

Report

STORMWATER MANAGEMENT REVIEW

SH2 DOWSE TO PETONE UPGRADE

Prepared for New Zealand Transport Agency (Client)

By Beca Infrastructure Ltd (Beca)

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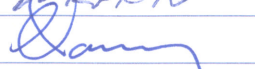
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Appendix A: Figure 1

Introduction

Transit New Zealand (now New Zealand Transport Agency, NZTA) commissioned Beca to carry out a review of the State Highway 2 Dowse to Petone Upgrade (SH2 D2P) project and provide stormwater related information on the catchments and the design.

The SH2 D2P Upgrade project involves the upgrade of a 3km section of the existing highway in the Hutt Valley, Wellington. It generally involves the construction of a grade-separated interchange; an overbridge for a local road and another for a railway station carpark; improving the road geometry and pavement; providing new barriers to separate the north and southbound lanes; railway station carpark rearrangement; and the construction of new local roads. Refer Figure 1 in Appendix A for a schematic diagram of the SH2 D2P Upgrade.

The design was developed and completed prior to a focus being made on stormwater attenuation and treatment in the Wellington region.

This information is provided for NZTA to use in their Stormwater Management Standard project.

This report has been revised for the second phase of NZTA's project. The draft Stormwater Treatment Standard for Road Infrastructure, July 2008 was provided and the report has been updated to assess the SH2 D2P project against the standard.

1 Environmental Factors

This section briefly describes the environmental factors characterising the SH2 D2P catchments.

1.1 Description of Catchments

1.1.1 Terrain

The SH2 D2P corridor is located at the bottom of the escarpment formed by the Hutt Valley's Western Hills and is also positioned between the hillside and the Hutt Valley railway line. Refer pictures 1, 2 and 3 taken recently during construction that illustrate the terrain.

The catchments that fall to SH2 D2P are typically steep with incised gullies and valleys that are drained by small streams and/or Council piped stormwater networks. The valley floor beyond the escarpment is very flat and fully developed. It also forms part of the wider Hutt River floodplain.

The upper catchments are part residential with regenerating native bush whereas and the lower parts of the catchments are generally industrial areas that lead into commercial and then residential zones further beyond the railway.

The largest example of this type of catchment is the Korokoro Stream catchment. This drains a significant part of the Belmont Regional Park. It contains mainly pastoral land with native bush including only some small areas of residential development.



Picture 1: Western end of the site showing Korokoro Stream valley on the left with the stream outfall in Wellington Harbour in the foreground (photos courtesy of Above Ground Level).



Pictures 2 and 3: Western half of the SH2 D2P site (works underway) looking west towards the Harbour (left photo) and the eastern half of the site looking east towards the Hutt River (photos courtesy of Above Ground Level).

1.1.2 Area

The catchments can be separated into two principal areas:

- i. Western Hills Culvert Catchment 177 ha (including the Percy Stream catchment of 78ha)
- ii. Korokoro Stream Catchment 1,650 ha

The highway east of Korokoro Road (shown in Figure 1 or the bridge crossing the railway in picture 3) generally drains to the Western Hills Culvert and the highway west of Korokoro Road drains to the Korokoro Stream.

1.1.3 Topography

The upgraded SH2 D2P corridor groundlevel varies from approximately a reduced level of 9m at the eastern end to 3m at the western end of the site. The highway gently undulates along its length between these levels.

The adjacent Western Hills escarpment rises very steeply, by approximately 20-40m, before flattening out into much less abrupt but still steep slopes.

The Western Hills Culvert catchment rises to a maximum reduced level of 248m over a horizontal distance of approximately 1.5km.

The Korokoro Stream catchment rises from sea level to a maximum height of 456m over a distance of approximately 6km.

1.1.4 Drainage Features

i. Existing Features

The larger hillside gullies contain old stormwater detention dams generally constructed for stormwater runoff attenuation. The newer of these dams are drained by piped outlets and the older ones by open channel spillways into small streams. The condition of the dams vary and many are silted up.

The residential suburbs in the Western Hills are generally drained by Hutt City Council piped drainage networks to either the Western Hills Culvert or to Korokoro Stream. The Western Hills Culvert is an old Council box shaped culvert (1.5m x 1.2m) that delivers stormwater flow to the lower reaches of the Hutt River – close to Wellington Harbour.

