated in accordance with the CTP. Dirtywater runoff diversion channels will be established that will direct flows to these devices. In recognition of the values of the receiving environment, super silt fences will also be placed along the toe of the embankments to act as a “back up” in the unexpected event of a sediment control failure.

Traherne Island

The works to the Causeway traverses Traherne Island from Chainage 2100 westwards to Chainage 2800. The works are relatively minor in this area and include shoulder widening activities. The interfaces between these areas and the proposed motorway widening are typically above high tide level and as such are only expected to be inundated, if at all, on an infrequent basis. Therefore traditional erosion and sediment control methods, such as super silt fences, or rock toe silt fences as described above, can be used. Erosion and Sediment Control Plan 20.1.11-3-D-EN-740-106 show a preliminary plan locating these measures over Traherne Island. In this section of motorway the main erosion and sediment control philosophy is to capture the sediment in any sediment laden runoff leaving the site by use of super silt fences. To provide a dry working environment temporary cofferdams (described below) will be used in conjunction with the super silt fences until the ground improvement works have been done. This will provide additional sediment control.

Causeway Bridges

Widening of the existing bridges and the construction of the new pedestrian/cycleway bridge will require wet concrete work over the waterway. Construction of the bridges utilising pre-cast elements is proposed to minimise the amount of in-situ concrete that will be required. Pre-cast beams are recommended for the main girders and pre-cast piles for the foundations of the motorway widening. The use of Super Tee girders with extended flanges will act as permanent formwork for an in-situ deck.

In-situ piles are typically cased with steel as they pass through the water and recent Holocene Alluvium stratum. The casing may be unable to prevent the ingress of water into the pile and concrete will be Tremie poured.

This will still result in cement contaminated water which will require treatment before discharge and this will either be conducted on site using treatment tanks and the water tested before discharge to the receiving environment, or the water removed from site and treated elsewhere through the use of sucker trucks.

Concrete placement will be carefully controlled to ensure no loss to the environment using pumps and skips. Designated concrete truck wash out areas will be required at the Construction Yard and these will contain the water from washing the trucks drums and chutes which can be treated or disposed of offsite.

The additional reclamation required at the bridge abutments will be done by Marine Deposit Displacement and Light Weight Fill as described in detail in Section 7 of this report. No structural sediment control measures would be required in these areas as the marine deposit displacement is done by the use of rock boulders and the light weight fill will be polystyrene blocks, both inert elements which will not generate sediment.

Great North Road Interchange to Rosebank Road (Excluding Traherne Island)

Between Great North Road Interchange and Rosebank Road the motorway traverses the Motu Manawa Marine Reserve and other areas of the CMA; a sensitive and protected marine environment. The interfaces between these areas and the proposed motorway widening are typically below high tide level and as such will be subjected to twice daily tidal inundation. This creates some challenges to control and capture any sediment that is generated by the works.

The existing Causeway between Great North Road Interchange and Rosebank Road is required to be widened and raised. This widening will involve reclamation of the CMA adjacent to each side of the existing motorway. To manage erosion and sediment control in this marine environment the Project needs to be constructed sympathetically; consideration must be given to, firstly, reducing the potential for sediment generation and, secondly, managing any suspended material generated from the earthworks.

In Technical Report No. G 23 Coastal Works, ground improvement works, by means of in-situ mudcrete mixing, are recommended for strengthening the marine mud along the Causeway to support the new embankments. However the in-situ mudcrete mixing in the marine mud may permit migration of silt and mud into the adjoining sea water, potentially polluting the harbour.

Approximately 1.48 km of works on sections of the Causeway from Ch 900 to the eastern abutment of the Whau Bridges at CH 4920 are below the MHWS level of 1.63mRL and will be subjected to tidal inundation. The

mitigation measures required include undertaking the work around the tidal cycle or the installation of temporary cofferdams to withhold the high tide and provide a dry enclosed working area. Cofferdams will have at least a 30% of the retained height based on MHWS as freeboard to prevent overtopping and minimise wave splash entering the enclosed area. Pump sumps will be monitored closely during the de-watering process. Only clean and un-contaminated water from surface run-off, seepage and possible wave splash will be pumped back into the CMA. Cement and sediment laden water will be removed by sucker trucks and discharge to a SRP for treatment. The cofferdams will also stay in place, until the bulk fill, which will mainly consist of granular material which should be a low sediment generator, is at an elevation above the MHWS. Sediment trapped within the cofferdam confinement will be removed and disposed of properly prior to removal of the cofferdam. The cofferdam should also be set back from the works area to limit potential damage to the dam.

Two construction alternatives exist for undertaking this work as follows:

Method 1: Temporary Water Filled Cofferdams

A method of capturing and controlling sediment contaminants generated by the CMA works is by utilising a temporary water filled barrier like the AquaDam® system. AquaDam® is a patented idea that combines three tubes and an available water supply. Two "inner" tubes contained by an outer "master" tube, are pumped full of water simultaneously during the installation process. Friction between the master tube and the inner tubes results in a stable, non-rolling "wall" of contained water, which adjusts automatically to the bottom terrain as the AquaDam® is deployed. An impervious dam is formed to provide a relatively dry working area. A factor to take into consideration is that the width of the footprint required for the AquaDam® is approximately 2 to 3 times the height i.e. a 2.4m high wall requires a 5.8m wide base. This will require an additional area to be cleared of mangroves as the AquaDam® will have to be clear of the working platform.

The use of the cofferdam would provide a dry working environment and the temporary cofferdam could stay in position until the ground improvement areas has been stabilised and the fill embankment is above the MHWS level. During the works period any contamination that results from the works will be sucker trucked away from the site of works. Damage to the cofferdam that could potentially pose the threat of releasing sediments to the adjoining environment is greatly countered by the design of the water filled cofferdam. Should one of the inner tubes be punctured, the other would still provide protection until remedial work could be performed.

Appendix E provides further detail associated with the AquaDam® product.

Method 2: Temporary Sheet Pile Wall

Interlocked steel sheet piles are commonly used as temporary watertight cofferdams throughout the world. The interlocks of the sheet pile sections are shaped like a thumb-and finger or a ball-and-socket for watertight connections. These connections can also prevent the migration of silts and fines from the mudcreting site to the adjacent water. For the proposed in-situ mudcreting works, a row of interlocked steel sheet pile wall can be installed to form a barrier separating the ground improvement treatment zone from the harbour. The sheet piles can be installed from a barge during high tide. The top of the sheet pile wall would be above the existing high tide level.

Analysis shows that installation of a sheet pile wall to form a watertight cofferdam is technically feasible. Sheet pile embedment length will need to be 17.5m at the most critical channel section of CH1600. Sheet pile embedment length may be shorter from chainage CH900 to CH1200 where the existing soft rock layer (Weathered East Coast Bay Formation) lies about 10m below the top of the existing mudflats. Sheet pile embedment length can also be shorter on the south side of the Causeway from CH 1340 to CH1870 where the mudflat top levels are above -0.1mRL.

In undertaking a best practicable option (BPO) approach to the methodology to be implemented it is considered that the temporary cofferdams provide for the BPO within the Project. In reaching this conclusion it is noted that whilst sheet piling is a viable solution, it is not recommended for the following reasons:

- Sheet piling in this terrain requires operations from a flat bottomed barge whose deployment will be complicated by the tidal cycle.

- Such marine sheet piling will not address the installation needs along the full length of the alignment. Elsewhere other techniques will be needed.

- There are technical difficulties installing sheet piles next to the existing embankment. The presence of boulders may prevent penetration or disrupt the continuity of the wall.

Where works are therefore constrained by the tidal cycle, then the option of utilising the cofferdams will first be explored. Working around the tidal cycle and the use of sheet piles still exist as options, however remain as secondary options for the reasons outlined above. Particular attention will need to be given to minimising sediment generation during these operations. Section 7.0 of this ESCP provides further discussion on this issue.

6.5 Sector Five Great North Road Interchange

This area and stage of works can be considered in discrete separate stages as follows:

Southern side of the existing State Highway 16 adjacent to the northern bank of Oakley Creek.

The works along the southern side of the existing State Highway 16 are constrained by the availability of space for the construction of significant (large volume) controls. The earthworks are however, relatively minor in this area and essentially include some shoulder widening activities with the new road construction consisting largely of a viaduct leading to the Causeway construction in Sector 4. Any earthworks undertaken in this area can be easily managed through the use of super silt fences. These are shown on Plan Number 20.1.11-3-D-EN-740-109. In addition to the super silt fences it is noted that there is space to install decanting earth bunds if necessary. These will have catchment areas less than 3000m^2 (as per TP90 guidance) however it may be beneficial to allow for these if necessary. In this circumstance any decanting earth bunds will be subject to chemical treatment as necessary.

In this location where small earthwork activities may occur outside of the super silt fence catchment, individual controls for the specific areas will be implemented. It is likely that these will also consist of super silt fence installation.

Great North Road Interchange

The interchange itself will involve the construction of two SRPs (referred to as SRP 5B and SRP 5D) during the construction phase of the Project. SRP 5D will have a catchment area of 2.08 hectares (including some clean water areas which cannot be practically diverted away from the catchment area) and will be chemically treated in accordance with the CTP detailed in Appendix B. SRP 5D will discharge via existing reticulation associated with the existing wetland feature. Dirtywater runoff diversion channels will be established that will direct flows to this device. These will consist of compacted material but will also be formed from the excess topsoil removed from the yard area. In addition to these key devices, super silt fences will be installed to protect those areas where dirtywater runoff diversion channels cannot be easily established.

As shown on Plan Number 20.1.11-3-D-EN-740-109 a large area associated with the interchange will be utilised as a laydown area and a stockpile area for material extracted from the tunnel operation. This is referred to as Construction Yard 4. It is expected that this area will be primarily utilised for construction plant and equipment, tunnel spoil and some stockpiling as outlined in Table 7.1 in Section 7.2 of this report.

To the west of this area a further construction yard (Construction Yard 3) area of 1.46 hectares exists. This area is the subject of a future fill batter associated with the road alignment, however will be utilised as a laydown area in the interim period. A SRP (SRP 5B) is provided in this area to treat the full area of the yard. SRP 5B will discharge via an existing reticulation system under the existing on ramp structure.

Construction yard establishment and stabilisation methodologies are discussed further in Section 7.0 of this report with the key element associated with these locations being the establishment of sediment control devices with progressive stabilisation of hard fill as the areas are excavated to the necessary grade.

No cleanwater diversion channels are required in this area because of the existing drainage and contours.

Moving to the east from the Great North Road Interchange, the works are all managed through the use of super silt fences and, where appropriate, decanting earth bunds as outlined in Sector 6.

Oakley Creek Crossing

The Oakley Creek crossing is an area of higher risk associated with the Project and as a result particular attention needs to be given from an environmental perspective. It is expected that a detailed specific ESCP will be submitted for this area which will ensure that all parties, including the consent authority and the contractor, have the opportunity to comment on and determine the final methodology to be implemented. The key aspects of this stage of works however include:

- There will be no piles located in the low tide Oakley Creek channel.
- A super silt fence will need to be established along the lower side of all works (Oakley Creek margin) below all piles and associated construction works.

