Attachment C

NZ Transport Agency and Auckland Transport

East West Connections Project

Construction Erosion and Sediment Management Assessment to Support Option Selection

November 2014

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1. Introduction

The East West Connections project is responding to the immediate and growing freight access issues at either end of the Neilson Street/Church Street corridor caused by inefficient transport connections and a lack of response to changes in the industry's supply chain strategies. The project is also addressing the inadequate quality of transport choices between Māngere, Ōtāhuhu and Sylvia Park.

The long list of options was developed in a 2-stage process. The option identification process began with identifying changes at a component level (e.g. lane widening; interchange improvements) across the geographical area.

To ensure a full spectrum of components was considered, the study area was separated into segments. All components were then assessed through a multi-criteria analysis. Where broadly equivalent components (in terms of either transport performance or social, environmental or cultural outcomes) were identified, the best alternative proceeded to the development of the long list options. If no broadly equivalent alternative component existed, the component was progressed to the development of long list options.

All options were assessed through a multi-criteria analysis, which considered a full range of impacts and performance against the project's objectives and the East West Connections outcomes. Six options were identified to progress to the short list for the Onehunga-Penrose connection. These options range from low investment to high investment.

These 6 options are the subject of this assessment and a detailed description of each are held in the Detail Business Case. The following summarised descriptions have been used as the basis of the following assessment.

1.1 Shortlist Option Summary

1.1.1 Option A (Long List Option 1): Existing route upgrade

This option looks to upgrade the existing roads. This includes improving capacity on SH20, Neilson Street and Church Streets. It also provides freight lanes.

- Auxiliary lanes / capacity improvements on SH20 (Queenstown Road to Gloucester Park)
- Some widening of Onehunga Harbour Road at Gloucester Park (e.g. around the Onehunga Port area, beneath SH20 and potential to increase this from 2 to 3 lanes up to Neilson Street / Onehunga Mall intersection).
- Upgrading of the intersection at Onehunga Mall / Neilson Street intersection (potentially including widening of bridge over the rail line) to provide for dedicated movements between Onehunga Mall / Neilson Street.
- Capacity improvements on Neilson St, for example extending the 4-laning from Alford St to Church St (potential impact on some road frontages, but looking to minimise)
- New signalised intersection to provide access to Metroport (for example, providing for dedicated turning median).
- Cycleway uses Hugo Johnston Road (within the road corridor), may impact on tree planting etc. in existing road reserve, will then connect to Church Street East and Great South Road (level crossing) to connect to existing cycle path to Sylvia Park.

- Freight lane priority at Mt Wellington Interchange where this can fit beneath existing bridge constraints.

1.1.2 Option B (Long List Option 2): Upgrade with South Eastern Highway Ramp

This option proposes an upgrade of existing roads with new ramp connections from Church Street to SH1 and South Eastern Highway.

- Auxiliary lanes / capacity improvements on SH20 (Queenstown Road to Gloucester Park).
- Some widening of Onehunga Harbour Road at Gloucester Park is likely (e.g. around the Onehunga Port area, beneath SH20 and potential to increase this from 2 to 3 lanes up to Neilson Street / Onehunga Mall intersection.
- At Onehunga Mall / Neilson Street intersection, upgrading of intersection is required (potentially including widening of bridge over the rail line) to provide for dedicated movements between Onehunga Mall / Neilson Street.
- Looking at capacity improvements on Neilson St, for example extending the 4-laning from Alford St to Church St (potential impact on some road frontages, but looking to minimise).
- New signalised intersections and upgrades to intersections at Metroport (for example: providing for a dedicated turning median), Church St, Hugo Johnston Drive and Great South Road (grade separation at Hugo Johnston Drive and Great South Road may be considered).
- Cycleway using Hugo Johnston Road (within the road corridor), may impact on tree planting etc. in existing road reserve, will then connect to Church Street East and Great South Road (level crossing) to connect to existing cycle path to Sylvia Park.
- New connections for ‘southern’ traffic on SH1, with ramps from the South Eastern Arterial (looking at ramps of 2-lanes in each direction to connect from interchange to tie in with SH1 at Mt Wellington). This requires an auxiliary lane extension on SH1 down to Princes Street interchange.

1.1.3 Option C (Long List Option 5): Upgrade with new Galway Street and inland connections

This option proposes a new connection from Onehunga Harbour Road to Galway Street, and upgrade of Neilson and Angle Streets and Sylvia Park Road, and a new connection for Angle Street to Sylvia Park Road and to SH1.

- Auxiliary lanes / capacity improvements on SH20 (Queenstown Road to Gloucester Park)
- Some widening of Onehunga Harbour Road at Gloucester Park is likely (e.g. around the Onehunga Port area, beneath SH20.
- New connection from Onehunga Harbour Road onto Galway Street (may impact on traffic movements / access to SH20 from Onehunga Mall / Onehunga Harbour Road)
- 4-lanes on Galway Street with upgraded intersection to Neilson Street, upgrading of intersection required (potentially including widening of bridge over the rail line) and to address increased traffic from Onehunga Mall to Galway Street.
- Looking at capacity improvements on Neilson St, for example extending the 4-laning from Alford St to Angle St and upgrading of Angle Street (e.g. up to 4-lane, which may require some additional land).

- New connection from Angle Street to Great South Road for between 2 and 4 lanes, and where practicable on land between Transpower towers and foreshore (not reclamation).
- At Sylvia Park Road, increasing capacity of some of Sylvia Park Road (e.g. additional lanes) and may require land take and relocation of Transpower towers.
- Ramps over Mt Wellington Highway to connect onto SH1, serving the south, with increased capacity (e.g. auxiliary lanes) on SH1 down to Princes St.
- Waikaraka Cycleway maintained and extended alongside new road sections to connect to Sylvia Park.

1.1.4 Option D (Long List Option 8): Upgrade with Gloucester Park interchange and new Galway St and inland connections.

This option proposes an upgrade at Gloucester Park Interchange and a new connection from Onehunga Harbour Road to Galway Street. It also proposes an upgrade of Neilson and Angle Streets and Sylvia Park Road, and a new connection for Angle Street to Sylvia Park Road and to SH1.

- Auxiliary lanes / capacity improvements on SH20 (Queenstown Road to Gloucester Park).
- New interchange at SH20 at Gloucester Park, to restrict access to Neilson Street and divert all traffic onto Onehunga Harbour Road (widening requirements for Onehunga Harbour Road, e.g. 3+ lanes).
- New connection from Onehunga Harbour Road onto Galway Street (may impact on traffic movements / access to SH20 from Onehunga Mall / Onehunga Harbour Road).
- 4-lanes on Galway Street with upgraded intersection to Neilson Street, upgrading of intersection required (potentially including widening of bridge over the rail line) and to address increased traffic from Onehunga Mall to Galway Street.
- Looking at capacity improvements on Neilson St, for example extending the 4-laning from Alford St to Angle St and upgrading of Angle Street (e.g. up to 4-lane, which may require some additional land).
- New connection from Angle Street to Great South Road for between 2 and 4 lanes, and where practicable on land between Transpower towers and foreshore (not reclamation).
- At Sylvia Park Road, increasing capacity of some of Sylvia Park Road (e.g. additional lanes) and may require land take and relocation of Transpower towers.
- Ramps over Mt Wellington Highway to connect onto SH1, serving the south, with increased capacity (e.g. auxiliary lanes) on SH1 down to Princes St.
- Waikaraka Cycleway maintained and extended alongside new road sections to connect to Sylvia Park.

