▪ Report

Vic Park Tunnel Project- Assessment of Land Disturbing Activities

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Vic Park Tunnel Project- Assessment of Land Disturbing Activities

Prepared for

Transit New Zealand

By

Beca Infrastructure Ltd

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Revision History

Revision Nº	Prepared By	Description	Date
A	Ross Winter	Initial Draft, Viaduct Option	April 2003
B	Aroha Russell	Revised Draft, Tunnel Option	22 Sept 2005
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on behalf of	**Beca Infrastructure Ltd**		

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Appendix A - Areas of Construction

Glossary

ACC	Auckland City Council
AEE	Assessment of Environmental Effects
alignment	The structural extent of the carriageway. Note the alignment is not the same as the designation.
ARC	Auckland Regional Council
ARP:SC	Auckland Regional Plan: Sediment Control
CMA	Coastal marine area. The area of foreshore and seabed below mean high water springs. This boundary is defined within the Proposed Auckland Regional Plan: Coastal.
Consent Holder	Transit New Zealand
DCT	Design Construct Team responsible for delivery of the project
designation	The area designated for use as an arterial route or other such public work within a district plan.
EMP	Environmental Management Plan
ESCP(s)	Erosion and sediment control plans.
Notice of Requirement	A notice to a territorial authority by a requiring authority of its requirement for a designation
Requiring Authority	A network utility operator approved as a requiring authority under Section 167 of the RMA. Transit New Zealand is a requiring authority in terms of this meaning allowing it to give notice to a territorial authority of its requirement for a designation
RMA	Resource Management Act, 1991.
SCPA	Sediment Control Protection Area, as defined by the ARP:SC
sediment generation	The amount of sediment eroded off any given piece of land or earthworks area (i.e. may be reduced by erosion controls).

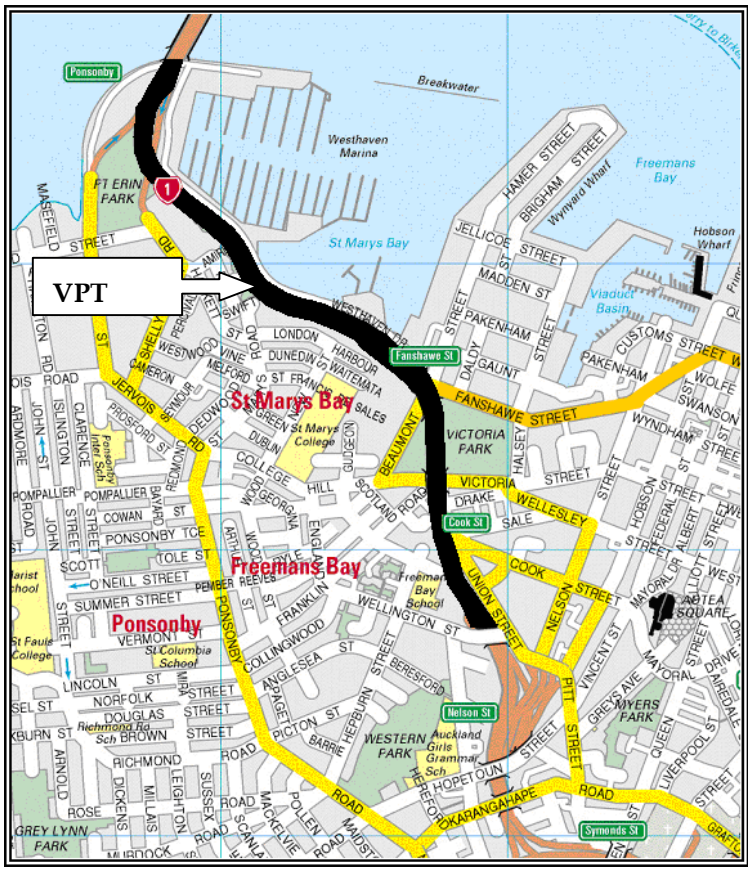
sediment yield	The amount of sediment discharged from any given piece of land or earthworks area (i.e. may be reduced by sediment control devices).
SH1	State highway 1
stabilised	Rendering the site resistant to erosion by the application of compacted basecourse, hydroseeding, mulch, polythene, jute, or similar, or works within low sediment bearing surfaces such as indurated rock. Where revegetation is the method used, then an area is considered to be stabilised once an 80% grass strike has been established.
Territorial Authority	A Council charged with the functions and purpose listed in Section 31 of the RMA
TP90	ARC Technical Publication No. 90: Erosion and Sediment Control Guidelines for Land Disturbing Activities, 1999.
Transit	Transit New Zealand
VPT	Vic Park Tunnel Project
VPV	Victoria Park Viaduct

1 Introduction

Transit New Zealand (Transit) proposes to undertake improvements to State highway 1 (SH1) between the Auckland Harbour Bridge and the Wellington Street over-bridge. The extent of the project, known as Vic Park Tunnel Project (VPT) (refer Figure 1) includes the following:

- Construction of a new 460-metre tunnel through Victoria Park, west of the existing viaduct to provide 3 lanes northbound.
- Retention of the Victoria Park Viaduct (VPV) to provide 4 lanes southbound.
- Widening of the existing corridor through St Mary's Bay to provide 5 lanes northbound and 5 lanes southbound and a bus shoulder lane.
- Extension of the Shelly Beach overbridge.
- Modifications to the Fanshawe Street on and off ramps and the Wellington Street on ramp.
- Tie in to the Central Motorway Junction works currently under construction.

Figure 1.1 VPT Location[1]



[1] Source: Wises Streetwise Mapping Software, **Copyright (c) Wises Publications, New Zealand**

1.1 Purpose

The purpose of this report is to assess the following matters:

- Area of soil disturbance likely to occur as a result of construction activities necessary to complete the VPT;
- Potential sediment generation and discharge from disturbed soil surfaces;
- The need for Auckland Regional Council (ARC) resource consent for land disturbing activities; and
- Erosion and sediment control measures required to meet ARC Guidelines and environmental obligations.

The means to avoid, remedy or mitigate sediment related effects have been addressed in generic terms in the VPT Environmental Management Plan (EMP), however, this report offers more detailed information associated with the land-disturbing construction activities likely to take place. This report does not consider contaminated material or groundwater management issues (these are discussed in the accompanying *Vic Park Tunnel Project - Environmental Management Plan, Technical Report 8* (Beca, March 2006), and *Vic Park Tunnel Project – Assessment of Contamination* (Beca, March 2006).

This report should also be referred to by the Design Construct Team (DCT – the preferred method of delivery for this project) when undertaking detailed design and construction works.

The content and conclusions of this report are intended to form the basis of a Land Use consent application to ARC.

2 Areas of Land Disturbance

2.1 Construction Methodology Assumptions

This assessment of land disturbing activities is based on a number of assumptions, particularly with regard to the construction methodology. The methodology has considered the specific site characteristics and design requirements involved in the VPT. These construction methodology assumptions affect the manner in which erosion and sediment control is proposed at the site, and relate specifically to the construction of the tunnel component, the timing of works, and the management of water within the work area.

