
**NEW ZEALAND TRANSPORT AGENCY**

**SH18 GREENHITHE DEVIATION**

**Stormwater Management System**

***Comparison with Proposed NZTA Stormwater Treatment Standard Requirements***

NEW ZEALAND TRANSPORT AGENCY

# SH18 GREENHITHE DEVIATION

**Stormwater Management System**
***Comparison with Proposed NZTA Stormwater Treatment Standard Requirements***

Prepared By
-----------------------------
Zeb Worth
Environmental Engineer

Reviewed By
-----------------------------
Peter Mitchell
Senior Environmental Engineer

Approved By
-----------------------------
Muir Coup
Project Team Leader

Opus International Consultants Limited
Environmental
Level 3, The Westhaven
100 Beaumont Street, PO Box 5848
Auckland, New Zealand

Telephone: +64 9 355 9500
Facsimile: +64 9 355 9584

Date: October 2008
Reference: 3-AW594.00
Status: Final v1

# Executive Summary

Adopting the proposed NZTA Stormwater Treatment Standard for Road Infrastructure for the SH18 Greenhithe Deviation project would have had little effect on the vast majority of design and construction aspects. This is mainly due to the fact that the stormwater management requirements under the proposed standard are generally the same (or less stringent) than those set out in the Auckland Regional Council guidelines. As, first and foremost, regional requirements must be met in order to satisfy resource consent conditions etc. the stormwater system must be designed to the more onerous criteria. The only notable difference between the designed/built approach and that under the proposed NZTA Standard would be the magnitude of the attenuation/peak flow control requirement.

The proposed standard recommends peak flow control up to a minimum of the 10% AEP event; while the designed/built system only provides peak flow control up to the 50% AEP event. This has the effect of increasing the required detention volume and associated device size under the proposed standard to around 1.5 times that required under the original design. However, it must be noted that the 50% AEP peak flow control requirement is in fact somewhat unusual in the context of stormwater management in the Auckland region and that regional guidelines generally require peak flow control up to at least the 10% AEP event (as required under the proposed NZTA Standard). In cases where there are known flooding issues downstream, peak flow control is usually extended up to the 1% AEP event under the regional guidelines (this is also recommended in the proposed NZTA Standard).

Overall, the main difference between the stormwater management system that would be required under the proposed NZTA Standard and the existing design/built system is one of increased cost due to the detention/attenuation volumes required under the proposed standard. A summary of the effect of the proposed standard on the scope, time and cost of the project is given below;

## Scope

Most objectives remain unchanged under the proposed NZTA Standard, with the exception of the peak flow control event volume which increases from the 50% AEP event under the existing design to the 10% AEP event under the proposed standard;

## Cost

The change in the scope of the required detention/attenuation elements of the stormwater system under the proposed standard would have a noticeable effect on the overall cost of the system. The total cost of the ponds would be increased from $1.15M to an estimated $1.32M (an increase of $152,000 or 15%). This cost increase relates only to the physical works required (due to the increased device volumes/sizes). However, the costs would be further escalated by the likely increase in the complexity of the engineered solutions (e.g. retaining structures etc. to provide the required volumes within the limited footprint available within the designation) and/or increased land acquisition costs to provide sufficient space for the required devices;

## Time

The increase in attenuation/peak flow control volume discussed above is considered to have little if any effect on the timing of the project. As the consenting, design, construction and installation of the designed/built stormwater management systems took place concurrently with the other design and construction elements of the project, increasing the volumes/sizes of the stormwater management devices would neither reduce nor increase the duration of the overall project.

# Contents



# Tables



# Appendices



*Cover photo: Braithwaite Stormwater Pond – Greenhithe Interchange*

# 1 Introduction

Opus has been commissioned by NZTA (New Zealand Transport Agency - formerly Transit New Zealand) to provide a comparison between the existing construction and design information for the stormwater system of the SH18 Upper Harbour Corridor: Greenhithe Section and the anticipated design requirements and outcomes under the draft NZTA Stormwater Treatment for Road Infrastructure document (from hereon referred to as the “proposed NZTA Standard”).

This report is part of the Final Stormwater Management Standard and Valuation Review undertaken by NZTA.

# 2 Environmental Factors

## 2.1 Description of Catchment

Under the existing design the SH18 Greenhithe Deviation is divided into 9 main subcatchments. As the subcatchment boundaries are generally defined by local topography and existing stream gullies the application of the proposed NZTA Standard would have no direct impact on the designation or nature of the selected subcatchments. The subcatchment areas are described in Table 1 along with the type of device selected under the existing design. The remainder of this section gives a general overview of the project catchment as a whole and highlights areas where the proposed standard would alter the design criteria. An overview of the subcatchment areas and device locations is given in **Appendix A.**

***Table 1: Subcatchment Area Summary***

| Subcatchment ID | Chainage | | Subcatchment Area ($m^2$) | | Discharges To |
|---|---|---|---|---|---|
| | From | To | Pervious | Impervious | |
| 1 | 5790 | 6470 | 23,234 | 29,057 | StormFilter |
| 2 (Tauhinu Rd) | | | 711 | 3,714 | Sand Filter |
| 3 | 4240 | 5790 | 58,106 | 51,901 | Wetland |
| 4 | 2820 | 4240 | 61,531 | 37,803 | Wetland |
| 5 | 2350 | 2820 | 18,923 | 23,904 | Wetland |
| 6 (Wicklam Ln) | | | 18,959 | 4,413 | StormFilter |
| 7 (Wicklam Ln) | | | 315 | 1,219 | Watercourse |
| 8 | 1940 | 2350 | 8,742 | 18,891 | NSCC System |
| 9 | 1250 | 1940 | - | 14,772 | NSCC System |
| | | **Totals** | **190,521** | **185,674** | |
| | | | **376,195** | | |

