Operations and Maintenance Guidelines for Planning, Design, Construction and Handover of Capital Projects in the Auckland South Area Motorway Network

October 2009
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<thead>
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<tbody>
<tr>
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<td>Bruce Chappell</td>
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<td>Tony Fisher</td>
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<td></td>
</tr>
</tbody>
</table>
Contents

Introduction ........................................................................................................................................................................ 1
  Background .................................................................................................................................................................. 1
  Capital Projects Breakthrough Workshop ........................................................................................................ 1
  Asset Classes ......................................................................................................................................................... 2
  Operations and Maintenance Guidelines for Capital Projects ................................................................. 2

Asset Management and Whole of Life Value ........................................................................................................ 4
  Highway Asset Management Cycle ............................................................................................................... 4
  Whole of Life Value ......................................................................................................................................... 4

Health and Safety ............................................................................................................................................... 5

Consenting ......................................................................................................................................................... 6

Project Deliverables and Timing .................................................................................................................... 7

RAMM and As-Built Data ............................................................................................................................. 8
  RAMM Data .................................................................................................................................................... 8
  As Built Data ................................................................................................................................................. 8

Pavements and Surfacing .......................................................................................................................... 9
  Whole of Life Cost Considerations .............................................................................................................. 9
  Planning and Design Considerations ......................................................................................................... 9

Structures ...................................................................................................................................................... 11
  Whole of Life Cost Considerations ........................................................................................................... 11
  Planning and Design Considerations ...................................................................................................... 11
    Drainage .................................................................................................................................................... 11
    Structure Inspections .............................................................................................................................. 12
    New Structure Components .................................................................................................................... 12
    Other Considerations .............................................................................................................................. 13
    Overweight Vehicles ............................................................................................................................... 14
    Over Dimension Vehicles ........................................................................................................................ 14
    Handover Considerations ........................................................................................................................ 14
    Production of all As-Built Information ................................................................................................. 14
    Bridge Data System (BDS) ......................................................................................................................... 14

Traffic Assets ............................................................................................................................................... 15
  Whole of Life Cost Considerations ........................................................................................................... 15
  Lighting ......................................................................................................................................................... 15
  Barriers ......................................................................................................................................................... 15
  Planning, Design and Construction Considerations .................................................................................. 15
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Operations</td>
<td>18</td>
</tr>
<tr>
<td>Traffic Signals</td>
<td>20</td>
</tr>
<tr>
<td>ITS Equipment</td>
<td>20</td>
</tr>
<tr>
<td>Whole of Life Considerations</td>
<td>20</td>
</tr>
<tr>
<td>Operational Requirements</td>
<td>20</td>
</tr>
<tr>
<td>ITS Hardware</td>
<td>21</td>
</tr>
<tr>
<td>Full Body CCTV Cameras</td>
<td>21</td>
</tr>
<tr>
<td>Emergency Motorway Telephones (EMT)</td>
<td>21</td>
</tr>
<tr>
<td>Lane Control Signals</td>
<td>21</td>
</tr>
<tr>
<td>Vehicle Detection Systems</td>
<td>22</td>
</tr>
<tr>
<td>Structures and Roadside Furniture</td>
<td>22</td>
</tr>
<tr>
<td>ATMS Cabinets</td>
<td>22</td>
</tr>
<tr>
<td>CCTV Poles</td>
<td>23</td>
</tr>
<tr>
<td>Gantries</td>
<td>23</td>
</tr>
<tr>
<td>Services</td>
<td>23</td>
</tr>
<tr>
<td>Handover Procedures</td>
<td>23</td>
</tr>
<tr>
<td>Procedure</td>
<td>23</td>
</tr>
<tr>
<td>Documentation</td>
<td>24</td>
</tr>
<tr>
<td>Spares Handover</td>
<td>24</td>
</tr>
<tr>
<td>Corridor Assets</td>
<td>25</td>
</tr>
<tr>
<td>General</td>
<td>25</td>
</tr>
<tr>
<td>Main attributes</td>
<td>25</td>
</tr>
<tr>
<td>Whole of Life Cost Considerations</td>
<td>27</td>
</tr>
<tr>
<td>Planning, Design and Construction Considerations</td>
<td>27</td>
</tr>
<tr>
<td>Management of Pest Plants</td>
<td>28</td>
</tr>
<tr>
<td>Introduction</td>
<td>28</td>
</tr>
<tr>
<td>Pest Plant Protocol</td>
<td>28</td>
</tr>
<tr>
<td>Handover information</td>
<td>30</td>
</tr>
<tr>
<td>Other Items</td>
<td>30</td>
</tr>
<tr>
<td>Stormwater Management</td>
<td>31</td>
</tr>
<tr>
<td>Whole of Life Cost Considerations</td>
<td>31</td>
</tr>
<tr>
<td>Planning, Design, &amp; Construction Considerations</td>
<td>32</td>
</tr>
<tr>
<td>General</td>
<td>32</td>
</tr>
</tbody>
</table>
Introduction

Background

Auckland Motorway Alliance (AMA) was established as an Operations and Maintenance (O&M) Alliance for the Auckland South network area in the Auckland Region of NZTA. The Alliance participants are New Zealand Transport Agency (NZTA), Fulton Hogan Ltd, Beca Infrastructure Ltd, Opus International Consultants Ltd, Resolve Group Ltd and Armitage (sub-Alliance participant).

The Auckland South network has had many Capital Projects undertaken between 2000 and 2009. Several projects are currently underway (2009) and planned for the next decade. Interfacing with Capital Projects is essential to ensure best for network outcomes occur during planning, design, construction and handover.

Capital Projects Breakthrough Workshop

AMA held a Capital Projects breakthrough workshop on Monday 6th April 2009 that identified several gaps that exist between current and desired outcomes from the various stages of Capital Projects. The workshop established means to close these gaps. The table below presents the workshop initiatives established.

<table>
<thead>
<tr>
<th>Gap</th>
<th>Breakthrough Initiatives</th>
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<tbody>
<tr>
<td>Little structure around handovers and maintenance during construction</td>
<td>Create and implement an agreed structure</td>
</tr>
<tr>
<td>Specifications and standards for maintenance during construction</td>
<td>Review these and propose improvements</td>
</tr>
<tr>
<td>Liaison issue for maintenance during capital project</td>
<td>Create AMA key account manager for each Capital Project</td>
</tr>
<tr>
<td>Expectations</td>
<td>Actions</td>
</tr>
<tr>
<td>Existing Capital Projects</td>
<td>Document and close out</td>
</tr>
<tr>
<td>Future Capital Projects</td>
<td>Be involved at planning, design, construction and handover stages</td>
</tr>
<tr>
<td>Stakeholder liaison</td>
<td>AMA to be involved at various stages</td>
</tr>
<tr>
<td>General lack of understanding of asset life and it’s demands</td>
<td>Solution to all these gaps is to produce a complete Operations and Maintenance Guidelines to accompany the usual Capital Project Design Standards, Manuals and Guidelines that will emphasise whole of life evaluation requirements. Regular interfacing with CP to audit O&amp;M issues Use AMA connections in NZTA to promote O&amp;M issues in Capital Projects</td>
</tr>
<tr>
<td>Design staff with little or no background in O&amp;M</td>
<td></td>
</tr>
<tr>
<td>No whole of life costs</td>
<td></td>
</tr>
<tr>
<td>No evaluation of congestion costs for future maintenance activity</td>
<td></td>
</tr>
<tr>
<td>Lack of interest in what is being handed over and associated documentation required</td>
<td></td>
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<tr>
<td></td>
<td>No practical completion issued until project finished:</td>
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<tr>
<td></td>
<td>- schedule an item with large sum for this, or</td>
</tr>
<tr>
<td></td>
<td>- withhold payment to progressively release</td>
</tr>
<tr>
<td></td>
<td>Early resolution of maintenance boundary issues once assets are known in Capital Projects</td>
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</tbody>
</table>
The breakthrough initiatives generated can be encapsulated in two action items:

- Establish AMA Capital Project ‘Key Account Managers’ to act as liaison portals with capital projects.

## Asset Classes

The Auckland South network comprises numerous asset classes, each with specific maintenance requirements:

- Pavements and Surfacing
- Overpass and underpass bridges of various materials and forms
- Tunnels
- Retaining walls
- High mast lighting
- Stormwater management assets
  - Surface water collection, conveyance and disposal
  - Management devices (e.g., treatment systems)
  - Waterway and network crossings (e.g., culverts)
- Street lighting
- Signage
- Pavement delineation
- Barriers
- Noise walls and fences
- Vegetation
- Intelligent Transportation System assets (cameras, phones, variable message signs)
- Traffic signals
- Weigh stations and associated buildings, facilities and pavements
- Electronic Weigh in Motion detection equipment

## Operations and Maintenance Guidelines for Capital Projects

This document has been prepared as the O&M Guidelines for Planning, Design and Construction of Capital Projects in the Auckland South Area Motorway Network. This is a unique opportunity to contribute to the processes in planning, preliminary design, detailed design, construction and handover of Capital Projects. By defining processes and outcomes with operations and maintenance considerations, for each stage of a Capital Project, whole of life issues and value for money can be included. Mitigation of risk of undesirable outcomes for post project handover operations and maintenance activities can also occur.

Data for production and review of these Guidelines has come from several sources:

- Planning and Capital Project personnel in NZTA
- Highway Network Operations personnel in NZTA
- Existing NZTA documentation aligned to O&M outcomes for capital projects
- AMA participants
All traditional entities (Client, Design Consultant, Construction Contractor, Maintenance Consultant and Maintenance Contractor) are represented by the AMA participants. This captures a knowledgeable group with experience across all stages of Capital Projects.

NZTA has published an existing standard document, *Asset Management Guide for Project Design, Standard Professional Services Guideline PSG/3 - Asset Management Guide, Version 1, March 2009* which shall be used. These new O&M Guidelines for Capital Projects are “Auckland motorway centric” in that it represents the O&M requirements for the Auckland South area motorway network in particular. These Guidelines are in addition to NZTA’s standard document.

The following table outlines the O&M inputs at various Capital Project stages:

<table>
<thead>
<tr>
<th>Capital Project Stage</th>
<th>Asset Type O&amp;M Inputs</th>
<th>AMA Team Inputs/Advice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning and Consenting</td>
<td>Depending on project.</td>
<td>Delivery - maintenance issues and relative costs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Asset Management - conceptual design issues.</td>
</tr>
<tr>
<td>Tender Stage for Detailed Design</td>
<td>All asset classes likely to have document input requirements.</td>
<td>Delivery, Asset Management, Traffic Operations</td>
</tr>
<tr>
<td>Detailed Design and Consenting</td>
<td>All asset classes likely to have input requirements.</td>
<td>Delivery, Asset Management, Traffic Operations</td>
</tr>
<tr>
<td>Site Handover to Capital Project</td>
<td>Nil</td>
<td>Delivery</td>
</tr>
<tr>
<td>Construction</td>
<td>All asset classes likely to have input requirements.</td>
<td>Delivery, Asset Management, Traffic Operations</td>
</tr>
<tr>
<td>Data Delivery</td>
<td>All asset classes likely to have some data requirements.</td>
<td>Delivery, Asset Management, Information Management</td>
</tr>
<tr>
<td>Site Handover to O&amp;M</td>
<td>All asset classes likely to have O&amp;M inspection requirements</td>
<td>Asset Management, Delivery, Traffic Operations</td>
</tr>
</tbody>
</table>

The focus of these Guidelines is to provide recommendations in the following areas:

- Consideration of maintenance and operating costs during planning and consenting stages of capital projects
- Whole of life value for money in selecting asset class components
- Provision of maintenance and operations designs that lead to safe and efficient maintenance activities

Users of these Guidelines should discuss issues requiring clarification with the organisations responsible for the current O&M and/or asset management contracts on the network.

