NEW ZEALAND TRANSPORT AGENCY
SH20 MT ROSKILL EXTENSION
Erosion and Sediment Control

Comparison with NZTA Draft Erosion & Sediment Control Standard Requirements
SH20 Mt Roskill Extension

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Executive Summary

The purpose of this study is to provide a comparison between the designed/constructed Erosion and Sediment Control measures employed on the SH20 Mt Roskill Extension project and the anticipated design requirements and outcomes under the Draft Erosion and Sediment Control Standard for State Highway Infrastructure (August 2010). The study is also intended to provide a high level assessment of the Draft NZTA Standard and the implications of adopting this standard for the design of Erosion and Sediment Control measures on state highway projects nationwide.

The SH20 Mt Roskill Extension project itself consisted of the construction of a 4km length of 4-lane motorway including two full diamond interchanges. The project also featured two dedicated bus shoulder lanes and provision for a future rail line. The majority of the project site drains to the upper reaches of the Oakley Creek. The southern limit of the project drains toward Onehunga Bay. Due to the sensitivity of both the Oakley Creek and Onehunga Bay to sediment discharges, rain activated chemical treatment systems for sediment retention ponds on the project were required as a condition of the Auckland Regional Council Land Use (earthworks) Consents. The adoption of the Draft NZTA Standard would not have fundamentally altered the consenting requirements or design objectives relating to Erosion and Sediment Control on the project. However, a number of aspects would have led to some variation in the scope of some of the sediment control measures and the construction, operation, monitoring and maintenance of these devices, namely:

- The adoption of a risk based approach for selection of the design storm event is considered to be a more appropriate method for determining the design runoff flows/volumes as it takes into account the specific characteristics of the site and receiving environment. However, this would have led to an increase of approximately 32% in the required storage volumes for all storage based practices (i.e. ponds and decanting earth bunds) with an increase of approximately 16% in ponds construction costs and associated time implications.

- The inclusion of minimum water quality monitoring requirements, would have increased the cost and man-hour requirements for monitoring and testing. However, the data collected from this monitoring over time will assist in refining the design and operation of Erosion and Sediment Control measures.

- The increase in maintenance frequency of some devices (e.g. silt fences) due to reduced allowable sediment accumulation would have led to higher operating costs.

The inclusion of the Erosion and Sediment Control Field Guide for Contractors provides extended guidance (over and above that provided in ARC TP90) for the construction, maintenance and decommissioning of practices in a concise, user-friendly format. It is expected that this will greatly improve contractors’ understanding of erosion and sediment control concepts and potentially lead to improved maintenance regimes and reduced cost/time for preparation of contractors’ environmental management plans.

Overall the Draft NZTA Standard would have equalled or exceeded the Auckland regional requirements for Erosion and Sediment Control on the project and represents an incremental improvement over current regional guidelines. Ultimately it is considered that, while it would likely have led to some increase in Erosion and Sediment Control costs on the SH20 Mt Roskill Extension project, the adoption of the standard nationally would improve the design, operation and maintenance of control measures and generally reduce the environmental impact of state highway projects in relation to construction erosion and sediment.
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1 Project Description

1.1 Project Location

The SH20 Mt Roskill Motorway Extension is a key part of the Auckland Western Ring Route which will provide an alternative to SH1 between Manukau City and Albany via SH20, SH16 and SH18. The project is located in the south-western sector of Auckland City and extends SH20 approximately 4km from the current western limit at Hillsborough Rd through Mt Roskill and adjacent suburbs to Maioro St in New Windsor (see Figure 1 for location plan).

Figure 1: SH20 Mt Roskill Extension Location Plan

1.2 Delivery Method

The project was delivered using the traditional delivery method. The Construction Contract was originally awarded as a Measure & Value Contract in August 2005 but was converted to a Lump Sum Contract and formalised by the “Agreement in Relation to Amendment to Construction Contract CA 2189 – SH20 Mt Roskill Motorway Extension” document in December 2007.
1.3 Project Scope

The project involved the construction of a 4km length of 4-lane motorway including two full diamond interchanges at Hillsborough Rd and Dominion Rd. Works at the southern tie-in with the existing SH20 involved widening and realigning the carriageway between the Queenstown Rd ramps and the Hillsborough Rd interchange. The north-western end of the route involved a new roundabout at the intersection with Sandringham Rd and widening of the Maioro St carriageway to four lanes from the Sandringham Rd roundabout to the Richardson Rd intersection. The project featured two dedicated bus shoulder lanes and provision for a future rail line.

Four road bridges were constructed as part of the project; one at each of the two interchanges and local road overpasses at May Rd and Hayr Rd. Two cable-stay pedestrian and cycle bridges were constructed over the route at Keith Hay Park and Ernie Pinches St to provide linkages between the residential areas to the south of the route and the commercial/industrial areas and schools to the north. Significant retaining walls were constructed along the route, particularly toward the southern end and at the Dominion Rd interchange to minimise the total width of the route and allow for provision of the rail corridor.

1.4 Site Constraints

The project was constructed in a relatively narrow designation corridor. This led to the use of extensive retaining walls and in some cases reduced shoulder widths along the route. This also meant that in several areas, the works came in close proximity to residential houses, presenting noise, vibration and dust issues. To minimise disruption, working hours had to be restricted and weekend work limited, placing constraints on the project program.

Due to the project location it crossed all of the major arterial roads leading from the Hillsborough and Mt Roskill south residential areas. This presented challenges in terms of maintaining access to and from these residential zones. Continuous access needed to be provided for both during construction and in the permanent designed solution.

Three separate contaminated sites were identified along the designation. A consent to discharge excavated contaminated soil to land was required by the ARC. Soil testing was undertaken and a Contaminated Site Management Plan prepared, detailing the procedures to be undertaken in the event of possible contamination being uncovered.
1.5 Natural Site Features

1.5.1 Oakley Creek

The majority of the project site drains westward toward the Waterview estuary via Oakley Creek. While the upper reaches of the Oakley Creek (in the immediate vicinity of the project) are generally heavily modified engineered channels and culverts, the lower reaches contain relatively high value fresh water habitats (including the last remaining natural waterfall within the Auckland City metropolitan limits). Sediment discharges into this environment could have significant adverse effects on both stream ecology and geomorphology. Accordingly, emphasis was placed on erosion and sediment control for all works in and around this watercourse and stormwater systems draining to it.

1.5.2 Onehunga Lagoon

The southern limit of the project drains toward Onehunga Bay/Lagoon. Due to the highly depositional nature of this environment, sediment discharges can have a significant impact on the marine habitat value of the lagoon. To minimise the risk of uncontrolled sediment discharges to the Onehunga Lagoon, robust erosion and sediment controls were required for all works in and around this area.