### 2.1.1 Terrain

The catchment area generally consists of bush/pasture land and medium density residential development. The main road alignment starts in an industrial/commercial area at the eastern end and terminates at the Upper Harbour Bridge at the western end, passing through alternating areas of low to medium density residential development, semi-rural and reserve/bush areas. ***There is no difference in the selection of BMPs between the existing system and that under the proposed NZTA Standard based on this parameter.***

### 2.1.2 Area

The route catchment area is approximately 37.6ha. The as-built catchment composition is approximately 18.6ha of impervious area (49%) with the remaining ~19ha pervious area (51%). ***The subcatchment areas draining to each of the stormwater management devices in the existing system are deemed to still be appropriate under Section 5.2.3 of the proposed NZTA Standard. The catchment area selection criteria used in the NZTA Standard is similar to that given in Table 4-1 of ARC TP10 to which the existing system was designed.***

### 2.1.3 Topography

The main alignment generally traverses the gently sloping northern flanks of the adjacent headland between the ridgeline to the south and the low lying areas to the North. Due to this the topography is generally undulating with the highway crossing numerous minor ridges and stream gullies, some of which are in excess of 10m deep. ***The proposed NZTA Standard would not alter the effects of this parameter on the selection and design of the stormwater treatment systems used on the Greenhithe Deviation.***

### 2.1.4 Drainage Features

Much of the Albany-Greenhithe component of the route traverses the relatively steep flanks of a hill with the old Upper Harbour Drive defining the ridge. Several small streams descend these flanks, crossing the main alignment before joining Lucas Creek at the Upper Waitemata Harbour. Where the main alignment crosses the natural hillside channels culverts were installed to maintain as best practicable the natural flow regime of the streams. In total 16 major culvert systems were installed on the project. Where culverts serve a watercourse that was identified as containing important ecological values, provision was made for fish passage. Further, to mitigate erosion at the interface between the natural stream channels and the culvert headwall/wing-wall structures, rip-rap protection and other energy dissipation measures were installed. ***The proposed NZTA Standard would not alter the effects of this parameter on the selection and design of the culvert systems.***

### 2.1.5 Geotechnical Limitations and Opportunities

Due to the underlying soils and associated low permeability and high winter groundwater levels, soakage was deemed to be unfeasible as a stormwater management technique. The numerous, high cut and fill embankments and historic geotechnical instabilities presented significant geotechnical limitations on the placement of stormwater management devices. ***The proposed NZTA Standard would not alter the effects of this parameter on the selection and design of the stormwater treatment systems used on the Greenhithe Deviation.***

### 2.1.6 Soils

The soils on the project site are derived from the weathering of the underlying inter-bedded sandstones and siltstones of the East Coast Bays Formation forming **Silty-Clays**. The soils of the downstream catchment consist of stream alluvium. As such both soils are generally characterised by high plasticity, high shrinkage, high winter groundwater levels and low permeability. ***The proposed NZTA Standard would not alter the effects of this parameter on the selection and design of the stormwater treatment systems used on the Greenhithe Deviation.***

### 2.1.7 Erosion Potential

Due to the rolling topography of the site and the numerous gullies which concentrate overland flows, the potential for erosion from raindrop impact, sheet flow and concentrated flow on the site is moderate. As such, robust erosion control measures were required during construction (see section 3.2.1). ***Soil erosion potential is not directly covered in the proposed NZTA Standard (i.e. there is no specific coverage of temporary stormwater management – E&S control). However, stream channel erosion is an important consideration in the proposed standard (Section 6.2) although regional requirements set more stringent criteria for this issue (see Table 2 below).***

### 2.1.8 Flooding

Previous studies undertaken within the catchment area indicated that flooding issues were not critical due to the deeply incised streams with no significant floodplains. North Shore City Council has no records of flooding problems within the main drainage area. ***Under Section 6.1 of the proposed NZTA Standard, the effect of this parameter on the selection or design of stormwater management devices would not alter significantly. However, the design storm events for peak flow control would alter slightly (see following section).***

### 2.1.9 Design Storm Events

The following table (*Table 2*) shows the design storm events and rainfall depths for both the existing design and those under the proposed NZTA Standard. Note that where regional requirements exceed those given in the proposed NZTA Standard, those regional requirements must be met.

***Table 2: Design Rainfall Events***

| Objective | Design Rainfall Depth (Existing Design – Regional Guidelines) | Design Rainfall Depth (under proposed NZTA standard) |
|---|---|---|
| Water Quality | • 1/3 of the 50% AEP 24hr rainfall depth (80mm) = 26.7mm design | • 90th percentile rainfall depth = 20mm **(does not meet regional requirements)** |
| Channel Erosion Reduction | • First 25mm of rainfall held and released over 24hr period | • Equivalent to WQV (i.e. 20mm rainfall event) held and released over 24hrs **(does not meet regional requirements – currently 34.5mm)** |
| Peak Discharge Control | • 50% AEP 24hr rainfall event (80mm) peak flow rate to match pre-development rate | • 50% and 10% AEP 24hr rainfall event (100mm and 150mm) peak flow rate to match pre-development rate **(exceeds original project requirements)** |
| Reticulation System Design | • Conveyance of the peak flow rate for the 10% AEP 24hr rainfall event (140mm) without surcharging | • No guidance given so assume standard NZTA requirement for 10% AEP conveyance as per existing design |