In these Guidelines the term “network operations and maintenance organisations” is used to define the current single or multiple organisations contracted by NZTA to undertake network operations and maintenance (this group is the AMA at the time of writing these Guidelines, 2009).
Asset Management and Whole of Life Value

Highway Asset Management Cycle

Many organisations are involved in the highway asset management cycle of:

- Highway management at national and regional level (NZ Government and NZTA specifically)
- Highway network planning (NZTA, consultants)
- Highway design (NZTA, consultants, contractors)
- Highway construction (NZTA, contractors, consultants)
- RAMM database updates (NZTA, contractors, consultants)
- Highway operations (NZTA, consultants, contractors)
- Highway performance monitoring (NZTA, consultants, contractors)
- Highway condition monitoring (NZTA, consultants, contractors)
- Highway maintenance (NZTA, contractors, consultants)
- Highway rehabilitation (NZTA, contractors, consultants)
- Highway replacement (NZTA)
- Highway revocation (NZTA)
- Highway asset management auditing (NZ Government)

Each capital project is an intrinsic part of the highway asset management cycle. Capital projects occur over a relatively short time frame in the total asset management cycle, typically around 5 years for planning and creation, in an asset operations and maintenance life of perhaps 50 to more than 100 years. The outcomes of the planning and creation stages of a highway asset have a major influence on operations and maintenance costs over the total asset life.

Whole of Life Value

Providing whole of life value in decision making is a fundamental requirement for sound asset management decisions. This decision making occurs throughout all steps in the highway asset management listed above. The requirement for whole of life value in decision making is a recurring theme in these Guidelines. Typically whole of life value can be assessed and provided by:

- Liaison with network operations and maintenance organisations for assessment input advice.
- Consideration of more than one option in design for asset types and associated components.
- Use of net present value cost analysis, using capital plus operational and maintenance costs in the analysis, to determine the best whole of life value option.
- Include operational costs, such as delay costs to highway users in analysis of maintenance requirements for options, NZTA Economic Evaluation Manual provides methodology and data.
- Striving for consistency in asset components, determine what is used elsewhere on the network and the advantages and disadvantages of different component types, refer network operations and maintenance organisations for relevant data.
- Strive for compatibility with existing asset components, e.g. ITS asset compatibility.
- Including allowance for spares and availability of such in the assessment.
- Understanding that some asset types have short life spans, e.g. ITS assets can have less than 10 year lives and spare availability is an important factor.
- Design to include allowance for future use for ITS and utility services, including installation of ducting.
Health and Safety

Network operations and maintenance activities provide health and safety challenges for field staff involved in such activities and for road users.

Capital project planning and design has a role in the whole of life management of health and safety risk associated with operations and maintenance activities. This can be achieved by:

- Liaison with network operation and maintenance organisations with respect to:
  - Design elements, or lack thereof, considered to be hazards for operations and maintenance activities or for the road user, e.g. manholes in shoulder or traffic lane areas, lack of access to stormwater treatment devices, steep areas or areas adjacent vertical drops that require maintenance.
  - Providing safe access and consideration of potential disbenefits of such, e.g. fixed ladders for structures access could be used by graffiti vandals.
- Liaison should occur through planning, scheme assessment, preliminary design and detailed design stages to identify and mitigate potential hazards.
- Including health and safety of road users and operations and maintenance staff in whole of life cost considerations for asset type and component options, e.g. traffic barriers are a hazard that protects road users from a hazard, is there an alternative to remove both hazards?
- Incorporate crime prevention through environmental design (CPTED) provisions in the design process.
- Demonstrating that the design option selected minimises maintenance interventions.
- Identifying how each asset component will be maintained and demonstrating that maintenance can be undertaken in a safe manner.
Consenting

During the planning, scheme assessment, preliminary design and design stages of Capital Projects designation and resource consenting authorities often require a level of detail on asset types and locations that can lock the project into early operations and maintenance requirements. These consent requirements and associated conditions may have considerable whole of life cost implications. Agreement may be reached without due consideration of alternative options that satisfy requirements and offer better whole of life value.

The organisations responsible for network operations and maintenance have considerable experience in asset types, options and the associated whole of life costs. It is recommended that organisations responsible for the planning, scheme assessment, preliminary design and design stages of Capital Projects seek advice from organisations responsible for network operations and maintenance during consent stages to ensure that what is being agreed to reflects consideration of whole of life value.

Consideration needs to be given to the conditions that require ongoing inspection and reporting. In addition to the safety of access, special attention should be given to the appropriateness of the frequencies, type and consequences of non-compliance of monitoring agreed to.

An example of this might be the concept of utilising soakage pits in the motorway shoulder in an area with a predominance of subsurface rock, combined with limited corridor width for stormwater disposal. This option may offer least capital cost, and an easy path for consenting, however to ensure adequate treatment of stormwater to required quality standards the provision of devices with a three monthly inspection and cleaning cycle can sometimes be required. The sum of capital cost and traffic management and cleaning costs over 25 years determined by net present value analysis for the stormwater system could well prove to be higher than an alternative conventional conveyance system to alternative treatment devices that do not require traffic management to maintain.

Capital Projects should aim to have one operations and maintenance resource consent, and this should align with the project Environmental Management Plan.
### Project Deliverables and Timing

A list of project deliverables for the organisations responsible for network operations and maintenance, and the timing of such are included in the table below.

This deliverable list and delivery dates should be included in Capital Project documentation.

<table>
<thead>
<tr>
<th>Deliverable Item</th>
<th>Deliverable Date</th>
</tr>
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<tbody>
<tr>
<td>Project geometric design, in digital version, as Autocad or Shape File, for NZTA Exor network model updates. (RAMM cannot be updated until Exor is updated).</td>
<td>As soon as available, but not later than 3 months before Practical Completion.</td>
</tr>
<tr>
<td>Structural data (bridge data) for NZTA bridge database system (BDS), to enable permits to be issued for overweight/over dimension vehicles.</td>
<td>As soon as available, but not later than 1 month before opening of structure.</td>
</tr>
<tr>
<td>Operational consents and their conditions.</td>
<td>As soon as agreed.</td>
</tr>
<tr>
<td>Building consents.</td>
<td>Not later than Practical Completion.</td>
</tr>
<tr>
<td>Code of Compliance Certificates, Producer Statements.</td>
<td>Not later than Practical Completion.</td>
</tr>
<tr>
<td>As Built drawings, in digital version, as Autocad file.</td>
<td>Not later than one month after Practical Completion.</td>
</tr>
<tr>
<td>RAMM data for all assets collected by NZTA qualified RAMM data collectors.</td>
<td>Minimum one month before permanently opening any section of the Works.</td>
</tr>
<tr>
<td>Notify Stage 4 Road Safety Audit date, for attendance.</td>
<td>Minimum two weeks in advance of audit date.</td>
</tr>
<tr>
<td>Joint inspections programme with network operations and maintenance personnel.</td>
<td>Minimum one month before permanently opening any section of the Works.</td>
</tr>
<tr>
<td>Maintenance boundaries and agreements.</td>
<td>Not later than Practical Completion.</td>
</tr>
<tr>
<td>Asset Owners Manual including O&amp;M requirements for specific asset components</td>
<td>Not later than Practical Completion.</td>
</tr>
<tr>
<td>Snag/Defects Lists</td>
<td>At practical completion and maintained and updated weekly by project personnel until completed and signed off</td>
</tr>
</tbody>
</table>

The organisations responsible for network operations and maintenance prefer that all project deliverables are delivered as digital versions, and not hard copy, for storage purposes. It is recommended that Capital Projects create a suitable secure document storage area for such deliverables that is accessible for project personnel, relevant NZTA staff and relevant staff from the organisations responsible for network operations and maintenance, to enable:

- Timely deposit of deliverables, with version control
- Relevant personnel to view progress on deliverables
- Simple file transfer to occur, with version control
- Tracking of deliverable progress against delivery programme.

Should the Capital Project be unable to create and maintain a document storage area, the organisations responsible for network operations and maintenance will create a web-based site for this purpose.
RAMM and As-Built Data

RAMM Data

A summary of asset information required for updating the RAMM system follows. These criteria are designed to assist Capital Project Managers in specifying the timely capture of such data and in the approved format.

- To enable RAMM data for Capital Projects to be collected, and Route Positions of assets recorded correctly, the Capital Project will require highway and ramp route stations, and interchange and ramp identification numbers to be fixed and agreed in accordance with the NZTA Manual SM051, Location Referencing Management System (LRMS). The Capital Project contract will identify what responsibilities, if any, the project has with establishment of this system for the project. The Capital Project is encouraged to liaise at an early date with the network operations and maintenance organisations, to identify roles and responsibilities and to ensure establishment of the system occurs well in advance of project opening to enable RAMM data collection to be carried out before project opening.

- RAMM data is to be submitted to the accredited individual for RAMM upload in the approved NZTA forms that can be obtained from the NZTA Asset Information Manager – due to constant updating of these forms it is essential that the latest forms are obtained from the source listed.

- RAMM data may also be provided in a digital format using Pocket RAMM databases, although spreadsheets are preferred. Pocket RAMM data could be collected and stored in an off-line “dummy” database before being exported for upload to RAMM to occur by the accredited individual.

- All RAMM data collectors shall be certified to NZTA Level 1.

- All asset fields for new items, highlighted in yellow, shall be completed, unless otherwise agreed by the NZTA Asset Information Manager. If fields are left blank, without permission, data is likely to be rejected.

- Project Managers are to ensure that project boundaries are understood and that all asset information within these boundaries is captured. Exact start and end RP's or ERP's will need to be clearly defined to ensure assets are accurately captured, as well as a clear understanding of Increasing and Decreasing sides of the route in the case of divided carriageway sections. This requires the network operations and maintenance organisations to produce a Network Update Form (NUF) with details of a route change (see LRMS Manual).

- The Network Update Form (NUF) should be prepared 1 month prior to opening, with the detailed data being provided at least 1 month prior to opening.

- Only once an NZTA official RAMM receipt has been received can the project be signed off as complete.

- Consider shifting RAMM data responsibilities to network operations and maintenance organisations.

As-Built Data

- All As Built data should be delivered not later than one month after Practical Completion of the project.

- Design geometric drawing data in the form of plans, long-sections and cross-sections should be delivered at least three months prior to Practical Completion to enable establishment of the LRMS system for RAMM data collection.

Capital Projects should ensure project handover documentation requirements are clearly defined with delivery timeframes, and adequate leverage in the MSQA and construction contracts to ensure delivery occurs on time. Suggestions are a minimum Lump Sum amount (say 1% of Contract total) in the project tender scheduling to ensure the RAMM and As Built data work is given due attention and not ignored or recorded poorly.
Pavements and Surfacing

Whole of Life Cost Considerations

Pavement concepts and designs should consider the following:

• Referring to the New Zealand Supplement to the Austroads Pavement Design Guide for good advice on pavement types and associated risks.