1.1.5 Option E (Long List Option 13): New foreshore Connection

This option proposes a new connection from SH20 to SH1 along the foreshore.

- Auxiliary lanes / capacity improvements on SH20 (Queenstown Road to Gloucester Park).
- New interchange at SH20 at Gloucester Park, with access to Neilson Street and onto Onehunga Harbour Road (may require some changes to traffic movements from Onehunga Harbour Road onto SH20).

- New connection from Gloucester Park along foreshore to Great South Road, with local connections at Captain Springs Road, Southdown (Metroport) and Great South Road to connect (via intersection) onto Vesty Drive.
- New bridge from Vesty Road to provide new ramp connection to SH1 at Panama Road (between businesses and residential areas).
- New ramp connections at Panama Road (potentially requiring replacement of Panama Road Bridge) with increased capacity (e.g. auxiliary lanes) on SH1 down to Princes St.
- Waikaraka Cycleway maintained and extended alongside new road sections to Great South Road and then onto alignment around Hamlin's Hill.

1.1.6 Option F (Long List Option 14): New foreshore and inland connection

This option proposes a new connection form SH20 to SH1 (partly along the foreshore and partly inland).

- Auxiliary lanes / capacity improvements on SH20 (Queenstown Road to Gloucester Park).
- New interchange at SH20 at Gloucester Park, with access to Neilson Street and onto Onehunga Harbour Road (may require some changes to traffic movements from Onehunga Harbour Road onto SH20).
- New connection from Gloucester Park along foreshore to Captain Springs Road and then inland to Great South Road.
- New intersections at Captain Springs Road, Southdown (Metroport) and Great South Road (may require relocation of Transpower towers).
- At Sylvia Park Road, increasing capacity of some of Sylvia Park Road (e.g. additional lanes) and may require land take and relocation of Transpower towers.
- Ramps over Mt Wellington Highway to connect onto SH1, serving the south, with increased capacity (e.g. auxiliary lanes) on SH1 down to Princes St.
- Waikaraka Cycleway maintained and extended alongside new road sections to connect to Sylvia Park.

1.2 Purpose of this report

A high level geometric design of the 6 short-listed road corridor options (A – F) has been undertaken. This design work was for the purposes of costing each option, and identifying potential areas of risk with regards to consentability, constructability and cost.

In conjunction with the high level design, this Construction Erosion and Sediment Management Assessment (CESMA) provides an overview assessment of the potential residual effects of construction related erosion and sedimentation and provides an assessment of each option against key relevant regulatory criteria including the Proposed Auckland Unitary Plan (PAUP).

This CESMA is to be used solely for the purpose of informing the selection selecting a preferred option. Rather than focusing on particular details which have not yet been designed or confirmed its purpose is to highlight the main issues with regards to erosion and sedimentation for each option. This CESMA identifies the potential risks and mitigation measures that could be adopted to manage and minimise these risks of construction related erosion and sedimentation.

There are a range of interrelated issues and effects between ecology (freshwater, terrestrial, marine) and hydrology and stormwater management and treatment which are described in the ecology and stormwater assessment reports.

The development of a quantitative assessment of the magnitude of the potential erosion and sedimentation effects for each of the 6 options has not been carried out and it is anticipated that the identification of any subsequent mitigation measures required will be the subject of further detailed analysis to be carried out in subsequent work packages.

1.3 Assessment brief

The East West Connection environmental team requested this assessment report be provided for use as a separate Appendix to the Detailed Business Case in the selection of a preferred option which is the subject of this CESMA

The brief also includes the preparation of a Recommendation Letter that identifies the nature of further technical investigations that are considered necessary to evaluate the preferred option. This letter will identify opportunities to note going forward for the project, considering mitigation and design considerations that may cross over into other disciplines.

1.4 Scope and Limitations

This CESMA has been prepared by GHD for the East West Connections Project and may only be used and relied on by the NZ Transport Agency and Auckland Transport (AT) for the purpose agreed between GHD and the East West Connections Project Team as set out above.

GHD otherwise disclaims responsibility to any person other than NZ Transport Agency and Auckland Transport (AT) arising in connection with this assessment. GHD also excludes implied warranties and conditions, to the extent legally permissible.

If the NZ Transport Agency and Auckland Transport (AT) wish to provide this assessment to a third party recipient to use and rely upon, then GHD's prior written consent will be required. Before this assessment is released to the third party recipient, the third party recipient will be required to execute a GHD prepared deed poll under which the recipient agrees:

- to acknowledge that the basis on which this assessment may be relied upon is consistent with the principles set out above; and
- to the maximum extent permitted by law, GHD shall not have, and the recipient forever releases GHD from, any liability to the recipient for loss or damage howsoever in connection with, arising from or in respect of this assessment whether such liability arises in contract, or tort (including negligence).

The services undertaken by GHD in connection with preparing this assessment were limited to those specifically detailed above and are subject to the scope limitations stated.

The opinions, conclusions and any recommendations in this assessment are based on conditions encountered and information reviewed at the date of preparation of the CESMA. GHD has no responsibility or obligation to update this assessment to account for events or changes occurring subsequent to the date that this document was prepared.

The opinions, conclusions and any recommendations in this CESMA are based on assumptions described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this CESMA based on the information provided by the NZ Transport Agency and Auckland Transport (AT) and others who provided information to GHD (including

Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in this CESMA report which were caused by errors or omissions in that information.

2. Methodology of the Assessment

This section outlines the general methodology followed in order to provide an indication of the effects of erosion and sedimentation resulting from the construction of the 6 short-listed options and sets out the context for our assessment.

The process undertaken for the current high level / conceptual design was as follows:

1. Review the conceptual geometric design of each option and assess the erosion and sediment control (ESC) measures required during the construction of the various elements of each option.
2. Determine the high level potential effects of erosion and sedimentation for the construction of each option.
3. Assess the effects of the construction of the project in relation to erosion and sedimentation; and
4. Identify the range of erosion and sediment control measures that could be used to reduce the effects of erosion and sedimentation from the construction of the works.

Assessment of Route Options

Drawings for the alignments of the 6 short-listed route options discussed in Sections 1.1.1 to 1.1.6 were reviewed.