- Works will only be undertaken in this area during periods of low flow.

- Pumping of any sediment laden or contaminated runoff can occur to SRP 5C with appropriate chemical treatment as necessary.

- Contamination management will be critical and the use of concrete and associated products will be the subject of specific details within Technical Report No. G 21 Construction Environmental Management Plan (CEMP).

Waterview Reserve

The Waterview Reserve area is shown on 20.1.11-3-D-EN-740-113. A construction yard will be established immediately west of Great North Road known as Construction Yard 6. The facilities associated with the construction yard include a workshop, covered stockpile building, concrete batching plant, bentonite plant and associated building structures. Table 7.1 in Section 7.2 of this report provides some more details of the expected activities in this area. The construction of this yard will involve earthworks to establish an appropriately graded site to allow the necessary activities to occur. It is expected that the yard area will be stabilised with clean metal over a period not exceeding one month following completion of earthworks. In association with all of the erosion and sediment control devices, a super silt fence will be installed on the southern embankment of the Oakley Creek and will remain in place for the period of use of the yard area. The lower area of this Construction Yard carries more risk as it does not discharge to one of the two SRPs in this location, and therefore is not subject to the same level of high treatment of runoff. This lower area will therefore be limited to activities that have a low risk in terms of contamination and will not be used for activities such as fuel storage or concrete batching activities.

Clean water will be diverted away from the works area through the provision of the existing kerb, channel and drainage network within the road reserve. Great North Road and Herdman Street provide this function.

Prior to any earthworks associated with the Construction Yard 6 the super silt fence will be placed around the southern boundary of the Oakley Creek as shown on plan number 20.1.11-3-D-EN-740-113.

This location is the northern extent of the cut and cover tunnel operation and will involve a cut to achieve the necessary gradients, in this circumstance up to 6m in depth. This will have the effect of creating a "hole" which creates a collection point for sediment laden runoff at the southern extent of the Waterview Reserve. Prior to any of these works occurring however, and prior to the establishment of the yard itself, two SRPs, referred to as SRP 5A and SRP 5C are to be established as shown on 20.1.11-3-D-EN-740-113. These SRPs will have water diverted to them via dirtywater diversion channels and have a contributing surface water catchment of 4.19 hectares for SRP 5A and 0.48 hectares for SRP 5C. SRP 5C is currently sized for a small contributing catchment only however based on volumes required for temporary stormwater purposes a larger volume will be constructed in this location early in the Project. Any earthworks that fall outside of these SRP catchments will be treated via the super silt fences.

SRP 5A is sized based on a contributing catchment area which includes the cut and cover tunnel operation. This operation involves the installation of pile walls and the following excavation of material from within these. Some of the surface water runoff from this area will not naturally fall towards SRP 5A. In this circumstance, the water will be pumped to the dirtywater runoff diversion channels which in turn will flow to SRP 5A. This pump

will be based on a portable system and will move with the excavation as necessary. It will be referred to as the Northern Portal Surface Water Pump.

SRP 5A will be chemically treated via a rainfall activated device. It will also be fitted with manually raising decants to allow flows to be fully captured and manually batch-dosed if necessary. Failure of the pump has minimal environmental consequence with the primary issue being the flooding of the works area. A sump and pump station will be established at the portal location to allow for temporary pumping to this device.

With consideration of the large volumes of stormwater that will need to be pumped to SRP 5A in storm events and with the sizing of SRP 5A based on TP90 volumes, it is assessed that careful consideration needs to be applied to the treatment options. Decant structures will be raised so that no discharge occurs, sediment laden runoff can be pumped into the SRPs via the forebay structure, batch dosing of the SRPs can occur and once 100mm of clarity is measured then the decants lowered into the water column and the pond slowly emptied to the dead storage level. This will be repeated as necessary during the works duration. It is not expected that pumping will be continuous in this location due to the flows related to rainfall only, however, if it is determined that pumping is required to be continuous, then flocculent will be added to the pumping regime at the necessary dosage rate. This will prevent the need for ongoing batch dosing with monitoring of the SRP to ensure that appropriate water quality is achieved. If pump dosing is undertaken, then the dosage rate will be based on the volume pumped per hour. The dosing pump will be linked into the power circuit for the water pump so the dosing pump runs when the water pump runs. A diaphragm pump is expected to be used with a speed and stroke control to enable easy dosage adjustment as necessary.

In addition to the primary control measures as outlined above, use will be made of decanting earth bunds and super silt fences within the Waterview Reserve area as required. These are not shown on any plans at this time due to the likely temporary nature of these devices as works progress. These will all be undertaken in accordance with TP90 (including any updates to this document) and in coordination and association with the consent authority on site.

The spoil material from the Northern Tunnel Portal is expected to be 260,000 m^3, with this material to leave the site via the existing motorway system. The material to be removed from the tunnel operation itself will be transferred via an enclosed conveyor system to the covered spoil disposal shed located within the Construction Yard 6 and from there progressively removed via stabilised access from the site. Due to the spoil disposal area being covered, there will be no runoff issues from this activity except for some runoff which may result from natural dewatering of the fill material during storage. Any runoff of this nature will be treated through the SRP 5A or the super silt fence device. A maximum excavation rate of 3400m^3 per day is expected and the storage area contains a 3 day storage capacity should there be a breakdown of truck movements.

It is noted that some of the spoil material within Construction Yard 6 will be transferred to Construction Yard 4 where it will also be stockpiled. However it will not be fully covered, and will be managed through the erosion and sediment control measures associated with that construction yard.

Further to the above, it will be important that no existing reticulation collect untreated sediment laden runoff. Stormwater Inlet protection will be utilised throughout this sector where, while not a primary sediment control device, will assist in ensuring that any unexpected discharge to these locations will be adequately addressed.

Care will be taken through ongoing monitoring (as outlined in Section 5.3 of this ESCP) to ensure that no blockage of the stormwater inlets occur, and therefore no localised flooding issues result.

A wheel wash facility is to be established on Cowley Street at the site entrance to SH16. The specific design of this wheel wash system is yet to be determined, however will likely be a waterblaster used to wash all vehicles leaving the site. A recycling system will be utilised resulting in no direct discharge apart from minor "splash". A manual system provides for more certainty to ensure only clean vehicles leave the site. No ingress or egress from the site will be established unless such a wheel wash facility is established. The final design will be the subject of consent authority approval through the CESCP.

6.6 Sector Six

This sector involves the shoulder widening activity along the existing State Highway 16 to St Lukes Road. It is considered a relatively low risk sector in terms of the area of earthworks, however has a higher risk associated with it due to the lesser sediment treatment efficiency of the proposed silt fence control measures. Progressive stabilisation of this sector will however occur as works proceed and in this way the risk of sediment generation and yield is significantly reduced. While there are no proposed works within the Meola Creek itself, a higher risk component of the sector is that associated with works in the vicinity of the Meola Creek. All the other works are associated with shoulder widening and can be relatively easily managed during the construction phase through the implementation of silt fences.

The long term stormwater management is to be addressed through the construction of a wetland referred to as the Meola Betterment Pond as shown on 20.1.11-3-D-EN-740-111. The construction of this pond will require approximately 5000m^2 of earthworks. It will also require installation of a stabilised entrance way onto Great North Road, establishment of dirtywater runoff diversion channels and construction of two decanting earth bunds (DEB 6A and DEB 6B) both sized for 3000m^2 catchment areas each.

The location of the Meola Betterment Pond will also be the location of a construction yard referred to as Construction Yard 5. This yard will largely be used for the purpose of construction plant and equipment. Erosion and sediment control during establishment will include the installation of dirtywater runoff diversion channels leading to decanting earth bunds 6A and 6B. A super silt fence will also be established below the actual Meola Betterment Pond excavation to assist with prevention of any offsite sediment laden runoff.

The remaining part of Sector Six involves road shoulder widening and will be largely contained within a corridor. To ensure that no discharge of sediment occurs a silt fence will be installed along the entire southern boundary of the works. The silt fences will include returns at 60m intervals to ensure that any flows along the length of works are slowed down to the maximum extent possible, with sediment also trapped within these returns. This will be further "backed up" with a decanting earth bund (DEB 5A) located at the Great North Road / State Highway 16 south eastern intersection (as shown on Plan Number EN-740-109 Rev B) which is designed to a 60m^3 capacity to capture any runoff from the Carrington Road bridge through to the decanting earth bund location. This catchment area will be a maximum of 3000 m^2.

Along the northern boundary of the works, the silt fence (with appropriate returns) will be replicated with consideration of the traffic safety issues identified earlier within this ESCP. A decanting earth bund (DEB 5B) will be established at the Great North Road / State Highway 16 north eastern intersection (as shown on Plan Number 20.1.11-3-D-EN-740-109) which is designed to a 60m^3 capacity to capture any runoff from the Carrington Road bridge through to the decanting earth bund location. A dirtywater runoff diversion channel will be established to take flows to this decanting earth bund.

Both decanting earth bunds will discharge into the existing reticulation system and will be fitted with rainfall activated chemical treatment devices.

The shoulder widening works involve minimal earthworks and will be progressively stabilised with hard fill as works progress. It is expected that the maximum time that any area within this sector will remain exposed in 1 month.

6.7 Sector Seven

Cut and Cover and Tunnel Excavation

This sector contains the cut and cover and tunnel operation which will include the installation of permanent drainage design including pump stations that will collect water from the lowest point in the tunnels and discharge to the Northern Tunnel Portal area where the water will be treated and discharged.

The sequence of events commences for the cut and cover operation with the installation of walls and/or piles which will involve minimal earthworks activity. Following this, excavation will occur which will predominantly be undertaken from the top down and will involve transporting of the material to Construction Yard 6 for disposal off site. If material is to be removed from this cut and cover section via the base of the trench, then a stabilised haul road will be established.

Progressive stabilisation through the installation of a concrete slab will also occur as works progress and as cut levels are achieved. Therefore, while the cut and cover excavations will involve substantial earthworks, they are progressively stabilised with any discharge water to be pumped and treated through the necessary treatment devices including SRP 5A. Clean water from the completed road surface will be diverted to the stormwater reticulation as works proceed.

Should both the tunnel portal earthworks and the cut and cover earthworks commence at the same time, this will involve surface excavations in two locations and two separate surface water pumping regimes would be required. This will simply follow the same methodologies as with one surface water pump, with the flows pumped to either SRP 5A or SRP 7A. Chemical treatment will be applied in the same manner as detailed in Sector 5, and will be based on flocculent added to the pumping regime at the identified dosage rate.

The material to be removed from the tunnel operation itself will be transferred via an enclosed conveyor system from the roadhaeader tunnel portal to the covered spoil disposal shed located within the Construction Yard 6, and from there progressively removed either via trucks along stabilised access tracks from the site or

via conveyor to Construction Yard 4 for reuse in Causeway or disposal offsite. Treatment of this area is defined above.