Due to the sensitivity of both the Oakley Creek and Onehunga Lagoon to sediment discharges, rain activated chemical treatment systems for sediment retention ponds on the project were required as a condition of the Auckland Regional Council Land Use (earthworks) Consents

1.5.3 Mt Roskill volcanic cone

The area around the base of the Mount Roskill Volcanic Cone potentially contained significant geological and cultural features. Works in this area required pre-construction briefing sessions to determine what features might be present and how to identify such features. Earthworks in the immediate vicinity of the Mt Roskill Volcanic Cone also required the presence of qualified archaeologists and geologists to identify and manage any significant finds.

Specific guidance and protocols were established for management of any significant archaeological or geologic artefacts. These protocols were documented in the site Environmental Management Plan.
2 Environmental Factors

The following table (Table 1) provides a brief outline of the various environmental factors and data relating to the design, construction and implementation of the SH20 Mt Roskill Extension project.

Table 1: Environmental Factors on SH20 Mt Roskill Extension Project

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrain</td>
<td>The project site generally consists of commercial/industrial land use along the northern side, with medium density residential development along the southern side. There are also significant areas of public reserve land at various locations along the route (i.e. Keith Hay Park, Mt Roskill Domain/Winstone Park).</td>
</tr>
<tr>
<td>Site Area</td>
<td>The total site area was approximately 43 ha</td>
</tr>
<tr>
<td>Size of earthworks</td>
<td>Approximately 33 Ha (based on tender Site Clearance area)</td>
</tr>
</tbody>
</table>
| Volume of material moved | ~828,000 m$^3$ including;  
  - 48,000 m$^3$ topsoil removed, stockpiled and re-spread  
  - 430,000 m$^3$ cut to fill  
  - 350,000 m$^3$ landscape fill and unsuitables |
| Topography           | The SH20 Mt Roskill Extension route generally follows the flat to gently undulating valley floor between the Mt Albert Rd ridge to the north and the Hillsborough Rd ridge to the south with average slope of <5%. Toward the south eastern end the route falls toward the Queenstown Rd ramps at the southern limit of the project with an average slope of between 5% and 10%. |
Catchments

The main length of the project west of Hillsborough Rd falls within the Oakley Creek stormwater catchment (total area ~1400 ha). The southern tie-in, from Hillsborough Rd to Queenstown Rd falls within the Royal Oak stormwater catchment (total area ~50 ha).

For the purposes of Erosion and Sediment Control the project was divided into 17 sub-catchments based on works areas/sequencing and topography. The 17 sub-catchments were as follows;

<table>
<thead>
<tr>
<th>Sub-catchment</th>
<th>Location</th>
<th>Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Queenstown Rd to Hillsborough Rd</td>
<td>9,050</td>
</tr>
<tr>
<td>1A</td>
<td>Queenstown Rd to Hillsborough Rd</td>
<td>9,540</td>
</tr>
<tr>
<td>2</td>
<td>Hillsborough Rd interchange</td>
<td>12,460</td>
</tr>
<tr>
<td>3</td>
<td>Hillsborough Rd interchange</td>
<td>12,800</td>
</tr>
<tr>
<td>4</td>
<td>Hillsborough Rd interchange</td>
<td>21,220</td>
</tr>
<tr>
<td>5</td>
<td>Hillsborough Rd to Hayr Rd</td>
<td>11,500</td>
</tr>
<tr>
<td>6</td>
<td>Hillsborough Rd to Hayr Rd</td>
<td>14,700</td>
</tr>
<tr>
<td>7</td>
<td>Hayr Rd to Melrose Rd</td>
<td>21,200</td>
</tr>
<tr>
<td>8</td>
<td>Keith Hay Park to Dominion Rd</td>
<td>11,120</td>
</tr>
<tr>
<td>9</td>
<td>Keith Hay Park/Somerset Rd</td>
<td>16,300</td>
</tr>
<tr>
<td>10</td>
<td>Keith Hay Park to Dominion Rd</td>
<td>16,990</td>
</tr>
<tr>
<td>11</td>
<td>Dominion Rd interchange</td>
<td>22,200</td>
</tr>
<tr>
<td>12</td>
<td>Dominion Rd to May Rd</td>
<td>31,630</td>
</tr>
<tr>
<td>13</td>
<td>May Rd to Sandringham Rd</td>
<td>41,125</td>
</tr>
<tr>
<td>13A</td>
<td>May Rd to Sandringham Rd</td>
<td>10,860</td>
</tr>
<tr>
<td>14</td>
<td>Sandringham Rd roundabout</td>
<td>17,240</td>
</tr>
<tr>
<td>15</td>
<td>Maoiro St tie-in</td>
<td>14,620</td>
</tr>
<tr>
<td><strong>Total Area</strong></td>
<td></td>
<td><strong>294,555</strong></td>
</tr>
</tbody>
</table>

Drainage Features

The majority of the project is located within the headwater catchment of Oakley Creek. Oakley Creek and its tributaries are heavily modified in the immediate vicinity of the project, consisting mainly of engineered channels. The lower reaches of Oakley Creek contain areas of high habitat value including the last remaining natural waterfall within the Auckland City metropolitan limits. The southern limit of the project, south of Hillsborough Rd drains south towards the Onehunga Lagoon via a predominantly piped stormwater system.

Geotechnical limitations/opportunities

The low permeability of the Waitemata Group clays meant that ponds in general did not require lining. The exception to this was in the vicinity of the Mt Roskill volcanic cone, where the highly permeable volcanic soils allowed for disposal to soakage.
### Environmental Factor | Discussion
--- | ---
Soils | The soil profile along the route generally consists of weathered Miocene Waitemata Group materials overlain by Holocene and Pleistocene Tauranga Group alluvium and peat deposits (ranging from silty clays to silty sands). In the vicinity of the Mt Roskill volcanic cone the Waitemata Group rocks are overlain by layers of volcanic tuff ash, scoria and basalt flows.
Erosion potential | The weathered Waitemata Group soils found along the route are highly susceptible to erosion. However, due to the relatively low site slopes and associated low runoff velocities the actual erosion potential on the project was generally low.
Site flooding history | Keith Hay Park is located within the floodplain of the upper reaches of Oakley Creek. During significant rainfall events the park serves a detention function by providing storage for runoff that would otherwise continue on to the lower reaches of the creek.
Design storm event | The designed erosion & sediment control systems were based on Auckland Regional Council’s “Technical Publication No. 90: Erosion & Sediment Control Guidelines for Land Disturbing Activities in the Auckland Region” (ARC TP90) criteria. TP90 uses the 5% AEP 24hr rainfall event for sizing of devices
VKT at time of completion | The estimated traffic volume along the route at the time of completion was 46,000 - 69,000 vpd (depending on location). Over the 4km length, this gives a total of 184,000 - 276,000 VKT/day.