The area west of Korokoro Road is currently drained by a relatively small piped drains to Korokoro Stream. A few soakage sumps are also in this area and are reportedly not functioning very well.

The Korokoro Stream is very constricted in the reach immediately up and downstream of SH2. It passes, under several buildings, the highway bridge, a rail bridge, a watermain crossing and a culvert before discharging to the Harbour at Petone beach.



Picture 4: Existing entrance to the Western Hills Culvert

ii. New Features

Where effected by the SH2 D2P works Council drains are being diverted, extended, strengthened and/or increased in diameter. Te works include a new 280m long 1800ø culvert to replace the old Percy Stream culvert and ditch that drains to the Western Hills Culvert.

The SH2 D2P works include significant quantities of new general carriageway drainage (catchpit/sump, pipe and manholes) part of which upgrades the undersized drainage to Korokoro Stream.

The works also include construction of a new 400m long concrete open channel drain discharging to the Korokoro Stream. While this channel drains a new local road it also protects SH2 by acting as a cut off drain along the foot of part of the Western Hills escarpment.

Refer Section 2.2.2 for a general breakdown of the drainage works.



Pictures 5 & 6: New open channel cut off drain and the new 1800 diameter Percy culvert inlet during heavy rainfall part way through construction

1.1.5 Geotechnical Limitations and Opportunities

SH2 is built on the flat alluvial Hutt River valley floor adjacent to a steep and often unstable Greywacke escarpment. This creates significant limitations for positioning drainage appropriately. It is difficult to achieve adequate longitudinal falls to the limited outfall points creating significant issues for the drainage design.

The escarpment also makes it very difficult to construct the drainage (ie trenching along the foot of +7m near vertical cut faces) without previously constructing retaining walls or other slope stabilisation.

Geotechnical studies recorded the groundwater table at approximately 500mm to 3m below ground level but most commonly 2m below ground. This is so far consistent with the conditions found during construction. At the western end of the site the groundwater table is influenced by the tide.

There are some soakage devices along the carriageway but these reportedly do not to function. Further use of soakage devices was not considered given the space constraints, soil types, runoff

volumes, groundwater depth, maintenance considerations and the poor performance of existing soakage devices.

Some areas of the site that were used as industrial yards have been found to contain very high levels of contaminated fill (heavy metals).

1.1.6 Soils

Soils on the hill slopes are mainly weathered Greywacke with a shallow topsoil layer.

The flat areas are generally formed from inter-layered alluvial silts and gravels to an approximate depth of 3m. Some areas have also been filled with crushed Greywacke as part of past construction work.

1.1.7 Erosion Potential

Significant erosion occurs throughout the steep hillslopes and associated gullies above SH2. The erosion potential upstream of the highway is therefore high.

Downstream of SH2 the erosion potential is low due to the piped nature of the watercourses.

The Korokoro Stream has a rocky bed as a result of erosion in throughout the catchment. Erosion, deposition and bed load transportation down to the harbour are ongoing processes in this stream.

1.1.8 Flooding

Flooding is a significant hazard in the SH2 catchments. Flooding occurs regularly on a local scale throughout the site, especially along the western section that drains to the Korokoro Stream. This flooding is generally due to the downstream capacity constrictions of the existing Council drainage and the Korokoro Stream.

The Korokoro Stream has overtopped its banks before causing widespread flooding. In 1976 a region wide extreme flood event inundated much of the surrounding land including the highway.

Secondary flow paths have been identified and allowed for as part of the upgrade design.

1.1.9 Design Storm Event

The design standards adopted were:

- | | |
|-----------------------------|---------------------------------------|
| i. SH2 carriageway drainage | 1 in 20yr ARI |
| ii. SH2 culvert crossings | 1 in 100yr ARI – with 500mm freeboard |
| iii. Secondary flow | 1 in 50yr ARI |
| iv. Local roads | 1 in 10yr ARI |
| v. Council Carparks | 1 in 5yr ARI |

However, due to the constricted nature of the downstream systems an exemption to these standards was allowed by Transit's Scope and Standards Committee. This meant that the drainage would be designed to function to the above standards if the downstream constrictions were alleviated in the future.

1.1.10 Vehicle Kilometres Travelled

The most recent Transit figures record the AADT at 36,299 for 2007 including 6.1% heavy. The site is 2.7km long therefore the kilometres travelled is 98,007 km/day.