A construction yard (Construction Yard 7) will be established in this sector as shown on Plan Number 20.1.11-3-D-EN-740-113 with the primary purpose of this yard providing an access road to the tunnel operation. In addition, a small benonite plant is expected to be located in this area associated with the cut and cover operation. Table 7.1 in Section 7.2 of this ESCP provides further details of the expected activities within the yard area. This yard has an area of 1.49 hectares and will be surrounded by a super silt fence which will provide the necessary sediment control during construction. In addition a temporary stormwater pond will be utilised as a SRP during construction with dirtywater runoff diversion channels established as necessary. These will be in the form of compacted soil also utilising the topsoil removed from the site. This is referred to as SRP 7A and is located on a plateau away from the Oakley Creek and the expected area of works.

Tunnel Excavation

In addition to the Northern Portal Surface Water Pump there will be the need to pump and treat any sediment laden groundwater from the tunnel excavation activity itself. It is possible that this water will have a relatively high pH level due to the concreting activities that will be occurring within the tunnels. While the sediment laden runoff from the surface flows will be treated through the SRPs, all tunnel water discharge will be pumped, via a separate system to a pre treatment facility which will consist of containers with baffle walls and provision for chemical treatment as necessary as shown in Appendix F. The containers will contain a vegetative mulch material which will provide some pH buffering. The discharge from these containers will be controlled through pump management and a turbidity and pH meter located at the discharge point. This pumping regime will be referred to as the Northern Portal Tunnel Pump and will pump all flows to the temporary stormwater treatment device located in Construction Yard 7.

A continuous turbidity and pH meter will be installed at the discharge from the container systems with a turbidity discharge standard to be established based on receiving environment values determined through the monitoring programme. This level will be set at an initial 50 NTU. Where the turbidity level is exceeded, or pH is greater than 7.5 the pump will be shut off and no discharge occurs. This will allow for further treatment to be achieved via chemical treatment and or pH management prior to discharge. In this event pumping will cease resulting in no discharge and further treatment through SRPs, removal of the material off site via sucker truck to an appropriate location or discharge directly into the Watercare wastewater network can occur. As an example if, after treatment, pH levels are such that further treatment is required, acid dosing will be implemented. It is noted that treatment with polyalluminium chloride will have the effect of reducing pH and may, in itself, provide the necessary pH adjustment.

Further, and as mentioned above, the containers will discharge to a sump and through pumping to the temporary stormwater treatment pond in Construction Yard 7. This stormwater pond has been designed with extra capacity to allow for the expected maximum 300m^3 of groundwater per day that will require removal. The stormwater treatment pond will provide further treatment and will also have the discharge monitored to ensure that pH and turbidity levels are achieved.

In summary all surface water from the cut and cover operation will be treated through the SRPs within Waterview Reserve, and all "tunnel" water will be treated through pre treatment facilities and a temporary stormwater pond, monitored for turbidity and pH and treated as required.

To ensure that surface water flows and tunnel groundwater do not mix and can be treated as detailed above, the portal location will be designed such that bunds will be established between the two pumping systems and associated sumps.

In the event of pump failure, and to ensure construction can continue in these areas, a "standby" generator will be on site at all times. In the circumstance of a failure, the sump area at the portal location will progressively fill and move over the works area at this location. If pump failure occurs then the standby generator is available and pump repairs can be undertaken as soon as possible. Once rectified, then pumping will recommence and, once water is drawn down to an acceptable level, works can recommence as normal.

6.8 Sector Eight

This sector is associated with the tunnel operation, and in terms of erosion and sediment control requires no specific measures. All works in this sector are underground and will be treated through the control measures as outlined for Sectors Seven and Nine.

6.9 Sector Nine

Chainage 400 to 1050

This sector includes a large cut area from the south towards Richardson Road leading to the Oakley Creek at approximately chainage 1050.

Prior to earthworks, it is important the cleanwater diversion channels are installed above the cut area to ensure that only that water from within the works area needs to be captured and treated. A cleanwater diversion will be installed on the southern side of the alignment to discharge to the existing Richardson Road pavement. This cleanwater diversion will take the runoff that may occur from the Christ the King School catchment with an area of 1.3 hectares.

On the northern side of the alignment is the Stoddard Road Oakley Creek tributary. This will be protected with super silt fences where the works are in close proximity to the stream environment. This tributary will remain as an active channel throughout the period of works except for a section of the tributary which will be diverted to accommodate the road alignment. This will be undertaken in accordance with the stream diversion methodology as outlined in Section 7.0 of this report. This diversion can be completed largely outside of the 100 year flood plain area with a bund formed below the works area to ensure that the during construction inundation does not occur.

At the confluence of the Stoddard Road Oakley Creek tributary and the Oakley Creek a further diversion will occur to enable appropriate alignment of the proposed bridge structure with the stream system. These works will also follow the stream diversion methodology as outlined in Section 7.0 of this report. This section of streamworks however is located within the 100year flood plain level, with no practical ability to install bund structures to achieve a working area outside of this flood level. The works will therefore be undertaken during

periods of low flow and will require daily stabilisation as also outlined in Section 7.0 of this report. This stream diversion will occur early in the Project to enable other construction activities to continue.

The Oakley Creek acts as a natural catchment boundary with respect to erosion and sediment control, and all earthworks on the southern side of the Oakley Creek will be treated as a separate component as below.

The works associated to the south east of the Maioro Interchange, and the off/on ramp structures, will use a previously installed SRP shown on 20.1.11-2-D-C-5210-002 Revision A within Appendix G of this ESCP. This SRP will remain in place throughout the works associated within chainage 400 to 1100 and will act as a "back up" facility as necessary. The SRP further to the south (SRP Number 2 shown on 20.1.11-2-D-C-5210-002 Revision A) will also remain in place and will be utilised for any pavement construction that will occur over this area. Dependent upon the sequence of works in this location the cut area south of Richardson Road can be diverted back to either of these pond features.

SRP 9C will be installed outside of the 1% AEP flood plain area and will discharge into Stoddard Road Tributary of the Oakley Creek. Chemical treatment through rainfall activated systems will apply. Due to contours in this area there is a small catchment area that cannot flow towards SRP 9C and this will be protected by a super silt fence.

A further SRP (SRP 9A) will be installed, outside the 1% AEP flood plain levels as shown on plan number 20.1.11-3-D-EN-740-118 and will discharge into Oakley Creek. Chemical treatment through rainfall activated systems will apply.

To ensure that dirty water will flow to this location, dirtywater runoff diversion channels will be installed where necessary with the cut under Richardson Road naturally diverting flows to this location. Dirtywater runoff diversion channels are likely to be only adjacent to areas of fill with the cut areas serving the same purpose along this length of alignment.

The fill batter leading to the proposed bridge over the Oakley Creek will be managed through the use of super silt fences. This is due to the contours making it difficult to allow water to flow back into SRP 9A. Super silt fences are considered adequate to achieve the necessary environmental outcomes.

A construction yard (Construction Yard 12) will be established as shown on Plan Number 20.1.11-3-D-EN-740-118 with the primary purpose of this yard providing construction related parking and activities. No contaminant producing activities will take place in this area due to its location adjacent to the Oakley Creek and associated risk. Table 7.1 in Section 7.2 of this report provides further details of the expected activities within the yard area. This yard will be surrounded by a super silt fence which will provide the necessary sediment control during construction. It is expected that the yard area will be stabilised in metal over a period not exceeding one month.

Valonia Street realignment will also utilise SRP 9A, and during construction will have all stormwater inlets protected to ensure that no sediment discharge enters the stormwater reticulation system that currently exists.

SRP 9A is sized for a catchment area of 4.89 hectares.

Chainage 1050 to 1800

This area includes three Oakley Creek stream diversions. The methodologies as detailed in Section 7.0 of this ESCP apply to the proposed diversions. In particular, prior to undertaking works in this area, the diversions and culvert installation (Hendon Ave Stormwater Culvert) will be undertaken. It is noted that the Hendon Ave stormwater culvert will assist with ensuring that cleanwater from the northern side of the alignment will be appropriately diverted away from the works area. The stream diversions are considered critical in achieving a workable area with the fill from these activities removed from site. Once the diversions are in place, the Oakley Creek will be fully protected with super silt fences as a further control measure, and to ensure that no sediment or construction rubble enters the stream. These diversions will be largely undertaken outside of the 1% AEP Flood Plain area. However, where sections of the diversions are within this 1% AEP flood plain area, bunds will be established to ensure these extreme events do not inundate the work area. As outlined in the methodology, an important feature of the construction of these diversions is the daily stabilisation of the channel and undertaking works during period of low flow.

The second phase of this area will involve the development of the construction yards as shown on plan number 20.1.11-3-D-EN-740-117 and 118. This will involve the installation of a super silt fence around the perimeter of the associated earthworks activity areas, outside of the 1% AEP flood level, and on completion of the earthworks, the stabilisation of the area with clean metal which will occur within a one month period. Further to this the super silt fence will remain in place throughout the utilisation of the yard area.

Four construction yards (Construction Yards 8, 9, 10 and 11) will be established as shown on 20.1.11-3-D-EN-740-117 and 118, with the primary purposes of the yards outlined in Table 7.1 in Section 7.2 of this report. Yard 8 is largely for material storage, Yard 9 includes stockpiles, workshops and construction plant, Yard 10 includes storage and also a concrete batching plant, with Yard 11 for construction plant and equipment. The use of the yards reflects their location with those yards in the vicinity of the Oakley Creek, and subject to flooding in large events only to be utilised for activities that will not create contaminant potential.

As part of the construction in this location, a SRP (referred to as SRP 9B) will be constructed which will be located outside of the grout curtain to be installed in this area. SRP 9B will also be lined with an impermeable liner to ensure that no leakage from this structure occurs into the portal location. The SRP 9B will be located such that it takes flow from the construction activity via pumping from an area of 2.72 hectares. Chemical treatment will be installed which will utilise manual batch dosing regimes or chemical introduced into the pumping system as detailed above in Sector 5.

From chainage 1050 to the Southern Tunnel Portal location at chainage 1800, sediment laden runoff will be collected in a sump and pumped to the SRP 9B. Due to the pumping regime it is required that the SRP 9B will have a manual rising decant system which will be raised during pumping activities, with manual chemical batch dosing occurring, after which a clarity of 100mm will be achieved the decant arms will be lowered to allow for discharge. It is noted that if pump failure occurs, then local flooding of the sump area will result, with the only effect being on the construction activity itself. No discharge will result to the receiving environment in this circumstance. This pumping system will be referred to as the Southern Surface Water Pump. Further to SRP 9B the Valonia Wetland provides a further detention structure which could be utilised for sediment control purposes if at all necessary.