Given the location of the tunnel and approach/exit points, it is assumed that the initial 0.5m of excavation below-ground will be managed by erosion and sediment controls that will discharge to stormwater. Below this, rainfall together with groundwater entering the tunnel works will need to be pumped away from the works area. As conventional erosion and sediment controls are of limited applicability, and as a consequence of the existing presence of contaminants in the groundwater, it is proposed to pre-treat this collected water. After treatment the water will be recharged to ground or otherwise discharged to sewer, subject to approval by either ARC or Metrowater respectively. This is discussed further as part of the '*Vic Park Tunnel Project – Assessment of Contamination*' report, and the '*Vic Park Tunnel Project – Environmental Management Plan*'.

The tunnel construction methodology (cut and cover method) is assumed to involve:

- Piling (constructing the walls of the tunnel without excavation of the tunnel first. Also includes some sections of the tunnel approach and exit);
- Shallow excavation to roof level;
- Roof placement (constructing the roof of the tunnel, prior to excavation under the roof);
- Backfill and stabilise over the roof;
- Continue excavation of tunnel under the roof, once in place; and
- Returning the surface as close to original ground level and appearance as possible.

The tunnel is expected to take 24 months to construct, 12 months of which will involve earthworks above roof-level. The earthworks are expected to be undertaken progressively over the 12-month period. For the purposes of this assessment however, only earthworks areas with runoff likely to discharge as stormwater have been considered. No further assessment of subsurface works have been made within this document.

The construction methodology assumes that works will be undertaken in stages, but that within those stages it will generally be undertaken progressively. For the purposes of this report, and to give the DCT some flexibility in their construction planning, progressive earthworks have not been incorporated into the assessment of land disturbing activities. This relates, for example, to the construction period assumptions relating to tunnel construction. In terms of surface earthworks (involving excavation of only the first 0.5m

depth of material, and the final 0.5m of filling above the tunnel roof with cleanfill back to original ground level), the expected earthworks period is approximately 2 months total.

2.2 Extent of Disturbance

The Auckland Regional Plan: Sediment Control (ARP: SC) identifies statutory 'tests' based upon (amongst other matters):

- Proximity to sensitive water bodies, including the coastal marine area (CMA). These areas are defined as sediment control protection areas (SCPA).
- Site slope. ARP: SC identifies different thresholds for works that occur on slopes greater than 15°.
- Exposed or unstabilised area. A definition of 'stabilisation' is contained within the Glossary. Based on that (ARC) definition, works that include exposure of compacted metal (e.g. roading basecourse) would not therefore be included in any assessment of exposed area. The ARP: SC defines earthworks to be:

  "The disturbance of land surfaces by blading, contouring, ripping, moving, removing, placing or replacing soil or earth, or by excavation, or by cutting and filling operations."

The assumed extent of the earthworks for the VPT Project is shown on drawings attached in Appendix A and summarised in Table 2.1. The chainages, description of areas listed in Table 2.1 correspond to project distances and notes as shown in Appendix A. The period of earthworks relates to the period of work during which the excavation is likely to be discharging to stormwater. As the design is yet to be finalised, the exposed areas and volumes are subject to change, however given the limited room within the designation this is unlikely to change significantly. Although some stockpiling is likely, no specific areas have been identified, and it is assumed that should stockpiling occur it would be within the work areas as identified in Appendix A. In addition, other minor activities, such as replacement, removal or upgrading of services, installation of stormwater treatment facilities, site establishment and accessways and other activities that may cause soil or earth to be disturbed outside of the areas noted should also be included for consideration.

The project earthworks are a balance cut-to-waste operation (cut material estimated at 125,000m^3), and any material required for reinstatement (fill material estimated at 5,000m^3) is expected to be cleanfill sourced from off-site (i.e. all contaminated material handled during the works will be removed off-site).

Table 2.1

Areas of Land Disturbance

Description of Area	Dimensions of Disturbance	Period of Earthworks Disturbance	Worked all at once or Progressively	Within SCPA and/or greater than 15°
St Mary's Bay, southbound, shoulder widening	**4025m²** (3.5 x 1150), from chainage 500-1650	3 months	Progressively	All except southern 50m within SCPA, <15°
St Mary's Bay, northbound shoulder widening	**3150m²** (3.0 x 1050) from chainage 250-1300	3 months	Progressively	All within SCPA, <15°
St Mary's Bay central median construction	**2850m²** (3.0 x950) from chainage 450-1400	2 months	Progressively	All within SCPA, <15°
Old Fanshawe St Northbound On-ramp removal. Conversion to grass	**2500 m²** (250 x10)	3 months	Progressively	Outside SCPA, <15°
Fanshawe Street northbound on-ramp	**3600m²** (300 x 12)	3 months	All	All within SCPA, <15°
Northern Tunnel exit	**4320m²** (240mx18m) from chainage 1330-1570	3 months	All	Outside SCPA, <15°
Tunnel	**6390m²** (355mx18m) from tunnel chainage 1525 to 1880	2 months	All	Outside SCPA, <15°
Southern Approach to Tunnel	**9900m²** (495mx20m) from chainage 1930 to 2425 (off Roading plan)	3 months	All	Outside SCPA, <15°
Batter slope Area (Napier Street)	**3000m²** (300mx10m)	3 months	All	Outside SCPA, <15°
Total	**3.97 ha**			

Note: SPCA = Sediment Control Protection Area as defined by the 'Auckland Regional Plan: Sediment Control'

The figures in Table 2.1 are based on the excavation activities that expose soil during the works. It is noted that this is a conservative estimate, as a number of the activities (along St Mary's Bay) have sections where works are only expected to expose the existing roading basecourse and are therefore not technically considered as earthworks.

2.3 Works Programme

It has been assumed that the earthworks for the VPT project will be undertaken over a 36-month period, including works over the winter period. It is proposed that the DCT will undertake winter works in accordance with the winter works protocols developed during the Grafton Gully Project (as detailed in Section 8.2). The estimates of the period of earthworks disturbance represented in Table 2.1 are based on the VPT estimated construction period work programme. The relative staging of the construction works is presented in Table 2.2. It should be noted that the VPT earthworks are expected to be progressive, but for the purposes of this report have been conservatively estimated as being staged. It should also be noted that the construction periods and staging are subject to change depending on detailed design and project priorities.

Table 2.2

Estimated Construction Staging (Relative)

Description of Area	Estimated Period of Construction	Period of Earthworks Disturbance*
St Mary's Bay southbound	6 months	3 months
St Mary's Bay northbound	9 months	3 months
St Mary's Bay median	6 months	2 months
Fanshawe Street northbound on-ramp	6 months	3 months
Area between existing Victoria Park Viaduct and Tunnel, removal of road conversion to grass	3 months	3 months
Northern Tunnel exit (from Church car park to northern end of Ngapona car park)	6 months	1 month
Tunnel	12 months	2 months
Southern Approach to Tunnel	8 months	1 month
Batter Slope Area (Western side of Southern Approach)	6 months	3 months

* Areas with the potential to discharge to stormwater only. The duration that subsurface works are exposed has been excluded on the basis that these are to be treated and discharged to sewer/recharged to ground.

3 Resource Consent Assessment

Given that more than 0.25 ha of land will be disturbed at one time (refer Table 2.1) within 100m of the CMA, and more than 1.0 ha is likely to be exposed at any one time outside this management area, a restricted discretionary Land Use Consent: Sediment Control for the land disturbing activities will be required, unless the works are strictly staged.