### 2.1.10 Vehicle kilometres travelled at time of opening

The most recent data for total traffic flow along SH18 gives approximately 25,000vpd (Transit New Zealand 2006). The total route length of the Greenhithe Deviation is approximately 5.5km. This gives an approximate value of 137,500 vehicle kilometres travelled per day along the route. However, this does not take into account induced traffic on the route due to the new motorway, nor does it account for the reduction in traffic along the route due to the construction of the motorway itself. The 2011 modelled traffic flows for the Upper Harbour Corridor along the Greenhithe Section is approximately 43,000vpd. This gives a value of 236,500 vehicle kilometres per day travelled. The true number of vehicle kilometres travelled on the route at the time of opening (or soon after) will fall somewhere between these two values. ***The proposed NZTA Standard does not contain any reference to this parameter or how it would alter the selection of the stormwater management system.***

### 2.1.11 Discharge Points

Each of the subcatchments discharges firstly into the stormwater management device installed for that subcatchment as listed in Table 1 (be it filter, wetland or existing drainage system). The treatment/management devices in turn discharge to the nearest watercourse within the subcatchment before ultimately discharging to the Lucas Creek estuary receiving environment. ***There would be no change in approach/objectives relating to the type of discharge point (i.e. stream) under the proposed NZTA Standard. The priority objectives outlined in the proposed standard for stream discharges in Section 3.1 and 7.1.6 (i.e. quality, quantity, erosion etc.) are consistent with the ARC regional guidelines.***

### 2.1.12 Catchment Classification

(Refer to the Transit document: NSHS-2007)

The project catchment can be classified as **peri-urban**, according to the SHS-2007 document.

Along the route the predominant land uses are low/medium density residential subdivisions and bush reserve/pasture with a small area of industrial/commercial properties adjacent to the eastern tie in near Albany Highway. ***The proposed NZTA Standard does not contain any reference to this parameter.***

## 2.2 Sensitivity of Receiving Environment

This section is referred to the Transit Document, 2007: "Identifying Sensitive Receiving Environments at Risk from Road Runoff, Land Transport New Zealand Research Report 315". ***There is no direct reference within the proposed NZTA Standard with respect to rating the sensitivity of the receiving environment. However, Section 7.1.6 gives some useful guidance as to priority objectives for various receiving environments. Ultimately, the recommendations given in the proposed NZTA Standard would lead to the same (or similar) selection of devices/practices for the Greenhithe stormwater management system.***

### 2.2.1 Schematic of SRE Rating Framework

The proposed method is based on a hierarchical system whereby the receiving environment (RE) is sequentially classified according to three attributes:

- Physical 'type sensitivity' (depositional vs. dispersive),
- Ecological values,
- Human use values (including cultural values).

Within each of the above attributes, the receiving environments are classified as being of 'high' (H), 'medium' (M), or 'low' (L) sensitivity and assigned a numerical score accordingly.

The overall sensitivity rating for each receiving environment is calculated by adding the scores for the type sensitivity, ecological value and human use value. The sensitivity rating is grouped under three broad categories, based on the total score, with high ratings indicative of high sensitivity, as follows:

- High sensitivity (high potential risk from road runoff): Total score >40
- Medium sensitivity (moderate potential risk from runoff): Total score 20-40
- Low sensitivity (low potential risk from road runoff): Total score <20

### 2.2.2 SRE Rating – Greenhithe Deviation

The ultimate receiving environment of the stormwater discharge from all of the subcatchments is the upper reaches of the Waitemata harbour via the Lucas Creek estuary and its numerous tributaries.

***Type Sensitivity***

The individual subcatchments discharge to various unnamed tributaries of Lucas Creek which are all deeply incised and fast flowing. However, due to the relatively close proximity of the project to the Lucas Creek estuary it is considered that type sensitivity for the Lucas Creek estuary is appropriate for the assessment. The Lucas Creek estuary is a low energy environment with a slow tidal exchange rate.

For these reasons, the receiving environment for the Greenhithe Deviation stormwater discharge is to be qualified as **Highly Depositional** with a High (H) sensitivity value **(Score: 30)**.

***Ecological Value***

The SH18 Greenhithe Deviation crosses a number of ephemeral and perennial watercourses along its length. The ephemeral watercourses were identified as having limited or low ecological value due to their nature and pre-existing condition. The perennial watercourses along the route were identified as having mainly local significance, with moderate habitat and species diversity. None of the watercourses directly impacted by the project have any formal conservation status. However, due to the moderate habitat and species diversity the overall project has been identified as having a Moderate **(M)** Ecological Value **(Score: 10)**

Many of the watercourses within the project had significant barriers to the migration of biota prior to construction. As part of the project some of these barriers were removed and fish migration upstream significantly improved.

***Human Use Value***

Detailed historical, archaeological and cultural investigations were carried out to determine if there were any sites of significance along the alignment route. No sites of significance were found that would affect the alignment route. However a ‘stop work’ condition was included to allow for the unlikely event of any archaeological discovery. Iwi representatives were consulted, and protocols established in case of discovery of any remains, artefacts, taonga or koiwi.

No human use of the watercourses within the alignment was identified. However, the Lucas Creek estuary has moderate human use value as a recreational boating and fishing area. Consequently the project has been given a Moderate **(M)** Human Use Value rating **(Score: 5)**

***Table 3: Overall Sensitivity Rating (Summary)***

| Attributes | Sensitivity | Score |
|---|---|---|
| Type Sensitivity | High | 30 |
| Ecological Value | Moderate | 10 |
| Human Use Value | Moderate | 5 |
| **Overall Sensitivity Rating (Sum)** | **High** | **45** |

Based on the scores found for each attributes, the Lucas Creek Estuary has a **HIGH overall sensitivity rating** (Combined score >40).