Southern Tunnel Portal

This portal is a large open-cut excavation and is required to be at formation level in time to receive the Roadheader tunnel construction equipment. Approximately 95,000m^3 of material will be excavated out of the southern portal area, with the portal location to have a vertical wall construction which has the effect of significantly reducing the cut batter faces and also ensures that there is adequate room for the stream diversion at that location. The facilities associated with the tunnel excavation such as workshop, stockpile building, batching plant and associated building structures will all be located within construction yards as detailed in Section 7.2 of this ESCP.

The construction of the Southern Tunnel Portal itself will involve a cut to the portal entrance which will mean that a depression will be established early in the earthworks programme, which will collect water and flow towards the portal location. All surface water from this area will be pumped via the Southern Portal Surface Water Pump to SRP 9B as shown on Plan Number 20.1.11-3-D-EN-740-117 as detailed above. A sump and pump station will be established at the portal location to allow for temporary pumping to this device to occur. SRP 9B may require to be established by partial bunding to ensure that outlet flows are able to discharge to the existing reticulated system In this circumstance a larger footprint may be required than that outlined within Table 5.2 of this ESCP. This can be achieved by extending the length of the SRP as necessary within the construction footprint.

In addition to the Southern Portal Surface Water Pump, there will be the need to pump and treat any sediment laden groundwater from the tunnel excavation in the same way as the northern tunnel excavation and as described previously. It is possible that the tunnel excavation water will have a relatively high pH level due to the concreting activities that will be occurring within the tunnels. While the sediment laden runoff from the surface flows will be treated through the SRPs all tunnel water discharge will be pumped, via a separate system, to a pre-treatment facility which will consist of containers with baffle walls and provision for chemical treatment as necessary as shown in Appendix F of this ESCP. The containers will contain a vegetative mulch material which will provide for some pH buffering. Two container systems will be utilised and the discharge from these containers will be controlled through pump management and a turbidity and pH meter located at the discharge point. This pumping regime will be referred to as the Southern Portal Tunnel Pump and will pump all flows to the temporary stormwater treatment device located in Construction Yard 9.

As with the Northern Portal Tunnel Pump, the Southern Portal Tunnel Pump will be installed with a continuous turbidity and pH meter at the discharge from the container systems with a turbidity discharge standard to be established based on receiving environment values determined through the monitoring programme. As also noted previously, this level will be set at an initial 50 NTU. Where the turbidity level is exceeded, or pH is greater than 7.5, the pump will be shut off and no discharge will occur. This will allow for further treatment to be achieved via chemical treatment and/or pH management prior to discharge. In this event, pumping will cease resulting in no discharge and further treatment through SRPs, removal of the material off site via sucker truck to an appropriate location or discharge directly into the Watercare wastewater network can occur. As an example if, after treatment, pH levels are such that further treatment is required, acid dosing will be implemented. Treatment with polyalluminium chloride reduces pH and may, in itself, provide the necessary pH adjustment.

Further, and as mentioned above, the containers will discharge to a sump, and through pumping to the temporary stormwater treatment pond within Construction Yard 9. This stormwater pond has been designed

with extra capacity to allow for the expected maximum 300m^3 of groundwater per day that will require removal. The stormwater treatment pond will provide further treatment and will also have the discharge monitored to ensure that pH and turbidity levels are achieved.

In summary, all surface water from the cut and cover operation will be treated, via pumping, through the SRP 9B and all "tunnel" water will be treated through pre-treatment facilities and a temporary stormwater pond, monitored for turbidity and pH and treated as required.

To ensure that surface water flows and tunnel groundwater does not mix and can be treated as detailed above the Southern Tunnel Portal location will be designed such that bunds will be established between the two pumping systems and associated sumps.

In the event of pump failure, and to ensure construction can continue in these areas, a standby generator will be required to be on site at all times. In the circumstance of a failure, the sump area at the portal location will progressively fill and move over the works area at this location. If pump failure occurs, then the standby generator is available and pump repairs can be undertaken as soon as possible. Once rectified then pumping will recommence and, once water is drawn down to an acceptable level, works can recommence as normal.

Chemical Treatment for SRP 9B will follow the philosophy of the CTP provided in Appendix B. This will follow the same methodology as outlined for Sectors 5 and 7 where flocculent will be added to the pumping regime at the necessary dosage rate with the benefits of minimising potential for flooding in the works site, be operational outside work hours and avoids potential delays associated with batch dosing requirements. A chemical batch dosing regimen can still be utilised whereby the decant structures will be raised so that no discharge occurs, sediment laden runoff can be pumped into the SRP 9B via the forebay structure, batch dosing of the SRP can occur and once 100mm of clarity is observed within the SRP, then the decants lowered into the water column. This will be repeated as necessary during the works duration.

Construction Yard 8 is located to the west of the southern portal area and will be used for laydown purposes. Erosion and sediment control is based upon the implementation of a chemically treated SRP (referred to as SRP 9D) with associated diversion channels for both clean and dirty water. A small area adjacent to Oakley Creek cannot be diverted to SRP 9D and as a result this is treated through the provision of a super silt fence which continues around Oakley Creek from Construction Yard 9 as a continuous measure.

<u>Commence Boring of Northbound Tunnel</u>

The tunnelling operation, while essentially all undertaken as an underground operation, creates a significant amount of fill material. The tunnel operation will include the installation of permanent drainage design, which will include pump stations that will collect water from the lowest point in the tunnels and discharge to the southern portal area. As a general principle, the water that will be discharged from the tunnels will be treated as detailed above.

The amount of material to be removed from the tunnel operation (both north and south bound) bulks to approximately 1,400,000m^3. For the Southern Tunnel Portal, this will be transferred via an enclosed conveyor system to the covered spoil disposal area located within the Construction Yard 9, and from there progressively removed via stabilised access tracks from the site. Due to the spoil disposal area being covered there will be

no runoff issues from this activity except for some runoff which may result from natural dewatering of the fill material during storage with treatment provided through the provision of a super silt fence.

7. Activity Details and Methodologies

7.1 Spoil Disposal Area

It is proposed to establish spoil stockpile areas at both the Southern and Northern Tunnel Portal locations within Construction Yards 6 and 9. The spoil disposal site areas will be completely covered within a shed environment and are approximately 2500m^2 in area. These spoil disposal sites are designed as "transfer" sites only and will act as temporary yards during the construction period. A maximum 3 days storage capacity is expected within these covered stockpiles. They will be located in association with a workshop, storage and project offices. Movements to this site from within the construction corridor, will be limited to moving material via stabilised access tracks via a covered conveyor for material from the tunnelling operation itself. Trucks will then take this material from the site to an approved off-site location, or in the circumstance of Construction Yard 6 may be conveyed to Construction Yard 4 for reuse purposes.

Spoil associated with activities such as diversion channel excavation that will require temporary stockpiling, will all be contained within the construction yard areas, and will be controlled through the associated erosion and sediment control measures. This spoil material will be stockpiled on a temporary nature only, and will be removed off site in an ongoing and progressive manner.

7.2 Construction Yard Establishment

Establishing the 12 construction yards typically involves stripping of topsoil, contouring and placement of hardfill dependent upon the use of the yard area. Construction yards will be required to have adequate erosion and sediment control and due to the temporary nature of the exposed area, will be based upon super silt fences and/or SRPs during construction followed by a progressive cover of hard fill material.

Due to the finished metal surface of the yards acting as impervious surfaces it is important that they are also managed from an interim stormwater perspective. This is addressed within Technical Report No. G 15 Assessment of Stormwater and Streamworks Effects. Where possible integration between the erosion and sediment control and the stormwater management will occur. Despite the fact that the actual earthworks activity will be undertaken over a relatively short duration, the erosion and sediment control measures will remain in place throughout the life of the specific yard area.

It is recognised that some of the construction yards are higher risk in that they may be inundated by flood water during flood events. In this regard all parts of all construction yards that are located below the 20 year flood level will be stabilised with clean gap 65 metal and compacted with a track roller. Further, these locations of the construction yards will not be utilised for any contaminant generating activities such as fuel storage or concrete batching plants. This particularly applies to Construction Yards 11 and 12.

The specific activities to occur within these areas will be varied and are detailed below in Table 7.1.

Table 7.1: Construction Yard Details

Yard Reference	Activity Details
Yard 1 (Orangihina Park)	• Offices/Ablutions • Storage and lay down areas • Workshop • Waste management/storage • Refuelling facility • Earthworks and stormwater devices • Car Parking
Yard 2 (Patiki)	• Storage and lay down areas • Waste management/storage
Yard 3 (Great North Road Interchange - Causeway construction area)	• Storage and lay down areas; • Workshop; • Offices/Ablutions; • Waste management/storage • Minor stockpile for Tunnel material • Stormwater Management
Yard 4 (Great North Road Interchange - Tunnel construction area)	• Offices/Ablutions • Storage and lay down areas • Workshop • Waste management/storage • Refuelling facility • Conveyor and/or trucked Tunnel spoil • Screening of spoil • Lime mixing / spoil drying • Carparking • Stormwater management and sediment control
Yard 5 (Meola Creek)	• Offices/Ablutions • Storage and lay down areas • Waste management/storage • Lime drying (rotary hoe) • Stormwater management • Carparking
Yard 6 (Waterview Park)	• Offices/Ablutions • Storage and lay down areas • Workshop • Spoil stockpile • Waste management/storage • Refuelling facility • Conveyor and/or trucked Tunnel spoil • Screening of spoil

	• Lime mixing / spoil drying • Carparking • Bentonite Plant • Vent building construction
Yard 7 (Oakley Creek Reserve)	• Offices/Ablutions • Storage and lay down areas; • Mobile bentonite processing plant • Concrete Batching Plant • Waste management/storage; • Conveyor and/or trucked Tunnel spoil • Stormwater management
Yard 8 (Alan Wood Reserve Mechanical laydown)	• Storage and lay down areas
Yard 9 (Alan Wood Reserve Tunnel Construction Yard)	• Offices/Ablutions • Storage and lay down areas; • Vent Building construction • Crusher • Covered Stockpile • Waste management/storage; • Conveyor and/or trucked Tunnel spoil • Stormwater management
Yard 10 (Alan Wood Reserve Driven Tunnel)	• Offices/Ablutions • Storage and lay down areas; • Concrete Batching Plant • Waste management/storage; • Laboratory • Stormwater management • Carparking
Yard 11 (Hendon Park) Piling Operation Yard	• Offices/Ablutions • Storage and lay down areas; • Waste management/storage; • Stormwater management • Carparking
Yard 12 (Valonia) Road Builders Yard	• Offices/Ablutions • Storage and lay down areas; • Waste management/storage; • Stormwater management • Carparking

7.3 Stream Realignments and Rehabilitation

Works within watercourses, including stream realignment and stream rehabilitation, can result in a number of adverse effects, typically:

- Adverse effects of sediment discharge from the construction process;
- Loss of habitat;
- Barrier to fish passage;
- Increased erosion; and
- Flooding.