The physical works are expected to take 36 months to complete, therefore some staging of the works will occur. It is understood that only one of the three sections of work to be undertaken along St Mary's Bay is able to be undertaken at any one time due to traffic management requirements. Should the shoulder widening activities (northbound and southbound) be undertaken in more than one stage, then the works may be undertaken as a permitted activity, provided the areas earth worked within the SCPA were kept to less than 0.25 ha.

However, the ARP:SC is concerned with contiguous areas of works, or works occurring within the same title at any one time. Therefore, if the works were to be undertaken as a permitted activity then the project wide 'open area' would need to be considered as a whole. This would make construction of the VPT difficult as very strict control of earthworks areas and timing would be required; therefore placing unnecessary and likely impracticable restrictions on the DCT.

Therefore, whilst the works will be staged, consent for a restricted discretionary activity is recommended to allow construction activities to be undertaken with some flexibility.

It has been assumed within this assessment that the earthworks will continue during the winter period, therefore specific approval will need to be sought from the ARC. This assumption is based on the successful winter works programme undertaken during the Grafton Gully Project. Accordingly, for the VPT approval to undertake earthworks through the winter period is sought by Transit.

4 Sediment Generation Potential

4.1 Estimating Sediment Yield

To assess the risk of sediment related effects, the three relevant aspects relating to erosion and sediment control have been considered, namely the:

- *sediment generation potential*, given the topographical characteristics of the land under consideration
- *sediment delivery,* the amount of eroded sediment that is retained on site prior to it entering sediment treatment devices
- *sediment yield*, the amount of sediment discharged from the site following treatment.

The focus of this assessment using the Universal Soil Loss Equation (USLE) is not to absolutely quantify the annual mass loading, but rather to allow the earthworks process and/or the erosion and sediment controls to be refined such that any adverse environmental effects may be appropriately avoided, remedied, or mitigated. It allows consideration of the areas of higher sediment generation potential to be targeted with more comprehensive control methodologies on site to reduce the likelihood of significant off-site discharges.

4.2 Limitations

The USLE is utilised to assess sediment yield, modified in accordance with the *ARC Erosion and Sediment Control Plan Preparers Industry Registration Programme*. The ARC has identified the modified USLE as the required means of assessing sediment yield for land disturbing activities. As noted above, the assessed yields should not be viewed as absolute values and will change should any of the assumptions upon which it depends alter. As such this report should not be used to administer compliance with any subsequent conditions of consent, but rather to target areas of higher sediment generation potential with more comprehensive site management practices.

The USLE is not considered to be appropriate for establishing sediment loss for the entire VPT construction period. Tunnel construction will use a "cut and cover" method, and construction water (including groundwater) will be discharged to sewer or, if approved by the ARC, treated and used for groundwater recharge. The USLE considers only the extent of earth worked surfaces that are exposed to direct rainfall, and relates only to areas discharging runoff as stormwater. As such, the USLE cannot be used to determine an estimated sediment yield from the works that will occur beneath the tunnel roof or from the broader tunnel excavations once these extend below ground level (0.5m depth).

4.3 Staging Assumptions

It is assumed that the earthworks for the VPT will be undertaken progressively over 36 months. Relative staging details are based on the estimated construction period programme (as contained in Table 2.2).

It is recommended that consent be sought with this flexibility built into it in order to provide greater certainty for the DCT. The assessment of sediment yield is nevertheless expected to represent what might typically be expected as arising from the project works and is useful for comparison to background loadings. Some contingencies have been built into the assessment and are discussed in the relevant sections of this report. Other contingency measures are identified within the EMP. This report is based upon compliance with both the critical assumptions and the EMP.

5 USLE Assessment

5.1 USLE Methodology

The USLE is a predictive agricultural model of soil loss reliant on detailed statistical records and the standardisation of soil characteristics. The USLE model was derived in the USA originally to estimate sheet and rill erosion from cropland. The USLE approach is limited in its application to Auckland earthworks (ARC Erosion and Sediment Control Registration Programme, 1996), thus:

1. Empirical formulae only and not a mathematical representation of the actual erosion process.
2. Predicts average annual sediment generation, unusually light or heavy rainfall is not represented.
3. Sediment deposition is not calculated.
4. Sheet and rill erosion is calculated only. Channel erosion is not calculated and any rill erosion greater than 100 mm in depth will be underestimated.
5. USLE has not been calibrated for New Zealand conditions.

The parameters that affect the potential for erosion, and subsequently sediment generation and sediment yield are, however, still limiting issues for any earthworks site:

- Rainfall intensity and duration
- Exposed sediment erodibility
- Slope length
- Slope steepness
- Degree and nature of ground cover
- Erosion control practices

There are also other issues to consider that both influence the amount of sediment leaving the site, and the final volume that is delivered to the receiving environment. These are:

- Sediment control efficiencies
- Duration of the earthworks season
- Delivery ratio
- Channel erosion

The USLE is based upon the parameters noted as follows:

$$A = R * K * LS * C * P$$

The factors are described as:

A = Soil loss (tonnes/year)

R = Rainfall erosion index

K = soil erodibility factor

LS = slope length

C = vegetation cover (crop) factor

P = erosion control practice (protection) factor

In addition to the above, the USLE estimate needs to be amended to account for the following:

- Earthworks duration;
- Sediment delivery ratio; and
- Sediment treatment device efficiency.

5.2 Rainfall

Rainfall details obtained from ARC Technical Publication 108 (TP108) 'Guidelines for Stormwater Runoff Modelling in the Auckland Region' identify that the 24-hour duration 2-year Annual Recurrence Interval Design Storm for the VPT area is approximately 80mm. This is converted by a factor of 0.628 to give the 6-hour duration, 2-year storm value of 50.24mm. The resultant R (rainfall erosion index) factor is 77.8.

5.3 Geology and K Factor

The ability of surface sediments, and those exposed underlying sediments to resist the erosive energy of rainfall affects the rate of sediment generation from an earthworks site. This factor relates to the in situ sediments rather than the sediment erodibility factor of any materials subsequently placed upon the site.

The erodibility (K) factor has been estimated by considering Waitemata group silts, clays and fine sands in a variety of lithologies. The K factor for the Waitemata materials is 0.49. It is noted that material to be worked north of Victoria Street is reclaimed, and that the Waitemata group material is overlain by Tauranga series material. It is considered however that the high erodibility or K factor for Waitemata derived soils, if applied to these soils as well, will provide a conservative estimate of the erodibility of these areas.

5.4 Length-Slope Factor

The works consist of excavations and cut to fill. Some of this will involve some degree of retaining structure, both permanent and temporary (which can assist in providing a comparative reduction in potential yield as construction generally involves building up or excavating in even, level layers). For the purposes of assessing the length-slope (LS) factor, it has been assumed that the works will occur at an assumed 'average' grade based on consideration of the initial and final slopes in the work areas. The length between erosion controls should reflect the work gradients.