***As no guidance is given in the proposed NZTA Standard as to assessing the sensitivity of the receiving environment, the overall sensitivity rating on the Greenhithe Deviation would not change if the proposed standard were adopted.***

# 3 Designed Solutions

This section provides a comparison between the existing design of the Greenhithe Deviation stormwater system and the requirements under the proposed NZTA Standard with respect to the following aspects:

- The design philosophy,
- The stormwater management devices and method used for the design, positioning and construction,
- Cost and time information.

## 3.1 Design philosophy

### 3.1.1 Objectives

In general, the design philosophy and objectives for Stormwater Management can be broken down into **short-term** (associated with the construction and earthworks activities) and **long-term** (permanent stormwater management) objectives, as follows;

**Short-Term Stormwater Management**

***No guidance on short-term stormwater management (erosion and sediment control) objectives is given in the proposed NZTA Standard.*** Consequently all short-term stormwater management objectives for the Greenhithe Deviation under the proposed standard would be as per the existing design - i.e. would need to comply with regional guidelines (Auckland Regional Council Technical Publication 90 (ARC TP90), 1999). These objectives can be summarised as follows:

- Diverting clean water before it flows onto the disturbed area and discharging this water untreated;
- Conveying sediment laden water to treatment systems before discharge to the receiving environment;
- Minimising sediment generation by minimising the disturbed area and stabilising disturbed surfaces as early as possible by hydro-seeding, mulching or sealing.

All projects involving land disturbing activities in the Auckland Region must incorporate erosion and sediment controls as an integral part of development. On all projects, erosion and sediment controls should be in place before earthworks commence and should be removed only after the site has been fully stabilised to protect it from erosion

**Long-Term Stormwater Management**

The anticipated design objectives under the proposed NZTA Standard for the development of the permanent stormwater management systems are as follows:

- Provide treatment to meet or exceed ARC TP10 standards, ***(note: Water Quality requirements under the proposed NZTA Standard are less stringent than the regional requirements so ARC TP10 guidelines take precedence).***
- Detain the first 25mm of Rainfall and release it over 24 hours to minimise stream channel erosion potential, ***(as per existing design as proposed NZTA Standard gives a lesser volume (first 20mm) so regional requirement governs).***
- Wherever practical, maintain peak discharge to the pre-development level for the 10% AEP rainfall event, ***(exceeds existing design requirement of peak flow control up to the 50% AEP rainfall event only). Note that the original design objective of peak flow control up to the 50%AEP event is unique to this project. Generally, ARC TP10 guidelines require peak flow control up to the 10%AEP event where no down-stream flooding exists (or up to the 1%AEP event when there are known downstream flooding issues).***
- Other objectives (e.g. maintaining natural flow regimes, preservation of ecological/habitat value etc.) would be likely to be set based on consultation and best practice but are not explicitly covered in the proposed standard.

***No specific guidance is given in the proposed NZTA Standard for sizing of the collection and conveyance systems. Consequently the design standard adopted for reticulation sizing would be the same as the original design namely; 10% AEP event for pipe system and 1% AEP event for overland flow.***

**Sources**

- Upper Harbour Corridor: Stormwater Management Report – Greenhithe Section, Opus July 2001,
- Draft NZTA Standard "Stormwater Treatment Standard for Road Infrastructure" (July 2008)

### 3.1.2 Options Analysis

It is likely that under the proposed NZTA standard, multiple options would still be considered as roading geometry was optimised. Consequently, adopting the proposed NZTA Standard would have little if any impact on this aspect of the design process. While It is difficult to assess exactly what options would be considered, assuming all other aspects of the project remained the same it is valid to assume that the same device options analysis and assessment would be undertaken and subsequently lead to the same outcomes in terms of device selection and placement. The proposed NZTA Standard (Section 8.4.9) does not encourage the use of proprietary treatment systems (although it does not prohibit it) and it is possible under the proposed standard that preference would be given to non-proprietary systems. However, this would still need to be considered on a site specific basis as often the best practicable option is indeed the use of proprietary systems for various reasons and they form an important component of the stormwater management toolbox. A specific example of this on the Greenhithe Deviation project was the Tauhinu Headland device, where a traditional bio-retention (non-proprietary) facility would have required an area of ~1,800m$^2$. Due to its location on the headland and prominent visibility, a device of this size was deemed unsuitable, through analysis of the available options the device size was reduced to around 450m$^2$ by redesigning it as a non-proprietary sand filter. However, this was still deemed to be too large to be an acceptable solution. Ultimately through the use of a proprietary device (StormFilter) the size was reduced to an area of just 50m$^2$ with the bulk of the device remaining below ground and therefore significantly reducing the visual impact.

### 3.1.3 Criteria

**Water Quality**

The treatment devices within the catchment area are designed to achieve at least 75% removal of suspended solids from the stormwater runoff from the carriageway and associated impervious areas (as per ARC TP10). Under the regional guidelines this is achieved by calculating the water quality volume based on 1/3 of the 50% AEP 24hr rainfall depth (26.7mm). ***Under the proposed NZTA Standard the water quality volume would be 20mm (i.e. the 90th percentile rainfall depth for the Auckland area based on the NIWA maps given in Appendix A of the proposed standard). However, as this is less than the project requirement under ARC TP10 (26.7mm), the regional guidelines would override the proposed standard. Consequently, the design water quality volumes used in the original design would not change.***

**Water Quantity**

The main water quantity criterion under the existing design was to ensure there was no increase to the pre-development 50% AEP peak discharge rate. This was achieved by adequate volume in each of the stormwater detention ponds to allow for the 50% AEP runoff volume to be stored and released at equal to or less than pre-development peak discharge rate. ***Under the proposed NZTA Standard this attenuation/detention volume would be increased to provide adequate volume for the 10% AEP runoff event to be stored and released at the pre-development rate. This would increase the required size of all attenuation/detention devices on the project as the peak storage requirement of these devices would increase as a result of this more stringent criterion.***