### Catchment classification

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Sensitivity</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type Sensitivity</td>
<td>Moderate</td>
<td>20</td>
</tr>
<tr>
<td>Ecological Value</td>
<td>Moderate</td>
<td>10</td>
</tr>
<tr>
<td>Human Use Value</td>
<td>Moderate</td>
<td>5</td>
</tr>
<tr>
<td>Overall Sensitivity Rating (Sum)</td>
<td>Medium</td>
<td>35</td>
</tr>
</tbody>
</table>

Source: SH20 Mt Roskill Extension Stormwater Management Systems Project Review and Summary (URS 2008)

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1 Refer “National State Highway Strategy” (Transit NZ, 2007)
2 Refer “Identifying Sensitive Receiving Environments at Risk from Road Runoff” (LTNZ, 2007)
3 Designed Solutions

This section provides a comparison between the designed/constructed Erosion and Sediment Control Measures on the SH20 Mt Roskill Extension project and the requirements under the Draft NZTA Standard with respect to the following general aspects:

- Design philosophy;
- Project Requirements (e.g. consents, phasing etc.);
- Erosion and Sediment Control practices;
- Cost; and
- Time.

Each element has been divided into the designed/constructed outcome (Existing Design) and the anticipated outcome under the Draft NZTA Standard

3.1 Design Philosophy

3.1.1 Objectives

### Existing Design

Under the Auckland Regional Plan: Sediment (November 2001), the following objectives are stated relating to earth disturbing activities;

7.1.1 To reduce the exposure of land to the risk of surface erosion leading to sediment generation.

7.1.2 To minimise sediment discharge to the receiving environment

The methods used for Erosion and Sediment Control on the SH20 Mt Roskill Extension project were generally in accordance with meeting these objectives and included the following principles;

- Minimising erosion by limiting the disturbed area and stabilising surfaces as soon as practicable;
- Reducing off-site run-on by diverting clean water at the site perimeter preventing it from flowing across disturbed areas and;
- Capturing sediment laden run-off and diverting it to treatment systems before discharge.

### Draft NZTA Standard

It anticipated that the above objectives would still have been applicable if the Draft NZTA Standard had been adopted for the project. However, in addition to regional requirements, the objectives outlined in Section 2.4 of the NZTA Environmental Plan (2008) would also have applied, namely:

- **ES1** Ensure construction and maintenance activities avoid, remedy or mitigate effects of soil erosion, sediment run-off and sediment deposition.
- **ES2** Identify areas susceptible to erosion and sediment deposition and implement erosion and sediment control measures appropriate to each situation with particular emphasis on high-risk areas.
- **ES3** Use bio-engineering and low-impact design practices where practicable
3.1.2 Criteria

Existing Design

The basic design criteria used for Erosion and Sediment Control practices on the SH20 Mt Roskill Extension project are those contained in ARC TP90. A summary of the applicable design criteria is given below;

**Sediment Retention Pond:**
2% pond sizing used (for site slopes less than 10% and less than 200m in length) i.e. 200m$^3$ per hectare of catchment area. Maximum catchment area of 5.0 ha. Maximum depth of 2 m

**Decanting Bunds:**
Volume sizing as per ponds. Maximum 0.3 ha catchment area.

**Diversion Channels:**
Conveyance provided for the 5% AEP storm event (20yr ARI) with nominal 300mm freeboard. Maximum longitudinal grade of 2% unless armoured.

**Silt Fences:**
Catchment size generally limited to 0.5 ha.

Draft NZTA Standard

The Draft NZTA Standard design criteria for the various erosion and sediment control measures used on the SH20 Mt Roskill Extension project are almost identical to those given in the ARC TP90 document. The most notable exceptions to this are the selection of the design storm event and the storage practice, i.e. pond and decanting earth bund sizing methodology (discussed further in Section 3.3.2) and decant rate calculation.

**Design Storm Selection:**
The selection of the design storm under the Draft NZTA Standard is based on the risk based approach given in the Australia New Zealand Environment and Conservation Council (ANZECC) guidelines. Due to the characteristics of the Mt Roskill Extension project the design storm event would be the 20-year 1-hour storm (essentially the same as that under ARC TP90). However, depending on the nature and location of a project, the methodology for the selection of the design storm event could lead to a different event being selected (as opposed to the blanket 5% AEP event used for all projects under ARC TP90).

**Storage Device Sizing:**
The sizing criteria used by the Draft NZTA Standard is based on the design storm event and the runoff characteristics of any given catchment using the Rational Formula to estimate runoff volumes. This means that storage volumes are based on more project specific parameters than those obtained using the sizing methodology in ARC TP90. On the Mt Roskill extension project this would have increased the required storage volumes by approximately 32%.

**Decant Rate:**
The decant rate calculation used in the Draft NZTA Standard is based on the total live storage volume released over 24-hours (as opposed to 3 L/s/ha used in ARC TP90). On the Mt Roskill Extension project this would have led to 29% reduction in decant rates from the various storage devices. This would also have led to longer retention times and potentially greater sediment removal efficiency.
3.1.3 References

**Existing Design**

References used for the design of the SH20 Mt Roskill Extension Erosion and Sediment Control practices included the following:

- Auckland Regional Plan: Sediment (November 2001)
- Auckland Regional Council Technical Publication No.90 “Erosion and Sediment Control Guidelines for Land Disturbing Activities in the Auckland Region” (March 1999)

**Draft NZTA Standard**

Under the Draft NZTA Standard, the reference documents used for the design and development of the Erosion and Sediment Control measures would generally remain the same, with the addition of the following documents:

- NZTA Environmental Plan
- NZTA Draft Erosion and Sediment Control Standard for State Highway Infrastructure
- Australia New Zealand Environment and Conservation Council (ANZECC) Guidelines for Fresh and Marine Water Quality.

These documents would be used in conjunction with the relevant regional policies and guidelines to establish the more stringent requirements and objectives for erosion and sediment control. The more stringent guidelines would be followed.

In the case of the SH20 Mt Roskill Extension project, the Draft NZTA guidelines would take precedence as they provide more stringent criteria for design and sizing of storage devices and at least equal criteria for all other erosion and sediment control practices used on the project.

The NZTA Environmental Plan is complimentary to the Auckland Regional Plan: Sediment and the design objectives in both documents would have applied to the project.

The ANZECC guidelines would serve as a reference for risk assessment of the receiving environment as the methodology used in the Draft NZTA Standard is based on these guidelines.
3.2 Project Requirements

3.2.1 Local Consent Requirements

Existing Design

A Land Use Earthworks Consent is required from the Auckland Regional Council under the Auckland Regional Plan: Sediment Control for all earthworks activities > 1.0 ha for land slopes less than 15° or > 0.25 ha for sites with slopes greater than 15° outside the Sediment Control Protection Area. For sites within the Sediment Control Protection Area any earthworks greater than 0.25 ha in area require a consent.