1.1.11 Discharge Points

The area west of Korokoro Road discharges to Korokoro Stream. The area east of Korokoro Road generally discharges to the Western Hills Culvert - refer Figure 1.

Both the Stream and the culvert have a lower capacity than Transit's standards.

Secondary flow generally crosses the highway in two locations:

- i. just east of Korokoro Stream bridge; and,
- ii. approximately adjacent the Western Hills Culvert.

1.1.12 Catchment Classification

The highway corridor is peri-urban as determined by the method described in Transit's National State Highway Strategy, 2007. Although, it is noted that the Korokoro Stream catchment is better described as rural in nature.

1.2 Sensitivity of the Receiving Environment

The sensitivity of the receiving environments has been determined by the method described in Land Transport's Research Report 315: Receiving Environments at Risk from Road Runoff, and is set out below.

Three receiving environments have been assessed: the Western Hills Culvert (including Percy Stream), Korokoro Stream and due to its immediate proximity, Wellington Harbour.

1.2.1 Western Hills Culvert

i. Type Sensitivity Value

Assessed as low due to the majority of the watercourse being culverted and the Percy Stream being relatively steep.

ii. Ecological Value

Assessed as medium. Percy Reserve forms a part of the catchment which is indentified by the Hutt City Council as a significant natural resource. However, the majority of the catchment is developed with relatively low ecological value. The Greater Wellington Regional Council (GWRC) ecological maps describe the presence of native fish in this catchment as "not probable".

iii. Human Use Value

Assessed as low. The majority of the catchment is culverted and therefore not accessible for use. However, it is noted that the Percy Stream branch does include duck ponds fed by the stream.

Attribute Score	Sensitivity	Score
Type Sensitivity Value	L	5
Ecological Value	M	10
Human Use Value	L	2
Total	L	17

1.2.2 Korokoro Stream

i. Type Sensitivity Value

Assessed as medium due to moderate gradient and the tidally influenced outlet.

ii. Ecological Value

Assessed as high. Even though large parts of the catchment consist of pastoral land, including the Belmont Regional Park, GWRC record several native fish species to be present. The upper reaches of the stream also include nationally threatened indigenous species.

iii. Human Use Value

Assessed as medium. The reach downstream of SH2 is largely unused by the public until it reaches Petone beach where better access allows the potential for greater contact. The upstream catchment includes moderately significant cultural and recreational areas of the Belmont Regional Park.

Attribute Score	Sensitivity	Score
Type Sensitivity Value	M	20
Ecological Value	H	20
Human Use Value	M	5
Total	H	45

1.2.3 Wellington Harbour

i. Type Sensitivity Value

Assessed as high due to the enclosed nature of the harbour. GWRC has also likened the harbour in many ways to a lake.

ii. Ecological Value

Assessed as high. The Petone foreshore is a reserve that is an important roosting and feeding ground for several threatened bird species. The wider harbour also provides habitat for the Blue Penguin.

iii. Human Use Value

Assessed as high. The harbour has a high contact and non-contact recreational usage and has high historical significance for Te Atiawa Maori and Europeans alike.

Attribute Score	Sensitivity	Score
Type Sensitivity Value	H	30
Ecological Value	H	20
Human Use Value	H	10
Total	H	60

2 Designed Solutions

This section provides a brief description of the designed stormwater modifications to the existing stormwater network that are included in the SH2 D2P works.

2.1 Design Philosophy

2.1.1 Objectives

Transit's and Beca's objectives for the design were:

- i. Increase the carriageway stormwater drainage standard to manage a 1 in 20 year ARI storm;
- ii. Avoid increasing flooding risk to others; and,
- iii. Achieve the best possible flood protection for up to a 1 in 100 year ARI storm.

The above objectives were agreed between Transit and Beca during the development of the design.

The various options for achieving the objectives were investigated and weighed up in the earlier Preliminary Design study and an even earlier Stormwater Scoping report.

The standards described in these documents were subsequently revised by the Scope and Standards Committee decision noted in Section 1.1.9.