The key purpose of the stream realignments to be undertaken for this Project is to allow stretches of streams to be diverted to a new permanent location such that the road alignment can be installed. The stream realignment procedure will ensure works are undertaken 'in the dry', that culverts are not necessary and that the loss of overall stream habitat is minimised. Stream rehabilitation works are designed for the purpose of stream enhancement within the Project.

The locations of the proposed stream realignment and rehabilitation works in the southern section of the Project are shown in Figure 7.1 below and are detailed further within Technical Report No. G 15 Assessment of Stormwater and Streamworks Effects.

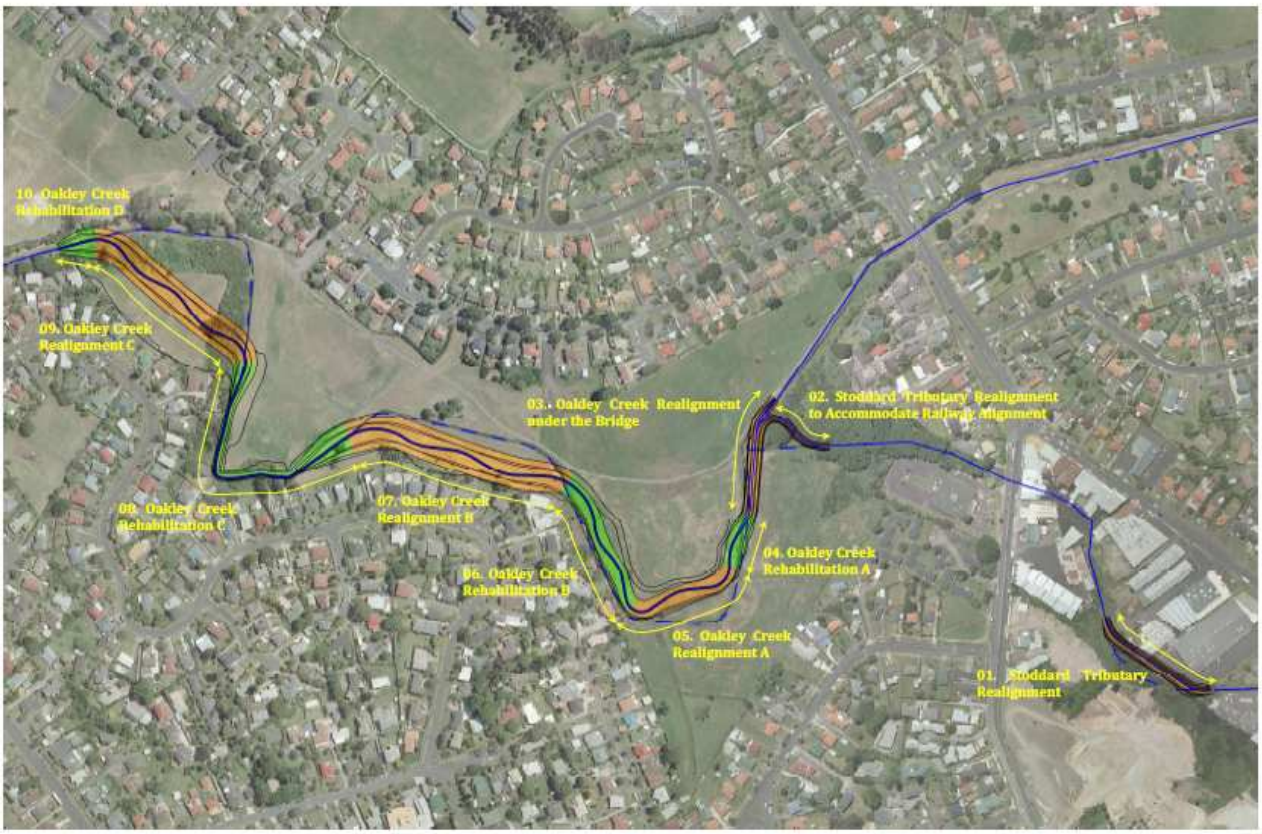

Figure 7.1: Southern Area Stream Realignment and Rehabilitation Locations

One major realignment of the Oakley Creek (Realignments C in Figure 7.1) and the Stoddard Tributary Realignment can be constructed outside of the 1% flood plain area. The Oakley Creek and Stoddard Tributary realignments at the SH20 Bridge and stream realignments B and C are within the 1% flood plain area due to the low lying nature of this land, and will be undertaken in accordance with the methodology below, and with particular consideration of the progressive stabilisation of the exposed areas (new stream realignment channel) on a daily basis or when rain is forecast.

Any realignment will commence early in the construction programme, taking advantage of the more settled weather patterns during this time and generally lower rainfall over the summer period. It is also important that the realignment activities are undertaken early in the construction program to ensure that the remaining earthwork activities are completed within the summer earthwork season.

Due to the methodologies to be employed, fish migration is not considered to be an issue, with stream flows continuing down the original stream bed during construction, with the new realignment utilised only at the time when the realignment is stabilised and able to accept new flows. At all times fish migration will be able to continue in the normal manner.

Methodology and Sequencing - Realignments

The proposed methodology allows for the entire stream realignment to be constructed in a dry environment isolated from the existing stream flows.

1. Temporary access will be provided over the existing stream by a bridge to allow for excavator and truck movements associated with the realignment formation.

2. Excavation of the realignment channel will occur leaving a clay plug at each end so that the stream does not breach the realignment.

3. Stabilisation of the realignment channel will occur to ensure it does not become a source of sediment. This will be undertaken utilising geotextile and rip rap material. Approval from Auckland Council will be obtained to certify that the realignment is fully stabilised and can accept stream flows. A planting programme will be undertaken to establish riparian plants along the newly formed stream banks.

4. Any water within the works area will be pumped to a SRP. Pumped volumes will be minor and the SRP will have the decants manually raised during this process to allow for settlement of sediment and chemical treatment if necessary. pH levels in the SRP can be tested if required to ensure no effect of the chemical treatment prior to discharge.

5. Once the realignment channel is stabilised (refer to 3 above) the downstream plug will be removed to allow stream flows to flow up the realignment channel, keeping some water within the channel to reduce scour problems when the upstream plug is also removed. The upstream plug can also then be removed allowing stream flows through the realignment channel.

6. A non-erodible dam will be immediately placed in the upstream end of the original channel. This dam will include formation of a sand bag barrier with an impermeable lining to avoid seepage. Clay will then be placed up to this barrier to allow the necessary filling.

7. A non-erodible downstream dam will be immediately placed to prevent backflow into the construction area. Fish recovery from the original channel will then occur and the channel drained by pumping to a SRP where treatment of the ponded water can occur prior to discharge to the receiving environment.

8. The original channel can then be backfilled forming part of the road alignment.

9. Cleanwater diversion bunds will then be installed above the area of work to ensure that no offsite cleanwater enters the site of the realignment during the works period.

10. Material excavated from the realignment itself will be placed in stockpiles away from the stream realignment and outside of the flood plain area. While works will not commence until a fine weather window is available, geotextile will be available on site to cover exposed areas on site during the works if flood conditions result in stream flows entering the newly-formed channel. The works will be staged such that if flood conditions result the area can be fully stabilised in a few hours to ensure no adverse

effects. Any sediment deposited within the newly formed channel will be pumped and removed to SRPs.

11. Once the filling of the original channel has been completed, other appropriate controls, such as silt fences, will be installed below the area of works.

It is likely that there will be some rainfall events to deal with during the course of construction. In the event of forecast rain, or before leaving the site for more than a day the following will occur:

- Any loose material that could enter a watercourse is to be removed.
- Where possible all exposed areas will be covered with geotextile to ensure no flows overtopping the existing stream banks create scour issues. It is expected that this will be achieved through geotextile and the placement of rock as necessary. The geotextile will be appropriately trenched in at the head and toe of the area.
- All existing and additional erosion and sediment control measures will be inspected and secured and maintained where required.

Contingency Measures will also be available as follows:

- Additional mulch and geotextile / polythene will be kept on site at all times.
- Extended working hours (i.e. 18 – 24 hour days) will be considered if it is believed significant benefit with regard to programme and environment impact is either required or possible.

Flood flows through the area of works is a possibility and the above methodologies will ensure no effects result, particularly when considering the low velocities that such flows will contain. In extreme circumstances the ability exists to place a bund, to the same height at the 1% AEP flood level, with 300mm freeboard between the works and the stream environment. For each stream realignment the final methodology will be determined prior to works commencing and detailed within a CESCP.

<u>Methodology and Sequencing - Rehabilitation</u>

Further to the stream realignments, stream rehabilitation will occur. This rehabilitation involves the activity of recontouring stream banks to a more natural grade, introducing, where practical, sinuosity into the stream channel and replanting of the channel margins. These works are all within the existing flood plain area and extreme care needs to be taken when implementing such works. Rehabilitation methodologies will be based around:

1. Utilising weather forecasting and ensuring that works do not commence until a fine weather window is available and low stream flows are observed;
2. Placement of filter socks immediately below the line of proposed excavation;

3. Undertaking the works in a staged manner such that only an area of work that can be completed within a 1 day period will be exposed at any one time;

4. At the end of each working day, and prior to any rainfall event, fully stabilising the exposed stream bank and flood plain areas with geotextile or, if practical, coir matting such that it can remain in place providing a stabilised surface and also assist with the revegetation programme; and

5. Revegetaion of the stream margins by planting through the coir matting previously installed.

As with the realignment process all material excavated from the rehabilitation works will be placed in stockpiles away from the stream location and outside of the flood plain area. No vehicle maintenance or material storage will occur within this immediate area.

7.4 Reclamation

For the construction of the carriageway widening, the existing Causeway between Great North Road Interchange and Rosebank Road is required to be widened and raised. This widening will involve reclamation of the CMA adjacent to each side of the existing SH16 motorway. To manage erosion and sediment control in this marine environment the Project needs to be constructed sympathetically. Consideration must be given to, firstly, reducing the potential for sediment generation and, secondly, managing any suspended material generated from the earthworks.

The construction method(s) of widening and raising the motorway by reclaiming the adjacent intertidal mud flats and increasing the thickness of the existing fill layer is important. Alternative construction methods will have different effects on the environment, especially with regard to erosion and sediment yield. Disturbance to this environment will need to be kept to a minimum.

Technical Report No. G 23 Coastal Works outlines possible form(s) that the reclamation works may take, such as working platforms formed of granular fill, light weight or mudcrete, and various ground improvement techniques and earthfill that is granular or cohesive or mudcrete. The report recommends ground improvement works by means of in-situ mudcrete mixing for strengthening the marine mud along the Causeway to support the new embankments. However, if undertaken without appropriate control measures, the in-situ mudcrete mixing in the marine mud may permit migration of silt and mud into the adjoining sea water.

The combined staging of reclamation and embankment work presents a potential construction methodology based upon the recommended mudcrete ground improvement method, and indicates the erosion and sediment control measures required to be implemented as part of embankment construction phases (eastbound and westbound, respectively) of the main carriageway construction.