• Undertaking whole of life cost analysis for the evaluation of design options using the risk based evaluation procedures in the NZ Supplement for the Austroads Pavement Design Guide.

• When undertaking risk based evaluation of pavement options ensure risk factors assigned to pavement type options are agreed with NZTA (as at 2009 there are many projects in NZ where this methodology has been used, refer to the network operations and maintenance organisations or David Alabaster of NZTA).

• For construction and maintenance costs evaluation remember to consider the additional cost of traffic management for maintenance activities that is applicable to the class of road being designed.

• For maintenance costs unit rates and traffic management costs refer to the network operations and maintenance organisations, RAMM database historical costs, and Roading New Zealand (RNZ) or it's member organisations for advice related to road class and location.

• Consider historical performance of existing pavements and their structural type in the area when evaluating risk for pavement options.

• Avoid designing grassed medians as the mowing operation is expensive, due to traffic control requirements, and has been shown to cause rutting and localised ponding in the median, loss of support at wire rope barrier posts, and potential for water ingress into pavement sides.

• Consider polymer binders in surfacings to provide extended life in heavy or very heavy traffic situations and/or high stress areas.

• Consider the practicalities of providing specialist surfacings that may require ongoing high maintenance costs to satisfy consent conditions, e.g. 80 mm thick two layer OGPA surface for noise mitigation may initially be cheaper than a noise fence, however long term replacement interval frequency and cost for the 80 mm thick layer to perform as intended and consented, might result in a noise fence being the more cost effective whole of life solution.

Planning and Design Considerations

• Gated median cross over points are useful when full closures in one direction are required during maintenance or emergency activities. Detours during full carriageway closure can result in significant additional travel time for vehicles and congestion in local areas. Having the option of a gated crossover with temporary barriers in a contra-flow traffic arrangement would provide a more efficient option for traffic management and emergency vehicles. Suggested spacing of gated median crossovers is one per kilometre, however this will depend on the alignments of opposing carriageways.

• If existing pavements are being utilised in the final design, check the stiffness of the existing pavement (Falling Weight Deflectometer deflection and curvature) and determine whether rehabilitation or upper pavement stiffening is required to provide the design life required and compatibility with new pavements.

• If widening of existing pavements is being undertaken then the pavement widening should match the stiffness (deflection and curvature) of the adjacent pavement unless a stepped transition zone of adequate width is created to mitigate potential for longitudinal cracking at the interface, or alternatively...
the existing pavement is rehabilitated to have similar stiffness characteristics as the new designed pavement.

- If widening of existing pavements is being undertaken then the existing pavement depth and subsurface drainage characteristics should be determined to ensure that the new design does not create ponding of subsurface water within the existing pavement area. Examples are new impermeable pavement types constructed to subgrade level and located adjacent to and downslope of existing pavements with a granular drainage layer, which would then require a subsoil pavement drain at the new/old interface.

- If cement bound pavements are an option, consider what measures are to be included in design and/or construction techniques to mitigate slab warping and/or reflective cracking in the pavement surfacing.

- Consider local aggregates and contractor construction and maintenance capabilities in design options.

- Design thickness of asphalt layers should be three times the mix nominal size to allow for construction tolerances and to ensure a minimum of 2½ times mix nominal size is achieved.

- Thin asphalt layers, <45 mm, can be significantly permeable. When used over unbound granular layers, design to include adequate waterproofing below the asphalt layer, to maintain water resistance and associated shear strength in the unbound granular layer, in the form of sufficient chip seal layers and/or bitumen emulsion added to the basecourse aggregate.

- Review potential aquaplaning issues where carriageway is widened or geometry changed such that drainage path length is increased.

- Consider all areas from which water might enter a pavement:
  - The sides, subsurface flow from batter slopes
  - Unsealed shoulders in super-elevated sections
  - Through the surfacing (thin asphalt surfacing and chip seals are not waterproof), and particularly through paving joins and cracked areas
  - Upward from the subgrade

- In wide motorway sections, with greater than 3% longitudinal gradient, water within the pavement will tend to flow along the alignment rather than across it. In steep areas (greater than 5% longitudinal gradient) granular pavement saturation can occur leading to loss of shear strength during wet weather. Consider design of herring bone subsoil pavement drains at regular intervals at the top of the subgrade layer to provide periodic release of the entrapped pavement water.

- Provide adequate and maintainable drainage systems with positive drainage to prevent water ingress, and remove water from, permeable pavement layers.

- Where edge beams are used in unbound granular layers, check whether the depth of these will affect pavement layer drainage. In the case where such edge beams are constructed to subgrade level provide large pavement layer drains to remove trapped water.
Structures

Whole of Life Cost Considerations

- Standardisation, where possible, for all structure joints to reflect best practice and operational knowledge from the network operations and maintenance organisations, to reduce outages, and the need for resetting and tightening of holding down components.
- No abrupt changes in longitudinal grade at joint locations. Longitudinal profile should follow design geometrics, and a maximum joint roughness of 50 NAASRA counts should be achieved.
- Review of component design to allow for fatigue long term.
- At concept design stage consider reducing the number of joints required.
- Allow for future inclusion of structural fittings for increased post tensioning to allow increased loading.
- Whole of life review of future capacity requirements for both traffic services and pedestrians.
- Consider whole of life value if considering partial prestress in design, which may allow cracking to occur with associated future maintenance and operation cost issues (refer to network operations and maintenance organisations for data on experience with poor performing examples that saved capital cost but added considerably to O&M costs).

Planning and Design Considerations

Drainage

- Standardisation of components, where possible, for surface drainage to aid efficient cleaning and repair.
- Review of access to secondary drainage system adjacent to structures, e.g. soak pits or treatment devices, to address potential damage during access and to facilitate effective cleaning and structural inspection.
- Appropriate inlets to ensure structure deck catchment capacity is adequately addressed for predicted return periods with appropriate mainline capacity.
- Design of a water catchment for under joint collection and reticulation to main storm water systems should be self cleaning and easily maintained. The installation should be able to cope with the expected flows and direct them into the drainage system.
- Main surface drainage should be captured before the structure’s expansion joint and not be required to go over or through the joints.
- All catchpit grates to have a frame, and not required to be bolted down with small fine threaded bolts.
- No scupper drains that need blowing or washing out. If installed they should be self cleaning.
• Finger joints to have drainage channel with access for cleaning. Hanging rubber skirts to have a cross fall.

• Avoid the installation of drainage systems and elements that require safety belt or specialist access. E.g. Newton No.1 Bridge drainage channel is outside the MB5 Barrier.

• Avoid level drainage pipes.

• Consider providing a system without sumps on the structure, only surface grates to prevent debris blockage of pipes, and provide all sumps and treatment devices off the structure in an area with easy access.

**Structure Inspections**

- Allow for access staging to carry out general and detailed inspections to be permanently attached to major structures (e.g. on the new Newmarket Viaduct).
- Construct access manholes in box sections on all concrete structures to allow permanent lockable access for internal inspection processes.
- Internal reticulation of lighting and power outlets with the appropriate security for structures where internal inspections and maintenance work may be required.
- Bird proofing should be installed where there is the possibility of pigeons or birds nesting/roosting or gaining access to the internal services and boxes.

**New Structure Components**

- Sweeping and maintenance of joints needs consideration in joint design as detritus accumulates in rubber expansion sections and reduces life.
- Appropriateness of coatings for lighting columns, holding down bolts and bearings, side protection review.
- Joints should be programmed to be reset possibly within defects liability period, if required, after elastic shortening and creep.
• Holding down bolts should have sufficient component room to allow operational movements to take place without stress.

Other Considerations

• Allowance for projected utility services components and associated maintenance access requirements.
• All of carriage way and associated shoulder areas should be accessible by the rubbish sweeper.
• All bridge joints to be steel edged with concrete or similar nosing. This prevents damaging the joints when resurfacing.
• Concrete nosing to be cast integrally with joint steel edge component.
• Do not use epoxy type material for nosing.
• Three or four bolts to be used on guardrail posts. This aids installation and repairing when required.
• No necked bolts unless specifically treated and installed e.g. galvanised and greased.
• No small recesses that overlap on to substantial components e.g. a panel sitting on an abutment, this can create maintenance issues.

• Investigate appropriate clearance for structures both on network and Local Authority underpasses.
• Full consideration for side security protection for both pedestrians and underpass motorists with the installation of debris screens appropriate for the particular environment.
• Appropriate design of screens to allow access by maintenance staff and other stakeholders (e.g. Local Authority and Railway).
• Review side protection requirements particularly when bridge is being widened or modified.
• Avoid recesses that create maintenance problems.

• Sealed Over Joints. These are shown in the design of bridges where the movement is very small and sometimes where the movement is practically zero. It is important to prepare the joint correctly.
before sealing or asphalting over the top. The use of products such as Polymer Modified Bitumen, PMB 400, or geogrid is not satisfactory because this will lead to cracking of the surfacing. It is necessary to cover the joint before surfacing with a high-strength multi-laminate tape bandage that is held in place by priming or by self-adhesive action. Design surfacing thickness to handle movement expected.

- When widening bridges the same joint type as existing shall be used at existing joint locations.
- Naming of new structures. Project designers to check with NZTA that the new name proposed does not duplicate existing names. E.g. The network has three Hillcrest bridges and three Puhinui Stream bridges. This confusion an be avoided at design stage before names are added to project drawings.

**Overweight Vehicles**

- Unless otherwise specified bridges shall be designed to carry HN-HO-72 loading in accordance with the NZTA Bridge Manual.
- Design shall not restrict overweight vehicles to certain travel paths over the structure
- Additionally, consider local effects of the footprint of individual overweight axles on components.
- The overweight design shall include all relevant components of the bridge including:
  - Foundation and sub structure
  - Superstructure
  - Approach embankments and all associated extra retaining structures

**Over Dimension Vehicles**

- Where specified, the bridge shall also be designed to carry specific over dimension vehicles.
- All bridges shall be designed and detailed to allow the passage of over dimension (6m high and 10m wide) & overweight vehicles either over or under the structure as specified in the Principal’s Requirements.
- In particular the following issues shall be addressed:
  - Deck width and vehicle tracking swept path
  - Clearance dimensions of 10m wide by 6m height
  - Where it is necessary for roadside furniture to be removed to allow passage of vehicles design of all such items shall allow for easy removal and replacement

**Handover Considerations**

**Production of all As-Built Information**

- Live load and overweight capacity calculations, should be formally handed over at least one month prior to opening. These should be incorporated as a deliverable in the Contract schedule. Production of all structural data on the standard forms for the Bridge Data System (BDS) to allow assessment of effects of passage of overweight vehicle from the first day of operation.

**Bridge Data System (BDS)**

- Complete BDS forms, in line with NZTA Bridge Maintenance Manual database operations requirements, shall be provided to the network operations and maintenance organisations one month prior to opening the structures to public traffic.
Traffic Assets

Whole of Life Cost Considerations

Lighting

• Use twin arc lamps. Longer life, less traffic management required over life of bulb.
• Control Monitoring System - use this technology for remote control of lamps to allow dimming and asset management decisions with respect to life of bulb and carbon footprint monitoring.
• Consider use of the central median for location of light columns. Removes a road side hazard and allows easier future widening.