2.1.2 Option Analysis

The following options were considered during preliminary and/or detailed design of the SH2 D2P project.

i. Korokoro Stream Capacity

Options considered to improve the Korokoro Stream capacity included:

- various stream channel works (lining, widening, etc);
- a bypass overflow culvert;
- a large attenuation dam further up the catchment;
- raising the rail bridge; and,
- raising the SH2 bridge.

ii. SH2 Drainage: Korokoro Road to Korokoro Stream

Options considered for the carriageway drainage to Korokoro Stream included:

- upgrading existing drainage pipes (both supplementation and full replacement);

- reducing the waterlevel in the Korokoro Stream (refer i); and,
- improving the cut off drainage at the foot of the Western Hills escarpment.

iii. SH2 Drainage: to Western Hills Culvert

Options considered to for the carriageway drainage to the Western Hills culvert included:

- upgrading existing piped drainage (both supplementation and full replacement);
- improving existing or constructing new attenuation dams in the Western Hills; and,
- modifying the Western Hills culvert to allow increased surcharging and pressurisation of the Western Hills culvert.

2.1.3 Criteria

The criteria for the stormwater detailed design led to relatively standard drainage solutions (ie pipes and channels) and did not require localised attenuation or treatment measures to be considered.

Erosion control was managed by the provision of rock rip-rap and also gabions where works were to be conducted in stream beds. This was designed in accordance to GWRC requirements.

It is noted that the design solutions were developed and completed (early 2003) prior to the time when quality treatment and attenuation came into focus in the Wellington region.

At the time Transit's capacity standards for stormwater design were generally in excess of the Council's downstream networks into which significant areas of the site drain.

2.1.4 References

The references used in developing the above objectives were:

- TNZ Bridge Manual;
- Korokoro Stream Flood Control Proposals, Wellington Regional Water Board, 1979;
- Western Hills Stormwater Runoff, Brickell Moss & Partners, 1986;
- SH2 – Melling to Petone Upgrade: Stormwater Drainage Scoping Report, Beca, 1998;
- SH2 – Stormwater Drainage Study Petone to Melling, Beca, 1999.

2.2 Stormwater Management Devices

2.2.1 Erosion and Sediment Control

Erosion and sediment control was designed in accordance with the Culvert Manual and GWRC guidelines. The solutions consist of stone rip-rap to inlets/outlets/stream banks, gabion baskets and hydroseeding earthworks surfaces.

Standard sumps and catchpits also provide sediment and gross litter traps in the finished works.

Construction erosion and sediment control is the Contractor's responsibility to manage in accordance with GWRC requirements. To date this has meant the use of silt fences, temporary sediment control ponds, sand bagged sump inlets, vehicle washes, stabilised site entrances and hydroseeding.

2.2.2 Operational Stormwater Management (Permanent)

From the kerb and channel runoff is generally collected and conveyed by standard municipal style sump, pipe and manhole drainage.

The complex existing drainage networks in the Western Hills, with attenuation dams and small streams, was modelled with XP-SWMM software.

Cut off open channels have been used where practical to intercept hillslope runoff before it reaches the road.

Other than sumps, that trap gross litter and sediment, there are no specific treatment devices or attenuation mechanisms in the design.

The positioning of the drainage was heavily dependant on the severe geographical confinements of the highway corridor. The limited longitudinal fall available and the flanking restrictions of the escarpment and rail corridor (and other private properties) coupled with the limited number of outfall locations effectively pre-determined many of the drainage routes.

The following generally summarises the quantity of the stormwater drainage works:

i. Sumps	142
ii. Manholes	107
iii. Greater than 1050ø pipes	330m
iv. Less than 1050ø pipes	4,500m
v. Open channels (mostly grassed)	1,100m
vi. Concrete open channels	670m
vii. Headwalls	21

2.3 Cost

2.3.1 Resource Consents

The stormwater consenting was part of a significant wider consenting project for all of the SH2 D2P Upgrade.

This included preliminary design investigations, public and stakeholder consultation, preparation of the Assessment of Environmental Effects for the Notice of Requirements, hearings and consenting. Due to this complexity the stormwater related consenting costs are not readily able to be separately identified with accuracy from the whole.

The consenting work for all of the SH2 D2P upgrade included preliminary design, public and stakeholder liaison, hearings, application preparation, consultation etc cost \$1,500,000. This was additional to the consenting process of an earlier version of the upgrade from Petone to Melling (further north than Dowse) that cost \$500,000. We estimate that the stormwater related component of this to be as is outlined in the following table (Percy Stream and Korokoro Stream consents where applied for during detailed design).

Consent	Cost (\$)
SH2 D2P Consents (SW component)	\$40,000 ¹
Percy Stream Consents (4N ^o)	\$6,400
Korokoro Stream Consents (4N ^o)	\$19,000

1: Stormwater related input into overall consenting / NoR etc process has been estimated as stormwater consents (other than those separately listed) were included in the overall project consenting.