Review of Technical Guidance documents

There are two main guidance documents applicable to this project as follows:

1. Auckland Regional Council, 1999 (updated 2007) '*Technical Publication 90 – Erosion and Sediment Control: Guidelines for Land Disturbing Activities in the Auckland Region' (TP90);* and
2. NZ Transport Agency, 2014, "Erosion and Sediment Control Guidelines for State Highway Infrastructure",

TP90 provides information on the appropriate use, design and construction of ESC devices and practices for the Auckland region.

The Transport Agency guidelines are " …*intended to provide the minimum requirement for erosion and sediment control that state highway construction projects shall comply with. Construction includes new construction and state highway maintenance projects. This guideline has been prepared with the intention that it will meet or exceed current local erosion and sediment control guidelines so that compliance with it will minimise consenting related issues. If a local standard is amended and becomes more stringent than this Standard, the more stringent requirements shall be met if required by resource consent"*

Both TP90 and the Transport Agency's guidelines are sufficient to develop appropriate erosion and sediment control practices to mitigate against the potential effects of sedimentation resulting from the construction of the final project. However, for the purposes of this assessment we refer to TP90.

3. Key Design Assumptions

The high level geometric design has been carried out for each option and this ESC assessment is based on the following drawing sets.

3818683-1, 2, 5, 8, 13 and 14 – all Revision B Preliminary

This CESMA has adopted the alignments articulated in the Indicative Business Case EWC Long List Summary, with the following key design amendments that have been adopted since then:

- The alignments that follow the northen foreshore of the Mangere Inlet (Options E and F) may be constructed on a new embankment separate from the foreshore and wick drains could be used to dewater sediments *in situ* beneath the embankment.
- Option F has an inland alignment through the current MetroPort area.
- We have assumed that the alignments that follow existing roads (including widening of the road carriageway and intersection improvements) require only shallow (unsaturated soil/rock) excavations.
- The construction works for all Options only require temporary dewatering, not permanent groundwater dewatering and the groundwater effects are assessed in the Groundwater Assessment Report.

3.1 ESC Assessment Assumptions

1. It should be noted that there are areas of risk that are not included in this assessment. This is a consequence of the high level nature of the review and design work carried out to date.
2. Calculations have not been carried out on the erosion potential and subsequent sediment yields for each option as part of this assessment and hence the location and size of ESC measures have not been assessed. It is anticipated that these will be carried out for the preferred option at subsequent design phases of the project, including the work required to support a full Assessment of Environmental Effects and lodgement of Resource Consent applications for the project.
3. The ESC measures described in TP90, in its current form, are considered to be appropriate for the management of erosion and sedimentation during construction works. *(It is noted that Auckland Council is currently in the process of updating a number of their technical standards and design guidelines. The various ESC measures and design standards associated with ESC may be change in any subsequent update or replacement of TP90).*
4. The ESC measures discussed in this assessment are a combination of physical control measures and good site / project management processes.
5. The ESC assessment described in this assessment does not provide sufficient detail to be used to establish a permanent or temporary construction designation for the preferred option and additional design and assessment works will be required in subsequent phases of the project.

3.2 Construction in Landfill Sites

It is anticipated that Construction across the landfills could comprise one of the following methods, as stated in the Contaminated Land Assessment. However, from an ESC perspective the effects can be managed through the implementation of appropriately design and constructed ESC measures and through site management practices:

1. Excavation of the refuse beneath the alignment prior to construction - Based on likely depths to original harbour sediments, excavation may need to extend to 8 metres below grade, although depths will be variable.
2. Development at-grade or on-embankment – This would rely on ground improvement by dynamic compaction or pre-loading. The primary effect of these techniques is upon groundwater, because the compaction will cause transient discharges of contaminants and a long-term reduction in the shallow aquifer (landfill) permeability that could cause leachate breakouts upgradient from the alignment. Modelling these effects reliably would be problematic. Similarly, the compaction would disturb the landfill gas equilibrium and create unintentional gas migration.
3. Construction on piles that extend to bedrock (either Waitemata series or basalt) - This would require the removal of contaminated soil and groundwater from within the pile caissons for off-site disposal, thereby benefiting the environment in relation to those materials. Depending upon the spacing of the piles, effects on groundwater flow may be limited because flow between the piles will be uninterrupted. Therefore, effects on groundwater quality could be managed to avoid leachate breakouts. Most of the refuse volume in the landfill would remain undisturbed, which would also limit the effects on landfill gas.

4. Erosion and Sediment Control Principles and Design Criteria

Erosion is a natural process and occurs when the surface of the land is worn away (eroded) by the action of water, wind, ice or geological processes. Through the erosion process, soil particles are dislodged, generally by rainfall and surface water flow. As rain falls, water droplets concentrate and form small flows. As this flow moves down a slope, the combined energy of the rain droplets and the concentration of flows has the potential to dislodge soil particles from the surface of the land.

Sedimentation occurs when these soil particles are deposited. The amount of sediment generated depends on the erodibility of the soil, the energy created by the intensity of the rain event, the site conditions (for example the slope and the slope length) and the area of bare earth or unstabilised ground open to rainfall.

During development works, that exposes areas of land, the erosion and sediment process is accelerated and it is essential that effective erosion and sediment control measures are provided during construction works to ensure minimal effect on the receiving environment.

4.1 Erosion Control versus Sediment Control

Erosion control is based on the practical prevention of sediment generation in the first instance. If erosion control measures and practices are effective then sediment generation will be minimised and the primary reliance on the sediment control measures is reduced.

Sediment control refers to management of the sediment after it has been generated (eroded). It is inevitable that some sediment will be generated through land disturbance activities even with best practice erosion control measures in place. Sediment control measures are designed to capture this sediment to minimise any resultant sediment-laden discharges to waterways.

Rather than primarily relying on sediment control measures, reducing erosion will have the direct effect of reducing sediment generation and therefore less sediment laden runoff will need to be intercepted, treated and discharged from the sediment control measures.

Typically, land with steep slopes and long slope lengths generate a greater amount of energy for rainfall and hence increase erosion. Any reduction of this energy through the use of erosion control measures will reduce erosion and hence any subsequent sedimentation.

4.1.1 General principles and management techniques

During construction of the preferred option, ESC should be undertaken and implemented with a hierarchy and priority order as follows:

1. **Prevention:** Excluding clean water runoff from entering the active work areas, therefore preventing clean water runoff from combining with excavated spoil and/or construction material and can be achieved through the use of clean water diversion (CWD) channels and/or bunds to divert runoff from the upstream side of the work area.
2. **Capture:** Any sediment laden runoff generated within the working area can be captured through the use of dirty water diversion (DWD) channels and/or bunds on the downstream side of the construction site which are used to direct silt laden runoff from the site to an appropriate sediment control device. Sediment capture could be implemented through the use of one or more sediment control measures.