Barriers

• For new concrete barriers preferred minimum reveal is 30 mm, to allow a pavement surfacing overlay (standard permits 0 mm minimum to 80 mm maximum).

Planning, Design and Construction Considerations

Lighting

• Slip base height. Ensure correct slip base height in design and installation. Consider location of base of pole relative to swale drains so that if the drains erode or are regraded they will not compromise the slip base height/performance.
• Ground stub and shear base protection. To comply with NZTA requirements both stubs and shear bases require corrosion protection whether or not they are founded in concrete.
• Review lighting levels where carriageway is widened to ensure compliance with modern standards, as existing lighting may be deficient in the modern context.
• Lighting column cover plates in median. Use design used on Manukau Harbour Crossing project to standardise cover plates.
• Consider location of Montrose (or similar) boxes and power supply infrastructure. Outside of clear zone or protected, and include a protected hard stand for maintenance vehicles to stop safely.
• Consider location/design of aprons/structures/slopes of drainage infrastructure relative to barriers and slip bases, so that vehicle characteristics/behaviour is not changed prior to impact.
• Consider lighting level at interchanges and intersections carefully.
• Integrate lighting, traffic signals and street names at interchanges and intersections on joint use poles to minimise the number of poles, reduce clutter and maximise visibility to signal displays.
• During construction, attention is required to ensure that a high standard of illumination is provided. Night time is a high risk period on motorways and in particular road work sites. Design documentation to show what appropriate level of lighting to be provided during construction.

Barriers

• Ensure Length of Need requirements are met at the start of all barriers.
• Ensure full run-out provision for the length of guardrail selected.
• Test level requirements for bridges to be agreed and implemented (generally TL5 for motorways including bridges).
• Ensure sufficient deflection available behind barrier to any lighting columns or other infrastructure.
• Create a hard stand area behind the trailing end of side barriers with sealed access from the shoulder:
  o If the location has other infrastructure and/or assets that require regular access (check with the network operations and maintenance organisations)
  o That is suitable for VMS signs and maintenance vehicles (in areas where VMS signs may be deployed)
• Refer to section Corridor Assets (Landscaping) for low maintenance considerations around barriers.
• Ensure major hazards with high severity for errant vehicles are protected even if the object is outside the clear zone, e.g. ponds, gullies, bridge piers and abutments.
• Gated median cross over points are useful when full closures in one direction are required during maintenance or emergency activities. Detours during full carriageway closure can result in significant additional travel time for vehicles and congestion in local areas. Having the option of a gated crossover with temporary barriers in a contra-flow traffic arrangement would provide a more efficient option for traffic management and emergency vehicles. Suggested spacing of gated median crossovers is one per kilometre.

Line Marking
• In accordance with NZTA Specifications P/30 and M/24, NZTA Auckland Local Procedure Manual and (with some local exceptions) the Manual of Traffic Signs and Markings.
• All motorway and rural edge lines to have audio tactile profile (ATP) ribs at 500 mm centres.
• All motorway lane lines to have ATP ribs at 250 mm centres.
• All rural road yellow centrelines to have ATP ribs at 500 mm centres.
• Motorway ramp edge and lane lines do not require ATP ribs.
• Use 150 mm wide edge lines at ramps (not the 100 mm wide as per Manual of Traffic Signs and Markings).
• Consistency on the network is important and standards regularly change. Please check line marking designs with the network operations and maintenance organisations to ensure network consistency.

Signage
• Consistency of sign size is important. Generally, all small ground-mounted signs are to be 750mm to 900mm in diameter of width. Larger or smaller signs used are to be consistent with other network treatments.
• All ground mounted signs to be mounted 2.0 to 2.5m from ground to bottom of the sign.
• Pay attention to signs spacing, order and height at on and off ramps. Use Manual of Traffic Signs and Markings for layout spacing and order of signs.
• All dedicated ramp signs e.g. no walking/no cycling, motorway begins, motorway ends, wrong way, are to be mounted 1.0 to 1.5m from ground to bottom of the sign.
• Protect all high-mounted gantry or large-structure-mounted signs with Dew Guard.
• Protect all small-ground-pole mounted signs with Graffiti Guard.
• Ensure all minimum height clearances are provided at overhead signs.
• Use wide observation angle material on all Motorway Guide Signs.
• Correct use of sign sheeting (High Intensity versus Diamond versus Fluoro)
• Fluoro-yellow to be used on all vulnerable user signs.
MOTSAM provides a combination of requirements and guidelines for signage. There are various criteria that need to be satisfied when finding the ideal location for a sign. Often, space is an issue. Consider the wider picture, too many signs create visual clutter and reduce a motorist’s ability to take-in information. Whilst ensuring messages are adequately displayed, consider carefully the spacing of signs and the number of signs you place at one location. Make every attempt to provide a sign so that a motorist can easily ‘pick it out’ from the visual environment. Check signs are located sensibly, for the benefit of road users, and, if necessary, agree with NZTA local variations to MOTSAM for this purpose. We want to avoid creating circumstances like below, as the motorist will likely be put off reading any message:

![Congestion of signs at Hobson St on-ramp](image)

**Other**

- Refer to the Safety Deficiency Database and CRS Studies to identify all previously identified deficiencies.
- Wherever possible design should seek to address and rectify existing issues to modern standards.
- The network operations and maintenance organisations will supply traffic safety deficiency information from databases upon request.
- The network operations and maintenance organisations expect to be advised of all traffic safety audits and fitness for purpose inspections in order to ensure that:
  - Safety auditors are aware of recorded existing safety deficiencies
  - The network operations and maintenance organisations can participate as observers in safety audits
Traffic Operations

The definition of Capital Projects in the traffic operations context is that a capital project involves any addition or significant alteration to the asset. This definition needs to include addition of Intelligent Transportation System (ITS) kit, communications facilities. These traffic operations projects are often delivered by staff outside of the capital projects team in NZTA Auckland region, and are often funded from outside of those project allocations e.g. from national allocations. Many of the ITS projects can significantly impact the existing assets and have a resultant effect on traffic performance and performance of existing ITS assets. The network operations and maintenance organisations can offer valuable advice which will allow a better “project” to be delivered.

The network operations and maintenance organisations need to provide balanced advice, and not just focus on one aspect. Recent (2009) examples of where improved safety has been achieved with little thought about ongoing costs and operational traffic efficiency include SH01 Ellerslie Panmure Highway Interchange roundabout lane marking, and the contra-flow provisions at the Johnson Hill Tunnels (SH01 Orewa to Puhoi section).

Traffic Management Unit (TMU) and ATOMS (Auckland’s Traffic Operations Management System) share a Service Level Agreement (SLA) with NZTA and Auckland Motorway Alliance (2009). They have various operational requirements in addition to concerns related to the ITS Assets.

Below is a list of Traffic Operations Assets and related issues that require operations and maintenance considerations:

- Whole of life cost considerations in design and specification of assets
- Emergency telephones.
- Lane control signals.
- Variable Message signs.
  - Permanent
  - During construction for motorist advice
- CCTV coverage.
- Traffic Detection and Counting Infrastructure (existing and required).
  - Includes maintenance locations
- Accessibility for maintenance.
- Cabinet location.
- Cabinet access and modification protocols.
- Electrical compliance certification (and other compliance issues).
- Gantry design and location (access, ability to work above live lanes for routine maintenance, security).
- ITS specification and location.
- Connection to communications (available bandwidth/fibres, standards and processes).
- Design for ITS maintenance; accessibility, ease of maintenance, avoiding the need for temporary traffic management (TTM) for routine activities.
- Supply of critical spares and ongoing provision of consumables.
- Design for traffic flow (especially merges).
- Incident response provision.
- Constructability (especially TTM).
- Traffic flow and TTM requirements, and methodology during construction
  - Impacts on ramp signal operations – both directly and due to changed traffic flows
o How will the new facility be opened?
• Traffic Signal Design (TMU).
• Maintenance and defect liability periods.
• Warranty provisions and response times for defect rectification
  o Manufacturer/installer requirements during warranty period
• Maintenance requirements (especially where maintenance period is not concurrent with Defects Liability Period).
• Type Approval of ITS items (Factory Acceptance Test and Site Acceptance Test requirements), compatibility with existing NZTA assets.
• Level of Service and requirements for maintaining operations of existing assets.
• Third party suppliers and requirements (e.g. TelstraClear for the fibre communications backbone).
• Graffiti prevention requirements.
• As Built and handover requirements (e.g. file types, prior to practical completion).
• Commissioning strategy and programme, including staged completion requirements
  o Signal commissioning, acceptance and fine tuning (including ramp signals)
  o Publicity and communications
• Provision for Over-Dimension vehicles.
• Provision for NZ Police activities (Patrols, Commercial Vehicles Investigation Unit and Booze Bus operation).
• Emergency stopping shoulders.
• Emergency procedures (both during construction) and after opening
  o Detour routes
  o Contact staff
  o Responsibility matrix
  o ATOMS procedures
• Operations and Maintenance Manual – Content, and delivery one month prior to opening, as part of Asset Owners Manual
  o ATOMS briefed and ATOMS systems operational prior to opening to traffic, including staged completions
  o Call-out lists
  o Detour routes changed/identified (manuals updated by network operations and maintenance organisations)
  o Design assumptions document (to assist development of detailed operating procedures in the future)
  o Risk register – asset and operational.
• Asset data handover (including RAMM, warranties, maintenance schedules, supplier details).
• SNAG closeout process prior to, and following opening to traffic
  o e.g. final cleanup prior to handover to remove construction detritus
• On-going service agreements for installed kit and items.
• Maintenance boundaries defined.
• Speed limits locations agreed to allow gazetting prior to removal of TTM.
• Motorway / State Highway declarations – requirements of NZTA to allow these to occur in a timely manner.
• Operational Involvement and/or review of Stage 3 and 4 safety audits to ensure operational aspects considered.
• Access keys and arrangements for ITS assets.
• Public Transport routes identified and allowed for in temporary and permanent works (incl. TTM).

Refer to the network operations and maintenance organisations for guidance/requirements on the above.
A concept of Traffic Operations needs to be developed at the planning stage of capital projects. This concept will need to be reviewed and updated as a Capital Project progresses. The network operations and maintenance organisations can assist with this.

Design for temporary traffic management aspects during construction needs careful and appropriate consideration. Examples are:

- When is it acceptable to reduce lane widths to 3.1m
- Removal of line markings
- Sight screens
- Appropriate storage of plant and materials on site

**Traffic Signals**

- Consultation with NZTA Highway Network Operations traffic and safety personnel during planning, design and construction
- Preparation of traffic signal controller software, 6 week lead time

**ITS Equipment**

*Whole of Life Considerations*

When designing a deployment of ITS field equipment the whole life of the equipment must be considered, the deployment of unsupported equipment types and systems can have significantly impact ongoing costs and reliability as do maintenance access issues.

It is important that there is consistency of hardware and communication protocols being integrated in the field and that the equipment is the current model and is supported by the manufacturer and more than one local supplier.

If a new type of equipment is proposed it must go through type approval testing by NZTA and the network operations and maintenance organisations to ensure compatibility with existing systems and functional requirements for operations.