For the purposes of this analysis, the site has been divided into ten areas of similar slope characteristics (refer Table 5.1):

Table 5.1

Length-Slope Characteristics

Location	Description	LS Factor
St Mary's Bay, southbound, shoulder widening	This area is slightly sloped (towards the receiving environment of the Harbour), therefore slope length has been taken widthways. Average slope = 5% Slope length = 8m	0.3
St Mary's Bay, northbound shoulder widening	Relatively flat. Assumes that all earthworks in these areas will follow current contours and remain at similar to the current ground level.	0.08
St Mary's Bay Central Median construction		
Old Fanshawe St Northbound On-ramp removal. Conversion to grass		
Fanshawe St Northbound onramp		
Northern Tunnel exit	Slope of the road from the tunnel exit up to the point where it meets the St Mary's Bay widening. Slope = 4% Slope length = 153m (along the road)	0.76
Tunnel	The tunnel excavation will be relatively flat throughout construction. Slope = 0.5% Slope width = 18m	0.09
Southern Approach to Tunnel	Downsloping approach to the tunnel. Slope = 6% Slope length = 100m (assumes the use of contour drains)	1.22
Batter slope Area (Napier Street)	Batter slope runs along the western side of the approach to the tunnel. Slope = 33% Slope length = 10m width (average)	5.41

5.5 Cover and Erosion Practice Factors

The USLE assumes, in effect, a constant rate of sediment generation over the course of a year. Due to the nature of the works, it has been assumed that the earthworks will be carried out throughout the year. The C (cover) factor provided by the USLE for earthworks is 1.0. The P factor (protection factor) has been chosen to reflect the expected combination of smooth surfaces and surface roughening by machinery track walked up and down the contours. A factor of 1.2 has been adopted for P.

5.6 USLE Estimate

Table 5.2 outlines the quantity of sediment generated (A) from each work area of the VPT, in units of tonnes/hectare/year. This is based on the USLE equation:

$$A = R * K * LS * C * P$$

Table 5.2

USLE Sediment Generation Rates

Site Area	R (J/ha)	K (t / J / ha)	LS	C	P	A (t /ha/ yr)
St Mary's Bay, southbound, shoulder widening	77.8	0.49	0.08	1.0	1.2	3.66
St Mary's Bay, northbound shoulder widening	77.8	0.49	0.30	1.0	1.2	13.72
St Mary's Bay Central Median construction	77.8	0.49	0.08	1.0	1.2	3.66
Old Fanshawe St Northbound On-ramp removal. Conversion to grass	77.8	0.49	0.15	1.0	1.2	6.86
Fanshawe St Northbound onramp	77.8	0.49	0.08	1.0	1.2	3.66
Northern Tunnel exit	77.8	0.49	0.76	1.0	1.2	34.77
Tunnel	77.8	0.49	0.09	1.0	1.2	4.12
Southern Approach to Tunnel	77.8	0.49	1.22	1.0	1.2	55.81
Batter slope Area (Napier Street)	77.8	0.49	5.41	1.0	1.2	247.50

5.7 USLE Modification Factors and Assumptions

To reflect the site characteristics, the estimates contained in Table 5.2 need corrections taking into account the area exposed, the duration of the works, efficiency of sediment control devices and the sediment delivery ratio.

5.7.1 Area and Duration

Areas to be exposed are based upon the assumptions set out in Table 2.1. The figures given are considered to be a conservative estimate of the area likely to be disturbed at any one time as progressive stabilisation and staging of the works will occur in those areas noted as occurring progressively on Table 2.1. This is of relevance for those areas anticipated to generate higher levels of sediment, such as the batter slope and tunnel approach. The duration of the works is based on the construction programme (reflected in Table 2.2).

5.7.2 Sediment Control Treatment Efficiency

The principal means of removing sediments from earthworks run-off is usually a sediment treatment / retention pond at the down gradient end of the earthworks site. Other treatment devices such as silt fences and vegetative filter strips can be used in association with a pond to augment any treatment. The effectiveness of any sediment control device, if sized and located appropriately relates to the correct installation (i.e. silt fences toed in), and appropriate maintenance (i.e. removing and correctly disposing of sediment deposited within sediment ponds).

The proposed method for sediment control for VPT is the use of isolated sediment treatment devices due to the lineal nature of any areas of disturbance, consisting generally of silt fences and decanting bunds. A specific dewatering methodology (detailed in the EMP) will be adopted for any sediment-laden water trapped within the tunnel excavation. As noted earlier, other than during initial excavation and final top-soiling, construction water and groundwater is to be discharged to sewer in the first instance, and has been excluded from this assessment. It should also be noted that the USLE estimate does not consider the area beneath the tunnel roof as a sediment-generating surface. That area will be predominantly affected by groundwater seepage and not by direct rainfall.

For the purposes of the estimating levels of sediment discharge in this instance, a 50% efficiency factor is suggested. This has been selected on the basis that sediment retention ponds will not be utilised, and that silt fences and decanting bunds are not considered to be as effective as sediment retention ponds. This efficiency factor is considered to be conservative.

5.7.3 Sediment Delivery Ratio

The USLE estimates gross erosion only, and does not make any allowance for sediment retained on site prior to reaching the sediment control measures. The delivery ratio describes the proportion of sediment that is eroded on site that will actually be transported to these treatment measures. It also gives consideration to the proximity of the works to sensitive receiving environments.

The sediment delivery ratio is derived with consideration to site topography, the size of the drainage area and the soil textural characteristics. The sediment delivery ratio may vary between 0.1 - 0.7 (ARC Industry Registration Programme). Having regard to the nature of the works and the slope characteristics on site, the following delivery ratios are estimated:

- 0.6 (60%) for those areas to be worked along St Mary's Bay (southbound) which are flat and will generally be undertaken below the surrounding level of carriageway seal, but are closer to the receiving environment (the areas are near to existing stormwater infrastructure, which discharges directly to the CMA);
- 0.7 (70%) for works on the batter slope on the west side of the tunnel approach, and;
- 0.4 (40%) for those surface works within the footprint of the tunnel and the approach and exit of the tunnel, which are highly unlikely to reach the receiving environment as these areas are flat and away from the receiving environment.

These delivery ratio estimates are considered to be conservative given the nature of the site ground conditions.

5.8 Estimate of Sediment Generation and Yield

Having consideration for the modification factors, Table 5.3 sets out the predicted sediment generation for VPT:

Table 5.3

USLE Sediment Yield Rates

Location	Sediment Yield (t / ha / yr)	Average Area Exposed *(ha)*	Delivery Ratio	Device Efficiency Factor	Period exposed (yrs)	Predicted Yield (tonnes)
St Mary's Bay, southbound, shoulder widening	3.66	0.41	0.4	0.5	0.25	0.08
St Mary's Bay, northbound shoulder widening	13.72	0.32	0.6	0.5	0.25	0.33
St Mary's Bay Central Median	3.66	0.29	0.4	0.5	0.17	0.08

Location	Sediment Yield (t / ha / yr)	Average Area Exposed *(ha)*	Delivery Ratio	Device Efficiency Factor	Period exposed (yrs)	Predicted Yield (tonnes)
construction						
Old Fanshawe St Northbound On-ramp removal. Conversion to grass	6.86	0.25	0.4	0.5	0.25	0.09
Fanshawe Street northbound on-ramp	3.66	0.36	0.4	0.5	0.25	0.07
Tunnel exit	34.77	0.43	0.4	0.5	0.08	0.24
Tunnel	4.12	0.64	0.4	0.5	0.17	0.09
Tunnel Approach	55.81	0.99	0.4	0.5	0.08	0.88
Battered Slope	247.50	0.3	0.7	0.5	0.25	6.5
Total Estimated Sediment Discharge						**8.36Tonnes**

5.9 Discussion

In general, the flatter areas where works are proposed offer very limited potential for sediment generation and discharge (reflected by the low sediment generation rate contained in Table 5.2). Limited runoff from these areas is likely, and may be treated by isolated sediment control measures. It is also noted that once excavated, the earthworks areas will be rapidly covered with hardfill/basecourse material, effectively stabilising these areas. The batter slope section of the route represents a higher potential for sediment generation and discharge due to the steeper nature of the area to be worked and longer slope lengths. This area should be considered in more detail when the final design of erosion and sediment control measures occurs.

