NEW ZEALAND TRANSPORT AGENCY
SH1 AVALON DRIVE BYPASS
Stormwater Management System
Comparison with Proposed NZTA Stormwater Treatment Standard Requirements

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Executive Summary

Based on the overall SH1 Avalon Drive Bypass project, little if any change would have occurred had the NZTA Stormwater Treatment Standard for Road Infrastructure been adopted during design of the stormwater management system. The environmental factors would have been analysed in the same way as the existing design and it is anticipated that they would have led to the same selection of stormwater management practices. The original stormwater management globally meets or exceeds the requirements of the Draft NZTA Standard; in particular the pond has been designed to mitigate the 50-year ARI event (Hamilton City Council Development Manual requirements), while under the proposed NZTA standard only mitigation of the 2- and 10-year ARI events would be required.

Whilst the Draft NZTA Standard introduces updated criteria and calculation recommendations for the Avalon Drive bypass stormwater pond, it is anticipated that no major change would have occurred in the design of the latter. The Water Quality Volume required for the pond would have been marginally smaller under the NZTA Standard as well as under Environment Waikato requirements (2,080m^3 instead of 3,500m^3), and a 300m^3 forebay would need to be installed. However the existing permanent pool volume allows for siltation and reduction in maintenance costs, and was constructed to match the flood control area requirements. Therefore Opus would not have recommended reducing the size of the existing pond.

If extended detention was deemed necessary (although this is unlikely given the nature of the receiving systems – i.e. piped reticulation and modified/stable stream bed), it would have been inherent in the flood control volume. Only the outlet structure would have been modified.

Scope

Generally, the design objectives of the stormwater management system would have remained unchanged as the criteria used in the original design meet or exceed the recommendations given in the proposed NZTA Standard, with the possible exception of the stream erosion control criterion (dependant on a more detailed analysis of the discharge pathway).

Cost

It is anticipated that the construction cost of the pond would have been unchanged as no major design changes would have been required. Costs associated with design, operation and maintenance, and consents would not have been likely to change under the NZTA Standard. The overall cost impact using the NZTA Standard would have been considered no more than minor.

Time

The changes introduced by the NZTA Standard would have had little if any effect on timing and it is likely that design and construction duration would have been the same.

Contents

Figures

Cover photo: Avalon Drive Stormwater Pond

1 Introduction

Opus has been commissioned by NZTA to assess the changes that would have occurred if the NZTA Stormwater Treatment Standard for Road Infrastructure (Draft July 2008) had been applied to the SH1 Avalon Bypass project.

The methodology applied was to keep the original design and construction information and to add comments in ***bold italics*** based on professional judgement of the use of the Draft NZTA Standard.

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

Figure 1 attached to this report shows the location of the various features of the Avalon Bypass project.

2 Environmental Factors

2.1 Description of catchments

2.1.1 Terrain

The catchment area is located in a peri-urban area – the roading project is located between a commercial and industrial area and a railway and is also crossing the Waitawhiriwhiri gully (urban type gully).

There is no guidance in the Draft NZTA Standard for this parameter.

2.1.2 Area

The catchment area may be divided into two topographical areas.

- The flat areas of the ex-railway yards and ex-rough pasture to the North of Forest Lake Road. These areas are bounded by Avalon Drive commercial in the West, the railway in the East and Crawford Street in the North;
- The areas to the South of Forest Lake Road and surrounding the Waitawhiriwhiri Stream Gully. These areas are bordered by the rail corridor to the East and the gully to the West.

The catchment, prior to construction was approximately 34ha included 19ha of railway yard and 15ha of grassed land.

Section 5.2.3 of the Draft NZTA Standard describes why the catchment area is a key element that determines the suitability of a stormwater management practice at a specific site.

The total catchment area is approximately 34ha; the catchment associated to the pond is 13ha.

Table 5-4 of the draft NZTA Standard document shows that ponds and wetlands are suitable for use for the catchment area involved. Therefore, the selection of stormwater management practice (pond) would not change under the proposed standard.

2.1.3 Topography

In general the catchment is flat with ground levels between RL 34m and RL 34.5 with the only major feature being the deeply incised Waitawhiriwhiri Stream gully near the Southern end.