3. **Minimisation:** Limiting the length of time and the area of disturbed soil is exposed to wind and rainfall can reduce the erosion potential to generate erosion. Timely stabilisation of exposed areas and the construction of impermeable areas can also reduce the potential for erosion to occur.

4. **Staging and Sequencing of Works:** Construction activity could be carried out in stages and works within those stages could be sequenced not only to enable the permanent works to be constructed efficiently but to also manage erosion and sedimentation. It is anticipated that working areas will be progressively stabilised to prevent erosion as appropriate as the works progress.

4.1.2 Streamworks general principles

Construction works within or adjacent to existing streams are generally considered to be a higher risk than earthwork activities due to the close vicinity of the receiving environment and the associated increased potential for sediment yield. Construction within streams should be undertaken in a manner that recognises this risk and the sensitivity of the receiving environment.

Where practical, streamworks activities and any associated works within these environments should be undertaken in an 'offline' environment and allow for the temporary diversion of flows around the area of works or working immediately next to the stream with no formal stream diversion required.

It is anticipated that streamworks are to be restricted or controlled to avoid the fish spawning and migration periods (September to February) or where this cannot occur then fish relocation methodologies will be developed and implemented.

Where such work needs to be undertaken during the main migration period, the section of stream in which the work is to be carried out is to be isolated (stop-nets at each end of the works section) and any resident fish caught and relocated within the stream. The lower stop-net should be retained to prevent any fish entering the works area.

4.1.3 ESC Measures and Design Criteria

Table 1 summarises the main ESC principles and design criteria which would be anticipated to apply to this project. :

Table 1 - ESC Measures and Design Criteria

Device / Methodology	Criteria
Erosion Control Measures	
Clean Water Diversions (CWD)	Clean water diversion channels and bunds are to be designed and implemented in accordance with TP90.
Construction Staging and Sequencing	Staging and sequencing are both important management measures and will be implemented as necessary to reduce the amount of exposed earth during construction and should be considered at design stages of the project.
Contour Drains	Where required, Contour drains are to designed and implemented in accordance with TP90.
Device Location	All ESC devices should be located outside the 20 year ARI flood level unless no other viable alternative exists.

Device / Methodology	Criteria
Dirty Water Diversions (DWD)	Dirty water runoff diversion channels and bunds are to be designed and implemented in accordance with TP90.
Pipe Drop Structures / Flumes	Flumes will be used in accordance with the TP 90 to safely transfer runoff from the top of batters to the bottom of the batter slopes to prevent erosion of the batter surface during rainfall events.
Rock Check Dams	Where required, rock check dams be placed in all CWDs and DWDs and will be designed and implemented in accordance with TP90.
Stabilisation for Erosion and Dust Management Purposes	Progressive and rapid stabilisation of disturbed areas utilising top soil (where necessary) and seed, mulch and geotextiles will be ongoing throughout the Project. Stabilisation will be undertaken to: • Minimise any open areas or disturbed earth which may be specified within future consent conditions for the project; and • Reduce the open area locations to assist with a reduction in sediment generation.
Stabilised Entrance Ways	Stabilised entrance ways are to be established at all ingress and egress points of the site.
Sediment Control Measures	
Construction Stage Erosion and Sediment Control Plans (CESCPs)	CESCPs or similar are to be submitted prior to commencement of work. CESCPs will likely include: • Contour information; • A list of proposed ESCs; • Chemical treatment design and details; • Catchment boundaries; • Location of the Work; • Details of construction methods; • Contingency measures; • Design details; • A programme for managing non-stabilised areas; • The identification staff who will manage ESCs – Including inspection, operation and maintenance during construction and any close down times outside of the normal "earthworks" season; • The identification of staff who monitor compliance with conditions; • A chain of responsibility for managing environmental issues; • Methods and procedures for decommissioning measures; and • Reporting and reactive procedures for the management and clean up in the event of the accidental discharge of sediment or other contaminants.
Container Impoundment Systems	Container Impoundment Systems will be used where necessary and will be sized based on the catchment size and as such will generally

Device / Methodology	Criteria
	apply to smaller catchment areas. Their primary use would be during the initial earthworks in steep or "difficult" locations prior to the formation of a SRP or DEB structure.
Decanting Earth Bunds (DEBs) and Decant Systems	Where required, DEBs and decant systems are to be designed and implemented in accordance with TP90
Decommissioning of Devices	Removal of devices will be in accordance with the CESCP.
Flocculation	Where considered appropriate, based on local soils conditions and the sensitivity of the receiving environment to sediment deposition, flocculation may be applied to SRPs and DEBs to assist in the reduction of sediment discharged to the receiving environment.
Non-Structural Measures	These elements could include: • Manually raised decant devices on SRPs and DEBs; • Batch dosing of SRPs and DEBs with chemical flocculant where required; • Proactive monitoring and reporting programme • Risk identification and management accordingly; • Progressive stabilisation as works progress; and • Weather response.
Pumping Activities	Pumping of sediment laden runoff and groundwater during construction should be to SRPs, DEBs to grass buffer zones or to temporary sediment retention devices such as Container Impoundment Systems.
Sediment Retention Ponds	Where required, SRPs are to be designed and implemented in accordance with TP90..
Streamworks	At all practical times these activities, and any associated works within these environments will be undertaken in an offline 'dry' environment. Construction during fish spawning and migration periods will be assessed and managed accordingly.
Super Silt Fences and Silt Fences	All super silt fences and silt fences are to be designed and implemented in accordance with TP90.

Through the design and construction phases of the Project, it is recognised that there will be scope for innovation and alternative means of achieving the same environmental outcome as may be specified in any future consent conditions.

It is recommended that ESC measures are planned during the detailed design phase of the Project and constructed and maintained during construction.

These principles and practices will also be further detailed and designed within site specific Construction Stage Erosion and Sediment Control Plans (CESCPs).

4.1.4 Construction Stage Erosion and Sediment Control Plans

The implementation of CESCPs will allow for further innovation, flexibility and practicality of approach to erosion and sediment control and in doing so will allow the construction of the Project to continually adapt to changing construction and climatic conditions.

CESCPs shall be submitted prior to commencement of work and will likely include a range of data and other information such as:

- Contour information;
- A list of proposed ESCs;
- Chemical treatment design and details;
- Catchment boundaries;
- Location of the Work;
- Details of construction methods;
- Contingency measures;
- Design details;
- A programme for managing non-stabilised areas;
- The identification staff who will manage ESCs;
- The identification of staff who monitor compliance with conditions;
- A chain of responsibility for managing environmental issues;
- Methods and procedures for decommissioning measures; and
- Reporting and reactive procedures for the management and clean up in the event of the accidental discharge of sediment or other contaminants.

5. Recommended mitigation required

Prior to construction commencing it is expected that CESCPs will be prepared by the contractor appointed to undertake the construction of the works.