The predicted sediment discharge is to occur over a number of consecutive earthwork seasons. Should the ARC give approval for the DCT to undertake winter works (it is expected that the DCT will seek to undertake winter works), the project duration is likely to decrease and with it the total period that sediments are exposed would also be reduced (depending on the nature and extent of winter works approved and undertaken).

6 Catchment Sediment Yield

6.1 Background

For the purposes of considering the likely increase in sediment discharge to the Harbour receiving environment, consideration of the "background" levels of sediment being discharged to the Waitemata Harbour in the vicinity of the site discharges needs to occur. There are two areas of consideration, being:

i. The length of motorway along St Mary's Bay, discharging directly to Waitemata Harbour from a number of discharge points, and

ii. The section of motorway from Beaumont St to Wellington St Overbridge. This area discharges into the Auckland City Council stormwater system with runoff from the Freeman's Bay Catchment. This system discharges to the Waitemata Harbour at an outfall at the southern end of Wynyard Wharf.

6.2 Catchment Discharges

6.2.1 St Mary's Bay Section

This length of motorway discharges via a series of outfalls that pass under Westhaven Drive directly to the Harbour in the vicinity of Westhaven Marina. The USLE estimate indicates that approximately 0.49 tonnes of sediment may be discharged from these works over the 3 to 4 month period of earthworks.

By comparison, stormwater from this area of carriageway alone is estimated to discharge 1.0 tonne of sediment per hectare per year[2] (Table 6.1), or approximately 6.75 tonnes for this 1500 m length of motorway. The adjoining residential catchment of approximately 50 ha (the area encompassed by Shelly Beach Road, Jervois Road, St Mary's Bay Road, Green Street and New Street across to Westhaven Drive) is estimated to contribute 0.2 t/ha/yr[2], and this equates to 10 tonnes of sediment per year.

Therefore, it is estimated that approximately 16.75 tonnes per year of sediment discharges to this area of Waitemata Harbour, or approximately 5.58 tonnes over the 3-4 month period of earthworks. Whilst the increase in discharge of 0.5 tonnes (over the 3-4 month construction period) represents an increase over the background sediment loading of approximately 9%[3], the quantum of the discharge is considered to be minor in the context of discharges to the Harbour.

[2] Reference: Auckland Regional Council Draft Update of TP10 (Stormwater Treatment Devices: Design Guideline Manual, 1992).
[3] 0.49 tonnes is 9% of the 5.58 tonnes of sediment produced over the 3-4 month construction period

Table 6.1

Typical Contaminant Loadings (kg/ha/year) from Urban Land Uses (ARC TP 10)

Land Use	TSS	TP	TKN	NH_3-N	NO_2-N	BOD	COD	Pb	Zn	Cu
Commercial	1124	1.68	7.53	2.14	3.48	70	472	3.03	2.36	0.45
Parking Lot	449	0.79	5.73	2.25	3.26	52.8	303	0.9	0.9	0.45
High density Residential	472	1.12	4.72	0.9	2.25	30.3	191	0.9	0.79	0.34
Medium density residential	213	0.56	2.81	0.56	1.57	14.6	81	0.23	0.23	0.157
Low density residential	11	0.05	0.03	0.02	0.11			0.01	0.05	0.011
Motorway	989	1.01	8.88	1.69	4.72			5.06	2.36	0.416
Industrial	966	1.46	4.27	0.26	1.46			2.7	8.2	0.562
Reserve	3	0.03	1.69		0.34		2.25	0.006		
Construction	67,416	89.9								

6.2.2 Beaumont Street to Wellington Street Section

This section of motorway lies within the 201 ha Freeman's Bay catchment, which has a mixed land use consisting of residential, commercial and some reserve areas, including Victoria Park. The USLE estimate indicated that 7.9 tonnes of sediment might be discharged from this section of the proposed works.

In contrast to these estimated discharges, the overall catchment is estimated to discharge approximately 107 tonnes per annum (based on: 13.5 ha reserve; 7.5 ha motorway; 70 ha commercial; and 110 ha medium density residential), or 214 tonnes over the construction period. Over the earthworks period for works in this area (24 months), a discharge of 7.9 tonnes represents an increase of 3% over background.

7 Erosion and Sediment Control Methodologies

7.1 Design Approach

For the purposes of providing the ARC with a suitable level of information to determine the potential effects of the proposed VPT construction activities, a likely scenario of earthworks and sediment control measures has been suggested. It is recognised up front that this report and the measures considered are conceptual only. However, conservative estimates have been used throughout the report to present the "worst-case" scenario. This conceptual approach has achieved ARC approval previously for significant highway works (e.g. the Grafton Gully Project and North Shore Busway), and it is considered that such a programme is suitable to be implemented for the VPT works.

In general, this will require that the DCT provide more detailed Erosion and Sediment Control Plans (ESCPs) in accordance with the conditions of consent and Construction Environmental Management Plan, both of which require ARC approval (refer to the EMP).

With regard to the construction programme and proposed works, and with experience obtained on similar earthworks developments, erosion and sediment control measures have been suggested.

7.2 Principles

The basic principles to be employed for an ESCP, are to undertake land disturbing activities in a manner that reduces the potential for erosion of bare soil surfaces to occur (Erosion Control) and to employ treatment devices to treat all sediment laden water prior to discharging from the site (Sediment Control).

Erosion control should always be focussed on ahead of sediment control, however, it is noted that the nature of the works, may preclude standard erosion control methodologies (for instance progressive stabilisation may not be achievable due to the subgrade construction requirements).

The basic erosion and sediment control principles applicable to this project are as follows (as noted in ARC Erosion and Sediment Control Guidelines for Land Disturbing Activities 'TP90'):

- *Minimise Disturbance*, only work those areas required for construction to take place.
- *Stage Construction,* carefully plan works to minimise the area of disturbance at any one time.
- *Protect Steep Slopes*, careful consideration of activities on steep slopes and the control of runoff from these areas need to occur.
- *Stabilise Exposed Areas Rapidly.*
- *Install Perimeter Controls,* divert clean water away from areas of disturbance and divert runoff from areas disturbed to sediment control measures.
- *Employ Detention Devices,* treat runoff by methods that allows sediment to settle out.
- *Undertake Training,* the ARC runs a training course that the relevant persons from the DCT need to have completed (refer to EMP).

- *Modify the ESCP throughout Construction,* as construction progresses and the nature of land disturbing activities change, the ESCP needs to be modified to reflect the changing conditions on site.
- *Assess and Adjust,* inspect, monitor and maintain control measures.

The USLE estimate shows that the 'Tunnel Approach' and 'Batter Slope' construction activities have the highest potential for sediment generation and discharge. As a result, these areas should be targeted for control during construction. The other areas assessed have minor potential for generation and discharge, and standard sediment control methodologies should be employed to treat runoff from construction areas.