Section 5.2.2 of the Draft NZTA Standard describes how slope and topography influence the selection of stormwater management practices.

Table 5-3 of the Draft NZTA Standard shows that the available suite of stormwater management practices is very restricted where the crossing of the Waitawhiriwhiri Stream is located, due to the steep slopes in this area. However, the majority of the catchment is essentially flat and allows for various stormwater management practices to be selected. Given this, it is anticipated that the selection of stormwater management practices would not change under the proposed NZTA Standard.

2.1.4 Drainage Features

The rail corridor is separately drained to the North via a substantial system of subsoil and piped drains. The new bypass drainage is handled entirely separately from the rail corridor system.

For the area North of Forest Lake Road, a new stormwater system is required whereas to the South existing drainage culverts to the Gully are utilised.

Section 3 of the Draft NZTA Standard describes the different possible receiving environments. However there is no mention of how existing drainage features can affect the choice of a stormwater management device.

2.1.5 Geotechnical Limitations and Opportunities

Ground water level is variable within the catchment; with ground water level being within 1 to 2m below the ground surface at the northern end of the project and around 12m depth adjacent to the gully.

Soakage was deemed infeasible due to soil type and the volume of stormwater to be discharged.

Section 5.2.4 of the Draft NZTA Standard lists constraints that may limit a given practice from being used on a specific site including geotechnical constraints.

High groundwater levels (on the majority of the catchment), slope instability (in the vicinity of the Waitawhiriwhiri Stream) limit the types of stormwater management practices available under the proposed NZTA Standard. However, these parameters were taken into account when the original stormwater management system was designed, and consequently, it is anticipated that the selection of stormwater management practices would not change under the proposed NZTA Standard.

2.1.6 Soils

Soils are heterogeneous within the catchment, with silts, silty sands or sand.

Section 5.2.1 of the Draft NZTA Standard shows how underlying soils are important to determine whether a given stormwater management practice will function as intended.

Table 5-2 of the document shows that ponds are more suitable in the silty clay and clay than in sand or loam. However, the inclusion of a clay or geotextile liner prevents infiltration of water and maintains a normal pool level. Consequently, the chosen stormwater management practice (pond) would be unlikely to change under the proposed NTZA Standard.

2.1.7 Erosion Potential

Due to the flat terrain of the general area, the risk of erosion over most of the project length is low.

However in the Waitawhiriwhiri Stream Gully potential for erosion is high, due to local steep embankments in the vicinity of a bed stream.

Gabion baskets and mattresses were used to line parts of the existing stream to protect the stream banks from erosion, around the new culvert inlet.

Several sections of the Draft NZTA Standard deal with stream erosion potential (sections 2.1.2, 6.2, 7.1.3). It is recommended in the document to check the 2-year ARI velocities within any stream where a discharge is possible, to ensure that velocities are non–erosive. If they are non-erosive in the post-highway condition, then no extended detention is required.

Most of the Avalon Drive bypass will be drained to the pond and then released to an existing piped system. Only the southern part of the road will be piped down to the Waitawhiriwhiri Stream. However there is no net increase in runoff (whilst the road area has increased the removal of large commercial buildings and parks areas have mitigated this effect) and so the 2-year ARI velocities are not likely to increase. In addition the urban stream channel has been lined with rock protection (mainly wire filled baskets and mattresses) that make it less prone to erosion. Consequently, the selection of stormwater management practices would not be affected by adoption of the proposed standard.

2.1.8 Flooding

There are no flooding issues except the low lying rough pasture to the North which was subject to ponding during rainfall.

Some of the commercial properties backing onto the bypass discharged stormwater into the ex-rail corridor (now bypass) and this resulted in the need for additional drainage.

In the gully area, behind the 5 major culverts of the stream, there are no floodable buildings.

The Draft NZTA Standard recommends preventing existing flooding problems from getting worse (sections 6.1.1 and 7.1.2). Where there are downstream flooding problems, peak discharges for the post-development 100-year ARI (1% AEP) storm may need to be managed to ensure that downstream flood levels are not increasing.

As no flooding problems were detected on the Waitawhiriwhiri Stream, this requirement is not relevant for the Avalon Drive Bypass.