The CESCPs will take into account the various environmental and ecological values within the natural environment in order to determine the most effective and appropriate form of ESC devices and management practices required to manage erosion and sedimentation during the construction of the project.

The options considered range from predominantly using existing road corridors to providing new roads across existing industrial land to new roads on embankment adjacent to the existing foreshore. The use of existing road corridors would limit the extent of exposed earth, thereby reducing the erosion potential of the construction works and hence would require a lesser degree of ESC than a new road across existing green fields for example and this would have implications for construction costs, which are outside the scope of this assessment.

5.1 Anticipated Erosion Protection Measures

ESC measures that are anticipated to be applicable to the construction stage of the project are expected to be a range of physical measures and site management practices as described below.

5.1.1 Construction Staging and Sequencing

The extent of exposed soil and length of time that area is exposed has a direct influence on the sediment yield leaving a particular area of the site. Bulk earthworks and construction activities should be staged and sequenced in order to limit the area of exposed soil required to complete an element of the work. Open earthworks areas need to progressively stabilised to reduce the potential for erosion to occur. It is possible that an open area limit may be adopted during construction as a control measure in this regard.

5.1.2 Clean and Dirty Water Diversions (CWD and DWD)

CWDs provide for the controlled conveyance of stormwater runoff and could be used on the Project to prevent run on water from the undisturbed catchment areas above the works from entering the construction area.

Where required, CWDs need to be designed in accordance with TP90 to ensure that the works are sufficiently protected from flows from the natural catchment outside of the works.

DWDs transfer sediment laden water to sediment retention devices for treatment within the construction areas. They are effectively a conveyance device and as with the CWDs need to be designed in accordance with TP90.

CWDs need to be fully stabilised with either vegetation or geotextile cloth. DWDs could also be stabilised but this would be dependent upon soil type for the specific area of works.

A maintenance programme should be implemented during construction activity to remove the sediment deposited within the DWDs. During construction, excavated pits or sumps could also be used and could be positioned at regular intervals.

5.1.3 Contour Drains

Contour drains are temporary ridges or excavated channels or a combination of the two that are constructed to convey water across a slope at a minimum gradient. They reduce the slope length and therefore the velocity of water flowing down disturbed slopes and hence reduce the erosive power of construction runoff.

5.1.4 Rock Check Dams

Check dams are small dams made of rock or other non-erodible material constructed across a swale or channel to act as a control structure. The purpose of a check dam is to reduce the velocity of flow within the channel and prevent scour of the channel surface. Check dams also allow for some settlement of suspended solids within the channel.

5.1.5 Stabilisation for Erosion and Dust Management Purposes

Stabilisation of exposed earth is a key element of erosion protection and could include a combination of the placement of mulching, geotextile and the use of hard fill material.

Progressive and rapid stabilisation of disturbed areas should be ongoing throughout the construction of the project. Stabilisation will particularly apply at stockpile areas and batter establishment to reduce both erosion and dust generation.

Mulch is typically applied to slopes of less than 15 degrees, above which alternatives such as geotextile should be considered. The development of the CESCPs will need to determine the specifics of this stabilisation technique and timing.

Stabilisation will be undertaken with three key purposes:

- To achieve any open area limitations that may be specified within consent conditions for the project;
- To reduce the open areas of disturbed earth in higher risk locations to assist with a reduction in sediment generation; and
- In response to the adaptive monitoring programme to address any potential effects or undesirable monitoring trends.

5.1.6 Pipe Drop Structure / Flume

Temporary pipe drop structures or flumes are constructed to convey construction runoff down a slope face without causing erosion of the slope and are generally used to prevent scour of the batters.

5.1.7 Stabilised Construction Entrance Way

Stabilised Construction Entrance Ways are a stabilised pad of aggregate placed on a filter base and are located where construction traffic enters or exits a construction site. They help to prevent site entry and exit points from becoming a source of sediment and also help to reduce dust generation and disturbance along public roads.

Alternatively wheel washes could be placed to ensure, that no vehicles leave a construction site and enter public spaces unless tyres are clean and vehicles do not contribute to sediment deposition on public road surfaces.

5.2 Anticipated Sediment Protection Measures

Sediment control during construction involves the interception and treatment of sediment-laden runoff from the various construction areas along the Project and should be carried out in accordance with the guidelines contained in TP90.

Sediment control will be established through the use of recognised sediment control measures and site management practices. Sediment control devices will need to be located outside the 20 year ARI flood level, unless no other viable alternative exists. If sediment control devices are required within the 20 year ARI flood level, they should be designed to capture the minimum catchment area and should be subjected to an increased inspection and maintenance regime.

The general sediment control measures and principles that may be used on the Project could be as follows:

5.2.1 Sediment Retention Pond (SRP)

Where required, SRPs should be designed and constructed in accordance with TP90 and are generally designed to receive the flows from the upstream catchment during a 100 year ARI rain event. They are designed with a minimum 3% volume criterion applied in relationship to catchment size (i.e. 300 m^3 SRP volume per 10000 m^2 or 1 ha of contributing catchment).

SRP spillways are to be designed and constructed to ensure that they safely pass the 100 year ARI rain event with low velocity, which will reduce the risk of scour on the downstream side of the spillway.

Forebays of SRPs need to be established and designed to capture the majority of the sediment entering the SRP. Any sediment that is not captured within the forebay area will be transferred into the main body of the SRP and will be captured through the provision of baffles within the SRP itself.

Prior to the construction of SRPs it will be necessary to:

- Check ground conditions through the use of bore holes and undertake a geotechnical assessment of the proposed SRP site;
- Determine the need or otherwise for a shear key establishment; and
- Remove any unsuitable material and confirm ground conditions as appropriate for SRP establishment.

5.2.2 Decanting Earth Bund (DEB)

Decanting earth bunds (DEB) are temporary berms or ridges of compacted soil, which are constructed to create impoundment areas where ponding of sediment-laden runoff can occur and which provide time for suspended solids to settle out before the runoff is discharged to the receiving environment.

DEBs should be designed and constructed in accordance with TP90.

All spillways from the DEBs are to be designed and constructed to safely pass the 100 year ARI rain event with low velocity and therefore minimal scour potential.

5.2.3 Pumping Activities

All SRPs and DEBs should be fitted with floating decants with a mechanism to control outflow such as a manual decant pulley system to be used during pumping activities to these structures. Wherever possible, gravity flow will be used rather than pumping. Where decants are manually plugged, they should only be lowered once an acceptable standard of discharge quality can be achieved. The pumping rates and volumes to SRPs and DEBs will be designed for the total pump volume to be fully captured within the SRP or DEB.

Further pumping will also be required with associated activities such as bridge construction. Pumping flows to SRPs and DEBs ensures that any sediment laden flows are discharged to a treatment device prior to entering the receiving environment.