7.3 Proposed Methodologies

Given the nature of the probable construction activities on site, the following methodologies are proposed to be employed to manage the generation and discharge of sediment from the site. These methodologies and management practices have been developed from those outlined in the EMP. It is expected, as stated in the EMP, that the successful DCT will use this information as the basis for an ESCP to be submitted to the ARC for approval.

For the purposes of drafting an outline ESCP, the activities on site have been separated into the following sections of similar characteristics:

- Shoulder-widening and median works (St Mary's Bay North and Southbound, and the former Fanshawe St onramp area to be grassed);
- Retaining wall construction (Fanshawe Street on-ramp, Tunnel exit past Church car park);
- Batter Slope construction;
- Tunnel, approach and exit construction (tunnel surface works); and
- Tunnel, approach and exit construction (tunnel below- surface works).

All erosion and sediment control measures shall be constructed in accordance with ARC Technical Publication 90 (TP90) to a minimum. The following controls have been included within the EMP:

7.3.1 Generic Controls

All works will require the following controls and methodologies to be considered and utilised where appropriate:

- No traffic may exit construction areas onto public roads with sediment and other material attached to the undercarriage and tyres. As such, material must be removed via a 'wheel wash'. If a wheel wash is not practical, sediment should be washed from vehicles with a hose or water blaster, or running the material off along on-site access roads.
- Stabilised construction entrances.
- Clean water diversion away from worked areas.

- Rapid stabilisation, especially for isolated areas is advised. The placement of hardfill/sub-basecourse will occur for those areas worked that are to be sealed. In addition, application of hay or straw mulch on batters may reduce the need for ongoing maintenance requirements as vegetation becomes established.
- Earth stockpiles should be minimised where practicable.
- Stormwater inlet protection. Any stormwater grates that may dispose of flow from 'dirty' areas shall be protected with aggregate and/or geotextile to provide some treatment of flows prior to discharge.

7.3.2 Shoulder widening of St Mary's Bay North and Southbound, Curran St, Area to be Grassed

These works will generally be isolated from any upstream catchment areas and will involve minor excavations and backfilling with hardfill to form the required grades and surface reshaping. Runoff from this work is expected to be minimal, due to the excavation being generally below the surrounding sealed area and backfilling with aggregate.

Where shoulder-widening works have the potential to intercept runoff from the carriageway, then the emphasis will be on stabilising these areas as soon as practicable and undertaking the works within identified periods of fine weather wherever possible.

Control measures will be limited to stormwater inlet protection and construction of decanting earth bunds within the works area to collect any runoff and allow settlement and soakage into the ground, or discharge to the stormwater system.

It is noted that stormwater inlet protection must not be allowed to prevent storm flows to drain and cause flooding of the carriageway, causing potentially dangerous conditions for motorway traffic. Methods such as a series of low sand bag dams within sections of curb and channel above inlets, without any covering of the inlets may be appropriate.

7.3.3 Tunnel Surface Works

There are two issues that need to be addressed here:

- The first is to minimise the amount of sediment draining to the collection points within the excavation. The approach and exit will be divided into smaller sections through the installation of contour drains and sumps at the end of each section. Silt fences will be used to treat sediment where contour drains cannot be used. It is assumed that as each section is created the base will be quickly stabilised to minimise erosion.
- The second issue is to maintain separation of clean and dirty water. For runoff collected above the ground water level it may be possible to discharge this from the collection points (sumps) to the stormwater system (after suitable treatment). For water collected within the excavation, this may require pumping and treatment prior to discharge to stormwater.

The walls of the tunnel approach and exit will be constructed using pile retaining walls (secant/bored piles or diaphragm wall). The walls will restrict the transport of sediment to the receiving environment.

7.3.4 Tunnel Sub-surface Works

Any sediment-laden water collected from this area (i.e. in the excavation associated with the tunnel works, below a depth of 0.5m) will need to be dealt with as outlined in the Dewatering Methodology. The sediment-laden water will be treated by a flocculation dosing system prior to discharge, however this is unlikely to remove any dissolved contaminants. Given the groundwater contaminant testing results currently available (refer to '*Vic Park Tunnel – Assessment of Contamination Report*' (March 2006)) water collected from this area (including following flocculation) is considered to be unsuitable for discharge into the stormwater system (it is likely to contain elevated levels of cyanide and heavy metals). The water will be discharged either to ground (i.e. groundwater recharge) or directly to the sewer. Either disposal option will require approval from the authority responsible for the receiving system's management. The Dewatering Methodology outlined in the EMP should be referred to for additional details.

7.3.5 Batter Slope in the Vicinity of Napier St

The batter slope is expected to have a slope ratio of 3:1, so the use of decanting bunds at the base of the slope will be most appropriate. Collected sediment can then be redistributed on the slope or where appropriate. If practicable, the slope should be benched and/or have contour drains installed to reduce the amount of sediment draining to the decanting bunds. The sections of the slope are to be stabilised as soon as practicable following exposure and completion of disturbance, to minimise sediment loss.

7.3.6 Fanshawe St On-ramp

Although the actual road surface of the Fanshawe Street On-ramp will be relatively flat, there will be a slope excavated to bring the area down to a similar ground level to the existing on-ramp. A retaining wall will be constructed at the extent of the works, extending through the church car park. The retaining wall will be a secant-pile wall, of similar construction to the walls of the Approach and Exit of the Tunnel. Silt fences are expected to provide the most practicable sediment control option for this area.

7.3.7 Miscellaneous Activities

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

7.3.8 Monitoring and Maintenance

The DCT, in accordance with the Environmental Monitoring Guidelines (EMG), will undertake regular monitoring and maintenance of the erosion and sediment control measures. Monitoring will consist of regular visual inspections of all erosion and sediment control devices, including during storm events.

Where identified as required, maintenance of control measures shall be undertaken immediately.

Records of the visual inspections and any maintenance shall be kept detailing:

- Monitoring of erosion and temporary sediment control devices that has taken place;
- Erosion and sediment controls requiring maintenance;
- Personnel responsible for completing the action, and by when;
- When the maintenance required was completed;
- Areas of non-compliance with the approved ESCP together with reasons for non-compliance.

8 ARC Feedback and Winter-works

8.1 Previous Correspondence

In 2003 the ARC provided confirmation of their acceptance of the philosophy proposed for managing earthworks activities associated with the VPV. The ARC also considered that the USLE sediment generation and discharge estimates provided were consistent with other projects of this nature. The project design has since been revised from a viaduct option to a tunnel option, and some minor revisions to the USLE assumptions (to bring them in-line with 2006 assumptions for similar-sized projects). The tunnel option will require additional earthworks (below-ground level) and the duration of works has been revised. However, it is considered that the management approach proposed for this project remains relatively unchanged from the 2003 approach and that therefore the ARC's acceptance of the philosophy proposed for managing earthworks activities should remain valid.

8.2 Winter-works

Works throughout the winter period (1 May – 30 September inclusive) are considered necessary for works to be completed within project time frames. To continue works through this winter period, it is understood that the ARC needs a high degree of confidence that the site would be managed comprehensively in relation to the land disturbing activities that fall within the terms of any resource consent.