2.1.9 Design Storm Event

The Design standard adopted for reticulation sizing was the 5-year ARI (Average Recurrence Interval) event without surcharge of the reticulation above ground level and the 50-year ARI storm for overland flow.

The storm water pond has been designed for the 50-yr 24-hr event.

Section 6.1 of the Draft NZTA Standard recommends having peak discharge control:

- ***For the 100-year ARI storm where there are existing flooding problems downstream***
- ***For the 2- and 10-year ARI storms (post-development peak discharges must not exceed pre-development peak discharges)***
- ***Taking account of the effects of climate change for the 2- and 10-year ARI storms***

In the absence of flooding problems, the Hamilton City Council Development Manual supersedes the NZTA requirements (for overland flow): the pond was designed for the 50-year ARI 24-hour event. Consequently, there would be no change to the current design if the proposed NZTA Standard was adopted.

2.1.10 Vehicle kilometres travelled at time of opening

The traffic flow on SH1 is around 25,000 vehicles per day. The Avalon Drive is 2km long so the traffic flow is around 50,000 vehicle kilometres per day.

Section 7.1.4 of the Draft NZTA Standard shows in table 7-4 the increase of contaminant loads in stormwater depending on the traffic. However, there is no direct reference to this parameter in the proposed NZTA Standard or its affect on the selection of stormwater management practices.

2.1.11 Discharge Points

All the northern extent of the project drains into the pond via a piped system. In turn, the pond discharges to the existing deep Avalon Drive stormwater main and eventually into the Waitawhiriwhiri stream.

The southern part of the roading project will discharge into the Lincoln street main which ends into the Waitawhiriwhiri stream near the Rifle road and Lincoln street intersection.

Section 3 of the Draft NZTA Standard describes the potential receiving environment (in particular Streams for the Avalon Drive bypass project) and how a stormwater discharge can affect them. The main issues of concern relate to both water quantity and water quality. There would be no change in approach relating to the type of discharge point under the proposed standard.

2.1.12 Catchment Classification

(Refer to the NZTA document: NSHS-2007)

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

The surroundings have diverse land uses such as commercial, industrial and residential – the bypass road is adjacent to the rail corridor and crosses a gully.

There is no mention of catchment classification in the Draft NZTA Standard, as mentioned in the NZTA document NSHS-2007.

2.2 Sensitivity of receiving environment

This section is referred to the NZTA Document, 2007: "Identifying Sensitive Receiving Environments at Risk from Road Runoff, Land Transport New Zealand Research Report 315".

Section 3 and 7.1.6 of the Draft NZTA Standard describes how stormwater can impact on receiving environment, including flooding issues, stream erosion issues and water quality. Table 3-1 gives recommendations prioritising issues to be addresses depending on the receiving system.

However the Draft NZTA Standard does not refer to the following document: "Identifying Sensitive Environments at Risk from Road Runoff, LTNZ Research Report 315" (in which the overall sensitivity rating system is defined).

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 Sensitivity of receiving environment – Avalon Drive Bypass

The design of the stormwater Avalon Drive Bypass is separated in two catchment areas:

- North of the Forest Lake Road and,
- South of the Forest Lake Road and surrounding the Waitawhiriwhiri Stream gully

The receiving environment of stormwater coming from both of the Avalon Drive Bypass catchment areas is the Waitawhiriwhiri stream.

Sensitivity

The Waitawhiriwhiri stream is an urban stream highly modified. It has been channelized over years and many culverts have been installed. The stream forms part of the gully system within Hamilton which drains most of the developed areas. The gully has been infilled by previous development and the main stream flow now carried by large culverts.

The Waitawhiriwhiri stream discharges into the Waikato River.

For these reasons, the Waitawhiriwhiri stream is to be qualified as dispersive and has a low sensitivity value (Score: 5).

Opus report, April 2005: "Avalon Drive Bypass, Stormwater Proposal, Resource Consent Applications and Assessment of Environment effects" detailed the ecological and human use values for the Waitawhiwhiri stream.

Ecological value

Biological: Typically macro invertebrate communities of Hamilton's streams are dominated by pollution tolerant taxa. Short finned eels are the predominant species in Hamilton's streams, including the Waitawhiriwhiri Stream.

Temperature: High water temperatures are found in the stream during summer months, consistently above 20°C and often approaching 25°C (Wilding 1998).