Accordingly the earthworks for the SH20 Mt Roskill Extension project required resource consent from the Auckland Regional Council. The consents with specific conditions relating to erosion and sediment control were:

ARC 26044 – Sediment control within the Royal Oak catchment (superseded by ARC 31074)
ARC 26047 – Sediment control within the Oakley catchment (superseded by ARC 31076)
ARC 26048 – Works in a watercourse within Oakley catchment (superseded by ARC 31077)
ARC 31074 – Earthworks within Royal Oak catchment
ARC 31076 – Earthworks within Oakley Creek catchment
ARC 31077 – Works in Watercourse within Oakley Creek catchment

The conditions of the above consents required all Erosion and Sediment Control measures to be constructed and maintained in accordance with ARC TP90. Further, as a requirement of the Environment Court decision on the project, all sediment retention ponds were required to be flocculated using rainfall activated flocculent dosing systems.

Other consents with reference to Erosion and Sediment Control were required from Auckland City Council for associated minor works outside of the main motorway site designation. These included; Earthworks and Tree Removal consent for Keith Hay Park (ACC AO/02/04104) and; Earthworks for Re-grading of Winstone Park Access Road (ACC AO/02/05661). The general requirement of these Auckland City Council consents in relation to Erosion and Sediment Control was to provide appropriate measures to prevent discharge of sediment off-site.

Draft NZTA Standard

Adoption of the Draft NZTA standard would not have change the regulatory environment in which the project occurred.

As such, the required resource consents and associated consent conditions would not have altered significantly, except for perhaps a consent condition that all practices must be designed and constructed in accordance with the Draft NZTA Standard, rather than ARC TP90.

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1 The Sediment Control protection Area is defined as 100m either side of a foredune or 100m landward of the costal marine area (whatever is the more landward of mean high water springs); or 50m landward of the edge of a watercourse or wetland of 1000 m² or more.
### 3.2.2 Phasing

**Existing Design**

Earthworks were phased in some areas such as the Keith Hay Park/Oakley Creek crossing to provide pre-loading of embankments over soft (alluvium/peat) soils to minimise long term settlement effects on the motorway carriageway.

In general, earthworks were staged along the route to ensure that the bare earth area open at any given time was within the limits given in the relevant resource consents. Areas not being worked were temporarily or permanently stabilised to reduce erosion and sediment generation from these areas (see Sections 3.2.3 and 3.3.1 for further details of stabilisation techniques used).

**Draft NZTA Standard**

While some discussion on construction sequencing and staging is given in the Draft NZTA Standard (in particular Sections 4.6 and 7.2.3), no direct requirements are given. Under the Draft NZTA Standard, the requirements for staging of works and maximum exposed areas would have been left to the discretion of the consenting authority, as was the case on the SH20 Mt Roskill Extension project via way of consent conditions.

### 3.2.3 Winter Construction

**Existing Design**

Some earthworks excavation was undertaken during the two winter periods over approx 1 km of the site in the volcanic area. A specific Erosion and Sediment Control Plan was prepared which sequenced excavation of limited cut areas then allowing the natural water-table to lower, followed by further excavation. Associated with this operation was placing of the excavated soft rock material in adjacent areas as required for fill on site. The Contractor also removed contaminated material from the site to off-site disposal, with extensive use of wheel washes and road sweeping to contain depositing of mud outside the site limits.

Where areas were to be shut down for the winter season, site preparation was generally limited to construction of diversion channels/bunds and contour drains to ensure runoff was directed to sediment ponds/decant bunds. Exposed areas were grassed/hydro-seeded or mulched as appropriate to provide temporary surface stabilisation until the areas were to be worked again in the following earthworks season.

**Draft NZTA Standard**

The approval for winter works comes under the jurisdiction of the consenting authority (Auckland Regional Council in the case of the SH20 Mt Roskill Extension project). The adoption of the Draft NZTA Standard would not have had a significant bearing on the approval of winter works or the limitations/procedures applied on site.
3.2.4 Conversion of Temporary to Permanent Practices

Existing Design

In total, four ponds were converted from temporary sediment retention ponds to permanent stormwater management ponds. These were;

- Roma Rd Stormwater Pond (Pond 13) – total catchment area of 41,125 m²
- Roseman Stormwater Pond (Pond 12) – total catchment area of 31,630 m²
- Keith Hay Stormwater Pond (Pond 8) – total catchment area of 11,120 m²
- Melrose Stormwater Pond (Pond 7) – total catchment area of 21,200 m²

Due to their location within the volcanic zone adjacent to the Mt Roskill volcanic cone, both the Roma Rd and Roseman Permanent Stormwater ponds were designed with a partial infiltration/sand filter component to dispose of runoff from regular events direct to ground. Extreme events were designed to overflow into the existing stormwater network.

Draft NZTA Standard

The Draft NZTA Standard does not contain any guidance for the conversion of temporary practices to permanent stormwater management devices. As such, it is not anticipated that the adoption of the Draft NZTA Standard would have any bearing on this aspect of the design.

3.2.5 Dewatering, Sediment Removal and Disposal

Existing Design

Ponds were generally dewatered by pumping out using floating suction pipes to ensure that only the cleanest surface water was decanted off and to minimise entrained sediment. Other storage controls (e.g. decanting earth bunds) were dewatered in a similar manner. Sediment was removed from the ponds using excavators and generally carted to non-structural fill areas where it was mixed/spread over the disposal area. No sediment excavated from the sediment retention ponds was disposed of offsite.

Draft NZTA Standard

The basic procedures recommended in the Draft NZTA Standard for dewatering, removal and disposal of sediment from storage practices are essentially in line with the guidance given in ARC TP90.

No significant change in procedures or equipment used would be anticipated had the Draft NZTA Standard been applied to the SH20 Mt Roskill Extension project.
3.2.6 Decommissioning

**Existing Design**

The contractor was required to obtain approval from the Auckland Regional Council before decommissioning any erosion and sediment control measures within the areas covered by the various earthworks consents.

The works areas had to be fully stabilised with permanent/temporary grass, hydro-seeded or covered with aggregate prior to any of the erosion and sediment controls being removed or decommissioned. This included perimeter controls such as diversion channels/bunds and silt fences.

**Draft NZTA Standard**

The Draft NZTA Standard contains explicit guidance on decommissioning procedures for the various erosion and sediment control practices (e.g. Section 6 of the Field Guide Document). No such guidance is given in ARC TP90, but approval to decommission Erosion and Sediment Controls was generally a condition of the earthworks consents issued by ARC.

The inclusion of the relevant decommissioning procedures within the Draft NZTA Standard provides the contractor with a single point of reference when decommissioning individual and site wide erosion and sediment control measures. This would provide consistency between state highway construction projects.