The potential construction methodology depicted in the drawings is based upon an ‘in-situ mudcrete working platform’.

This methodology is summarised as follows:

Example of Reclamation and Embankment Staging based upon an 'In-situ Mudcrete Working Platform'

1. Install temporary traffic management.

2. Install silt fence immediately landward of the existing rock armour.

3. Strip off and remove existing top soil between motorway and silt fence.

4. Lay geotextile between motorway and silt fence and construct construction access/haul road by placing and compacting granular pavement material.

5. Clear mangroves within the construction zone during low tide utilising low impact methods such as hand removal where possible.

6. Prepare a smooth footprint area surface (i.e. remove rocks, rock armour for returns, mangrove roots, etc.) for the Temporary Water Filled Cofferdam approximately 5m to 10m clear of the works area.

7. Place and fill the temporary water filled cofferdam (AquaDam® or similar approved) on the tidal mud flats with returns back onto the existing Causeway. The cofferdam is to have a minimum freeboard of 30% above MHWS level of 1.63mRL.

8. Remove any captured water inside cofferdam by pumping to create a dry work environment. This water is expected to be able to be pumped back into the coastal environment, however this will be discussed with the consent authority at that time prior to pumping.

9. Form pump sumps along the inside of the cofferdam wall to frequently remove seepage water. Contaminated water (i.e. cement laden runoff) should be pumped to tankers and removed from site.

10. Construct a granular working platform to launch the ground improvement works by placing geotextile/Combigrid directly onto the virgin holocene alluvium (marine mud) approximately 5m wide by 15m long.

11. Place approximately a 1m thick AP300 Hardfill material with GAP65 material on top to fill the gaps directly on the geotextile/Combigrid adjacent to the existing toe. Compact the granular layer using light compaction plant. This will now form a working surface for heavy construction plant.

12. Carry out mudcrete improvement works up to a depth of 4.0m below founding level. Locally excavate through the working surface and geotextile/Combigrid in order to install ground improvement measures. Use mudcrete improvement works as work platform to do ground improvements within dry area provided by cofferdam

13. Install a geogrid reinforced raft over the mudcrete ground improvement works.

14. Place geotextile filter cloth on top of the reinforced raft and place granular (AP300) shoulder fill to a level above MHWS.

15. Place layer of granular fill (GAP65) in front of shoulder fill and place geotextile filter cloth on the outside face. Then place granular filter layer followed by coastal protection rock armour. The geotextile filter cloth will prevent leaching of fines and sediment, if any out of the granular fill.

16. Install a silt fence on top of the shoulder fill next to the rock armour above MHWS.

17. De-water temporary cofferdam and move to next work face, and repeat steps above.

18. Commence the construction of the embankment shoulders then proceed with bulk earthwork filling.

19. As bulk back filling progresses, consideration should be given to the rock armour revetment. The revetment may either be placed in a late stage operation effectively cladding the outer surface of the embankment shoulders, or it may be brought up in stages as the embankment and shoulder fill is raised.

20. Install motorway temporary stormwater drainage.

21. Continue to bulk back fill and raise the granular filter layer and the rock armour until the design levels are reached.

In deeper areas that are permanently submerged or inundated, such as at the bridge abutments at the Henderson Creek, Whau River and Causeway Bridges, the installation of temporary cofferdams will not be possible. The reclamation and embankment construction in these areas is proposed to be done by Marine Deposit Displacement and Light Weight Fill. It is anticipated that erosion and sediment can be reasonably controlled using the following methodology because:

1. Marine deposit displacement will be undertaken using AP500 to AP300 rock fill which will be carefully placed using a long reach excavator, to reduce disturbance.

2. Light weight fill will be undertaken using proprietary products manufactured from polystyrene, which is a stable product.

3. Fill material will be selected that contains very low or no-fines to reduce sediment yield when it becomes inundated during high tides.

4. Clean and non-contaminated fill material will prevent contaminants from being washed into the CMA.

Therefore it is anticipated that erosion and sediment can be reasonably controlled using the above methodology because:

- clearing of the mangroves by hand will ensure minimal disturbance to the marine mud;

- placing of the temporary cofferdam by hand and working at low tide will mostly eliminate possible disturbance to the marine mud. Once the cofferdam is in place it will provide a relatively dry enclosed work environment and protection to further disturbance from subsequent stages of construction;

- undercutting or excavation into the marine mud will be contained within a cofferdam;

- careful placement of any fill material, such as placing the rock armour boulders onto the geo-synthetic using a long reach excavator, will reduce disturbance;

- selecting fill material that contains very low or no-fines will reduce sediment yield when it becomes inundated during high tides;

- selecting clean and non-contaminated fill material will prevent contaminants from being washed into the CMA;

- stage construction: to limit sediment yield, sites should use only the areas needed for the immediate activity and current stage of the construction so that earthworks are undertaken in small units at a time – having no more than 0.25ha (approximately 100 metre Chainages) exposed to erosion during each work phase will minimise sediment yield intensities in the event of a temporary cofferdam failure;

- timing the works by the lunar cycle in order to take advantage of tidal variations;

- installing traditional E&SC devices, such as silt fences, on land above MHWS;

- installing motorway temporary stormwater drainage;

- the formation of mudcrete bonds finer material together and locks them thus helping to reduce sediment yield; and

- the formation of mudcrete also effectively immobilises many contaminants including heavy metals and some organics. This is an added environmental benefit gained from using mudcrete.

If geotechnical conditions dictate that at certain sections along the corridor ground improvement (such as mudcrete for example) is not required, then the construction works should proceed in the same manner as described in the above sections, but without the ground improvement installation phase.

7.5 Culvert Installation

Culvert installation, both construction and permanent, is required in a number of locations as identified within the erosion and sediment control plans that form part of this ESCP. The key purpose of the culvert installations is to allow for road construction, with the culverts providing for a dry environment over which the construction activity can occur. All culverts associated with the Project will be sized to allow for the 5% AEP

storm event, or based on existing culvert sizing, and will pass this event with no scour or erosion at the inlet and/or outlet locations. Secondary flow paths will be provided for as detailed below.

As with the stream diversion methodologies, it is also important that the culvert activities are undertaken early in the construction program to ensure that the remaining earthwork activities are completed within the summer earthwork season.

Fish migration is considered an important issue, and at all times fish migration will be able to continue in the normal manner with culvert construction creating no expected issues.

Methodology and Sequencing

The typical methodology for the culvert installation works allows for the entire stream works associated with the culvert installation to be undertaken in dry conditions, isolated from the existing stream flows.

1. Works will occur outside the fish migration period and will not commence unless there is a forecast period of at least 3 days of fine weather.

2. A pump will be installed approximately 5m upstream of the extent of an upstream temporary bund. This pump will pump upstream flows around the work area to discharge back into the watercourse downstream of the culvert works. Sand bags or similar will be used to impound flows for this pump. The inlet of the pump will be supported above the base of the stream.

3. Where there is no practical ability to install a more robust diversion channel, pumping will remain as the primary methodology for stream diversion during the culvert works with the pump to have capacity for low flows only during which works will occur. Where there is the ability to install a more robust temporary diversion channel this methodology will be implemented as in point 5 below. Where the upstream bund is complete and the diversion pipes have been installed the pump will be removed.

4. Where upstream bunds are installed as part of a diversion methodology, they will be installed including two 150mm novacoils at stream level.

5. A temporary (for the duration of works) diversion channel sized for the 5% AEP event will then be constructed, and flows in excess of the novacoil capacity will be diverted by this lined channel constructed to the side of the works.

6. Following the construction of the diversion channel, a decanting earth bund will be constructed across the isolated stream above the downstream end of works. This bund will prevent any backflow of water into the site and will provide the sediment control for the work area.

7. Cleanwater diversion channels will then be installed above the area of work if necessary.

8. With these controls in place, any fish or eels observed in any of the pools within the work area will be removed by hand netting and released downstream of the work area. Any fish or eels discovered during excavation will also be captured and released downstream.

9. The initial excavation will remove the vegetation from the work area followed by the excavation of unsuitable material. This excavated material will be disposed of elsewhere on site within the perimeter of other erosion and sediment controls.

10. Once all unsuitable material has been removed, the culvert area will be backfilled with structural material to an appropriate depth for culvert installation. The culvert will be installed with associated wingwalls, retaining walls and backfill as necessary. Rock rip-rap erosion control will also be installed at the inlet and outlet of the culvert. Care will be taken during the placement of this rip rap material so that a low flow channel for fish passage purposes remains and will be maintained for the life of the culvert.

11. The associated activity over the culvert will occur (filling etc) with other erosion and sediment controls in place such as silt fences and super silt fences. When the works have been completed the lower decanting earth bund will be removed with any disturbed area to be stabilised with a biodegradable erosion mat.

12. With the lower bund removed, and the area stabilised, a pump and sandbag dam will again be used to divert flows while the upper bund is removed and the area stabilised in a similar manner to the lower area. The pump will then be removed and the stream flows diverted through the new culvert structure.

13. Where the culvert works are associated with a culvert extension, at the outlet end of the existing culvert a plywood bulkhead with a 150mm diameter nova coil cut into and fixed into the bulkhead 100mm above the invert of the culvert will be installed. The bulkhead will be sealed to the base and sides of the culvert. A supplementary pump will be utilised if necessary to ensure a dry working environment. However, it is noted that a single 150mm diameter nova coil will pass approximately 12 litres per second (full). With a head of 400mm (the height of the bulk head) a 150mm diameter nova coil will pass approximately 25 litres per second. The nova coils will be a sufficient length to allow low flows to discharge beyond the works area discharging below the lower bund feature.

For all culvert works:

- Prior to any works commencing with the culvert installation, a 3 day weather window will be confirmed, the Council Compliance Officer will be advised, and any concerns or further clarification at the time, will be addressed immediately and prior to any works commencing on site.

- Culverts will be installed in sections (all precast units) with that particular section fully completed and stabilised within the day works programme.

- Any water within the works area will be pumped to a sediment control device which will be located away from the stream environment.

- On completion of the culvert extension, all plant and resources will be demobilised and the site will be permanently stabilised to as per Council requirements. Should any rock armouring be required to be placed at the outlet of the culvert for stabilisation of the streambed and banks, this can be accommodated as required.

In the event of high rainfall during the course of construction, or prior to leaving the site for more than a 24 hour period, the contractor will ensure the following:

- Any lose material that could enter a watercourse is to be removed.
- Any downstream sand bag barriers will be checked and, if required removed for heavy discharge events.
- All existing and additional sediment control measures will be inspected and secured and maintained where required should a significant rainfall event be imminent.
- The streambed will be fully stabilised to ensure no flows overtopping the upstream cofferdams create scour issues. It is expected that this will be achieved through geotextile and the placement of rock as necessary. The geotextile will be appropriately trenched in at the head and toe of the area.