**Stream Channel Erosion**

At the time that the original consents were granted there was no criterion for stream channel erosion set by the regional council and detaining and releasing the first 25mm of rainfall over 24hrs was generally accepted as best practice. Under the current regional guidelines (ARC TP10 2nd Edition 2003) this extended detention volume has been increased to the first 34.5mm of rainfall. However, in order to draw an accurate comparison the proposed NZTA standard has been compared to the former figure (25mm). ***Under the proposed NZTA Standard a rainfall depth of 20mm would be required. This is less than the 25mm stated in the original design and as such the extended detention volume would not change (i.e. it would be based on the more stringent 25mm regional requirement). The 20mm requirement under the proposed standard is also significantly less than the current regional requirement of 34.5mm.***

### 3.1.4 General

The general design criteria used for the design of the system were as follows. ***Under the proposed NZTA Standard, these general design criteria would be unlikely to change:***

- To maintain wherever practicable the pre-construction hydrological flow regimes and reduce the potential for downstream flooding by attenuating the peak discharge rates from the carriageway;
- To improve access for migratory fish species by the removal of barriers/obstructions and the installation of fish passage systems at the perennial watercourse crossings;
- To mitigate the effects of runoff borne contaminants by treatment of contaminated carriageway runoff before discharge to the receiving environment;
- To reduce the erosion potential in the downstream channels.

### 3.1.5 References

References used for the design of the Upper Harbour Corridor – Greenhithe Deviation stormwater management system were:

- Stormwater Management Devices: Design Guidelines Manual (1993) Auckland Regional Council Technical Publication 10 – First Edition.
- Erosion & Sediment Control Guidelines for Land Disturbing Activities in the Auckland Region (March 1999) Auckland Regional Council Technical Publication 90
- Guidelines for Stormwater Runoff Modelling in the Auckland Region. (1998) Auckland Regional Council Technical Publication 108:
- Harrison Grierson Consultants Ltd. (August 2000) Kyle/Orwell Catchment Area Stormwater Management Plan. Prepared for North Shore City Council
- Harrison Grierson Consultants Ltd. (March 2001) Greenhithe Catchment Area Stormwater Management Plan. Prepared for North Shore City Council
- Beca Carter Hollings & Ferner Ltd. (1998) SH18 – Upper harbour highway (Greenhithe) Route Selection & Environmental Effects Investigation
- Bruce White (1998) Unsworth Views and North harbour Industrial Estate

***Under the proposed NZTA Standard the above documents would still play a significant role in the design and selection of the stormwater management system on the Greenhithe Deviation.***

## 3.2 Stormwater Management Device Design Methods:

### 3.2.1 Erosion and Sediment Control (Short-term)

As no specific guidance with respect to short term stormwater management (erosion and sediment control) is given in the proposed NZTA Standard, sediment and erosion control measures would be designed and implemented in accordance with the original Erosion and Sediment Control Plan and Auckland Regional Council guidelines (ARC TP90). ***In short there would be no change to the erosion and sediment control measures employed on the project under the proposed NZTA Standard,*** these measures include;

- Clean water diversion drains upslope of earthwork areas to prevent off-site runoff from flowing onto the disturbed area and minimise the contributing catchment areas;
- Minimised on site flow velocities by the use of contour drains;
- 51 silt ponds constructed in accordance with TP90 guidelines ranging in size from $100m^3$ to $1,500m^3$.
- Silt fences installed at the base of fill slopes and around watercourses in areas where work was located in close proximity to watercourses. Silt fences installed to provide additional treatment rather than as sole treatment devices. In total, approximately 11,000m of silt fences installed including 1,200m of super silt fence (steel mesh reinforced).
- Works in or adjacent to watercourses, such as the installation of culverts, considered high risk activities and particular attention paid to erosion and sediment control, in these areas.

### 3.2.2 Operational Stormwater Management (Long-term)

#### i. Collection

The carriageway runoff is collected primarily via direct runoff to swales or by kerb and channel systems directing the flow to catchpits in locations where swale drains are impractical. ***No specific guidance is given in the proposed NZTA Standard with respect to the stormwater collection system. Consequently, there would be no change to the method and design of the collection system. As the swales used on the Greenhithe Deviation are not specifically designed as treatment swales their design falls outside the scope of the swale design methodology given in the proposed standard (NZTA Stormwater Treatment Standard Draft July 2008 - Section 8.4).***

#### ii. Conveyance

The primary conveyance system consists of swale drains alongside the carriageway within the clear zone. In locations where swales were impractical due to large fills/cuts or level constraints, runoff is collected via a piped reticulation network. Where the route crosses watercourses culverts capable of passing the 1%AEP critical duration flow have been installed to allow the watercourses to flow unimpeded without compromising the motorway fill embankments. Where significant fish species were identified in the watercourses, fish passage consisting of rocks and micro-pools installed in the culvert invert was provided to allow fish to migrate and maintain a healthy ecosystem upstream of the culverts. ***As for the collection system, no specific guidance is given in the proposed NZTA Standard for the design of the primary conveyance network. As such the primary conveyance system falls outside the scope of the proposed standard and no change to the design would be anticipated if the proposed standard had been applied to the Greenhithe Deviation project.***

**iii. Attenuation**

Attenuation in the context of this project can be divided into 2 categories – Extended Detention (ED) and Flood Control attenuation (FC). The objective of ED is to minimise the erosive forces imposed on the downstream channel. The objective of FC however, is to restrict the peak discharge rate from the impervious catchment area to match that of the pre-development catchment in order to reduce the flooding risk in the downstream catchment. ***Both objectives are covered in the proposed NZTA Standard and the effects of the new standard on the specific aspects of the stormwater system design are outlined in the following paragraphs.***