However, in general, the guidance given in the Draft NZTA Standard is in accordance with industry best practice and it is likely that the exact procedures followed would have been similar had the Draft NZTA Standard been used as the main guidance document. In addition, the same levels of approval and control would still have been required by the consenting authority.
3.3 Erosion and Sediment Control Practices

3.3.1 Erosion Control

Existing Design

Erosion controls used on the project generally included;

- Clean-water diversions
- Contour drains
- Straw mulching of bare areas not being worked
- Temporary grassing/hydro-seeding of un-used stockpiles and steep batter slopes (where mulch would not remain in place)

The use of these practices minimised the amount of sediment generated from the site by reducing runoff from offsite areas, protecting exposed soil from rainfall erosion and reducing onsite runoff velocities.

Benched slopes were also used within sub-catchment 4 on the cut slope adjacent to the Hillsborough Rd south-bound onramp works. This was done to stabilise the slope and to limit the velocity of down-slope runoff.

Outlets from storage devices and clean-water diversions were generally stabilised using rock rip-rap and/or geotextile to prevent scour and erosion from concentrated flows at the discharge location.

Draft NZTA Standard

The Draft NZTA Standard design methodologies and procedures for the erosion control measures used on the SH20 Mt Roskill Extension project do not differ significantly from those given in ARC TP90 to which the erosion controls were designed. Accordingly, it is not anticipated that there would be any significant change to the design or implementation of the erosion control measures used.

The Draft NZTA Standard contains some minor differences in fertiliser types/application rates for temporary/permanent grassing and improved guidance on hydro-seeding and mulching procedures over that given in ARC TP90. However, these differences would have had only minor effects, if any, on the methods, techniques and materials used on the site.
3.3.2 Sediment Control

Existing Design

The predominant method of sediment control utilised on the project was Sediment Retention Ponds (SRPs). The Erosion and Sediment Control Plan issued with the contract documents included a total of 17 SRPs relating to the 17 sub-catchments described in Section 2 (including 4 ponds which were eventually converted to permanent stormwater ponds – see Section 3.2.4). Each of the SRPs was designed and constructed in accordance with ARC TP90 requirements. A table showing the summary design information for each of the SRP is given as Table 2 in Appendix B.

With the exception of the four permanent stormwater ponds, all SRPs were designed on a 2% sizing basis in accordance with ARC TP90 methodology (i.e. 200 m$^3$ of storage per hectare of catchment area). Rainfall activated chemical flocculation was required on all temporary sediment control ponds and on all permanent ponds used as temporary ponds during construction. Diversion channels were used to convey silt-laden runoff from exposed areas to the SRPs. Perimeter controls (e.g. silt fences, decanting earth bunds) were also installed, particularly in difficult areas or works in close proximity to watercourses or drainage systems to provide additional mitigation in these high risk locations.

As a condition of consent, wheel wash facilities were installed at all entrances/exits to the site to prevent sediment from being tracked out of the site on vehicle tyres.

Draft NZTA Standard

The location and layout of Sediment Control devices would not be anticipated to vary significantly had the project been designed using the Draft NZTA Standard. Generally, the design procedures for the various sediment control practices used on the project are similar under both the Draft NZTA Standard and ARC TP90.

However, different sizing and decant rate methodologies for storage devices are used by the Draft NZTA Standard. Due to this difference, the required storage volumes for each device would increase by around 32% under the Draft NZTA Standard. Additionally, the allowable decant rate would reduce by approximately 29%, meaning less decants would be required. A comparison table is given as Table 3 in Appendix B.

Some other minor differences between the Draft NZTA Standard and the project design methodology (ARC TP90) have been identified, namely:

- The Draft NZTA Standard specifically requires a forebay on all SRPs. This would increase the total excavation required on each pond as a designated forebay was not strictly required by ARC TP90.
- The cleanout trigger for silt fences under the Draft NZTA Standard is when accumulated sediment reaches 20% of the fabric height (vs 50% of the fabric height in ARC TP90). This would lead to more frequent maintenance of the silt fences.
3.3.3 Non-sediment Contaminants

Existing Design

Protocols for managing non-sediment contaminants on the SH20 Mt Roskill Extension project were set out in the site Environmental Management Plan (EMP). This document set out, amongst other things, the methods and controls for avoiding and mitigating discharges of non-sediment contaminants on the site including:

- Refuelling and maintenance activities (oil, diesel, lubricants etc.)
- Concrete and grouting (cement, grout, wash-down waste etc.)
- Road sealing/surfacing works (oil, PAHs, bituminous waste etc.)
- Vegetation clearance (woody debris, noxious weeds)
- Sanitary Facilities (toilet and ablutions waste)
- General site waste (litter, construction waste etc.)
- Specific measures for the control of non-sediment contaminants on the SH20 Mt Roskill Extension project included but were not limited to the following;
  - All refuelling and maintenance activities were centralised wherever practicable.
  - Bulk fuel, oil and chemical storage areas were provided with secondary containment systems
  - Concrete pours were supervised in a manner that avoided/minimised over-pours
  - Covers were placed over adjacent stormwater grates during sealing and concreting activities.
  - Water based bitumen emulsions were used where practicable to reduce the use of kerosene.
  - Felled timber was mulched for landscaping where practicable.
  - Clearance of noxious plant material was undertaken in a manner that restricted the spreading of seeds or plant material.
  - Waste construction/demolition materials were cleared as quickly as possible after demolition
  - A reputable waste contractor was employed to remove recyclables from the construction site to an approved recycling facility.
  - Sanitary wastes were collected and disposed of off-site by an approved contractor. Portable units were protected from traffic movement and not located within 10m of any watercourse.

Draft NZTA Standard

Section 10 of the Draft NZTA Standard outlines the potential non-sediment contaminants on state highway construction projects. This section also outlines the specific measures to be taken to prevent discharge of non-sediment contaminants from the site.

Generally, the contaminants discussed in the Draft NZTA Standard and the associated control measures do not differ significantly from those outlined in the project EMP. Accordingly, the management methods relating to non-sediment contaminants would still have been appropriate had the project been designed under the Draft NZTA Standard.

However, it is worth noting that the inclusion of what contaminants require consideration and the defined management protocols within the Draft NZTA Standard may have streamlined the preparation of the project EMP.
### 3.4 Cost

#### 3.4.1 Resource Consents

**Existing Design**

The Auckland Regional Council consents for the project were the subject of a notified consent hearing. A subsequent appeal was lodged with the environment court. The estimated cost of stormwater input to the AEE and for presenting evidence to both the ARC and Environment Court hearings was approximately $40,000. The proportion of this cost directly attributable to Erosion and Sediment Control is unavailable as this component was not accounted for individually in the above costs.

The council consent processing fees and costs associated with the two hearings (e.g. legal fees) are currently unavailable.

**Draft NZTA Standard**

As the adoption of the Draft NZTA Standard would not have changed the consenting process, it is not anticipated that it would have had any impact on the costs related to resource consents.