Extended working hours (i.e. 18 – 24 hour days) will be considered if it is believed significant benefit with regard to programme and environment impact is either required or possible.

7.6 Bridge Works

Wet concrete work over the waterway

During construction of the bridges, it is proposed to minimise the amount of in-situ concrete that will be required. Pre-cast beams are recommended for the main girders and pre-cast piles for the foundations of the motorway widening. The use of Super Tee girders with extended flanges will act as permanent formwork for an in-situ deck. The piles of the cycleway may be cast in-situ to allow consistency of design with the Whau River Cycleway Bridge or pre-cast piles similar to the motorway widening.

In-situ piles are typically cased with steel as they pass through the water and recent Holocene Alluvium (commonly referred to as marine, estuarine or intertidal mud). The casing may be unable to prevent the ingress of water into the pile and concrete will be Tremie[2] poured. This will result in cement contaminated water which will require treatment before discharge, and this will either be conducted on site using treatment tanks and the water pH tested before discharge, or the water removed from site and treated elsewhere through

[2] In the Tremie Concrete method, concrete is placed below water level through a pipe, the lower end of which is kept immersed in fresh concrete so that the rising concrete from the bottom displaces the water without washing out the cement content.

the use of sucker trucks. Concrete placement will be carefully controlled to ensure no loss to the environment using pumps and skips. Designated concrete truck wash areas will be required near the bridge construction activities. These will contain the water from washing the truck's drums and chutes which can be treated or disposed of off site.

Temporary Staging platforms

The construction of all bridges is assumed to be completed from temporary platforms constructed adjacent to the widening. This allows construction of the bridge without the need for construction plant to be placed on the existing bridge decks. This is to both ensure that the existing structures are not overloaded and that the existing motorway traffic can be maintained during construction.

The staging platform will vary depending on which contractor is conducting the works. A width of 8m is allowed for to provide a 0.5m clearance between the temporary and permanent bridges for formwork to be placed. A typical structure arrangement of this platform would be for it to be supported by driven piles. These would be driven into the underlying mud until they reached a sufficient bearing capacity. Typical arrangement of piles would be in pairs at 9m centres longitudinally along the bridge, and 5-6m apart laterally. The piles would support a cross beam to form a pier headstock, and this would be typically constructed from a 0.7m deep welded steel beam. Pairs of welded beams on each edge of the platform would span between these headstocks, and these would also typically be 0.7m deep welded steel beams. These beams would support a thick timber decking which forms the surface of the temporary platform. The deck and supporting beams can be set at a level high enough so that it will not restrict the vertical clearance to the water further than the existing span arrangement of the bridge.

Following construction the platform will be removed using cranes from the platform. The piles will be removed through the use of vibration equipment and cranes.

The use of driven piles will not generate sediment but the surrounding water body may be discoloured. However this effect would only be evident during, and immediately after, installation or removal of the piles.

7.7 Bentonite Yard

Within Construction Yard 6 or 7 a bentonite yard will be established. The exact location of this yard is yet to be determined through the Project implementation, however it is noted that the bentonite yard itself is a fully self-contained yard which will sit within a construction yard.

Plan Number 20.1.11-3-D-EN-740-204 within Appendix I of this ESCP shows the layout of the bentonite yard. The yard will have a maximum area of 2500 m^2 with a decanting earth bund established to control any surface water runoff from the yard area. This decanting earth bund will discharge through a diversion bund which will be placed around the perimeter of the yard containing runoff up to the 1% AEP flows. A raised vehicle access will be provided through the bund as the only ingress and egress point from the bentonite yard area. Further any discharge which "escapes" from the yard will be treated through the specific construction yard SRP facility which already incorporates the bentonite yard catchment.

The bentonite yard will consist of an area where dry bentonite clay is stored, The clay will be mixed in a formal mixer and then transferred to the storage tanks as a bentonite slurry. From these bentonite tanks the slurry is pumped to the pile and wall construction area associated with the cut and cover tunnel operation. As the excavations increase in depth, further bentonite slurry is added, and as the piles and walls are constructed, excess bentonite is pumped back to the bentonite yard. Any bentonite spill at these locations will be immediately cleaned up and transferred back to the bentonite yard. After each pile construction the area surrounding the pile will also be cleaned to ensure material is not unnecessarily transferred via vehicles or foot traffic around the construction area. After this stage the bentonite slurry is passed through a desanding device with the "clean" bentonite then pumped to the storage tanks for further use. Any sand or unsuitable material collected as a result of the desanding process is removed offsite to a cleanfill facility.

Within this process there is a certain amount of bentonite that will no longer be suitable for use. This will be pumped to the bentonite pond where it can settle, either unassisted or with the addition of flocculants, and then discharged away from the bentonite yard to the construction yard control measures for further polishing treatment. Any bentonite slurry that remains will be disposed off site and while it is expected, based on previous bentonite operations, that this material can be considered as cleanfill, it will be tested prior to disposal to a cleanfill site.

Important aspects of this yard are:

- the bentonite yard includes the use of bentonite which is a naturally occurring clay;
- the bentonite system is based on a fully recycled system with no discharge from the operation; and
- any unexpected discharge that may result will be contained within the bentonite yard decanting earth bund, and in extreme events, will be further treated through the construction yard treatment devices.

Overall the bentonite plant is considered an activity that is easily managed and that will create no effects on the receiving environment.

8. Planning Considerations

Section 3 of this ESCP provides an overview of the planning framework associated with the earthworks activity and the Project. This section that follows details the specific statutory provision of relevance to earthworks and places this ESCP in the context of these provisions. This section should be read in conjunction with the Technical Report No. G 6 Assessment of Freshwater Ecological Effects, and Technical Report No. G 11 Assessment of Marine Ecological Effects.

8.1 Assessment against the Statutory Provisions

Resource Management Act (RMA)

Section 104(1) of the RMA requires regard to be had to specific factors, subject to Part 2 of the RMA ("Purposes and Principles"). The purpose of the RMA is to promote the sustainable management of natural and physical resources. Sustainable management means the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while: sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and safeguarding the life-supporting capacity of air, water, soil, and ecosystems; avoiding, remedying or mitigating any adverse effects of activities on the environment.

With respect to earthworks activities, the Project adequately recognises and provides for relevant matters of national importance (section 6). Particular regard has been had to the identified matters of section 7 of the RMA, and the Project does not compromise those matters.

Section 105 and 107 requires regard to be had to additional matters associated with the discharge of contaminants. This ESCP outlines a comprehensive programme of implementation of erosion and sediment control measures which will be the subject of detailed design, implementation and ongoing monitoring to ensure effectiveness. All of these aspects confirm that the effects of any sediment yields associated with the construction activity will be less than minor.

Hauraki Gulf Marine Park Act 2000 (HGMPA)

Section 7 of the HGMPA relates to the interrelationship between the Hauraki Gulf, its islands, and catchments and the ability of that interrelationship to sustain the life-supporting capacity of the environment of the Hauraki Gulf. Section 7 of the HGMPA has regard for the life-supporting capacity of the environment of the Gulf and its islands to provide for the historic, traditional, cultural, and spiritual relationship of the tangata whenua of the Gulf with the Gulf and its islands. Furthermore, this section of the HGMPA provides for the social, economic, recreational, and cultural well-being of people and communities to use the resources of the Gulf by the people and communities of the Gulf and New Zealand for economic activities and recreation and to maintain the soil, air, water, and ecosystems of the Gulf.

Section 8 of the HGMPA relates to management of Hauraki Gulf. It calls for regulators recognise the national significance of the Hauraki Gulf, its islands, and catchments, the objectives of the management of the Hauraki Gulf, its islands, and catchments. Specifically Section 8 relates to the following:

a) the protection and, where appropriate, the enhancement of the life-supporting capacity of the environment of the Hauraki Gulf, its islands, and catchments;

b) the protection and, where appropriate, the enhancement of the natural, historic, and physical resources of the Hauraki Gulf, its islands, and catchments;

c) the protection and, where appropriate, the enhancement of those natural, historic, and physical resources (including kaimoana) of the Hauraki Gulf, its islands, and catchments with which tangata whenua have an historic, traditional, cultural, and spiritual relationship;

d) the protection of the cultural and historic associations of people and communities in and around the Hauraki Gulf with its natural, historic, and physical resources;

e) the maintenance and, where appropriate, the enhancement of the contribution of the natural, historic, and physical resources of the Hauraki Gulf, its islands, and catchments to the social and economic well-being of the people and communities of the Hauraki Gulf and New Zealand;

f) the maintenance and, where appropriate, the enhancement of the natural, historic, and physical resources of the Hauraki Gulf, its islands, and catchments, which contribute to the recreation and enjoyment of the Hauraki Gulf for the people and communities of the Hauraki Gulf and New Zealand.

With the consideration of the extensive erosion and sediment control measures to be implemented, the Project is in accordance with the HGMPA.

Auckland Regional Policy Statement (ARPS)

The ARPS is a strategic document which sets out the direction of managing the use, development and protection of the natural and physical resources of the Auckland region. The strategic objectives and policies of the ARPS provide a framework to achieve the integrated consistent and co-ordinated management of the Region's resources. This framework is based upon not compromising the strategic direction of containment and intensification and the avoidance of adverse effects on the environment.

Under the ARPS, matters related to environmental protection, such as the coastal environment, water quality, water conservation and allocation and air quality have specific objectives, policies and methods to achieve sustainable and integrated management of major natural and physical resources in the Region.

Chapter 8 of the ARPS contains objectives, policies and methods which address, among other things, the effects of the discharge of contaminants from stormwater and wastewater on water quality in the region. In particular,

Chapter 8 – Water Quality

Objective 8.3(1)

To maintain water quality in water bodies and coastal waters which have good water quality, and to enhance water quality which is degraded particularly for the following purposes:

i.) Estuaries and harbours: protection of aquatic ecosystems, recreation, fishing and shellfish gathering, cultural and aesthetic purposes.

ii.) Lakes, rivers and streams: protection of aquatic ecosystems, recreation, food gathering, water supply, cultural and aesthetic purposes.

iii.) Wetlands: protection of aquatic ecosystems.

Policy 8.4.4(2)

Land use intensification in rural areas to countryside living or urban developments (whether reticulated or not) shall only occur where adequate provision is made for:

i.) the matters listed in 8.4.4-1;

ii.) retention of vegetation (excluding plant pests) wherever practicable adjacent to water bodies and coastal waters;

iii.) maintenance of normal access for biota throughout stream channels;

iv.) protection of the intrinsic values of aquatic systems.

Note: matters listed in 8.4.4-1 as referred to above, include:

i.) control of sediment discharges;

ii.) control of stormwater discharges;

iii.) collection, transport, treatment, purification and disposal of sewage;

iv.) protection of the quality of groundwater recharge especially into aquifers used for water supply purposes;

v.) protection of water quality and riparian margins.