Metals: In many places the substrate is coated with iron floc.

The Waitawhiriwhiri stream has a low ecological value (Score: 5).

Part of the gully is in the ownership of Hamilton City Council and is included in the Gully Reserves Management Plan (2000), which looks at enhancing the ecological, recreational and cultural values of the gully systems.

The project works have resulted in the removal of significant debris and invasive species from the gully and the end result has seen a significant improvement in the gully value, however inflows from upstream residential developments are still of poor quality.

Human use value

Detailed historical, archaeological and cultural investigations were carried out and no sites within the immediate project area were identified; however the gully area is of significance to the local Iwi, Ngati Wairere, for fishing and eeling purposes.

Iwi representatives have been consulted, and a protocol is to be followed in the event of the discovery of any remains, artefacts, taonga or koiwi has been developed by the Iwi for this project.

No other human use has been reported.

The Waitawhiriwhiri stream has a moderate human use value (Score: 5).

Overall sensitivity rating (Sum)

Attributes	**Sensitivity**	**Score**
Sensitivity	Low	5
Ecological Value	Low	5
Human Use Value	Moderate	5
Overall Sensitivity Rating (Sum)	**Low**	**15**

Based on the scores found for each attributes (less than 20), the Waitawhiriwhiri stream has a low overall sensitivity rating.

3 Designed Solutions

This section provides a brief description of:

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

3.1 Design philosophy

3.1.1 Objectives

Assumptions

Opus objectives for developing the stormwater design were:

- To comply with the Hamilton City Council stormwater design standards,
- To comply with the existing Hamilton City Council system capacity; so the new stormwater design will not result in any adverse effect on it.
- To ensure a less overland flow into neighbouring properties
- Not to increase runoff without mitigation,
- To improve stormwater quality discharging into the existing systems

The design standard adopted for reticulation sizing was the:

- 5-year ARI (Average Recurrence Interval) storm event for pipe system design
- 50-year ARI storm event for overland flow

The Draft NZTA Standard would not change the objectives, assumptions or design standards used on the Avalon Bypass project. The 50-year storm design standard (from the Hamilton City Council Design Manual) supersedes the 2- and 10-year storm mitigation requirements of the NZTA document.

Source

- Avalon Drive Bypass: Design Philosophy Statement Report, Opus April 2005
- Hamilton City Development Manual 2000. Hamilton City Council, New Zealand

Options analysis

The original scheme concept for the road was:

- To convey stormwater from the Rotokauri Road roundabout and surrounding area including three commercial development sites to a medium size (8,700m3) detention pond
- To convey all the stormwater from the detention pond and the road reserve south to Forest Lake Road by a deep gravity pipeline to the Waitawhiriwhiri Stream.

The revised design of the stormwater Avalon Drive Bypass is separated in two parts:

- North of the Forest Lake Road and,
- South of the Forest Lake Road and surrounding the Waitawhiriwhiri Stream gully

North of Forest Lake Road, the main part of the stormwater of the undrained land, is drained by pipes, to a large attenuation pond (13,400m3) with discharge from the pond to the existing Avalon Drive stormwater pipeline with a 300mm diameter pipe, which is not significantly more flow than from the un-drained land. The remaining un-drained stormwater will be connected to the existing system without significantly flow modification.

South of Forest Lake Road and surrounding the Waitawhiriwhiri stream, there is no net increase in runoff (i.e. the impermeable surface area is equivalent). Whilst the road area has increased, the removal of large commercial buildings and parks areas has mitigated this effect. Only the existing Waitawhiriwhiri stream culverts under the railway have been extended.

Using the Draft NZTA Standard would have ultimately led to the same options analysis. The proposed options were all complying with the recommendations of the Draft NZTA Standard. However the option that considered discharging the pond directly into the Waitawhiriwhiri Stream would have had to include provision for extended detention.

3.1.2 Criteria

Water Quality

Groundwater:

The effect of the stormwater pond on the groundwater is considered minor compared to the effect of the site being made impervious, which was lower than the local groundwater table to a small degree.

Pollutants/ Suspended Solids:

Use of the stormwater retention pond will assist in retaining pollutants and suspended solids.