#### 3.4.2 Final Design

**Existing Design**

The final detailed design was undertaken by URS Consultants. Based on the best information available, the design fees for stormwater related works for the project were approximately $390,000. It is not clear from the available data whether this figure included design of the Erosion and Sediment Control measures for the project or if so, what proportion of this cost can be attributed to Erosion and Sediment Control.

**Draft NZTA Standard**

As the design of the various practices would not have varied significantly under the Draft NZTA Standard, it is not expected that there would have been any noticeable change to the overall cost of designing the erosion and sediment control measures on the SH20 Mt Roskill Extension project.
3.4.3 Construction

Existing Design

The total cost of the Erosion and Sediment Control measures on the SH20 Mt Roskill Extension project was ~$2.14m (including operation maintenance and management of practices).

The following table provides a breakdown of the costs for the various elements:

<table>
<thead>
<tr>
<th>Element</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment Retention Ponds</td>
<td>$219,000</td>
</tr>
<tr>
<td>Diversion Channels &amp; Bunds</td>
<td>$191,300</td>
</tr>
<tr>
<td>Flocculation Systems</td>
<td>$48,000</td>
</tr>
<tr>
<td>Super Silt Fences</td>
<td>$36,000</td>
</tr>
<tr>
<td>Wheel Wash Systems (Install &amp; Remove)</td>
<td>$105,000</td>
</tr>
<tr>
<td>Stabilisation/Erosion Control</td>
<td>$115,000</td>
</tr>
<tr>
<td>Maintenance of Controls</td>
<td>$180,000</td>
</tr>
<tr>
<td>Environmental Compliance Monitoring and Testing</td>
<td>$1,250,000</td>
</tr>
<tr>
<td><strong>Total Cost Of Erosion &amp; Sediment Control</strong></td>
<td><strong>$2,140,000</strong></td>
</tr>
</tbody>
</table>

Draft NZTA Standard

Due to the increased volume requirements of the Draft NZTA Standard (refer Section 3.3.2), the construction cost of the storage devices would increase as larger excavation volumes would have been required.

Assuming that excavation contributes 50% of the total pond construction cost and given the volume increase requirement of 32%, the additional cost to the pond construction would be in the order of $35,000 (0.32 x 0.5 x $219,000) or a 16% increase in the cost of pond construction.

3.4.4 Proportion of Total Cost

Existing Design

The final total project construction cost was around ~$187,000,000.

The construction cost for the Erosion and Sediment Control measures (see Section 3.4.3 above) was $2,140,000. This represents around 1.14% of the total cost of physical works on the project.

Draft NZTA Standard

It is not anticipated that the adoption of the Draft NZTA Standard would have had a significant effect on the proportion of the total cost attributable to Erosion and Sediment Control. However, the total cost would likely have been slightly higher due to the cost of the increased storage volumes (see above) and more stringent monitoring requirements (see Section 3.4.5)
3.4.5 Monitoring Costs

Existing Design

The cost of operating, managing and maintaining the Erosion and Sediment Control measures during construction was approximately $1,250,000 (see Section 3.4.3). This included monitoring, testing and reporting costs for all erosion and sediment control practices and associated facilities (e.g. flocculant dosing systems). This does not include the Auckland Regional Council officer’s monitoring and processing fees.

Draft NZTA Standard

The Draft NZTA Standard requires, at a minimum, water quality monitoring of total suspended solids, turbidity and pH (when chemical flocculation is used) of the discharge from sediment control practices. The monitoring protocols are set out in Appendix A of the Draft Standard and reiterated in the accompanying Field Guide for Contractors. No such requirements are contained in the ARC consents where monitoring of Erosion and Sediment Control measures was limited to visual qualitative and quantitative monitoring only.

As the Draft NZTA Standard requires more stringent water quality monitoring than the ARC resource consents, the cost of monitoring would increase significantly. It is not possible to quantify the actual cost of the water quality monitoring that would have been required by the Draft NZTA Standard, but it is estimated that it would be in the order of hundreds of thousands of dollars additional cost.
3.5 Time

3.5.1 Resource Consents

Existing Design

The resource consent application was completed in November 2000. The Auckland Regional Council notified consent hearing was held in March 2002. The Environment Court hearing was held in June 2002 with a final decision released and resource consents granted in January 2003. This process took a total of ~26 months.

Draft NZTA Standard

The processing of resource consents and the approval of the Site Specific Erosion and Sediment Control Plans may have taken slightly longer had the Erosion and Sediment Control measures been designed using the Draft NZTA Standard. This is mainly due to the fact that the consenting authority (ARC) is familiar with the current design guidelines used (ARC TP90) but not so with the Draft NZTA Standard. The ARC would need to be satisfied that the proposed measures were at least equivalent to those designed under ARC TP90.

However, due to notified status of the consents and the subsequent Environment Court hearing, the total time taken to process the consents would not realistically have increased significantly.

3.5.2 Final Design

Existing Design

The initial professional services contract for detailed and preliminary design of the project was awarded to URS Consultants for a duration of 12 months. All stormwater related design elements (including Erosion and Sediment Control) were undertaken concurrently with the other design disciplines during this period.

Value Engineering and other design revisions added a further 6 months to the design timeframe, giving a total duration for final design of 18 months.

Draft NZTA Standard

The design methodology for storage practices given in the Draft NZTA Standard is slightly more involved than that used by ARC TP90. This may have added to the time required to design the individual storage devices. Additionally, the need to determine which document has the more stringent requirements means that the practices must be designed using both methodologies in parallel. However, the much extended guidance given for maintenance, monitoring and decommissioning of the various practices would likely reduce the time required to prepare the Erosion and Sediment Control Plans themselves.

Due to the above factors, it is considered that the effect of adopting the Draft NZTA Standard for design of the Erosion and Sediment Control measures on the project would have been time neutral i.e. no significant increase or decrease in the final design time would be expected.
3.5.3 Construction

Existing Design

The main construction contract was awarded in August 2005 with the subsequent establishment on site in September 2005. Under the original terms of the contract the total construction period was 48 months (4 years), giving an original completion date of September 2009.

During the course of construction the scope of the physical works contract was increased due to various factors resulting in a negotiated completion date of 30 December 2009.

The final physical works completion date was 15 May 2009, seven months ahead of the negotiated completion date (30 December 2009), giving a total construction duration of 45 months.

Due to staging of works the total time taken to install the Erosion and Sediment Control measures on the project is unavailable. However, in general terms, temporary sediment retention ponds took approximately 3 days to construct (including pond excavation and installation of the inlet and outlet systems). The rainfall activated flocculant dosing system for each pond generally took an additional day to install and set up. The installation of other controls such as silt fences, diversion channels and decanting earth bunds generally took 1-2 days depending on size/length.