5.2.4 Container Impoundment Systems

In locations where SRPs or DEBs cannot be located due to slope, room constraints or instability issues, container impoundment systems will be used. These are retrofitted with a decant system and will also be subject to chemical flocculation.

It is expected that these systems will be used primarily in the early stages of earthworks for small catchment areas before it is possible to construct SRP structures.

5.2.5 Super Silt Fence (SSF)

Super silt fences are fabric fences reinforced with stakes and netting backing to allow a physical barrier to flows leaving the area of earthworks without passing through the SSF. Their design and placement will be based upon the criteria contained within TP90. SSFs will be used in those areas of work adjacent to, or in the immediate vicinity of watercourses.

As a risk management tool for SSFs the fabric will be installed with a minimum 200mm of fabric placed upslope at the base of the trench.

5.2.6 Flocculation

Flocculation is a chemical treatment method for increasing the retention of suspended solids from construction earthworks runoff in SRPs and DEBs where chemical flocculant is added to the construction runoff flowing into a SRP or DEB via a rainfall activated system (flocculant shed) or via manual batch dosing.

The use of flocculation chemicals increases the efficiency of SRPs and DEBs and reduces the amount of sediment discharged to the receiving environment (sediment yield).

Where considered appropriate, depending on soil conditions, SRPs and DEBs will be chemically treated with a flocculant appropriate for the soil type and discharge location.

5.3 Other Measures

5.3.1 Permanent Stormwater Devices

The Project will also include the installation of a number of permanent stormwater treatment wetlands and swales for permanent stormwater treatment from impervious surfaces.

Where practical, permanent stormwater treatment and detention devices should be installed early in the Project.

Where the location of a SRP coincides with a permanent stormwater treatment wetland, the wetland will be used on a temporary basis as a SRP. These will be converted to long term stormwater wetland features at the completion of the earthworks activity within that sub-catchment.

No existing natural wetlands will be used for primary treatment of sediment-laden runoff from the construction phase.

5.3.2 CESCPs

CESCPs are detailed erosion and sediment control plans which will be submitted for specific work areas or activities within the site. They will provide the detailed design, specific ESC measure location, staging and sequencing of works for that location.

The CESCPs will be developed prior to construction works commencing and will determine specific measures to be employed in particular areas.

5.3.3 Contaminated Land

The Contaminated Land Assessment for the project identifies the presence of a number of landfill sites through the project study area. Any future erosion and sediment control measures proposed will need to take cognisance and reference the recommendations and requirements of any future Contaminated Land Management Plan (CLMP). The provisions of a CLMP .can be incorporated into the CESCPs for the relevant areas of the project.

5.3.4 Decommissioning of Devices

All ESC measures will remain in place until such a time as the catchment contributing to that device is stabilised. Once the contributing catchment is considered stabilised the particular ESC measure can be decommissioned. The decision process and procedure for this will be outlined within the CESCPs.

5.4 Non-sediment contaminants

There are a range of non-sediment contaminants typically used during construction activity and these generally consist of materials that may directly or indirectly discharge into the receiving environment from site activity.

Non-sediment contaminants that are typically used in construction activity are listed in Table Table 2:

Table 2 – Typical Non-Sediment Contaminants

Product / Work Activity	Potential Contaminants	Indicator	Non-Visible Potential Contaminants
Adhesives	• Adhesives • Glues • Resins • Epoxy • PVC Cement	Oily sheen or discoloration from some products	• Phenols • Formaldehydes • Asbestos • Volatile Solvents and • Naphthalene
Asphalt Paving	Hot and Cold Mix Asphalt	Oil Sheen	Oil, petroleum distillates, Poly aromatic hydrocarbons
Cleaning Products	Cleaners, ammonia, lye, caustic sodas, bleaching agents, chromate salts	Discolouration	Acidity / alkalinity
Concrete	Cement	Discolouration	Alkalinity (High pH)
Flocculants	Specific to Flocculant used but can include pH and aluminium	Clarity	• Aluminium toxicity • pH

Product / Work Activity	Potential Contaminants	Indicator	Non-Visible Potential Contaminants
Sanitary Waste	Portable Toilets, disturbance of sewer lines	Discolouration, sanitary waste	Bacteria, Biological Oxygen Demand, Pathogens
Vehicle and Equipment Use	Equipment operation, maintenance, washing, refuelling	Oil sheen, sediment	Hydrocarbons and coolants

5.4.1 Storage and Management of Non-Sediment Contaminants

The management of these non-sediment contaminants will be subject to specific best management practice and industry guidelines.

It is currently unclear as to the specific nature of these non-sediment contaminants and the associated volumes however Table 3 provides some generic guidance as to the expected management approach.

Table 3 – Non-Sediment Contaminant Management Approach

Product / Work Activity	Management Approach
Adhesives	• Store materials in an area that is not subject to rainfall contact • Use adhesives carefully and clean up any spilled material • Properly dispose of containers once they are empty
Asphalt Paving	• Water runoff should discharge to a treatment system designed to capture hydrocarbons
Cleaning Products	• Store materials in an area that is not subject to rainfall contact • Use adhesives carefully and clean up any spilled material • Properly dispose of containers once they are empty
Concrete	• Concrete truck chutes, pumps and internals should only be washed out into the formed areas awaiting installation of concrete • Unused concrete remaining in trucks shall be returned to the concrete batching plant • Hand tools should only be washed out into the formed areas awaiting installation of concrete
Flocculants	• Ensure the use of flocculants follows an approved flocculant management plan and industry best practice. • Regularly measure pH of the discharge from sediment retention devices.
Sanitary Waste	• Avoid knocking over portable toilets • Place portable toilets away from site vehicle movement areas

Product / Work Activity	Management Approach
	• Service portable toilets regularly • Empty portable toilets before they are moved. • Avoid breaking sanitary sewer lines that may exist on site
Vehicle and Equipment Use	• Fuel storage tanks shall be bunded to store a minimum of 100% of the tank's capacity. Note that for this project no bulk fuel storage is expected and mobile refuelling will occur. • Procedures and practices shall be put in place to minimise or eliminate the discharge of lubricants, coolants or hydraulic fluids to the receiving environment • Have spill prevention and control measures and procedures in place

6. Assessment of Options

There are 6 options currently being assessed in the current phase of the project. The options share similarities, particularly from an erosion and sediment control perspective. The proposed alignments traverse the same catchment areas and runoff generated by both existing and proposed surfaces generally discharge to the same receiving environments – ultimately the Manukau Harbour, Mangere Inlet, or Otahuhu Creek.

6.1 Assessment of Option A

The effects of Option A on the environment are relatively minor with regard to erosion and sediment control as the majority of this option utilises the existing road corridors. There will be limited soil disturbance.

As discussed in the Contaminated Land Assessment there is the potential that shallow soil within the road corridor could be contaminated from adjacent HAIL sites and as a result it is anticipated that excavated soil would be removed from site in sealed truck and trailer units, to be disposed of at a licensed tip facility.