The discharges of sediment from the Project are not expected to have any significant effect on water quality. The implementation of erosion and sediment control measures, which are beyond TP90 in many circumstances, in addition to the monitoring programme, will ensure that any effects are quickly detected and

necessary amendments made to the erosion and sediment control methodology. Sediment yields from the Project will be low with attention paid to progressive stabilisation and chemical treatment.

Auckland Regional Plan: Sediment Control (ARPSC)

The ARPSC was made operative in November 2001. The ARPSC addresses the issue of sediment discharge, and defines the mechanisms for avoiding, mitigating or remedying any adverse effect on the environment due to sediment discharge from bare earth surfaces.

In summary, the ARPSC has the following general objectives:

- "To maintain or enhance the quality of water in waterbodies and coastal water.
- To sustain the mauri of water in waterbodies and coastal waters, ancestral lands, sites, waahi tapu and other taonga.
- To reduce the exposure of land to the risk of surface erosion leading to sediment generation.
- To minimise sediment discharge to the receiving environment."

The ARPSC has restricted the Auckland Regional Council's discretion to matters related to the effects of sediment discharges as outlined in Rule 5.4.3.2(i) – (xi) of this plan (Attached as Appendix H to this ESCP).

The following aspects are considered relevant in an assessment of the effects of the Project earthworks.

1. Techniques used to restrict or control sediment being transported from the site and the effects or impacts of sediment on water quality from the techniques chosen, including the practicality and efficiency of the proposed control measures

Assessment of Proposed Erosion & Sediment Control Measures

The nature of TP90 controls anticipates discharges (albeit with the majority of sediment removed) and it is unlikely that 100% of the incoming sediment will be retained in the control measures.

A number of erosion and sediment control measures are proposed to be utilised. The measures have been proposed to reduce erosion, and therefore reduce the sediment generating potential of the site. The measures include progressive stabilisation with vegetation and hard fill and controlling upper catchment 'cleanwater' by diverting it around the earthworked areas, which will limit contributing catchments to the sediment control devices and reduce runoff volumes.

The main sediment control device to be utilised is SRPs with chemical treatment and it is considered this is the most appropriate device to be utilised.

The contractor will be required to prepare and implement CESCPs. This will allow for contractor innovation and technologies to be incorporated. Further, it is noted that monitoring to determine the extent of any sediment

discharge from the site and any resultant effects will in turn enable control measures, including staging, to be fine tuned through the earthworks activity.

Effects of Sediment Discharges on Receiving Environment

As outlined previously, sediment discharges have the potential to cause adverse effects to both freshwater and marine environments. Discharges from the sediment controls are likely to be highly turbid and can be expected to discolour the water column of the receiving waters during flow conditions. However, this effect will only be evident during, and immediately after, rainfall events and/or pumping activities.

In assessing whether the effects of the proposed sediment discharges are more than minor, the risk of the sediment discharge is balanced against the nature of the receiving environment and consequent risk in terms of potential impact. The area and duration of the activity, as well as the time of the year when the activity will be undertaken, are also taken into account. In an attempt to avoid and mitigate adverse effects on the receiving environment, a number of measures will be implemented to reduce the overall risk by the use of TP90 compliant controls and progressive stabilisation of the disturbed area. In addition, the use of a pH and turbidity meter to ensure tunnel dewatering activities do not exceed a threshold will allow for further confidence in addressing any effects.

Whilst there may be very limited discharges from the site during periods of rainfall, it is overall considered that the adverse impacts of sediment upon the receiving environment will be no more than minor.

2. The proportion of the catchment which is exposed

The Project involves earthwork activities over a large area. However, these works will be undertaken as separate operations, and with erosion and sediment controls installed in all circumstances. The approach outlined above in Section 5.0 with respect to the approach to erosion and sediment control will ensure that responsibilities are clear, and that the measures are installed pre any works and are also maintained as required.

3. **The proximity of the operation to the receiving environment**

The Project is in close proximity to both the Oakley Creek and the coastal marine area and includes both instream works and reclamation. Erosion and sediment control measures have been considered and are to be implemented as detailed within this ESCP. While these measures are robust and exceed the provisions of TP90 in many cases, the important aspect to implementing this Project is the methodologies to be employed. These are detailed within the body of this ESCP and recognise the risk and the values of the environments to which sediment is discharged. Ongoing inspections, monitoring and maintenance all assist with ensuring that the Project erosion and sediment control will operate effectively.

4. The concentration and volume of any sediment that may be discharged

Sediment laden discharges from exposed earthworks areas have the greatest potential to result in significant adverse effects on receiving environments during the construction phase of any development. Clays, silts and sands washed from exposed areas can enter freshwater streams either directly, or after treatment via sediment control devices (such as SRPs, silt fences etc). Sediment which does not settle in the freshwater receiving environment, will eventually settle out in the estuaries or be transported to open coastal waters. Once in the

water column, sediment can cause a variety of effects including smothering of habitat, invertebrates, fish and plants and changes in the physical stream characteristics.

NIWA have undertaken a study and utilised the GLEAMS model to determine the sediment yields and consequent risk of sediment discharge from the site. This risk has been assessed in terms of the erosion and sediment control approach and provides the basis for not only the structural control measures, but also the non-structural measures such as maintenance and monitoring procedures.

5. The time during which the bare earth surface is exposed and the time of the year when the activity is undertaken.

It is proposed that works will occur throughout the year with winter works activity required. The nature of the activity through the winter months will be limited by the wetter conditions and the focus of these works will change as a result. Tunnel excavation can continue throughout, and with the utilisation of a covered conveyor for the spoil material which will transfer the material to a covered stockpile no erosion or sediment effects will result. Where stockpiling is to occur outside of the covered yard, areas any sediment laden runoff will be treated through chemically treated SRPs with a high level of treatment expected. It is anticipated that winter works will be able to be authorised and undertaken in a safe and controlled manner utilising best management practices.

Streamworks activities associated with the stream diversions and culvert extensions will also be undertaken during the summer period.

With respect to the duration of exposure, the proposed works by their nature require progressive stabilisation. As detailed above, this will be put into practice with utilisation of hardfill in all of the construction yards, in addition to vegetation and mulching activities.

The ARPSC details specific regulatory provisions as follows:

- Objective 5.1.1 states that "To maintain or enhance the quality of water in waterbodies and coastal water".

- Objective 5.1.2 states "To sustain the mauri of water in waterbodies and coastal waters, ancestral lands, sites, waahi tapu and other taonga".

- Policy 5.2.1 states that "Land disturbance activities which may result in the generation and discharge of elevated levels of sediment will be required to employ methods which avoid, remedy or mitigate adverse effects on the quality of water in waterbodies and coastal waters".

- Policy 5.2.2 states that "Land disturbance activities which may result in the discharge of elevated levels of sediment into waterbodies and coastal waters shall be considered inappropriate where they will have a significant adverse effect on:-

i.) The qualities, elements and features which contribute to the natural character of areas of the coastal environment, (including the coastal marine area) wetlands, lakes and rivers and their margins; and which

are identified in the Auckland Regional Policy Statement and the Auckland Regional Plan: Coastal as having outstanding or regionally significant ecological, landform, geological or landscape values.

ii.) Outstanding and regionally significant natural features and landscapes as identified in the Auckland Regional Policy Statement and the Auckland Regional Plan: Coastal.

iii.) Areas of significant indigenous vegetation and significant habitats of indigenous fauna as identified in the Auckland Regional Policy Statement and the Auckland Regional Plan: Coastal as having international, national and regional significance.

iv.) Areas of significance to Tangata Whenua as identified in the Auckland Regional Policy Statement and the Auckland Regional Plan: Coastal.

v.) Areas identified by Tangata Whenua in accordance with Tikanga Maori as being of special spiritual, cultural and historical significance. Unless the adverse effects can be avoided, remedied or mitigated.

The receiving environment associated with this activity is the Oakley Creek and the Upper Waitemata Harbour which is recognised as containing a range of values that require protection. The assessment of environmental effects undertaken in this ESCP and the Assessment of Environmental Effects concludes that the adverse effects on the receiving environment of the proposal are less than minor.

Overall Assessment of Earthworks

Earthworks Assessment Criteria	Description
Erosion and Sediment Control	Erosion and sediment control measures will be fully implemented as part of the Project implementation. These will be implemented in accordance with this ESCP and the CESCPs which will require future Auckland Council approval on an as-required basis.
Water Quality	All discharges will be treated to a minimum standard associated with TP90. This standard is exceeded in many circumstances and includes comprehensive chemical treatment and stabilisation techniques. Turbidity and pH discharge standards will be implemented on all tunnel water discharges.
Aesthetics and odour	After reasonable mixing, any sediment discharged will not give rise to: • Conspicuous oil or grease films, scums or foams, or floatable or suspended materials; • Any conspicuous change in the colour or visual clarity; and/or

Earthworks Assessment Criteria	Description
	• Any emission of objectionable odour. Erosion and sediment controls are comprehensive and reflect the best practical option approach while also adopting standards and monitoring of discharges. With treatment and after mixing no conspicuous change to the receiving waters is expected. Similarly, no emission of objectionable odour is expected.

A range of earthworks and streamworks activities that will be undertaken as part of the Project have numerous requirements under regional policy and planning documents. Several key items are of importance in terms of erosion and sediment control:

- Proximity to sensitive waterbodies including the Coastal Marine Area (CMA),
- Values of the receiving environments adjacent to, or downstream of, the Project,
- Site topography,
- Areas of exposed soils or geotechnically unstable areas, and
- Loss of terrestrial and stream habitat that may occur as a result of the Project implementation.

These items have been considered in full in developing this ESCP and are reflected in the overall approach taken.

The NZTA has adopted as part of its wider national Environmental Management Plan (NZTA EMP), a series of erosion and sediment control objectives for roading projects. This part of the NZTA EMP is attached as Appendix C of this ESCP and is also detailed within Section 3 of this ESCP. These objectives have been fully considered and are reflected within this ESCP.

9. Conclusions

The following key points are noted for the erosion and sediment control methodologies for the Project.

- The statutory framework and policy guidance from Council and the NZTA require the Project operators to be aware of, and ensure, implementation of appropriate erosion and sediment controls including construction and maintenance of these devices.

- NIWA calculations show a relatively low risk of sediment generation for the various sectors of the Project. However those works associated with the streamworks activities are high risk and need careful management to ensure that the construction effects are less than minor.

- A range of erosion and sediment control measures are proposed to be employed on the Project. These will be implemented in the same location as the interim and long term stormwater structures where possible, and will at all times achieve as a minimum the requirements of TP90.

- The erosion and sediment control methodology relies on a future erosion and sediment control plan (referred to as a CESCP) to be submitted at a later date, pre any earthworks activity, to allow for flexibility, contractor input and also input from various other bodies such as the Auckland Council.

- Chemical treatment will be implemented on the site and will be done so in accordance with the Chemical Treatment Plan provided with this report. This will take the form of rainfall activated, pumping and batch dosing regimes.

With these measures in place it is considered that overall, any adverse effects on the receiving environment will be no more than minor.

10. Key References

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