2.3.2 Building Consents

There were no specific Building Consents associated with drainage works however the whole SH2 D2P upgrade was approved by Hutt City Council during the Notice of Requirements procedure.

2.3.3 Final Design

The fee cost of the detailed drainage design, including production of construction drawings, was approximately \$140,000 (2003 dollars).

2.3.4 Construction

The construction costs for the stormwater were tendered as part of the SH2 D2P Upgrade contract 418N as a Measure and Value contract.

In 2008 and subsequent to the tender being awarded, Transit and the Contractor agreed to a lump sum for the stormwater drainage component of the contract. The breakdown of the lump sum stormwater work is approximately:

i. Carriageway collection (sumps)	\$270,000
ii. Collection and Conveyance (open channel cut off drains)	\$840,000
iii. Conveyance (pipes & manholes)	\$1,150,000
iv. Attenuation	\$Nil
v. Treatment (erosion control rip-rap & gabions)	<u>\$42,000¹</u>
vi. Total Lump Sum Stormwater Drainage	\$4,600,000

1: Cost of construction erosion and sediment control is built into the price for the wider drainage works.

2.3.5 Monitoring Costs

Beca is providing MSQA services to Transit for the construction of the SH2 D2P Upgrade. The stormwater component of this fee may be estimated as \$150,000 for the total construction period.

There are no specific stormwater devices that require specific monitoring aside from that included in the general highway maintenance contract for the region.

2.3.6 Operational and Maintenance Estimated Annual Cost

The only regular annual operational and maintenance costs associated with the works is the cost to clean out the catchpits and sumps.

The highway maintenance contract for the Wellington region is a Hybrid Contract and as such the cost of cleaning out catchpits is part of a lump sum and not readily identifiable.

However, a rough estimate of the cost for cleaning out all the sumps with a sucker truck, including traffic control, would be approximately \$11,000 and we would expect this to be carried out biannually giving \$22,000.

2.4 Time

2.4.1 Resource Consents

The Resource Consents, including several stormwater related consents, for the SH2 D2P Upgrade were applied for and granted in the following order:

Consent	Submitted	Approved
SH2 D2P Upgrade Notice of Requirements	30 March 2001	21 November 2001
Percy Stream – 4 consents	1 May 2003	26 June 2003
Korokoro Stream – 4 consents	11 December 2002	13 August 2003

Several new consents and amendments to consents have also been required during the construction phase as unforeseen issues arise.

2.4.2 Building Consents

No Building Consents were required specifically for the stormwater drainage works. Also refer Section 2.1.1.

2.4.3 Final Design

The stormwater detailed design took approximately 20 weeks to complete. This excludes the earlier preliminary design and option development.

2.4.4 Construction

The contractor has programmed the stormwater drainage to take 59 weeks (often with works progressing concurrently on different parts of the site) out of an overall project duration of 118 weeks.

Separation into construction times for collection, conveyance, etc is not practical as they are generally being constructed at the same.

2.4.5 Operation and Maintenance

The life expectancy prior to the main drainage works varied with the life expectancy of parts of the network being significantly less than 50 years. Some drains constructed in the early 1900's have been found to be in a very poor condition and could not have been expected to last longer than 5 years under the amended SH2 alignment.

The estimated life expectancy for the renewal is generally 50 years with the expectancy of the large pipe work components being greater than 50 years.

3 Review Against the Draft Stormwater Standard

This Section covers the second phase of NZTA's Stormwater Management Review Project and examines the potential impact on the SH2 D2P drainage had the Stormwater Treatment Standard for Road Infrastructure, July 2008 (referred to as the "Standard") been used from the on set of the project.

The information provided in this Section details our evaluation of the most likely changes that could have eventuated from the application of the Standard.

The format of this Section follows the sub-section titling of the previous two Sections.

3.1 Environmental Effects

Sections 1.1.1 to 1.1.8 and 1.1.10 to 1.1.12 detail the assessment of the existing catchments and drainage features (except 1.1.4ii which is covered below) and as such are not affected by the Standard.

3.1.1 Design Storm Event

The design standards would be different from those listed in Section 1.1.9 and would have included the following criteria:

- i. 1 in 100 year peakflow post development controlled to 80% pre-development levels;
- ii. 2 and 10 year peak flow restricted to pre-development levels;
- iii. Climate change allowance of 7 to 8% increase to the peak flows (depending on each catchment concerned);
- iv. Stream erosion criteria; and,
- v. Water quality control elements.