To meet these expectations, a threefold comprehensive environmental management approach is proposed: process and planning (environmental framework); field controls and systems; and communication and monitoring. This has been developed and implemented successfully at the Grafton Gully Project. This has been incorporated into the EMP and is briefly outlined below:

8.2.1 Environmental Management Framework

The environmental framework proposed comprises:

- A consent holder environmental management plan (EMP) prepared by the consent holder in support of the resource consents sought from ARC and the Notice of Requirement (NOR) submitted to the Auckland City Council. Its purpose is to demonstrate, at a strategic level, how the potential environmental effects identified in the Assessment of Environmental Effects report would be avoided, remedied or mitigated during the implementation of the project. Compliance with the EMP is expected to be required as a condition of consent and NOR.

- Environmental Monitoring Guidelines (EMG) prepared by the consent holder that identify field observation of the erosion and sediment control measures implemented on the site during the course of the works.
- A Construction Environmental Management Plan (CEMP), developed by the DCT in accordance with the EMP and conditions of consent represent a more detailed set of objectives, issues, strategies and management methods to provide compliance with the overriding or relevant environmental statutory and legislative requirements.
- An Environmental Effects Register (EER) compiled to form a record of all environmental management requirements.

8.2.2 Field Measures and ESCPs

ESCPs are proposed to be developed and updated for the site as works progress. The plans will consist of a site plan, on which catchment areas are marked, and individual erosion and sediment control measures highlighted. Supporting these plans will be a description of the works methodology, timing, control measures, monitoring and maintenance requirements, and stabilisation details.

It is proposed that the DCT develop these plans and discuss on site with ARC staff. Following this discussion, the ESCPs should be amended as appropriate, and approved by the ARC and the VPT Environmental Manager. The plans will require updating as works progress and new areas are disturbed, or works require the modification of existing control measures.

8.2.3 Winter Works Communication and Monitoring Protocols

It is expected that the ARC consent for the project will require that no works be undertaken throughout the winter period without ARC approval. Therefore, a staged approval approach is proposed requesting that works be authorised to continue on site, subject to a monthly approval process, as per the successful GGP model. The approval procedure requires close and frequent communication between the parties and regular site visits with ARC to assess progress and compliance. The monthly schedule of ARC site visits, meetings, reporting and approvals is proposed as follows:

(i) The winter-works approval is to be reviewed during the first week (day to be agreed between DCT and ARC) of every month, and a formal site visit with ARC staff undertaken during the last week of every month (day to be agreed between DCT and ARC). This site visit is to determine compliance for the month and ensure any matters that require addressing have been completed. This site visit is to confirm that works may continue into the next month.

(ii) Site meeting mid-month. To make certain that the site is in a state that allows approval to occur, a site visit is proposed to occur a week prior to the final monthly site visit and includes a full site walkover with any areas of concern identified. Should only minor matters be noted during this site visit, the final site visit could be deferred in lieu of photographs being emailed to ARC with an accompanying description noting the works that have been completed.

(iii) VPT may provide monthly reports to ARC if required, confirming the works completed the previous month, and to outline the works proposed for the following month, including how these works might be accommodated in relation to current approvals and erosion and sediment control requirements.

In addition to the formal site visit procedure as set up, it is also anticipated that ARC staff may undertake regular field visits as occurs generally on such earthworking sites. VPT staff will also undertake regular monitoring of the construction activities and site control measures to assess compliance and identify any potential areas of concern.

9 Discussion and Conclusions

The following key points are noted from the assessment of the proposed construction activities along the VPT alignment:

- A resource consent from ARC should be sought for land disturbing activities. This conclusion is made on the basis that more than 2500m^2 will be exposed at one time within 100m of the CMA and/or greater than 1 ha will be exposed at any one time during the project.
- The resource consent required is a restricted discretionary consent pursuant to the Auckland Regional Plan: Sediment Control.
- As land disturbing activities are necessary in the period of 1 May to 30 September inclusive, approval to work is being sought from ARC, but shouldn't materially alter the mitigation proposed.
- Conservative values for the variables in the USLE, and the modification factors have been used to give a 'worst-case scenario'.
- Overall, the quantum of the sediment yield expected from the works is relatively minor (approximately 8 tonnes). The site involves minor areas of earthworks on generally flat slopes, with the larger excavation within the tunnel and its approach and exit (which will drain into the excavation), and a small batter-slope area representing the higher-sediment generation potential areas of the site.
- The potential for erosion in the southern section of works may be reduced by reduction in slope length (arbitrarily estimated at 100m for the purposes of this report). Tighter controls should be incorporated by the DCT into a final ESCP for this area (this may include staging).
- The sediment mass loadings or USLE estimates have been compared against likely background yields from the catchment for the construction periods for those areas. This represents between approximately 3% and 9% increase over the background yield if the works are undertaken at the same time.
- Erosion and sediment control measures are proposed.
  - In general these consist of standard control measures including silt fences, decanting bunds and stormwater inlet protection.
  - The dewatering methodology (detailed in the EMP) addresses the management of any sediment-laden water from within the tunnel (tunnel, approach, and exit) excavation (below an excavation depth of 0.5m).
- The EMP identifies activities of risk and means to avoid or mitigate the effects from these, together with a framework for anticipating, preventing, and responding to non-compliance or emergency situations. Application of the principles and requirements contained within the EMP will assist in managing erosion and sediment yields from the site.

- A structured monitoring procedure is proposed in the EMG. Providing this frequent monitoring and auditing of the monitoring process occurs, the likelihood of significant sediment discharge will be minimised by ensuring that all erosion and sediment control measures are constructed appropriately and that maintenance is undertaken in a timely manner.
- Implementing appropriate erosion and sediment control measures can significantly reduce the potential for sediment discharge. Overall, the sediment yield calculations indicate that the potential sediment yield from these works to be relatively minor. While treated sediment will be discharged from on-site devices, leading to some changes to the environment, the magnitude and period of the discharges together with the environmental management procedures are such that significant adverse environmental effects should be avoided, remedied, or mitigated.
- Undertaking earthworks throughout the winter period may increase the risk of sediment generation and discharge. However, given that the majority of tunnel earthworks runoff will not be discharged to stormwater, and if the ARC approved a winter works programme as implemented on the Grafton Gully project, then it is considered that a high level of site management can occur and counter any increase in the potential for offsite effects as a result of instigating winter works.

▪ Appendix A

Areas of Construction

Drawing Plotted: 03 Apr 2006 11:20

LEGEND

PROPOSED DESIGNATION BOUNDARY

GENERAL AREAS SUBJECT TO EARTHWORKS

WESTHAVEN MARINA

AUCKLAND HARBOUR BRIDGE

WESTHAVEN DRIVE

WESTHAVEN DRIVE

REFER DRAWING C012

MATCHLINE

ST. MARY'S BAY
CENTRAL MEDIAN CONSTRUCTION

ST. MARY'S BAY
SOUTHBOUND SHOULDER WIDENING

ST. MARY'S BAY
NORTHBOUND SHOULDER WIDENING

SHELLY BEACH OVERBRIDGE
SUBSTRUCTURE

SHELLY BEACH ROAD

PT ERIN PARK

0.00
100.00
200.00
300.00
400.00
500.00
600.00
700.00
800.00

No.	Revision	By	Chk	Appd	Date
B	MINOR REVISIONS	PN			16.03.06
A	FIRST ISSUE	PN			26.10.05