Also, the storage pond provides an opportunity to trap any accidental spills of substances that occur on the new Avalon Drive. In the event that such a spill occurs, the pond outfall can be blocked off until contaminated water and sediment are removed.

In section 6.3 of the Draft NZTA Standard, it is recommended determining water quality treatment volumes and flow rates from the NIWA 90% storm map or using a local criteria if more stringent. In the case of the SH1 Avalon Drive bypass, there was no local criterion that was directly concerning water quality at the time of the design phase. However in recent projects, Environment Waikato required ARC's TP10 water quality criterion (permanent pool volume equivalent to 1/3 of the 2-year ARI 24 hour storm).

Under the proposed NZTA Standard, the water quality rainfall depth for the Avalon Bypass would have been 20mm, which would result in a permanent pool volume of 2,080m^3.

Under the Environment Waikato requirements (recommended in recent projects), the water quality rainfall depth would have been 1/3 of 63.3mm (that equals to 21.1mm), which would approximately result in the same pool volume required using the NZTA standard.

The existing permanent pool in the pond is 3,500m^3. However reducing the permanent pool volume would not have been a recommended option. On the one hand, the 3,500m^3 water quality volume allows siltation and a reduction of the maintenance frequency and associated costs. On the other hand the required pond area for flood control has forced a minimum permanent pool volume of 3,500m^3.

Therefore it is likely that no change in the water quality volume would have occurred from the application of the Draft NZTA Standard.

Water Quantity

Opus objective for the water quantity criteria was to reduce to effect of the peak run-off for the North of Forest Lake Road. A pond was built to mitigate the increase of impervious areas.

Effect on the Rotokauri/Avalon Drive roundabout:

There is no anticipated change in impervious area at the Rotokauri Road roundabout. The extra impervious area of roading is balanced by the drainage of the pavement of Avalon Drive to the south of the roundabout to the large retention pond, which is large enough to hold the 50 year Average Recurrence interval 24 hour storm.

Effect on the Norton/Avalon Drive roundabout:

There is no anticipated change in impervious area at the Norton Road roundabout. The only extra impervious area of roading is balanced by the demolition of a building and car park immediately north of the roundabout, and replacement with a grassed area.

There are three recommendations related to peak discharge control in section 6.1 of the Draft NZTA Standard:

- ***Where there are existing flooding problems downstream, the 100-year storm is to be mitigated***
- ***It is recommended that the 2- and 10-year ARI post-development peak discharges not exceed the 2- and 10-year ARI pre-development peak discharges***
- ***Rainfall data for the 2- and 10-year ARI storms should be increased to take account of the effects of climate change***

The 50-year ARI event design requirement from the HCC Design Manual supersedes the NZTA Standard. Peak discharges are limited by the capacity of the downstream stormwater piped system.

Stream channel erosion criteria

North of Forest Lake Road,

A large detention pond (13,400m3) was designed with a discharge to the existing Avalon Drive stormwater pipeline through a 300mm diameter pipe. The pond is large enough to hold the 50 year ARI 24 hour storm.

South of Forest Lake road and surrounding the Waitawhiriwhiri stream,

There is no anticipated change in impervious area. The stream channel erosion criterion is not applicable for this area.

Section 6.2 of the Draft NZTA Standard recommends calculating the 2-year ARI storm velocities within the stream. If these velocities are erosive in the post-highway condition, it is recommended implementing extended detention or volume control.

The pond discharges into a piped stormwater system and is not directly affected by this criterion (this is discussed later in part 3.2.2).

The southern part of the highway does not present changes in impervious area, so the 2-year storm velocities are not likely to change in post-highway condition. In addition the artificial rocky bed of the stream makes it less prone to erosion. As a result it is unlikely that extended detention would be required under the proposed NZTA Standard.

3.1.3 General

The benefits of the existing large storage pond as part of the system include:

- Reduction in peak runoff flows to the receiving environment;
- Improved stormwater quality discharging into a natural waterway, in particular a reduction in suspended solids concentrations and in turn a reduction in pollutants.

The original stormwater management design globally meets or exceeds the requirements of the draft NZTA Standard.