The required attenuation volumes (both ED and FC) were calculated using the methodology outlined in Auckland Regional Council Technical Publication 108 – Guideline for Stormwater Runoff modelling in the Auckland Region. This methodology is based on the SCS method whereby runoff is estimated according to the catchment size, cover and topographical characteristics. ***As no specific methodology is recommended in the proposed NZTA Standard, the regionally prescribed method for estimating rainfall runoff (ARC TP108) would still apply to the project.***

*Extended Detention*

The design rainfall depth for ED in the existing design was taken as the first 25mm of rainfall during an event of unspecified duration. ***The proposed NZTA Standard gives an ED rainfall depth of 20mm (equal to the WQ event). As the existing regional requirement (used in the original design) is the more stringent of the two, this design depth (25mm) would govern. Consequently there would be no change to the design ED volumes under the proposed standard.***

*Flood Control Attenuation*

Under the existing design, attenuation for the 50% AEP event runoff volume is provided in the wetland ponds. The outlets from the ponds have been configured in such a way as to restrict the peak discharge rate from the ponds to the same as or less than the pre-development peak discharge rate. The design rainfall depth for attenuation was taken as 80mm (being the 2yr ARI 24hr rainfall depth as per ARC TP 108 Figure A.1). ***Under the proposed NZTA Standard, the design attenuation rainfall depth would be increased to***

***provide peak flow control up to the 10% AEP 24hr rainfall event. Using the NIWA rainfall maps given in Appendix A of the proposed standard, the peak attenuation volume would be based on a 24hr rainfall depth of around 120mm (10% AEP) with an additional 6.3% allowance for the effects of climate change (as per Section 6.1.3 of the proposed NZTA Standard) - giving a total design depth of 128mm. This would increase the required live storage volumes of the pond/wetland devices by approximately 50% (i.e. 1.5 times the existing design volume).***

A summary of the anticipated design volumes for each of the subcatchment areas under the proposed NZTA Standard versus those of the existing design is given in **Appendix B.**

**iv. Treatment**

Treatment is provided for stormwater runoff up to the water quality design storm as described in Section 2.1.9. The runoff volumes were calculated using the methodology outlined in ARC TP108. In the case of the wetland ponds, the WQV is provided as permanent standing water in the ponds. Due to the provision of Extended Detention only 50% of the full WQV is required (Auckland Regional Council TP10). This value has been used to determine the required permanent water volume for each of the wetland ponds.

In the case of the proprietary filtration devices (StormFilters and Sand Filters) treatment of the full WQV has been provided based on the manufacturers design criteria and regional guidelines. The reticulation system has been designed such that flows in excess of the WQ event bypass the devices and are discharged safely and effectively to the receiving environment.

***The WQV would still be governed by regional requirements (ARC TP10) under the proposed NZTA Standard. Additionally, the design methodology for wetlands and pond systems in the proposed standard is essentially the same as the TP10 design guidelines to which the ponds were designed. For these reasons it is anticipated that there would be no change to design treatment volumes under the proposed standard.***

## 3.3 Cost

### 3.3.1 Resource Consents

The resource consents for the Greenhithe Deviation were combined with those of the wider Upper Harbour Corridor Project including the Upper Harbour Bridge and Causeway, and the Hobsonville Deviation section (including SH18 and SH16 extension). As such, the costs for consent preparation and lodgement of the individual project sections are unavailable. However, for the purpose of comparison it is assumed that the Resource Consent costs for the Greenhithe Deviation project were around 5% of the total design fees. ***It is not considered that adopting the proposed NZTA Standard would have any effect on the consent preparation, lodgement and processing costs.***

### 3.3.2 Building and other Consents

Any building consents required as part of the stormwater management system (e.g. culvert headwalls) were included in the consenting costs (see above).

### 3.3.3 Final Design

The stormwater system was designed concurrently with the civil, roading and structural design disciplines. No separate costs are available for the design of the Greenhithe Deviation stormwater systems. Furthermore the design was undertaken by both Opus and Meritec consultants, adding additional difficulties to extracting meaningful design cost information.

Many of the design features of the final detailed design overlap significantly with both the specimen design and other design disciplines. We were unable to extract the design costs purely for the stormwater management systems and the final design fees for the entire project would be misleading and would not represent the cost of the stormwater components. However, the design costs for the stormwater related components are likely to be between 10-20% of the total design fees.

***As difference in the final design of the stormwater management system would be no more than minor under the proposed NZTA Standard, it is not considered that there would be any noticeable effect on the overall design costs of the stormwater management system compared to the existing design.***

### 3.3.4 Construction

i. Collection

The construction cost for the collection system (i.e. kerb & channel, catchpits etc.) was estimated at approximately **$632,000**. This cost is based on the 2003 tender rates (i.e. is now 5 years old with no adjustment for cost escalations). ***As the proposed NZTA standard does not alter the design of the stormwater collection system it is anticipated that there would be no change to the associated construction costs.***

ii. Conveyance

The total construction cost for the conveyance network (i.e. piped reticulation, swale drains, major culverts etc.) was estimated at around **$5.5m**, including $3.28m for the major culvert crossings and $2.2m for the piped reticulation network (2003 tender rates). The balance of the conveyance costs was for the 4,000m of swale drains – a total cost of $9,000 – the rate for this item was very low due to the fact that the swale drains were essentially formed as part of the general earthworks and grassing covered by the general landscaping costs and as such did not add a significant cost to the project. ***As the proposed NZTA standard does not alter the design of the stormwater conveyance network it is anticipated that there would be no change to the associated construction costs.***

iii. Attenuation

It is difficult to separate the costs for attenuation from those of treatment only as many of the devices (i.e. ponds) are designed to provide both treatment and attenuation. The cost of constructing a "treatment only" pond (as opposed to treatment plus attenuation pond) would be in the order of 50-70% of a "treatment plus attenuation" pond, as many of the high cost items (e.g. outlet structure, pond lining etc) need to be installed for a "treatment only" pond as well. However, for the purpose of this report the full cost of the ponds has been included in this "attenuation" section to differentiate them from the "treatment only" devices (e.g. StormFilters etc.), noting that this is not necessarily an accurate cost for the attenuation component of the pond devices.