It is acknowledged that the ITS field is driven by constant technical advances and thus the network operations and maintenance organisations can provide guidance for any issues that the contractor may perceive.

It is very important to provide safe maintenance access for ITS installations as the sites are often critical to the safe operation of the road corridor and rapid access to the asset without the requirement of traffic management.

**Operational Requirements**

During the design phase it is critical that the ATOMS operation centre, TMU and the network operations and maintenance organisations are consulted on the proposed locations of new equipment to ensure that the equipment locations are both serviceable and provide the ATOMS centre and TMU with an asset that fits their requirements for use.
ITS Hardware

Full Body CCTV Cameras
Full Body CCTV Cameras should meet the minimum specifications below:

- Pelco D/P protocol compliant
- Camera C/CS mount
- Camera = ½ CCD
- Lens C/CS Mount
- Lens =/> 200mm
- Focal length F1.8 – F1.2
- Camera heater function
- Wiper function
- Camera environmental attributes meets NIWA area requirements.
- Video output = PAL
- Video Resolution =/> 540 TVL
- Min Lux rating =/> 1.2 @ F1.2 colour
- Camera housings =/>IP55
- Remote receiver configuration
- Remote/Site camera configuration

Emergency Motorway Telephones (EMT)
Currently (2009) the network operations and maintenance organisations only support Clearsonics GSM VCE Emergency Telephones due to the EMT self testing services provided by the Clearsonics Wayphone manager environment.

When deploying EMTs the following issue must be addressed:

- Solar power with battery backup is the preferred power supply
- A single button for operation on the front panel
- Should be lighting column mounted or pedestal
- The user should have free unobstructed access from the road
- Offset between phones to be 1200m +/- 200m unless otherwise required due to road design such as bridges or tunnels
- EMTs must be installed at junctions
- Pedestal phones to be sheer base
- Phone colour is to be Dulux X15 Orange
- Phone lettering and numbering to be advised by the network operations and maintenance organisations
- For pedestal mounted phones please contact the network operations and maintenance organisations for standard plinth drawings.

The network operations and maintenance organisations will supply SIM cards for all new phones and will undertake configuration of the new phones and head end system.
Please allow 28 days for the supply of SIM cards and 7 days for phone and head end configuration.

Lane Control Signals

- UPS must be fitted in local control cabinets
- Entry into sign and connectors must be unobstructed for maintenance purposes
- Sign must be serviceable with the requirement to remove the sign from its mounting
Vehicle Detection Systems

Radar.

At present radar detection devices are not supported by NZTA however they may be deployed as temporary measures to collect data from a road environment which may be changing due to lane reconfiguration during construction.

Inductive Loops.

All loop reinstatement and new site installations to meet NZTA Specification, TNZ P/28 November 2006 for all specification requirements with the exception of loop layout dimensions appendix drawing 1. Clarification of details and or requirements can be taken up with the network operations and maintenance organisations in regards to dimensions for TDM, ATMS and TMS loops.

All loop locations and Toby boxes to be marked on site, use of a Reflective Road Pavement Marker (Contact network operations and maintenance organisations for colour of RRPM) to highlight the centre line of the loops and Toby box if at different locations; RRPM to be placed on the LHS of carriageway edge beam or suitably visible location.

Structures and Roadside Furniture

ATMS Cabinets

The network operations and maintenance organisations promote the use of a standard ATMS cabinet which is proven in the field, details of this cabinet are available from the network operations and maintenance organisations upon request.

Cabinet details are as follows:

- Cabinet colour to be Karaka Green
- Anti graffiti coating
- Electrical warning stencilling to be administered to all cabinets
- Fibre optic radiation stickers to be administered to all cabinets where fibre optic is present
- 19’ internal racking
- Padlock security
- The network operations and maintenance organisations to supply replacement padlocks when transitioning to maintenance phase
- Front and rear door access
- 1m clear access around the cabinet to be provided
- Fibre optic splice trays are ATG-8
- An equipment shelf is to be provided for the mounting of non 19’ rack mount equipment
- 19’ fan shelves to be installed in sites where significant heat exposure or reduced air flow is expected
- Transmission equipment to be specified by the network operations and maintenance organisations or NZTA
- IMV Match 1500RM UPS or suitable alternative to be installed in node, LSU and VMS cabinets.
- UPS to be SNMP compliant
- ABB distribution box with RCD protection to be installed in all cabinets
- All cables to be glanded
- All cable entries to be covered upon completion of cable works
• All cabinets to be subject to electrical Certificate Of Compliance
• “Half” or “Mini” cabinets are not supported by the network operations and maintenance organisations

Further details for plinths and cabinet standards are provided by network operations and maintenance organisations upon request

**CCTV Poles**
• Poles must be of a folding type unless otherwise required
• Installation to consider the weight of the CCTV camera to ensure correct balance and fixings
• Poles to be slip base
• Standard poles are to be 15m (including lightening rods)
• Poles to meet New Zealand standards for galvanisation
• Pole to be a maximum of 10m from the ATMS cabinet

**Gantries**
• Gantries must allow unimpeded access for the maintenance crew
• Gantries must be secured against unauthorised access
• Gantry handrails and toe boards must comply with the New Zealand building code
• Maintenance access to the walkway must not be from a cherry picker or other elevated platform
• Internal access to all electric signs must be from the back
• Internal sign access must not be impeded by the gantry structure

**Services**

**Ducting and Pits.**
• Pits are to be standard NZTA pits
• Pits to be suitable for application, where required trafficable pits are to be installed.
• Pits and conduits cleaned, unblocked prior to hand over
• Pits are to be secured
• All ducts are to be supplied with draw strings
• Ducts to have long radius bends.
• Duct entry into pits to be sealed
• Ducts to be installed as per NZTA standards
• Accurate As Built information for all ducts and pit locations to be provided

**Handover Procedures**

**Procedure**
• Preparation of traffic signal controller software, 6 week lead time
• The network operations and maintenance organisations request that a minimum of 2 months advanced notice of proposed handover be given to allow for site inspections. The network operations and maintenance organisations will report to NZTA on any issues found during such inspections.
• Inspection of signals and commissioning to be attended by TMU representative.
• Maintenance arrangements. Preference is to hand signals to area signal maintenance contractor as quickly as possible. Only defects and warranty issues would be referred back to the construction contractor.
• Training can take up to 8 weeks due to shift work patterns.
• Support agreements are to be established prior to project closure.
• Maintenance call-out procedures are required before opening.
Documentation

- As-built drawings (refer to network operations and maintenance organisations for specifications)
- Relevant manuals and technical documentation for all hardware
- Operations manuals required 1 month before opening to traffic
- Completed FAT documents
- Completed SAT documents
- All items to be entered into RAMM, data collection by NZTA accredited RAMM data collectors
- GPS references for all sites
- COC documents for all electrical installations
- Complete details system configurations
- Source code for any PLC or programmable devices.

Spares Handover

- 10% working spares for all items installed to be supplied to maintenance contract
- Critical spares to be identified and suitable level of spares to be purchased
- A list of all spares to be handover is to be supplied, including serial numbers, manufacturer's details, product suppliers and any current warranties.
Corridor Assets

General

Much of this section is special requirements for Auckland’s motorways, as the “standard” NZTA requirements are not always appropriate for achieving performance measures sought by NZTA for this network.

Specifically this document focuses on creating, maintaining and enhancing the aesthetic appearance of the motorway/highway corridor on the basis of whole of life and best value for money principles. This includes landscape considerations, including the ongoing maintenance requirements of vegetation and physical structures in and/or accessed from the corridor. A list of some “Key Assets” that are within the corridor are included in Appendix 1.

The following documents are some of the NZTA documents involving corridor assets (and other assets):

<table>
<thead>
<tr>
<th>Document Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional Services Forms (PSF) Particularly PSF2a – Checklist for Statutory Approvals, Consents and Agreements, PSF 3g Capital project Handover Checklist, PSF 15 – Maintenance Responsibilities During Construction</td>
<td>March 2009</td>
</tr>
<tr>
<td>Professional Services Guidelines (PSG) relating to the Minimum Standards (Series) above</td>
<td>March 2009</td>
</tr>
<tr>
<td>Various Guidelines (e.g.) Guidelines for Highway Landscaping SP/M/020</td>
<td>December 2006</td>
</tr>
<tr>
<td>Draft: DZ6806/V1.14 Acoustics – Road traffic noise – New and altered roads</td>
<td>2009?</td>
</tr>
</tbody>
</table>

Main attributes

The main “Attributes” (as listed in PSG 15) to be included under Corridor Assets, or otherwise referred to, are:

- Cycleways/pedestrian facilities
- Graffiti Guard
- Landscaping
- Landowners
- Legal Boundary – Draft, NZTA Maintenance Boundary
- Resource consents – Ongoing (PSF 2a)
- Retaining walls (not included under Structures), Noise Walls
- Roadside Furniture
- Social and environmental management
- Stakeholders (other) with ongoing maintenance responsibilities
- Utilities/services
- Other
This does not include addressing the impacts contained in the NZTA 2008 Environmental Plan which also need to be considered and addressed where appropriate.

Stormwater requirements are separately addressed in this document, however the access to, and maintenance of, stormwater assets within the corridor (e.g. swales, plants and ponds) need to be considered as part of the overall aesthetic considerations.

All areas of the corridor should be included in a landscaping plan that identifies ongoing maintenance requirements including areas to be maintained by weed spraying, and concreted areas. This is related to future costs expectations, with the details being included in an Asset Owners Manual. Two stage planting programmes should be clearly identified and include post handover activities and costs likely to be incurred by the network operations and maintenance organisations.

Similarly, a Graffiti Management Plan is required to ensure all surfaces are assessed for potential graffiti vandalism and surfaces selected for treatment are protected, from the moment they are installed, with products and quality management procedures complying with NZTA specifications. This includes addressing how graffiti will be removed (e.g. avoid having to use a cherry picker and two attenuators to get access to a site to remove graffiti). Ongoing maintenance costs of graffiti coatings need to be included. This includes management of the capital project contractor’s plant and site. This is discussed in detail in Appendix 4.

Allowances for existing and future utility services, including Local Authority piped services, within the corridor should be made. This includes consideration of agreements NZTA has made with others about future use of motorway/highway land. These areas, including access, should be identified in the planning and design stages. Where additional lanes are to be added at a future date, appropriate allowances should be made to avoid the relocation of existing or future services, including motorway lighting.

Access to utility organisations, Local Authority and NZTA assets, chambers, manholes, ponds, cell towers, should, if possible, not be from the motorway. If motorway access is unavoidable, how these assets will be accessed without unnecessarily incurring significant traffic management costs, reducing efficiency or safety needs requires consideration. This could include consideration of safe deceleration and acceleration needs.

Access to the network motorway corridors will be subject to the National Code of Practice for Utilities’ Access to the Transport Corridors, 2009.

Maintenance responsibilities and related matters during the construction period including the defects liability period should be agreed prior to the tendering of any physical work contract.

The corridor should look “good” during the defects liability period. This will require a corridor management plan designed to ensure plants and other assets are maintained for that period.