The construction constraints, whilst working within an existing road corridor results in the extent of exposed earth, that has the potential to become eroded during rainfall events, being minimised and with implementation of appropriate construction staging and site management practices during construction, it is not expected that significant sediment would be generated.

Whilst considered to be a secondary form of ESC, the placement of catchpit protection, such as filter cloths and filter socks would also assist in the capture of sediment laden runoff from the site prior to its discharge to the existing, and proposed stormwater reticulation system and subsequently the receiving environment.

There are works proposed to provide auxiliary traffic lanes on State Highway 20 which are within the existing road designation near to the Coastal Marine Area (CMA). From an erosion and sediment control perspective effective robust ESC measures would need to be provided, such as staging of the works to reduce the erosion potential of any exposed earth along with appropriately designed and constructed sediment retention ponds capture any generated sediment, dosing the SRP with chemical flocculant may be required to increase the efficiency of the SRP and reduce sediment yields discharged to the marine environment.

Specific management measures should be developed as part of the CESCP production to include the handling or treatment of any contaminated soil areas. This would also be included in a Contaminated Land Management Plan (CLMP).

6.2 Assessment of Option B

As with Option A above, the effects of Option B on the environment are considered to be relatively minor with regard to erosion and sediment control as the majority of this option utilises the existing road corridors and as with option A there will be limited soil disturbance.

As with options A, there is also the potential that shallow soil within the road corridor could be contaminated from adjacent HAIL sites, and the ESC measures required would be similar to option A.

As with Option A , there are works proposed to provide auxiliary traffic lanes on State Highway 20 which are near to the Coastal Marine Area (CMA). From an erosion and sediment control perspective effective robust ESC measures would need to be provided, such as staging of the works to reduce the erosion potential of any exposed earth along with appropriately designed and constructed sediment controls to capture any generated sediment, dosing the sediment controls in the case of SRPS and DEBs with chemical flocculant may be required to increase the efficiency of the SRP and reduce sediment yields discharged to the marine environment.

Specific management measures should be developed as part of the CESCP production to include the handling or treatment of any contaminated soils areas. This would also be included in a Contaminated Land Management Plan (CLMP).

6.3 Assessment of Option C

The effects of Option C on the environment in relation to erosion and sediment control are relatively minor, but will depend on the construction method adopted for the sections of carriageway that cross the existing closed landfills of Pikes Point East and the NZ Rail Fill Site and the new connection from Onehunga Harbour Road onto Galway Street where the alignment adopts a route through the Galway Street landfill. These are discussed in more detail in the Contaminated Land Assessment.

At the Gloucester interchange the alignment utilises roads that skirt the periphery of the Gloucester Reserve, and along Nielsen Street the alignment skirts the Pikes Point West landfill.

Further east the alignment also crosses areas around the former Southdown freezing works including Southdown reserve and industrial sites where asbestos is prevalent in soil.

At 36 and 38 Miami Parade, the alignment skirts to the south of the former Dominion Oil Refinery which has a discharge to ground and groundwater.

Specific ESC measures would need to be developed and any recommendations provided in the CLMP would need to be incorporated and considered in any CESCP prior to construction commencing.

The management of stormwater runoff would need to be considered carefully so as to prevent any exposed refuse, and potentially leachate, from the landfills from becoming mobilised during rainfall events.

Depending on the volume of stormwater runoff generated during, it may be possible to construct SRPs in the vicinity to collect stormwater runoff from the landfill areas to allow any sediment to settle out and then pump collected stormwater to the nearest wastewater manhole.

If leachate contaminated stormwater is generated and pumped to the wastewater system, approval would be needed from Watercare and the downstream wastewater system would need to be analysed to ensure it has sufficient capacity to receive pumped stormwater flows without impacting on the downstream system. Alternatively, on site treatment will be required or sucker trucks will need to be utilised to collect contaminated stormwater for off-site treatment and disposal.

SRPs would need to be isolated from the landfill material through the use of an impermeable layer (such as a clay liner or impermeable synthetic membrane).

Ongoing and consistent weather monitoring would be required so that effective planning of construction activities could be carried out along with any required stabilisation of exposed earth along the route.

There are works proposed to provide auxiliary traffic lanes on State Highway 20 which are near to the Coastal Marine Area (CMA). From an erosion and sediment control perspective effective robust ESC measures would need to be provided, such as staging of the works to reduce the erosion potential of any exposed earth along with appropriately designed and constructed sediment retention ponds capture any generated sediment, dosing the SRP with chemical flocculant may be required to increase the efficiency of the SRP and reduce sediment yields discharged to the marine environment.

6.4 Assessment of Option D

This Option is the same as for Option C, with additional works in the Gloucester Reserve to provide the upgrade at Gloucester Park Interchange. The alignment across Gloucester Reserve introduces an increased risk of encountering landfill material in this area. Otherwise, the assessment of contaminated land effects for Option D is the same as for Option C (including the considerations regarding construction techniques through the landfills).

6.5 Assessment of Option E

The alignment of Option E was influenced by the geotechnical, hydrogeological and contaminated land considerations and the design response was to provide for a new embankment separate from the existing foreshore, so that this option does not impinge upon the landfills and the existing leachate interception trench and as such works are proposed within the Coastal Marine Area (CMA).

From an erosion and sediment control perspective, effective robust ESC measures would need to be provided, such as staging of the works to reduce the erosion potential of any exposed earth and to minimise the disturbance of the marine muds along the proposed embankment.

For the landside works appropriately designed and constructed sediment retention ponds to capture any generated sediment and dosing the SRP with chemical flocculant may be required to increase the efficiency of the SRP and reduce sediment yields discharged to the marine environment.

Access would be required within the CMA to facilitate the construction of the proposed bridge piers between the eastern end of the proposed embankment and Ann's Creek.

The construction of the bridge foundations and piers could potentially mobilise marine sediment at each location and a detailed construction methodology would need to be developed and incorporated within the CESCPs for the works.

This option also includes the Gloucester Reserve considerations, and also extends across industrial land to the east of Ann's Creek. Most of the eastern industrial zone is relatively recent (post 1990's) with the exception of the Westfield Freezing Works and Westfield Chemical Fertiliser Works.

Works within the contaminated land areas of this option would be subject to the provisions and requirements set out in a future CLMP.

Overall, the potential effects of this Option on the environment with respect to erosion and sediment control are considered to be minor and further mitigation and ESC measures may be required.

6.6 Assessment of Option F

As with Option E, the alignment of Option F was influenced by the geotechnical, hydrogeological and contaminated land considerations and a new embankment within the separate from the existing foreshore is proposed along the western part of the Mangere Inlet. On the eastern side of the Mangere Inlet the alignment crosses Pikes Point landfill and the NZ Rail fill sites.