The effect of the above would not be expected to significantly alter the size of the drains as they are designed for 1 in 20 year peak flows (once downstream controls are upgraded by others in the future).

Due to the existing developed nature of the SH2 D2P Site the post-development runoff is not significantly greater than the pre-development runoff. Therefore, item ii. would be expected to have little effect on the design, however, a combination of items i. & iii. would require the limiting of peak discharges ie attenuation, to be incorporated in the design where there currently is none.

The stream erosion criteria would not significantly alter the design as stream erosion has already been considered in the current design.

The water quality control criteria parts of the Standard would also provide the framework for incorporation of these into the project.

3.2 Sensitivity of the Receiving Environment

Section 1.2 of this report is generally unaffected by the Standard.

Due to the relative size difference between highway and upper catchments along SH2, it is unlikely that any of the catchment sensitivities would be significantly altered with the inclusion of stormwater mechanisms resulting from the Standard.

3.3 Designed Solutions

3.3.1 Design Philosophy

3.3.1.1 Objectives

The Standard would have resulted in water quality control receiving greater prominence in the project objectives due to:

- the sensitivity of the receiving environments;
- the large size of the catchments concerned; and,
- the very high public visibility factor and potential for controversy (consents for the project were not easily obtained).

The other quantity related objectives in the Standard would have resulted in slightly different objectives relating to flooding control and drainage capacity requirements. However, this difference could have a significant impact on the project.

3.3.1.2 Option Analysis

It is noted that the potential implications of the Standard (attenuation ponds etc) would require careful consideration given the work would have almost certainly fallen under the retro-fit guidelines. Also allowance of the potentially significant implications of the Standard would need to be accommodated during the designation process for the project.

i. Korokoro Stream Capacity

Overall, no effect as all of the feasible options for increasing the capacity of the stream or controlling the stream flow were considered in the preliminary design stage.

ii. SH2 Drainage: Korokoro Road to Korokoro Stream

Due to the very restricted “built up” nature of SH2 through this section of the Site the drainage system would likely to remain unchanged from the current design ie a system of sumps, manholes and pipes.

However, the requirement for flow control ie attenuation, could have significant impact on the design. There currently is no space available in this area of the Site to provide a large attenuation feature such as a pond or wetland without setting aside or purchasing additional land that is currently developed for commercial/industrial use. The cost of doing so may well have proved prohibitive.

The Standard would also have likely resulted in the inclusion of water quality devices in the design – most likely proprietary devices in order to fit into the Site constraints. For example, swales would not be appropriate along the SH2 carriageway (due to footpaths and the narrow corridor) but could have been incorporated in the train station carpark if the resulting reduction in the number of carparks was accepted.

“Hard” style treatment devices (sandfilters or other similar devices) could have been incorporated in the design either by locating them under the carriageway or if the many trunk utility services were diverted to create space, in the few areas of NZTA land that would potentially be suitable.

Soakage would not likely assist in flow or quality control due to existing ground conditions.

iii. SH2 Drainage: to Western Hills Culvert

This section of the Site is less built up than the area that drains to Korokoro Stream. Swales could be located along some parts of the carriageway but there would be significant lengths for which swales would not be practical.

The trunk drainage system of pipes and manholes would still be required – including the main components like the 1800Ø culvert.

Again due to lack of available land, attenuation elements would not likely be feasible in this section of SH2. A more likely option would be to modify the existing Council dams upstream of SH2 to provide the required net attenuation of flows.

“Hard” treatment options could be provided for most locations in this section of the Site but most of these would have to be located under the carriageway due to spatial constraints.

3.3.1.3 Criteria

As noted above, the Standard would require inclusion of attenuation and water quality control in the project's objectives and therefore in the criteria too.

3.3.1.4 References

The Standard would be included in the list of references.

Other secondary references would also be used such as ARC's TP10 and Ministry for the Environment's climate change guidelines.

3.4 Stormwater Management Devices

3.4.1 Erosion and Sediment Control

The likely incorporation of attenuation and quality control devices would significantly improve the control of sediment along the SH2 D2P Site relative to the current design.

The Contractor's responsibility for control of sediment during construction would not likely be effected by the Standard.