The reasons plants fail to establish during the defects liability period should be investigated before the same plants are replanted. They may not be suited to that particular area for a variety of reasons.
Whole of Life Cost Considerations

- Vegetation maintenance requirements/costs should be minimised.
- Landscaping designs based on sound (whole of life) asset management principles fully supporting NZTA and the network operations and maintenance organisations visions and objectives. This should include all costs associated with the ongoing maintenance of the corridor including traffic, litter, stormwater and graffiti management.
- As part of this process future operational, maintenance and rehabilitation/renewal costs for at least 20 years should be estimated to identify the best whole of life value in design options. Traffic management costs and cost of any road user delays on the network should be included in these estimates.
- Seek advice on current operations and maintenance costs from the network operations and maintenance organisations, to enable designers to determine realistic estimates for whole of life costs, especially for motorways where the NZTA publish costs that might not reflect the actual costs.
- Landscaping designs recognising long term requirements to maintain and replace plant species. Some plants have short life cycles, (e.g. Whau, five year), and are not recommended.
- Grass mowing should be able to be carried out with a tractor mower, and ideally without the need for significant traffic management. This includes mowing in planted areas.
- Areas of grass that require weed eater maintenance should be avoided as they are costly to maintain and present a hazard to maintenance crews and possibly motorists. This includes steep banks and grass under guard rails (refer photo of steep bank Appendix 2).
- Areas to be maintained by spraying should be avoided.
- Planting rows of trees “diagonally” makes tractor mowing very difficult and potentially unsafe (e.g. risk of tractor mower rollover on Mt Roskill section of SH20 with diagonal planting on batter slope).

Planning, Design and Construction Considerations

The design of corridor assets should include holistic future maintenance considerations for all assets within the motorway/highway corridor boundaries (excluding traffic lanes and shoulders). This includes considering the design and particularly the location of:

- Structures (including gantry signage).
- Graffiti prevention measures/coatings.
- Noise management devices (fences or bunds).
- Inanimate objects (e.g. urban design features such as the reptile at Khyber Pass Road).
- Stormwater assets including swale drains.
- Safety assets (barriers, lights and signs), because they have to be safely accessed to be maintained and/or maintained around.
- Assets of others e.g. power lines, rail corridor, cable ducts.
- Boundary fences and type of fencing – avoid wire mesh, timber fences are better to deter animals/people.

The design should also be reviewed by NZ Police, which requires provision for “safe areas” for Incident Management related activities and consideration of areas for Police to be able to stop vehicles.

Consideration should also be given to the potential adverse impacts of carrying out inspection, operational and maintenance activities. E.g. impact on network efficiency through lane closures. Some of these activities may be carried out by non NZTA organisations such as utilities organisations within corridor access.

Other considerations:
• Motorways/highways to look great (NZTA’s two Visual Quality objectives).
• Special treatment areas and areas with “wow” factors where appropriate.
• Identification and enhancement of specific features that add value aesthetically.
• Safety of maintenance crews not compromised.
• Safety of vehicle occupants (driver sight lines and risk of tree toppling) with fully grown plants/trees.
• Addressing all the impacts identified in Part 2 of the NZTA June 2008 Environmental Plan. Particular attention to be given to 2.11 Visual Quality.
• The network operations and maintenance organisations Environmental Management Plan(s) should be requested and referred to.
• To have good relationships with neighbours – noise, views and air quality.
• Crime prevention through environmental design (CPTED) review to ensure that areas accessible to the public are “safe” and opportunities for graffiti, vagrants and other criminal activities are minimised.
• Timing of the landscaping activities and consideration of the designed landscaping maturity at the end of the defects liability period. Early removal of pest plants, bio-remediation of poor or contaminated soils and early planting is encouraged.
• Appendix 4 of Guidelines for Highway Maintenance has some useful information but may not always be appropriate for Auckland South motorway network.
• The network operations and maintenance organisations have considerable experience of what works well and what does not in the motorway and highway corridors, and in particular historical experience with past capital projects. These organisations should be invited to contribute to concept and later design stages.
• Surfaces deemed prone to graffiti attack, such as noise walls, should be screened by plantings.

Appendices 2 and 3 have specific vegetation guidelines and further considerations.

Management of Pest Plants

There have been issues with pest species being introduced to an area through motorway plantings and/or the mulch used (e.g. brush wattle is now present in SH18 and at SH01 north of Orewa). The following outlines pest plant management strategies and actions for Capital Projects.

Introduction

NZTA is required to control pest plants on their land through Auckland Regional Council’s Regional Pest Management Strategy (RPMS). Pest plants to be controlled have been specified by the ARC. A pest plant management plan approved by ARC is maintained by the network operations and maintenance organisations. The plan recognises that to successfully control pest plants and comply with the RPMS, NZTA needs to address pest plants on all its land and potential cross boundary issues. There also needs to be consistency in NZTA’s approach to pest management.

Capital works projects can harbour pest plants. Generally, land that is being affected by Capital Works lies under the management of the Capital Works team while the network operations and maintenance organisations maintain any motorway that is still being used by the general public as part of the state highway network. To ensure NZTA are compliant with the Regional Pest Management Strategy during both Capital Works and Network Operations it is recommended the following protocol is implemented.

Pest Plant Protocol

Design:

Under Rule 18.2.1.1 c. in Auckland’s RPMS, NZTA shall not distribute by any means, any species listed in their pest plant management plan or otherwise act in such a way to encourage or cause the propagation or
multiplication of any species listed in their agreed management plan. There are a number of species that have previously been used in highway landscaping design that are listed in the RPMS. These include Agapanthus (*Agapanthus praecox*; *A. orientalis*) and English Ivy (*Hedera helix species*). Capital Works projects are to ensure species specified in the RPMS are not included in any landscape designs.

Construction and Handover:

- **Pests are to be controlled using methods approved by ARC and agreed upon by the network operations and maintenance organisations.**
- **The use of herbicides is to be in keeping with NZS: ‘NZS 8409:2004 Management of Agrichemicals’. Rules in PARP:ALW Chapter 4a which target discharge to air are to be adhered to.**
- **Land that has been purchased by NZTA specifically for a Capital Works project shall be cleared of all pest plants, as listed in the approved pest plant management plan, before works begin. This is to reduce the potential spread of pests through excavation and placement of potentially contaminated fill (e.g. pest plant seeds or fragments that could establish in new areas). Ideally pests are to be controlled before they have flowers or are seeding. Follow up control may be necessary.**
- **Once handed over to Capital Works, the responsibility for maintaining the area pest-free is the responsibility of the Capital Works project team unless otherwise agreed between Capital Works Project Team and the network operations and maintenance organisations. Follow up inspections are to be undertaken at regular intervals at no less than four times per year. Any follow up pest control required shall be specific to the species of plant being eradicated and is to adhere to the methods approved by ARC and agreed upon by the network operations and maintenance organisations.**
- **Where pest plants lie on the boundary of Capital Works projects the network operations and maintenance organisations will undertake pest control unless otherwise agreed.**
- **Any materials brought on to site (e.g. aggregate, fill, chip mulch) are to be free of pest plant contaminants that are able to potentially germinate and establish. Quality Assurance documents are to be provided stating this. Any mulch that has a pest plant component in it (e.g. chipped monkey apple) is to have been aged as per industry standards to ensure there is no risk of pest plants establishing.**
- **On completion of the Capital Works project the area is to be inspected for pest plants by the network operations and maintenance organisations and ARC. If pest plants, as listed in the approved pest plant management plan, are present the Capital Works team are to control these to the satisfaction of the network operations and maintenance organisations before the area is handed over to NZTA Network Operations.**

Defects Liability Period:

Capital Works are to include a clause in all landscape contracts that pest management is to be included in the defects liability period maintenance programme. On handover to NZTA Network Operations, Capital Works projects shall provide the network operations and maintenance organisations with the following information:

- **The period each landscape plot falls under defects liability period.**
- **The agreed maintenance programme to be undertaken during the defects liability period.**
- **Agreed methods used for pest control by Capital Works during the defects liability period.**
- **Key contacts for landscape maintenance, including the contact from the Capital Works team and the Landscape Contractor.**

All landscaped areas will be inspected 6-monthly by the network operations and maintenance organisations. Any landscaped areas that still fall within the defects liability period of a Capital Works project that require pest management will be noted. The Capital Works contact will be informed and pest management is expected
to be undertaken within 2 weeks of notification or an otherwise agreed time between the network operations and maintenance organisations and Capital Works team.

To ensure infestation is minimised it is recommended a clause be written into any landscape contract specification for pest species not to be present in the plant stock/mulch and that the landscape contractor is responsible for pest plant control of species for at least two seasons after the planting/application of mulch. Methods should be used aligned with the network operations and maintenance organisations’ pest management strategy. Pest control is to be to the satisfaction of the network operations and maintenance organisations and ARC before handover to NZTA Network Operations.

**Handover information**

- A draft Asset Owners Manual (AOM), in hard and soft copy, should be delivered one month before practical completion inspection, to enable it to be reviewed and questions to be asked at the on-site inspection. *(NZTA document PSF 3g requires it at the inspection).*
- Refer to Appendix 5 for landscaping issues to be included in the AOM.
- The AOM should have a separate section for each of the main (PSG/15) attributes listed above. It should be linked to all other key assets within the corridor, such as stormwater, where appropriate. It should be written in a manner to enable it to be used by those maintaining the assets.
- The AOM should include costs for operation, maintenance, replanting, traffic management, for the next 20 years so that the operations and maintenance organisations can include these works/costs in their forward works programme, asset management plans, and other forward planning documents.
- The AOM will include, or refer to, the maintenance programme during the defects liability period and include allowance for any necessary traffic management and items such as watering.
- The network operations and maintenance organisations will respond with comments to the NZTA Project Manager on the Draft AOM within one month following the practical completion inspection.
- The final AOM, in hard and soft copy, should be produced at least two months before the corridor assets are handed over to the operations and maintenance organisations at the end of the defects liability period. This will enable resources to be programmed for the additional maintenance requirements.
- Utility information and any other relevant agreements that the network operations and maintenance organisations need to know about should be included.
- All other requirements for the handover as per PSF 3g shall be complied with and preferably delivered early to allow the operations and maintenance organisations to use the information in forward programming.

**Other Items**

- Padlocks need to be 'motorway padlocks’. Refer to the network operations and maintenance organisations for type and source and registering of such.
- Route Stations and Route Positions need to be measured and have signs installed before the road opens. As well as the operations and maintenance organisations, the Police also require this information.
Stormwater Management

This section of the Guidelines is to contribute to capital projects to help achieve positive outcomes that are important for good operational management of Auckland Motorways stormwater management assets. The intended target audience is all personnel involved in the asset management cycle for the NZTA stormwater management asset (e.g. planners, designers, contractors).

The three primary classifications of Auckland Motorways Stormwater Management Assets (See Operation and maintenance Schedule at Appendix 6) are:

- **Surface water collection, conveyance, and disposal**: This is the means of getting stormwater off the motorway surface (e.g. median drains, slot drains, catchpits), conveyance (e.g. pipes, manholes, open channels, entryway crossing, secondary flows), and discharge disposal (e.g. streams, soakage to ground, pipe networks);
- **Stormwater Management Devices**: Water quality (treatment), and quantity control (for attenuation) devices such as grass swales, ponds, basins, infiltration trenches, biodetention, proprietary devices;
- **Waterway and Network Crossings**: Where the motorway alignment crosses a major waterway or network (e.g. major culverts at streams, local council pipe, or coastal waterway).