Draft NZTA Standard

As the design of most Erosion and Sediment Control measures used on the SH20 Mt Roskill Extension project would not have varied greatly had the Draft NZTA Standard been adopted, it is expected that the time to construct the majority of measures would not have changed significantly.

The exception to this would be the storage practices. Due to the increased volume requirements of the Draft NZTA Standard, the time required to excavate ponds and decanting earth bunds would have increased proportionally (i.e. 32% increase in excavation time).

3.5.4 Monitoring

Existing Design

Monitoring of the Erosion and Sediment Control Measures was undertaken by the ARC on a weekly basis during construction. This included inspecting and scoring each of the individual Erosion and Sediment Control Practices within each zone of the work site during site walkovers by ARC monitoring and compliance staff. No water quality monitoring of pond discharges was undertaken in relation to sediment control.

Draft NZTA Standard

As adoption of the Draft NZTA Standard would not have significantly altered the conditions of the various resource consents, the ARC would likely have required the same frequency of monitoring and the same monitoring regimes to be put in place.

However, the minimum requirements for water quality monitoring set out in Section 7.3 of the Draft NZTA Standard (see Section 3.4.5) would have significantly increased the man-hours required for monitoring of the individual devices.
4 General Comments

4.1 Design/Construction Issues

4.1.1 Design
There were no known design issues relating to Erosion and Sediment Control on the SH20 Mt Roskill Extension project that caused difficulties or time delays during the consenting process.

4.1.2 Construction
The only known issue relating to Erosion and Sediment Control during construction was an uncontrolled sediment discharge which occurred in March 2006, where sediment laden water was able to bypass a decanting earth bund via the granular bedding and backfill material of an adjacent large diameter pipe trench. This was the subject of an incident report to ARC. Remedial measures were taken to remedy the problem and site staff made aware of the potential for water to track through pipe bedding material. This issue did not cause any significant cost increase or time delay.

4.2 Project Completion
The SH20 Mt Roskill Extension project was completed ahead of time allowing for Time Extensions granted, and approx 25% (excluding Escalation) above the original Tender Price, although variations and changes of scope account for most of this increase. Erosion and Sediment Control works were not the subject of any variation claims for the extended contract period. Most of the Erosion and Sediment Control works were scheduled as Lump Sums, so the cost risk was mainly borne by the Contractor.

4.3 Anticipated Effects of Applying Draft NZTA Standard
The most notable expected changes to the design and operation of the Erosion and Sediment Control measures, had the Draft NZTA Standard been used on the SH20 Mt Roskill Extension project, would have been;

*Increased storage volumes and requirement for forebays on all sediment ponds:* would have led to an increase in excavation volumes and associated time and cost increases for the construction of these practices.

*Increase in water quality monitoring requirements:* would have led to a significant increase in cost and man-hour requirements for monitoring and testing.

*Decrease in allowable sediment accumulation behind silt fences:* the cleanout trigger for silt fences under the Draft NZTA Standard (20% vs 50% of the fabric height) would more than double the maintenance frequency of the silt fences.

It is not anticipated that there would have been any significant streamlining of the design process. However, the extended guidance given in the document relating to construction, maintenance and decommissioning of the various practices and detailed guidance for flocculation systems would have led to improved maintenance regimes and reduced cost/time for preparation of device management plans.
4.4 General Comments

While the adoption of the Draft NZTA Standard may not have led to significant streamlining of the design of Erosion and Sediment Controls on the SH20 Mt Roskill Extension project or cost savings (and in fact would have increased the total cost of Erosion and Sediment Control due to larger), it is considered overall to represent an incremental improvement over current regional guidelines. In particular, the adoption of a risk based approach for selection of the design storm event is considered to be a more appropriate method for determining the design runoff volumes as it takes into account the specific characteristics of the site and receiving environment.

In addition, the inclusion of the Erosion and Sediment Control Field Guide for Contractors provides invaluable information for the construction, operation, maintenance and decommissioning of erosion and sediment control in a concise, user-friendly format. It is expected that this will greatly improve contractors' understanding of erosion and sediment control concepts and assist site personnel when undertaking works related to erosion and sediment control measures.

The inclusion of minimum water quality monitoring requirements, although increasing the monitoring costs, will ultimately lead to improved device efficiency and design/construction methodology. The data collected from various construction sites over time will assist in refining the design parameters and maintenance frequencies, leading to improved environmental outcomes and reducing the environmental impact of state highway projects in relation to construction erosion and sediment.
Appendix A: Design Erosion and Sediment Control Plans
NOTES:
1. ALL EROSION AND SEDIMENT CONTROL MEASURES TO BE CONSTRUCTED IN ACCORDANCE WITH CONSENT CONDITIONS AND AUCKLAND REGIONAL COUNCIL SLOPE STABILIZATION (SLOPE STABILIZATION) REQUIREMENTS.
2. PRIOR TO ANY FILL WORKS OR EARTHWORKS ACTIVITIES COMMENCING A FULL EROSION AND SEDIMENT CONTROL PLAN (FILL) IS TO BE SUBMITTED TO THE AUCKLAND REGIONAL COUNCIL AND APPROVED BY THE AUCKLAND REGIONAL COUNCIL.
3. DRAWN TO THE SPECIFICATION FOR FULL EROSION AND SEDIMENT CONTROL, EROSION AND SEDIMENT CONTROL, EROSION AND SEDIMENT CONTROL.
4. REFER TO THE TECHNICAL SPECIFICATION FOR FULL EROSION AND SEDIMENT CONTROL.
5. REFER TO SHEETS C1-124-40, C1-124-50, C1-124-60 FOR DETAILS.

POND 12 - ROSEMAN SW POND
VOLUME = 1,150m³ @ 1m DEPTH
CATCHMENT AREA = 31,630m²

CLEAN WATER DIVERSION NOT TO ENTER Silt Pond
DISCHARGE DIRECTLY TO EXISTING RETENTION

LEGEND
- PROPOSED SLOPE DRAINAGE
- PROPOSED FILL DRAINAGE
- CLEAN WATER DIVERSION CHANNELS
- EXISTING DRAINAGE CHANNELS
- EROSION AND SEDIMENT CONTROL
- PROPOSED PROPERTY BOUNDARIES
- EXISTING PROPERTY BOUNDARIES
- EXISTING DRAINAGE CHANNELS
- EXISTING DRAINAGE CHANNELS
- PROPOSED WETLAND CONSTRUCTION
- EXISTING WETLAND CONSTRUCTION
- STORMWATER TREATMENT AREA
- SEGMENT POND

CONSTRUCTION

TRAFFIC DESIGN GROUP

1/86/35/7914/125005
NOTE:
1. All erosion and sediment control measures to be constructed in accordance with current contracts and approved by the Tasman Regional Council.
2. Prior to any stream works or earthworks activities commencing a full erosion and sediment control methodology is to be submitted to the Tasman Regional Council for approval.
3. Water quality audits, water sampling, and regular inspection of the wetland are to be undertaken by the developer and approved by the Tasman Regional Council.
4. The wetland shall be removed, as required, to accommodate any expansion of the site.
5. Refer to the technical specification for full erosion and sediment control requirements.
6. Refer to sheet C-124-66 for details of erosion and sediment control measures.