3.4.2 Operational Stormwater Management (Permanent)

The constraints on the SH2 D2P site and the resulting effects on the drainage design remain unchanged. If significant changes to the designation and additional land were made available then the following additional drainage items would have likely eventuated from the design process:

- i. Increasing the capacity of the Council's hillside attenuation dams (4N⁰) that drain to the Western Hills Culvert;
- ii. Purchase of property and construction of an attenuation pond/wetland in the catchment that drains to Korokoro Stream;
- iii. Swales, filter strips and raingardens to the public carpark areas; and,
- iv. Several sand filters (or similar) type devices located throughout the Site.

The above are just some of the possible options for providing attenuation and quality control that could have resulted if the Standard had been available from the outset of the project.

3.5 Cost

3.5.1 Resource Consents

Due to the varied issues involved in the SH2 D2P works and the relatively small component of this that is related to drainage, the Standard would have had little overall effect on the project resource consents. It is therefore likely that overall consenting costs would not have been very different than those incurred.

However, it would have been beneficial in providing a defined framework to better include some of the stakeholders interests.

However, had the SH2 D2P project development and design been carried out in more recent times then the Standard would be very useful for covering issues that now have much greater stakeholder and public awareness. For example, we would expect GWRC to be much more focused on runoff quality and require essentially much of what is included in the Standard than was the case several years ago.

3.5.2 Building Consents

It is unlikely that the Standard would significantly impact on the Building Consents required for the SH2 D2P project. Additional Building Consents could be required with respect to pond fencing / public safety etc however the additional cost of these would be minimal compared to the overall consenting costs for the project.

3.5.3 Final Design

The detailed design fee would have been more expensive to allow for the significant additional attenuation and quality control design and drawing production required. We estimate this would have required an additional \$60,000 in fee.

3.5.4 Construction

Inclusion of attenuation and quality control elements in the design would obviously increase the construction cost for the drainage works and the associated MSQA fee.

The provision of attenuation is unlikely to significantly reduce the overall construction cost of the remaining trunk drainage system.

Excluding land purchase for an attenuation pond – which would be a very significant cost – the cost of the additional drainage works could be in the order of \$500,000. This is made up of attenuation costs of approximately \$300,000 and quality control costs of approximately \$200,000.

This rough estimate allows for 1 large attenuation pond / wetland, 4 large sand filters (or similar) and bypass structures, works to 4N^o existing attenuation dams and some swales to carparks and other suitable areas of the Site.

Obviously these costs are “ball park” estimates as costs would be very much dependant on the results of the investigation, liaison and design process.

3.5.5 Monitoring Costs

The monitoring of the potential quality control devices would be unlikely to incur significant costs, other than increased MSQA fee during construction, as the design would be expected to be carried out under the Best Practicable Option rather than stringent water quality requirements. Total annual monitoring costs for the mechanisms described above has been estimated as follows:

- i. Pond inspections after monthly storms = \$3,000
- ii. Filter (or similar device) inspections = \$5,000
- iii. Carpark swale inspections = \$2,500

The above makes allowance for traffic control costs and record annual costs.

Also the increased MSQA fee for the additional works would be approximately \$20,000.

3.5.6 Operational Maintenance Estimated Annual Cost

Maintenance costs would be expected to increase significantly with the addition of an attenuation pond and several water quality devices. The majority of the sumps would still likely be required so the maintenance cost of these would not be expected to significantly reduce.

The additional annual cost for cleaning out the pond, treatment devices and the hillside attenuation ponds (assuming a cost share with Council for these) could be approximately:

- i. Pond maintenance after monthly storm = \$6,000
- ii. Pond sediment fore-bay clean out = \$10,000¹
- iii. Filter (or similar device) cleaning = \$5,000
- iv. Carpark swale maintenance = \$20,000

1 – cost is not an annual cost, occurs approximately every 5 years.

Again these are “ball park” estimates that depends very much on the options chosen.

3.6 Time

3.6.1 Resource Consents

Due to the nature of the many resource consents required for the SH2 D2P project it is unlikely that the Standard would significantly effect this overall time taken for the consents to be granted.

Similarly, the few specific stormwater consents would not have been significantly effected by the Standard.

3.6.2 Final Design

The additional time that would have been required to complete the detailed design and produce the drawings for the additional attenuation and water quality control items would be approximately six weeks.

This is based on the options and costs described above.