The total construction cost for the stormwater ponds is estimated at approximately **$1.15M** including earthworks (2003 tender rates). ***Assuming that attenuation accounts for 30% of this cost and given that under the proposed NZTA Standard the attenuation volumes would increase by approximately 50%, it is estimated that the total construction cost for the ponds/wetlands would increase by 15% (i.e. an increase of 50% of the 30% attributable to attenuation). This gives an estimated construction cost for the stormwater ponds of around <u>$1.32M</u> – an increase of ~$152K. Additionally, the increased volume requirement (and associated increase in device sizing) would lead to a larger area required for these devices within the designation. This would likely lead to more complex and expensive "engineered" solution (e.g. retaining walls around ponds etc.) and/or additional land costs, further increasing the overall cost of these devices.***

iv. Treatment

The total cost for the construction of the treatment devices (filters) on the Greenhithe Deviation is estimated at around **$415,000**, including supply and installation (2003 tender rates). ***It is anticipated that, under the proposed NZTA Standard, there would be no change to the cost of these devices as their design is based solely on the calculated water quality volume (WQV) which would not change under the proposed standard (see Section 3.1.3 and 3.2.2 (iv) for details)***

See above (iii – attenuation) for explanation of treatment/attenuation cost separation.

### 3.3.5 Monitoring Costs

i. Construction

The Auckland Regional Council construction monitoring costs to date are approximately **$146,000**. ***This value would be unlikely to change under the proposed NZTA Standard as the regional authority (ARC) would be likely to require a similar level of control and monitoring on the project.***

ii. Operational

The route was only recently commissioned, and operational monitoring costs are currently being defined (and refined) as is typical of any new installation. ***There may be opportunities to optimise the operational monitoring costs under the proposed NZTA Standard as some guidance is given in the proposed standard with respect to recommended operation and maintenance activities and consideration of the relevant issues during the design phase (i.e. a pro-active approach to operation and maintenance is advocated in the proposed standard) – see section 8.3 and 10 of the Draft NZTA Standard (July 2008). The operation and maintenance monitoring requirements are generally covered by the checklists given in Appendix C of the proposed NZTA Standard which are almost identical to those given in ARC TP10. Therefore, the operational and maintenance monitoring requirements (and associated costs) are not likely to change under the proposed standard.***

### 3.3.6 Operation and Maintenance Estimated Annual Cost

Operational and maintenance costs have been excluded from consideration in this report as they are unknown at this time and are currently being determined. ***However, under the proposed NZTA Standard there would potentially be an opportunity to optimise these costs as discussed above.***

## 3.4 Time

### 3.4.1 Resource Consents

Resource consent applications were lodged in July 2001 with the consents being granted in February 2002, a consenting period of approximately 7 months. Due to the scale and complexity of the project, requests for further information and resource consent hearings during this time prolonged the consenting process***. No change in consent processing times would be anticipated under the proposed NZTA Standard. However, if NZTA held the authority to issue resource consents for state highway projects (as discussed in Section 7.1.1.1 of the NZTA July 2008 draft standard), greater time efficiencies could be realised. It is of course difficult to quantify the potential time savings as it would depend largely on the nature of any agreement between the regional authority and NZTA for the transference of consenting authority under Section 33 of the RMA.***

### 3.4.2 Building and other Consents

Not applicable.

#### 3.4.3 Final Design Time

Detailed final design for the Greenhithe Deviation stormwater systems was concurrent with the other design disciplines on the project. As many of the devices underwent numerous iterations due to refinement of the alignment and roading geometry, the 'true' design time for the stormwater systems is unable to be assessed.

The final design and construction drawings for the project were undertaken over a period of approximately 2 years, with the stormwater design being a part of that design process.

***As the overall design of the stormwater system would not change significantly from the existing design if designed to the proposed NZTA Standard, it is anticipated that the effect on the total design time would be no more than minor.***

#### 3.4.4 Construction

Construction began on the project with an enabling contract in March 2002, then the main construction contract starting in September 2003 with final completion in December 2007, a total duration of over 5½ years. Construction of the permanent stormwater management system was undertaken concurrently within the main construction contract civil works. Various elements were constructed as required to coincide with the staging of the project with most of the major culverts installed at the start of the works and the various treatment devices being completed towards the end of the project.