Although ownership of the stormwater management asset remains with NZTA, all personnel involved in the development and delivery are encouraged to be inherently outcome focused and develop a strong sense of ‘ownership’. Throughout the project life:

- always challenge yourself to think about the legacy of the asset (positive, safe, sustainable and resilient)
- think about the stormwater implications on the efficiency and reliability of the State Highway network
- think about how customers and stakeholders (including yourself) will value/perceive the stormwater asset
- ensure robust evaluation of whole of life implications, and value for money
- think about holistic health of the stormwater management asset (environmental, social, cultural, financial)

Whole of Life Cost Considerations

Delivery of a robust whole of life value in decision making is critical for good stormwater asset management. Considerations include:

- Consider the implications of potential Resource Consent conditions on maintenance and operation costs for components that are an outcome from planning and design stages. Look for solutions and agree consent conditions that have low operational monitoring and maintenance cost implications.
- Ensure that a robust evaluation of options is undertaken. This is generally best supported by a value analysis matrix (e.g. a transparent weighted multi criteria evaluation) including a rigorous assessment of whole of life operation and maintenance costs (including consent condition compliance costs).
- Whole of life value assessment (robust lifecycle analysis) should demonstrate holistic value for money. As part of this process the 50 year operational monitoring and maintenance costs should be estimated for asset management purposes (e.g. forward work planning, annual plan).
- It is preferred that the network operations and maintenance organisations be engaged to provide robust inputs for whole of life considerations and maintenance requirements.
Planning, Design, & Construction Considerations

To achieve good stormwater asset management there are a number of points of consideration that should be addressed in the development and delivery of the stormwater management asset. A number of points are general and relate to all phases of the asset management cycle, whilst some points are more specifically influenced at the planning, design, or construction phases. This list is not exhaustive and is intended to provide a guideline that will help to ensure that NZTA stormwater management needs are better achieved.

General

- It is important to always be mindful that the two primary drivers for the stormwater management asset are to deliver an appropriate Level of Service (e.g. pavement surface drainage, flood protection), and to effectively deliver Legislative Compliance (e.g. comply with conditions of resource consent).
- Auckland Motorways desire informed engagement (i.e. consultation and approval) of the Stormwater management solutions, including copies of the project life reporting documents (preliminary feasibility reporting; scheme assessment reporting, assessment of environmental effects, preliminary and detailed design reporting, peer review reporting, & construction reporting). Good consultation with the Operators will help to ensure the effective transfer of knowledge (especially 'intent') and capture of appropriate information in the appropriate form (Specialist operational review as part of Consent sign off process).
- Carefully consider every element of the total stormwater management system (collection & conveyance network; major waterway & network crossings; treatment devices). Auckland Motorways can offer planning and design guidance for surface drainage and for effective waterway and conveyance networks as well as treatment planning and design guidance of preferred options and elements for the Stormwater system.
- Ensure that all general conditions, specific conditions and advice notes of the Resource Consents are adhered to in the design and construction, and ensure that linkage of relevance to the operational requirements is captured for the AOM. Challenge the statutory 'requirements' (consent conditions) to ensure that a consistent and pragmatic regime for intelligently aligned cyclic monitoring and maintenance can be pursued. Also see Section – Consenting.
- Less is more. Consider opportunities to minimise the extent of asset whilst delivering the required outcomes (e.g. a grass swale can provide the collection, conveyance, and treatment objectives as a single and simple asset which is easy to monitor and maintain).
- Consistency (and compatibility) of asset elements, standards, and specifications. Consistency reduces the need for specialised tools, resources, and personnel, for effective operational monitoring and maintenance to be undertaken.
- Consider all aspects of safety (e.g. clear zone requirements, road users, operational staff during monitoring and maintenance activities, neighbours, emergency services). Safe off road access is important. It is most important that safe access be provided owing to the time required to maintain some assets such as ponds. It is however important to carefully weigh-up consumption of land viable for treatment (often limited by designation footprint, or available hydraulic head limitations) versus the provision of the off-road access. Also see Section – Health and Safety.
- Stormwater management solutions should adhere to good principles of crime prevention through environmental design (CPTED). In context this includes minimising the risk of vandalism, judicious landscape planting at ponds, thoroughfare control at major culverts and waterway crossings;
- Ease of monitoring and maintenance. Think that monitoring and maintenance may be undertaken in the dark (night works) if lane closures are required, and often in the wet, hence all weather access required. Avoid treatment devices in areas where operational monitoring and maintenance needs to be undertaken within the carriageway area and requires temporary traffic management. Best practicably avoid solutions that require specific permitting or operational activities (e.g. working at heights or confined spaces).
• Ensure full consideration is given to emergency incidents (i.e. capacity of the system to contain or intercept environmental incidents such as network spills, or flood situations). Ideally the stormwater management system should include mechanisms to remove oil, grease and other floating contaminants, as well as to provide an isolation capacity of 20m$^3$ (e.g. consider the event of a petrol tanker spill, or say a truck load of milk powder entering the network and receiving environment).

• Ensure that robust (i.e. durable) and secure (e.g. easements) secondary flow paths are established (and mapped).

• Swales at median or gore areas should be avoided owing to the operational challenges of safe access and limitations to achieving practical mowing areas.

• Debris blockage will impair performance of the network, and all elements of the stormwater management asset need to be given consideration of the BPO to minimise the risk of blockage occurring through accumulation (i.e. appropriate protection gills at pond outlets, and waterway culverts).

• Aesthetics. It is important that Auckland Motorways always look great. A good stormwater management asset should best blend with nature (e.g. swales, waterways, and ponds to be of 'naturalised' appearance) or be hidden (e.g. below ground pipe networks, or treatment vaults). Avoid solutions attractive to graffiti artists.

• Spend mental time at the asset. Imagine the completed asset and the full range of conditions encountered during a lifetime of operational monitoring and maintenance (e.g. think about daily conditions, night activities, wet weather, drought, the asset after a month of operation, after a year, ten years, safety of users and operators, aesthetics, health of vegetation, ecological health, risks of failure such as erosion or flooding).

• Through the planning, design, and construction phases, an awareness of operational risks, liabilities, and opportunities will be raised and considered. From day one, develop and manage an outcome focused risk and opportunity strategy (level of service and compliance related). This should include the likelihood, consequence, and operational monitoring and management strategy.

**Planning**

• The high level philosophy and objectives for the stormwater management system is to provide a best practicable option (BPO) to avoid, remedy or mitigate adverse environmental effects. The Resource Management Act states: “Every person has a duty to avoid, remedy or mitigate any adverse effect on the environment arising from an activity...” Section 77 (2) of the Land Transport Management Act 2003 (LTMA), also includes that adverse environmental effects be avoided or managed with the (BPO). This includes important consideration of whole of life operational monitoring and maintenance.

• Consider opportunities for an integrated and centralised approach to manage Stormwater quality and quantity issues (i.e. maximise the value of water management systems through partnerships with others, and avoid piecemeal systems which require multiple operational establishments).

• Ensure that works will not induce or increase erosion or flood risks on the upstream and downstream properties, requiring additional O&M intervention. Best practicably mimic the predevelopment hydrologic regime and setting, to deliver outcome objectives which are aligned with the issues and values of the receiving environment (e.g. post development discharges to mimic predevelopment flow rates and volumes to manage erosion and/or flood risks).

• Future-proofing: Ensure that culvert designs are future-proofed for the maximum probable development (MPD) for the catchment. In some cases the existing district plan does not accurately reflect the 'likely' MPD for example at sites adjacent to the metropolitan urban limit. Also consider positioning of all stormwater asset elements with respect to future road widening or development projects.
Although there are no Instruction Standards or Policy the best practicable consideration of the scope to retrofit stormwater management objectives (quality and/or quantity management) should be robustly explored and demonstrated. For the Auckland region a precedent of about 30-35% total suspended solids removal efficiency rate is considered standard practice to existing roads that are being modified or re-built (Auckland Motorways would like to do better).

**Design**

- **Standards and Level of Service:**
  - Ensure that appropriate engineering standards are applied. Aside from NZTA Minimum Standards (Z series), few NZTA Stormwater Instruction Standards, Policy, Interim Standards (or standard drawings) are documented or available (aside from 1977 NRB Highway Surface Drainage), and the design expectations or ‘requirements’ are often not clearly defined. NZTA need a stormwater engineering standards document (current default to Austroads).
  - Auckland Motorways need to be safe and trafficable for 1% AEP critical storm event. This includes the need for design tide levels and rainfalls to include appropriate allowances for climate change.
  - The maximum surface water depth at any point on any running lane, including merge, diverge and gore areas, during a 50% Annual Exceedance Probability (AEP) 5 minute duration rainfall event should not be greater than 4mm above the top of the surface texturing. Pavement surface water depth should be calculated using the Ministry of Works and Development ‘Highway Surface Drainage Design Guide for Highways with a Positive Collection System’ (1977) which is based on the formula developed by the Road Research Laboratory (RRL) in 1968 for the UK Ministry of Transport. The Galloway or any other method should not be used. In situations where this standard cannot be achieved, such as super-elevation development, specific departure is required. Normal crossfall on all pavements of 3% should be maintained wherever practical. Where it is impractical to maintain a 3% crossfall then specific design should be undertaken to ensure that the pavement remains free from surface water.
  - Sufficient collection and conveyance capacity should be provided so that the shoulder flows do not encroach onto trafficable lanes during a 5% AEP 10 minute duration rainfall event. The depth of shoulder flow should not exceed 100mm depth and its velocity should not exceed 2m/s.
  - In a 1% AEP 10 minute duration rainfall event one lane of a multi-lane section of carriageway may be covered with water that is no more than 100mm deep and its velocity should not exceed 2m/s. On a single lane link road in the same event, at least 2m of carriageway should be kept free of stormwater greater than 4mm depth.
  - At super elevated areas the design should include for the collection of stormwater adjacent to the normal centreline. No stormwater from the uphill side of the carriageway should be allowed to flow across the pavement of opposing lanes of traffic or, in the case of multiple on/off ramps, across the pavement of traffic on adjacent carriageways.
  - For water quality and quantity management standards, the 2008 draft NZTA Stormwater Treatment Standard is to be applied, however Auckland Regional Guidelines will take precedence through the current consenting process i.e. ARC Technical Publication 10 (TP10).

- **Durability:**
  - All elements of the Stormwater Management asset should be designed to provide adequate durability. Culverts >3.4m² should be in accordance with requirements in the TNZ Bridge Manual and relevant material design codes. All mainline crossing culverts should be designed with a minimum design life expectancy of 100 years. The surface collection and conveyance network, and management devices should be designed with a minimum life expectancy of 50 years.
Where culverts or piping material, other than concrete, is proposed (e.g. corrugated metal pipes) demonstrate the adherence to the longevity criteria by assessing whole of life value in design, including the costs for providing and maintaining adequate protection against corrosion and/or abrasion throughout the life of the structure.

Structures should be sufficiently durable to ensure that without reconstruction or major renovations, they continue to fulfil their intended function throughout the design life.