3.1.4 References

References used for the stormwater drainage proposal report and stormwater design report:

- Stormwater Disposal Report 15: Waitawhiriwhiri Stream Improvements (October 1976). Hamilton City Council, City Engineers Department, New Zealand.
- Hamilton City Development Manual 2000. Hamilton City Council, New Zealand
- Erosion and Sediment Control- Guidelines for soil Disturbing Activities Tech Report 2002/01. Environment Waikato, New Zealand
- Horner and Mars (1985) Assessing the Impacts of Operating Highways on Aquatic Ecosystems, Surface Drainage and Highway Runoff Pollutants. Transport Research Record 1017, Transportation Research Board, National Research Council.
- T. K. Wilding (1998) The State of Hamilton Streams, Environment Waikato, New Zealand
- Stormwater Management Devices: Design Guidelines Manual (May 2003) Auckland Regional Council Technical Publication 10.

3.2 Stormwater management devices methods:

3.2.1 Erosion and Sedimentation control

Design statement

Stormwater management for large earthworks projects rely on:

- Diverting clear water before it flows onto the disturbed area and discharging this water untreated;
- Conveying brown water in channels (often lined) and treating the water before discharge;
- Minimising brown water volume by minimising the disturbed area and hydromulching all erodible surfaces 'sealing' disturbed surfaces as early as possible.

Prior to construction, sediment and erosion control measures must be designed and implemented in accordance with the Erosion and sediment control guidelines (Environment Waikato, 2002).

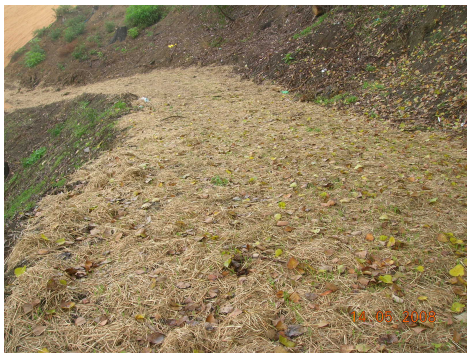
Avalon Drive Bypass

Sediment and erosion control measures have been implemented by contractors on site in accordance with the Erosion and sediment control guidelines (Environment Waikato, 2002).

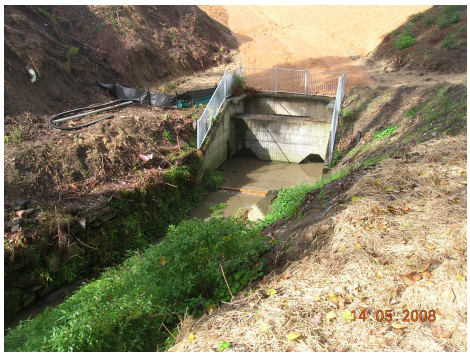
A site visit dated 14 May 2008 provided visual evidence of some measures to control sediment and erosion for the pond catchment and the south of Forest Lake Road in the Waitawhiriwhiri Stream.

The pond catchment is flat and the ash soils are well protected from erosion by the surfacing of plantings. Likewise, the rock mattress is protected the batters from erosion. Measures introduced to control erosion are shown with the two photos below:

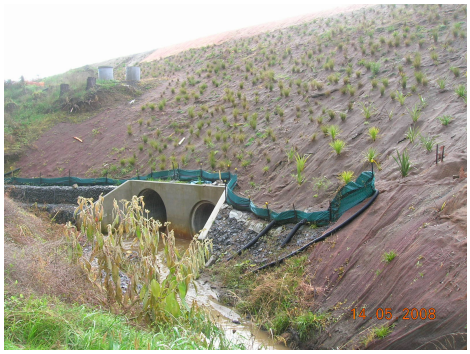
The construction of the embankment in the south of Forest Lake Road represented a period of high risk in terms of discharge of sediments to the watercourse. Measures introduced to minimise these risks are shown with the four photos below:



Mulching (Protective layer of straw)

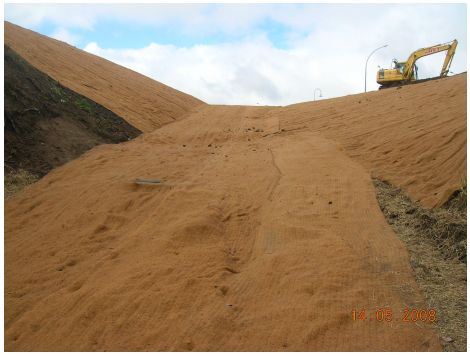


Silt Fence



Stabilisation by revegetation and Gabion basket

Silt Fence



Fibrous geo-textile fabric (coconut fibre matting) allows to reinstated batter before vegetation is established.