3.6.3 Construction

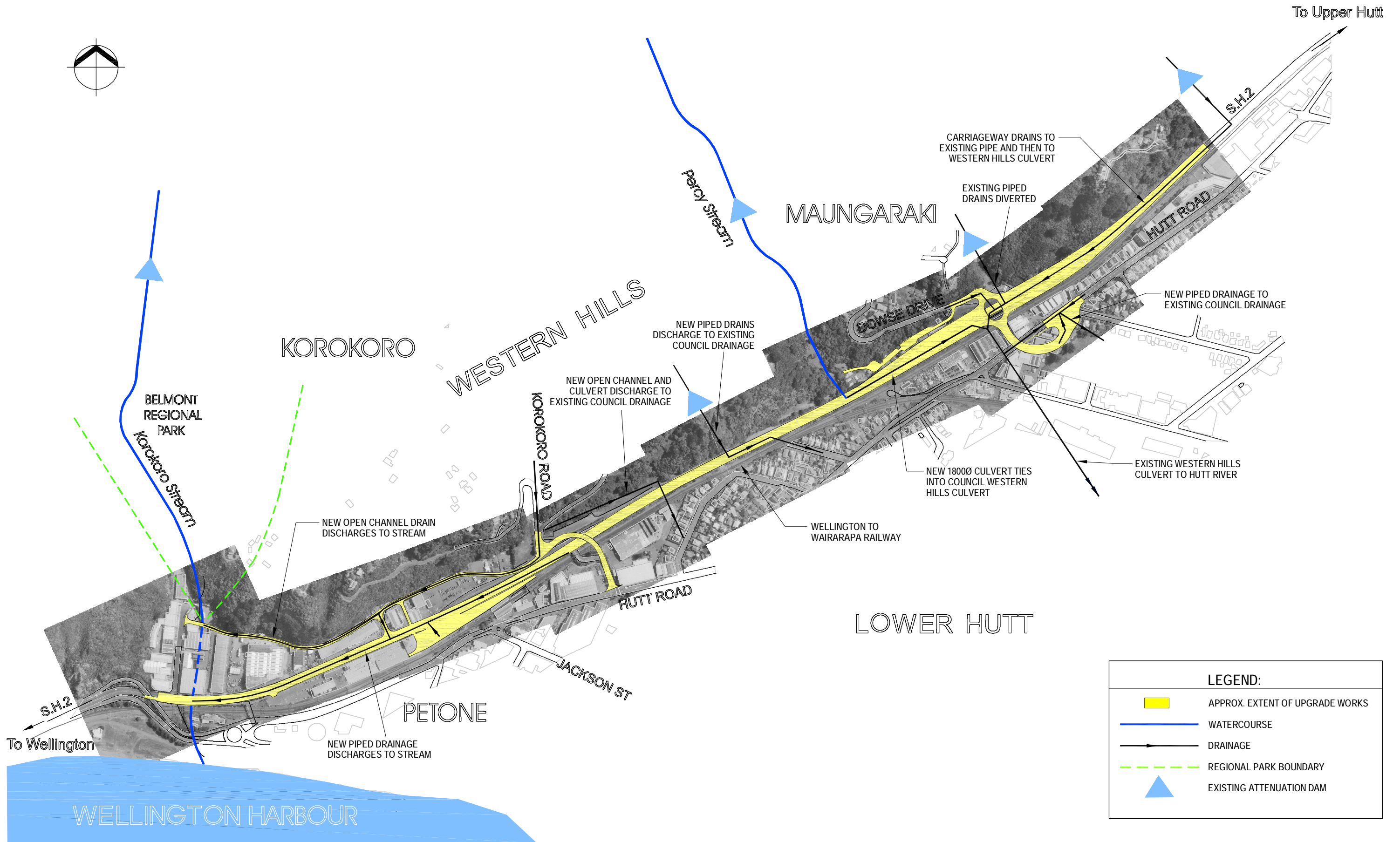
The additional time taken to construct the resulting attenuation and water quality items would be approximately another 16 weeks. However, it is likely that much of this time would be concurrent with other construction activities so there is potential for not increasing the overall contract duration.

This is based on the options and costs described above.

3.6.4 Operation and Maintenance

The life expectancy of the drainage would not likely to be significantly effected by the Standard.

Appendix A: Figure 1



SH2 DOWSE TO PETONE UPGRADE
SCHEMATIC DRAINAGE LAYOUT