From an erosion and sediment control perspective effective robust ESC measures would need to be provided, such as staging of the works to reduce the erosion potential of any exposed earth and to minimise the disturbance of the marine muds along the proposed embankment.

For the landside works appropriately designed and constructed sediment retention ponds to capture any generated sediment and dosing the SRP with chemical flocculant may be required to increase the efficiency of the SRP and reduce sediment yields discharged to the marine environment. SRPs would need to be isolated from the landfill material through the use of an impermeable layer (such as a clay liner or impermeable synthetic membrane).

The construction of the bridge foundations and piers could potentially mobilise marine sediment at each location and a detailed construction methodology would need to be developed and incorporated within the CESCPs for the works.

The eastern sector crosses the Pikes point East landfill and NZ Railways fill area. The alignment also encompasses Miami Parade and according to the contamination assessment runs adjacent to the HAIL sites in that area and within the contaminated land areas of this option would be subject to the provisions and requirements set out in a future CLMP.

As with Option E, the potential effects of Option F on the environment with respect to erosion and sediment control are considered to be minor and further mitigation and ESC measures may be required.

7. Conclusion and Recommendation

7.1 Conclusions

1. We have carried out a high level assessment of environmental effects that relate to erosion and sediment control based on a high level geometric design of the 6 short-listed options. We have identified ESC measures that can potentially be implemented to avoid, remedy and mitigate possible environmental effects that are a consequence of the project options and the results of this assessment are summarised below:

   i) Options A and B appear to have the least potential to cause adverse residual effects in relation to erosion and sedimentation and would be the preferred options from an ESC perspective;

   ii) Options C and D require works within existing known landfill sites and careful consideration of the construction methodology will be required. However from an ESC perspective, with appropriate ESC measures and following the requirements of any CLMP the effects on the receiving environment would be considered minor; and

   iii) Options E and F appear to have the most potential for adverse effects on the Marine Environment requiring engineered fill to be placed to form the proposed embankment along the foreshore within contaminated marine sediments. Depending on the final design these options may also require bridge supports and foundations to be constructed with the marine environment.

2. We note that this is a high level assessment with detailed analysis of earthworks volumes and the locations of construction accesses and haul roads not yet being developed it is not possible at this stage to determine the sediment yields that would be discharged to the receiving environment. However, it is considered that with the implementation of a range of ESC measures in place, as described in Section 5; then the overall residual environmental effects that relate to the project's management of erosion and sedimentation are likely to be less than minor for Options A and B) and minor for Options C, D E and F.

3. The sensitivity of the receiving environment is assessed in the Ecology Assessment and to a large extent the existing environment is degraded and modified.

4. The potential water quality effects can largely be mitigated by the placement of appropriate ESCs and through the implementation of robust site management practices and construction methodologies.

7.2 Recommendations

Undertake a comprehensive quantitative assessment of the magnitude of the environmental effects that relating to erosion and sedimentation and confirm the subsequent required measures needed to minimise these effects. To do this the project requires further detailed analysis as follows:

1. Confirm the design proposals and construction methods for the various elements of the preferred option;

2. Develop a conceptual construction sequence on the preferred option and include as a minimum:

   i) A conceptual programme of works

ii) A mass haul diagram to identify where fill material will be cut from and will be placed along the route alignment

iii) A construction methodology for each element of the works, including excavations, construction of structure including culverts, bridges and viaducts

iv) The location of haul roads, construction yards and compounds.

3. Undertake a hydrological assessment to determine and confirm the extent of the stormwater catchments and flows;

4. Assess and quantify the key areas of risk not be included in this assessment;

5. Determine discharge locations for the construction related stormwater runoff, in order to determine the most appropriate form of ESC to be provided prior to discharging to the receiving environment.

6. Assess existing ecological and environmental values along the route to determine the most appropriate method of ESC, which may also include limiting the extent of open earthworks;

7. Undertake a more detailed level of design to determine the alignment's designation requirements for the construction and operational phases of the project;

8. Determine the overland flowpath locations so as to determine the size, extent and discharge location of any clean water diversions required to prevent run-on water from entering active work areas.

9. Develop Erosion and Sediment Control Plans (ESCPs) as part of the design process and are expected to be required as part of any required resource consent application process and appropriately detailed ESCP will be needed to inform the Assessment of Environmental Effects and determine any temporary construction related designations that may be required.

7.3 Summary

The following key points are noted for the management of erosion and sediment for the preferred option.

- A range of ESC measures would be required for all options, however the scale and complexity of the required ESC measures depends on a range of factors such as the extent of exposed earth; the staging of the construction works; the movement of imported and excavated fill material; the time of year the works are carried out etc.
- Where possible permanent stormwater quality devices should be used during construction for the capture of sediment, such as siting SRPs in the same locations as permanent constructed wetlands, placing CWD and DWDs in the same locations as permanent swales etc.
- ESC measures not only rely on the appropriate design and placement of physical controls but also require rigorous site management practices to be implemented during construction.
- ESCPs shall be prepared during the detailed design stage. The ESCP will rely on the preparation of the construction stage ESCPs (CESCP) which will allow for contractor input into the preparation and management of the site from an ESC perspective.

The options range in scale in terms of complexity of construction and as such a range of erosion and sedimentation effects are to be expected.

Both TP90 and the Transport Agency guideline documents place emphasis on a number of principles that apply to the prevention of erosion and interception of sediment generated and thereby reducing any sediment discharging to the receiving environment.

There will be constraints on construction working room to facilitate the construction of sections for some of the proposed options; and particularly for the options involving works within the existing road network. This can been seen as both a positive and negative scenario in relation to erosion and sedimentation, as firstly it would place a limit on the exposed areas of earth and hence reduce the erosion potential of the works, but conversely space is limited for the ESC measures. However, with the implementation of appropriately designed, constructed and maintained ESC measures in place, in combination with effective site management processes it is considered the effects of erosion and sedimentation would be minor.

As noted in the Contaminated Land Assessment the presence of a number of landfill sites could represent a major constraint for construction and they also pose the greatest environmental risks. From an erosion and sediment control perspective, the adoption of a piled construction through the landfill areas would be preferred as this reduces the extent of any excavation required and subsequent potential for erosion to occur during rainfall events.

On the basis of existing information provided to undertake this assessment, from an ESC perspective Options A and B would be preferred.

However, the preferred Option should be selected on the basis of network performance and overall objectives of the project, provided that the alignment either avoids known landfills or adopts a construction method that minimises effects on the environment.

8. References

1. Auckland Regional Council, 1999 (updated 2007) '*Technical Publication 90 – Erosion and Sediment Control: Guidelines for Land Disturbing Activities in the Auckland Region' (TP90);* and
2. NZ Transport Agency, 2014, "Erosion and Sediment Control Guidelines for State Highway Infrastructure",
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