There is no general guidance relating to erosion and sediment control in the Draft NZTA Standard document. However the document describes the important inspection aspects related to the construction of the pond in section 9.4.5.2.

3.2.2 Operational stormwater management (permanent)

i. Collection

Stormwater will be collected through kerb, channel and catchpit in accordance with Hamilton City Council Standards.

Position and construction depend on site conditions.

There is no guidance for collection design in the Draft NZTA Standard.

ii. Conveyance

Drainage design catchments were drawn based on survey data and existing stormwater systems locations and levels.

Stormwater pipeline design was modelled using Infoworks CS.

There is no guidance for conveyance design in the Draft NZTA Standard.

iii. Attenuation

The minimum required pond volume was calculated through the formula:

$V_{tot} = CAR$

In which

V_{tot} = Volume minimum required pond

C = Runoff Coefficient

R = Rainfall event in m

A = Area of the catchment in m^2

The stormwater pond has been designed for the 50-year ARI 24hr event. In longer duration events, the existing HCC system will not be at full capacity, and will therefore make continuous drainage of the pond to the existing HCC system possible. This continuous discharge from the pond ensures that storage of the entire runoff volume in the pond is not required. The weighted average C-factor representative of the entire catchment is 0.8.

Therefore the critical duration that determines the required storage volume in the pond has been set at 24 hours. The total rainfall depth during the 50-year ARI 24hr storm is 125mm.

The total catchment area draining to the stormwater pond is 13ha.

The pond is designed for the 50-year event and the discharge flow is limited by the capacity of the receiving stormwater reticulation. These parameters supersede the attenuation requirements that are recommended in the Draft NZTA Standard (mitigation of 2- and 10-year events). Consequently, there would be no change to the final attenuation design volumes under the proposed standard.

iv. Treatment

Stormwater coming from areas that are not drained to the large stormwater retention pond will be treated by passage through sediment traps before the water flows into the Waitawhiriwhiri via the existing stormwater drainage system.

The stormwater inflow to the pond is likely to have a low suspended solids content. In any case, a silt trap has been designed to reduce the necessity for maintenance dredging of the pond.

The pond itself will improve stormwater quality by reducing significantly suspended solids concentration and by retaining pollutants.

Section 8.4.6 of the Draft NZTA Standard details the parameters and procedure to properly design wet ponds, in particular to improve stormwater quality treatment.

Using the proposed standard, the pond design would have had a forebay at any associated inlet to help reduce sediment and contaminant loads. Extended detention would have been recommended if the pond directly discharged into a stream. The pond currently discharges into a piped system at a reduced rate, so extended detention would probably not be considered necessary.

For information, extended detention would have required 2,080m^3 and the forebay about 300m^3 (15% of the water quality volume). However extended detention is inherent in the total volume of the pond and only the outlet structure would have had been modified.

The Permanent pool volume would have been estimated at 2,080m^3 instead of 3,500m3. However Opus would not have recommended reducing this volume as it allows for additional siltation and reduces maintenance costs.

3.3 Cost

3.3.1 Resource Consents

The costs of the Stormwater related Resource Consents were:

- $5,128 for the Consent Application and Processing Fees from EW,
- $9,723 of Professional Fees for Consents application and documentation.

So a total of $ 14,851, including AEE, council Fees, other professional services

The Draft NZTA Standard would not lead to any change on the consent processing costs.

3.3.2 Building and other consents

Not applicable to stormwater. No building consents required for ponds and outlet structures.

3.3.3 Final Design

The final design cost of the Stormwater system including surface drainage design, culvert systems, ponds and outlet was estimated at $ 78,000.

Changes in design due to the application of the NZTA draft would not lead to any noticeable variation in the final design cost.

3.3.4 Construction

i. Collection

The construction cost for collection is $1,100,000 (rounded)

ii. Conveyance

The construction cost for conveyance is $1,660,000 including $435,000 for works linked to the culvert extension on the Waitawhiriwhiri stream.

iii. Attenuation

The pond will act both as attenuation and treatment device. Thus the presented cost is for both actions.