POND 6
VOLUME = 300 m³
DIMENSIONS = 30.0 m x 10.0 m
CATCHMENT AREA = 64,700 m²

POND 7 - MELROSE SW POND
VOLUME = 4,200 m³ at 1.0 m depth
REFER TO SHEET C-124-66 FOR DETAILS
CATCHMENT AREA = 21,200 m²

FALL EARTHWORKS TOWARDS POND UNTIL FINAL GRADE CONSTRUCTED.

POND 5
VOLUME = 230 m³
DIMENSIONS = 28.0 m x 8.5 m
CATCHMENT AREA = 11,500 m²

CATCHMENT 7

CATCHMENT 6

CATCHMENT 5

STIMMEL PARK RD
MELROSE RD
MELROSE ROAD TO FORM CLEAN WATER DIVERSION

URS
TRAFFIC DESIGN GROUP

TRAFFIC NEW ZEALAND

URS

EROSION AND SEDIMENT CONTROL PLAN 7

C-125-088

1/86357/11/4/ 125008
NOTES:
1. ALL PROPOSED INTERNAL SYSTEMS ARE TO BE CONSTRUCTED IN ACCORDANCE WITH CONSENT CONDITIONS AND AUSTRALIAN REGULATORY REQUIREMENTS.
2. CONSTRUCTION IS TO BE PERFORMED IN ACCORDANCE WITH THE CONTRACTOR'S CONDITIONS OF CONTRACT AND PERMITS ISSUED BY THE LOCAL GOVERNMENTS.
3. BULK DRAINAGE CONSTRUCTION IS TO BE PROVIDED ON ALL SEGMENTS OF THE SYSTEM, IN ACCORDANCE WITH THE CONTRACTOR'S CONDITIONS OF CONTRACT AND LOCAL GOVERNMENT REQUIREMENTS.
4. REFER TO THE TECHNICAL SPECIFICATION FOR FULL DETAILED REQUIREMENTS AND REGULATORY REQUIREMENTS.
5. REFER TO SHEETS C-125-011 FOR ADDITIONAL DETAILS.

LEGEND:
- PROPOSED DITCHES
- PROPOSED FILL DITCHES
- CLEAN WATER DIVERSION CHANNELS
- BULK DRAINAGE PIPES
- SUPER SILT FENCE
- EARTH BARRIER
- PROPOSED ROADWAY CONSTRUCTION
- PROPERTY BOUNDARIES
- EXISTING CONTAINERS (C chronological)
- STORMWATER TREATMENT AREAS
- STORMWATER PONDS

POND 1
VOLUME = 188m³
DIMENSIONS = 25.0m x 7.5m
CATCHMENT AREA = 9,300m²

POND 1A
VOLUME = 191m³
DIMENSIONS = 25.5m x 7.5m
CATCHMENT AREA = 9,540m²

POND 2
VOLUME = 35.5m³
DIMENSIONS = 30.0m x 8.5m
CATCHMENT AREA = 12,450m²

POND 3
VOLUME = 266m³
DIMENSIONS = 28.0m x 9.5m
CATCHMENT AREA = 12,320m²

POND 4
VOLUME = 444m³
DIMENSIONS = 37.0m x 12.0m
CATCHMENT AREA = 51,220m²

DISCHARGE FROM PONDS INTO EXISTING STORMWATER RETICULATION

CATCHMENT 1
CATCHMENT 1A
HENDRY AVE
Sediment Retention Pond for Catchments up to 1.5ha

Cross Section

Geotextile should be laid into the pond to a depth of at least 500mm below the spillway invert.

Geotextile secured firmly to the embankment face.

2.0m long wire or steel strands to join decant and float.

Flexible rubber joints glued and clamped - two joints to be used only for lower decant.

Wire or steel strands to join decant and float.

Attaching 1.6m long wire to weight decant.

Refer to sheet C-125-02 for general notes.
Appendix B:
Design Information
### Table 2: Sediment Retention Pond Summary Design Parameters

<table>
<thead>
<tr>
<th>Pond ID</th>
<th>Catchment Area (m$^2$)</th>
<th>Dimensions</th>
<th>Design Volume (m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9,050</td>
<td>25.0m x 7.5m</td>
<td>188</td>
</tr>
<tr>
<td>1A</td>
<td>9,540</td>
<td>25.5m x 7.5m</td>
<td>191</td>
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<tr>
<td>2</td>
<td>12,460</td>
<td>30.0m x 8.5m</td>
<td>255</td>
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<td>3</td>
<td>12,800</td>
<td>28.0m x 9.5m</td>
<td>266</td>
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<td>4</td>
<td>21,220</td>
<td>37.0m x 12.0m</td>
<td>444</td>
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<tr>
<td>5</td>
<td>11,500</td>
<td>28.0m x 8.5m</td>
<td>238</td>
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<tr>
<td>6</td>
<td>14,700</td>
<td>30.0m x 10.0m</td>
<td>300</td>
</tr>
<tr>
<td>7 (Melrose SW Pond)</td>
<td>21,200</td>
<td>250m x 30m (nom.)</td>
<td>4,500 at 1m depth</td>
</tr>
<tr>
<td>8 (Keith Hay SW Pond)</td>
<td>11,120</td>
<td>80m x 20m (nom.)</td>
<td>1,100 at 1m depth</td>
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<tr>
<td>9</td>
<td>16,300</td>
<td>30.5m x 11.0m</td>
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<td>11</td>
<td>22,200</td>
<td>38.0m x 12.0m</td>
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<td>12 (Roseman SW Pond)</td>
<td>31,630</td>
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<td>1,150 at 1m depth</td>
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<td>13 (Roma Rd SW Pond)</td>
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<td>2,200 at 1m depth</td>
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<td>13A</td>
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<td>14</td>
<td>17,240</td>
<td>31.0m x 11.5m</td>
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<tr>
<td>15</td>
<td>14,620</td>
<td>30.0m x 10m</td>
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</table>
Table 3: Sediment Retention Pond Design Comparison

<table>
<thead>
<tr>
<th>Pond</th>
<th>Required Volume (m³)</th>
<th>Required Pond Area (m²)</th>
<th>Recommended Pond Area (m²)</th>
<th>Recommended Volume (m³)</th>
<th>Required Retention Volume (m³)</th>
<th>Ratio of Retained Volume to Pond Volume</th>
<th>Required Number of 10mm Holes</th>
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<tbody>
<tr>
<td>1</td>
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