***There would be very little difference in the overall stormwater system under the proposed NZTA Standard compared to the existing layout (apart from the additional attenuation volume requirements for the stormwater ponds). Additionally, the construction of the stormwater system would still occur concurrently with the main civil works. Accordingly it is anticipated that there would be little if any difference in the total construction time for the stormwater system.***

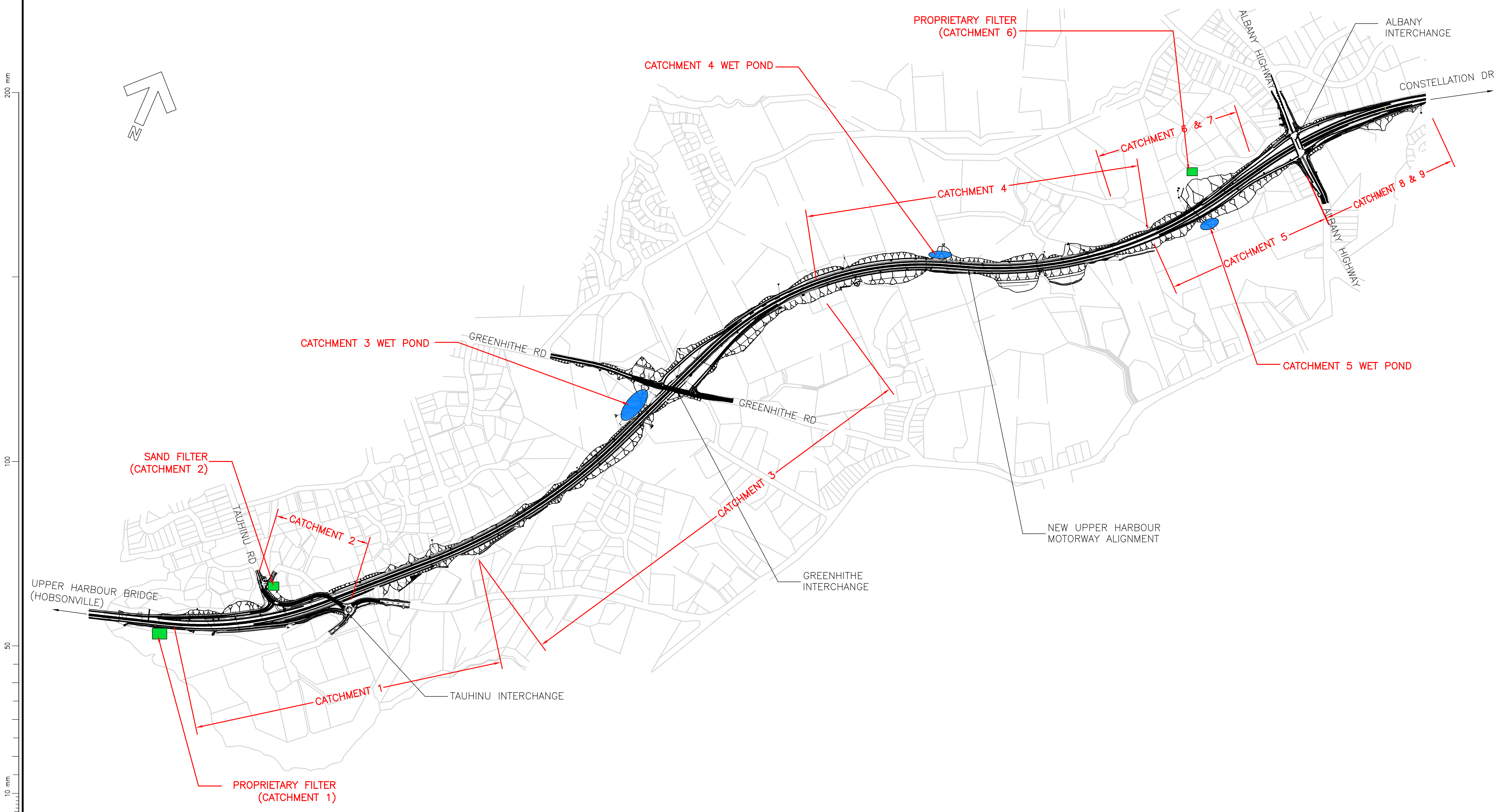
#### 3.4.5 Operation and Maintenance

(i) Life expectancy prior to major works: expected be of 50 years with minor maintenance works.

(ii) Life expectancy for renewal: expected to be greater than 50 years.

***The proposed NZTA Standard would not have any direct bearing on this aspect of the stormwater management system design and the design life expectancies would be the same under the proposed standard.***

# Appendix A:
## Stormwater Management System Location Plan




| Client | Prepared by | | SCALE | FIGURE | REVISION |
|---|---|---|---|---|---|
| NZ TRANSPORT AGENCY WAKA KOTAHI | OPUS | NEW ZEALAND TRANSPORT AGENCY<br>SH18 UPPER HARBOUR CORRIDOR: GREENHITHE DEVIATION | NTS | APPENDIX_A V2 | R0 |
| | | APPENDIX A: STORMWATER MANAGEMENT SYSTEM<br>LOCATION PLAN | ISSUE DATE 31 October 2008 | | |



O:\env\transport\transit\proj\3-aw594.00-transit_swms_project_review_greenhithe\600 Deliverables\620 CAD\APPENDIX_A v2.dwg

# Appendix B:
## Selected Device Design Parameters

**Table B-1: Device type selection and treatment/storage volumes under proposed NZTA Standard**

| Catchment ID | Treatment Device Type | Cumulative Design Volumes - $m^3$ *(original design volumes shown in brackets and italics)* | | |
|---|---|---|---|---|
| | | **WQ** | **ED** | **FC** |
| 1 | Proprietary Filter | 649 *(649)* | High Flow Bypass | |
| 2 | Sand Filter | 83 *(83)* | High Flow Bypass | |
| 3 | Wet Pond | 702 *(702)* | 1,557 *(1,557)* | ~6,600 *(4,602)* |
| 4 | Wet Pond | 544 *(544)* | 1,112 *(1,112)* | ~4,700 *(3,330)* |
| 5 | Wet pond | 307 *(307)* | 1,024 *(1024)* | ~3,000 *(2,102)* |
| 6 | Proprietary Filter | 98 *(98)* | High Flow Bypass | |
| 7 | Untreated | N/A | | |
| 8 | NSCC System | N/A | | |
| 9 | NSCC System | 165 *(165)* | 444 *(444)* | ~850 *(620)* |