Drawing Originator:
Beca Engineers ■ Planners ■ Managers

Original Scale (A1) 1:1000
Reduced Scale (A3) 1:2000

Design			Approved For Construction*
Drawn	PN	11.10.05	
Dsg Check*			
Dwg Check*			Date

* Refer to Revision 1 for Original Signatures

Client: TRANSIT NEW ZEALAND ARARAU AOTEAROA

Project: VIC PARK TUNNEL

Title: AREAS SUBJECT TO EARTHWORKS SHELLY BEACH

Discipline: CIVIL

Drawing No.: 3120457-C011

Rev.: B

Document No. 0457C011.dwg

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Drawing Plotted: 03 Apr 2006 11:20

LEGEND

- PROPOSED DESIGNATION BOUNDARY
- GENERAL AREAS SUBJECT TO EARTHWORKS

WESTHAVEN BOAT HARBOUR

ST MARY'S BAY

OLD FANSHAWE STREET ON-RAMP REMOVAL. AREA TO BE GRASSED

ST. MARY'S BAY SOUTHBOUND SHOULDER WIDENING

WESTHAVEN ROAD

MATCHLINE

REFER DRAWING C011

REFER DRAWING C013

FANSHAWE STREET NORTHBOUND ON-RAMP

NGAPONA

NORTHERN TUNNEL EXIT RAMP

PORTAL

HARBOUR STREET

JACOBS LADDER

CHURCH

ST. MARY'S BAY CENTRAL MEDIAN CONSTRUCTION

ST. MARY'S BAY NORTHBOUND SHOULDER WIDENING

RING TERRACE

LONDON STREET

ST MARY'S ROAD

800.00 900.00 1000.00 1100.00 1200.00 1300.00 1400.00 1500.00

No.	Revision	By	Chk	Appd	Date
B	MINOR REVISIONS	PN			16.03.06
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Dwg Check*			Date

* Refer to Revision 1 for Original Signatures

Client: TRANSIT NEW ZEALAND ARARAU AOTEAROA

Project: VIC PARK TUNNEL

Title: AREAS SUBJECT TO EARTHWORKS ST. MARY'S BAY

Discipline: CIVIL

Drawing No. 3120457-C012

Rev. B

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Document No. 045TC012.dwg

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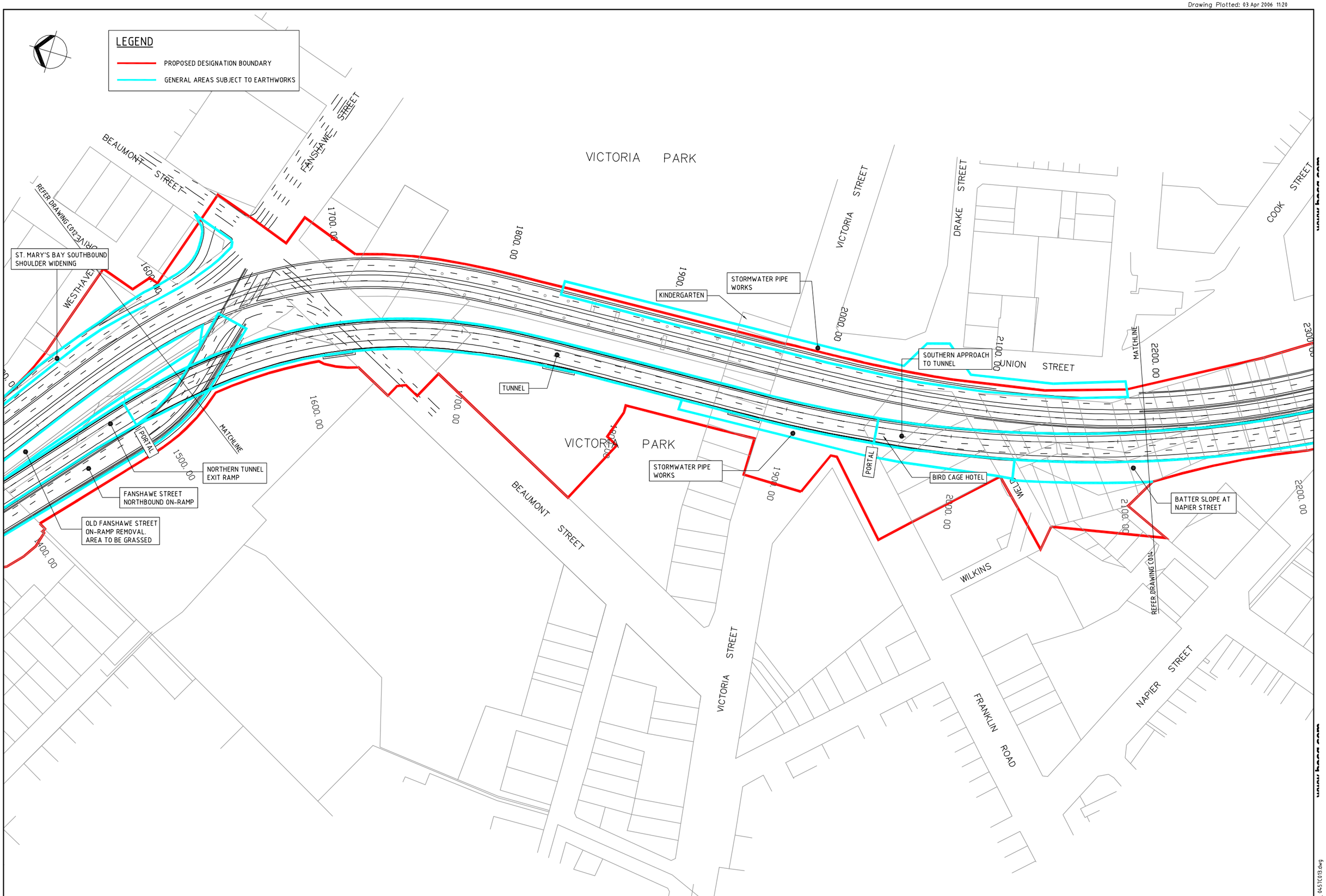

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	Dwg Check*		

Approved For Construction* Date

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Client: TRANSIT NEW ZEALAND ARARAU AOTEAROA

Project: VIC PARK TUNNEL

Title: AREAS SUBJECT TO EARTHWORKS VICTORIA PARK

Discipline: CIVIL

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LEGEND

- PROPOSED DESIGNATION BOUNDARY
- GENERAL AREAS SUBJECT TO EARTHWORKS

COOK STREET

SAM WRIGLEY STREET

UNION STREET

WELLINGTON STREET

STREET

MATCHLINE

2200.00

2300.00

2400.00

2500.00

2350.00

2400.00

2300.00

2200.00

SOUTHERN APPROACH TO TUNNEL

BATTER SLOPE AT NAPIER STREET

REFER DRAWING C013

No.	Revision	By	Chk	Appd	Date
B	MINOR REVISIONS	PN			16.03.06
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Design			Approved For Construction*
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Dsg Check*			
Dwg Check*			Date

* Refer to Revision 1 for Original Signatures

Client: TRANSIT NEW ZEALAND ARARAU AOTEAROA

Project: VIC PARK TUNNEL

Title: AREAS SUBJECT TO EARTHWORKS VICTORIA PARK TO WELLINGTON STREET

Discipline: CIVIL

Drawing No.: 3120457-C014

Rev.: B

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