The construction cost for attenuation and treatment is $760,000, including $130,000 for temporary erosion and sediment control.

iv. Treatment

See above.

As extended detention would not be necessary even under the proposed standard (due to discharge to a piped network and/or stable urban stream) it is anticipated that there would in fact be no noticeable difference in the construction costs for the stormwater management system. Anyway, would extended detention have had been necessary, it would have been inherent in the flood control volume of the pond.

Even if estimation of the water quality volume leads to a smaller permanent pool volume under the Draft NZTA standard, Opus would not have recommended reducing the existing one as it allows for siltation and a reduction of maintenance costs. This volume also matches the area required for flood control. Therefore no reduction in cost would have been expected.

3.3.5 Monitoring Costs

(Including surveillance, inspection and performance)

i. Construction

Monitoring costs during construction are $14,500 (to date).

Section 9.4.5.2 of the Draft NZTA Standard describes important inspection aspects related to construction. It is likely that this proposed guidance would lead to an increase of the monitoring costs during construction by an estimated 30%.

ii. Operational

Operational monitoring costs have been excluded from consideration in this report as they are unknown at this time and will be determined afterwards. However they are expected to be less than $1,000pa.

Operational monitoring costs can be considered as part of operation and maintenance costs. See next paragraph.

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 will be determined afterwards.

Section 10.3.1.4 of the Draft NZTA Standard describes the operation and maintenance recommended for ponds and wetlands. It includes removal of sediments and debris at inlet and outlet structures.

Some guidance is also described in section 8.3 of the proposed NZTA document about operation and maintenance purposes relating to stormwater management devices. It is likely that this guidance will enable improved practice, all but an estimated increase of 30% on operation and maintenance costs (e.g. Forebay maintenance, etc).

3.4 Time

3.4.1 Resource Consents

The resource consents were granted non-notified on 13 September 2005, 15 weeks after that the application was submitted.

Section 7.1.1 and 7.1.1.1 discuss existing consent requirements and issues, but it is not likely to make any change on resource consent application timeframes.

3.4.2 Building and other consents

Not applicable.

3.4.3 Final Design Time

The final design and construction drawings for the bypass were undertaken in 8 months with the stormwater design being a part of that design process.

As no major design changes would occur, it is likely that the overall design duration would have been the same using the proposed NZTA standard.

3.4.4 Construction

It took 6 months for the main drainage works (part of conveyance and attenuation) and outlet to gully.

As no major design changes would occur, the overall construction duration would have been the same using the proposed NZTA standard.

It will take 2 years to complete the project, including completion of stormwater conveyance and collection.

3.4.5 Operation and maintenance

i. Life expectancy prior to major works

   Life expectancy prior to major works is expected be of 50 years with minor maintenance works.

ii. Life expectancy for renewal

   The life expectancy for renewal is expected greater than 50 years.

   There would not be any changes on life expectancy if we were using the Draft NZTA Standard.

AUCKLAND

Avalon Drive

Crawford Street

Drainage to existing system

NEW ROTOKAURI ROUNDABOUT

Drainage to existing system

Rotokauri Road

NEW STORMWATER POND

Outlet to existing piped drainage system

DRAINAGE TO POND

North Island Main Trunk Railway

Existing Avalon Drive (SH1)

New Avalon Drive

FOREST LAKE ROAD OVERBRIDGE

Forest Lake Road

NEW NORTON ROAD ROUNDABOUT

Norton Road → HAMILTON CITY CENTRE

Extension to Existing Drainage Culvert

Drainage to Existing Culvert Pipes to Gully

Rifle Range Roads

Lincoln Street

LEGEND

Drainage system

N

200 mm
100
50
10 mm
0

GRAPHIC SCALES

Client: TRANSIT NEW ZEALAND ARARAU AOTEAROA	Prepared by: OPUS	TRANSIT NEW ZEALAND SH1 AVALON DRIVE BYPASS (HAMILTON)	SCALE: 1:5000 A3	FIGURE: FIGURE_01	REVISION: R0
		STORMWATER MANAGEMENT SYSTEM LOCATION PLAN	ISSUE DATE 26 May 2008 		

PLOT DATE

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