Network Design:
- The stormwater management system should be via gravity systems (except tunnels).
- All pipes within the local road network should have a minimum diameter of 225mm. For all other pipes the minimum diameter should be 300mm except lines crossing the carriageway, in which case a minimum diameter should be 375mm dia.
- The minimum water velocity in the stormwater conveyance network (e.g. channels and pipelines) should be 0.6m/s at a flow arising from half the 50% AEP critical storm.
- All new pipelines crossing the road should cross as directly as is practicable, and in no case, should the angle between the longitudinal direction of pipeline and the centreline of the road be less than 40° (degrees).
- A maximum pipe run should be 90m, or as required to suit change in pipe direction, or grade and to suit inspection structures such as manholes and catchpit locations (or rodding/flushing points for subsoil drainage).
- Reticulated networks should be self cleansing (consider pipe grade, flow rates and network tractive forces).
- No access covers (e.g. catchpits and manholes) should be situated within the trafficable flexible pavement lanes. Consider safety, comfort of ride, pavement resurfacing and differential surface/lid levels. These should be located in (or beyond) the shoulder. Where structures cannot be avoided in trafficable lanes, consider adjustability of lid levels to match surface upon pavement re-surfacing. It is also important that any hard chamber lid edges in flexible pavement do not reflect through to the surface.
- Grating covers should be attached by a removable hinged system, not by small fine threaded bolts (these may work on a brand new clean asset system, but during night works on a dirty system it is very difficult to re-attach such gratings). Consider the direction of traffic flow for hinge orientation.
- Additional catchpits or suitable collection systems should be placed at gore areas or low points (and include secondary overflow paths) to best manage the risk of surface water ponding or flooding issues.
- All catchpits should have sumps at least 400mm deep (below the invert of the outlet pipe level). These provide good pre-treatment benefit reducing the frequency of maintenance at treatment devices. Sumps also help to minimise the migration of sediments into often flat pipe networks where gradual sediment accumulation becomes bedded and cement-like.
- Any catchpit siphons should be removable to facilitate flushing, rodding, and CCTV inspections.
- All grass swales should provide a discrete trafficable section (e.g. a 3m wide strip of gobi-block lining) to enable maintenance vehicles to safely traverse across the swale without causing damage to the profile or invert (e.g. to avoid wheel rutting).
- Also see Section – Structures.

Stream and Waterway Crossing Design:
- Where any proposed culvert serves a permanent watercourse that contains existing or potential future ecological values (e.g. upon restoration) in addition to meeting the hydraulic requirements for passing
design flows, culverts should be designed to include features for the provision of ecological connectivity for the passage of aquatic and terrestrial fauna.

- To mitigate erosion at the interface between natural streams and culvert headwalls, wing-walls and structures, appropriate erosion control and energy dissipation measures should be incorporated. Also consider contractions and expansions of the streams at the proposed culverts in order to minimise local scours, erosion and increases of flood levels.

- **Device Design:**
  - Ensure that any below ground structures have safe access and best optimise the ability to safely perform operational monitoring and maintenance activities without the need to enter the system (e.g. grated tops over sediment chambers, manhole access over the forebay zone as well as the filter bed for sandfilters, observation wells at infiltration and biodetention systems).
  - All Ponds (forebay and main pond elements) should have dewatering facilities (i.e. to incrementally draw down the water levels to pond base level for the purpose of maintenance operations). Carefully consider dewatering orifice sizes relative to practical draw down time.
  - All stormwater management devices (i.e. ponds, sandfilters) should have a flow bypass facility as an integral part of the solution, to facilitate routine activities (e.g. desludging) as well as emergency procedures (e.g. spill containment).
  - Stormwater management devices should have benchmarks for the convenient monitoring measurement of accumulated sediments (e.g. at pond forebays and main ponds).

- **Landscape Design (also refer to Corridor Assets):**
  - Consider the types of landscape species best suited to the delivery of operational function of the stormwater management asset e.g. slow/low growth grass desirable; avoid/minimize the use of deciduous trees at locations where catchpit or system blockage can result in level of service issues such as flooding, buffer planting for safety at pond perimeters, cabbage tree leaves cause problems for mowing, avoid specimen trees in ponds and at margins where dying roots can generate ‘piping’ failure issues (e.g. at perched ponds).
  - At shallow ponds ensure that appropriate planting is selected to best minimise the risk of weed and algae blooms that are often induced by thermal and contaminant loading effects. Ensure appropriate wetland plant species are incorporated into a pond of good bathymetric design, as well as to ensure that the design includes for specimen trees to be planted at the northern aspect to provide shading from the time of commencement of the treatment device operation (i.e. a seedling planted today may not provide the necessary shading benefit objectives for 20 years when grown).
  - Carefully consider the use of bark mulch in areas contributing runoff to the stormwater management network. The asset is regularly adversely affected by bark blocking concrete channels, and excessive bark mulch appearing in ponds. Use good stabilising agents if bark mulching.

- The practicality of all operations should be considered (by design) for context of Auckland Motorways (e.g. consider that traffic volumes often >100K vehicle per day). As simple as it may seem, it is important to ensure that the asset can actually be physically monitored and maintained.

- All planning, design, and construction deliveries should be reviewed and certified by an appropriately experienced stormwater management engineer.

**Construction**
- Decommissioning of existing stormwater management infrastructure made redundant by new works should be appropriately treated in a manner that will prevent any future deformation or loss of support to the pavement or any other structure (e.g. remove redundant or fill with 5MPa flowable fill backfill).
• During construction and earthworks, ensure that industry best practice is applied for the management of erosion and sediment control (refer to ARC TP90). This is a regulatory requirement, and also helps to best ensure the longevity of the asset performance (e.g. filtration and infiltration characteristics of systems will be best preserved by minimising the scope for premature clogging). Carefully consider the implications of transitioning between an earthworks site (ARC TP90) versus a permanently stabilised site (ARC TP10).
• During construction secondary flow paths should be well maintained. Any secondary flow paths interrupted by the temporary works should accommodate the effects caused by the works (e.g. safe and efficient management of disposal to the receiving environment).
• During project construction delivery, proactive monitoring and maintenance are considered to be in the best interest of NZTA and the Contractor. The quality of the stormwater management assets should not be compromised by the activity or inactivity of others (e.g. sub-contractors).
• The stormwater management asset should always look great including during the defect liability period (e.g. consider the separable portion of landscaping associated with ponds or grass swales).

Handover Information
• Asset Owners Information: The draft stormwater AOM (including asset information data) and a familiarisation briefing should occur at least one month prior to Practical Completion. This will enable adequate time for handover meeting, project snag and document review, for the final AOM to be supplied before Practical Completion. Hard and electronic copy of the AOM Document (MS Word format) and Drawings (CAD and PDF). Refer to Appendix 6 for Asset Owners Manual - Stormwater Management requirements.
• Asset Information Data: NZTA format RAMM and spatially compatible digital format data to include fundamental asset management data including what, where, condition, design performance for quality and quantity. Also see Section – RAMM and As-Built Data.
• Handover Condition: Verification of the condition including CCTV records and inventory record/reporting sheets. This includes that appropriate maintenance is undertaken prior to the handover (i.e. flush, clean and CCTV network that is utilised by the finished solution). Handover to include operational monitoring inspection, and maintenance activity closure forms at the time of handover. It is important to note that a ‘new’ asset should be just that – a NEW asset. Too often the assets historically received have been very poorly maintained (if at all), and are often not even at an adequate commissioning standard.
• Special Tools and Parts: Any special tools or parts (e.g. manhole or penstock keys, fish passage moulds) to be supplied prior to opening.
• Handover Meeting(s): A joint inspection and meeting to debrief on the specific operational monitoring and maintenance, as well as any defect liabilities for the stormwater management asset should be held at least six (6) weeks prior to opening. Depending on findings there may be important need for a second meeting for issue closure. This should occur at least two (2) weeks before opening.
Appendices
Appendix 1 – Corridor Assets

“Assets” in Corridor requiring one or more of planning, design, construction, managing, maintaining and/or monitoring:

- Grass (mowable)
- Grass (non-mowable) and areas controlled by weed spraying
- Wild flowers
- Plants/shrubs
- Trees
- Barriers
- Signs, lights
  - Lights in the central median are preferred as they are less likely to get hit
  - Lights on bridges and other structures should be designed mindful of a desire to restrict access for graffiti vandalism opportunities (e.g. over the side of a bridge. - see example in Appendix 4)
- Structure related assets
  - Retaining walls
  - Sculptured panels and other urban design elements
  - Non-aesthetic wall – e.g. crib block
  - Artificial rock walls
  - Bridges
  - Noise fences
  - Existing
  - New
- Steep banks (not able to be tractor mown)
- Stormwater (see earlier comment re separate strategy)
  - Swales, catchpits
  - Swales filled with rock (for reduced maintenance requirements?)
  - Pipes from catchpits
  - Access for maintenance purposes
  - Planting around ponds
  - Surface water collection and conveyance
  - Treatment Devices:
    - Discharges
    - Major stream and waterway crossings
- Islands and gore areas
  - Central median
  - Around ramps
  - In roundabouts
- Client owned services
  - E.g. lighting ducts, roadside cabinets
- Utility Services
  - Below ground ducts and cables
  - Above ground structures
- Sculptures
  - Sculptured panels that are not part of (e.g.) concrete structures – i.e. they are bolted on.
  - Flower at Nelson Street Off ramp
  - Lizards at CMJ
- Views
- Maintenance of pleasant views by not planting in front of them
- Graffiti and Litter – design of areas that make it difficult to clean graffiti and retrieve litter
- Abandoned vehicles
- Busway dotterels area and similar special ecological areas
- Land owned by others subject and/or to special agreements
  - e.g. ONTRACK Mt Roskill
  - Mt Roskill planting – agreement with ACC community groups
  - Traherne Island (DoC)
- Monitoring
  - Consent required monitoring E.g. Noise and air quality – Mt Roskill
  - General ongoing monitoring
Appendix 2 - Vegetation Guidelines for Auckland South

Vegetation Specific Issues

- Any vegetation that is in the median, other narrow area between carriageways or intersection islands is difficult and extremely costly to maintain. Paved or designed rock filled medians are the preferred option. It is suggested hard landscape design is considered over soft landscape in these areas.
- Tagging is an ongoing cost with noise walls and structures being obvious targets. It is recommended that vegetation is planted in front of noise fences to deter people from tagging. Ideally this should be taken into consideration in the initial design rather than having to revisit it at a later date.
- SH1 8’s (Greenhithe Deviation) stencilled walls have been met with a degree of success with few cases of tagging. This section of the network is within a less built up area than other areas, so may not necessarily work close to residential areas.
- Vegetation that is planted behind noise walls can be difficult to access. It also encourages littering from residential properties and is 'out of sight, out of mind' which carries a high risk of being neglected. For planting behind noise walls, species that establish quickly and maintain a dense cover are preferred.
- As with noise walls, planted mounds/bunds can suffer from neglect with maintenance regimes not extending maintenance to the side of the bund away from the carriageway. This tends to be due to access constraints and because they are out of the view of the road user. Access to both sides of mounds/bunds is critical for maintenance, as is establishing a dense cover to combat pest plants.
- Where there is a guard rail or barrier, planting should be extended down to it, provided it does not compromise other aspects of motorway operations (e.g. safety, stormwater, access to utilities).
- Vegetation should be selected to ensure that it will not obscure motorway signs.
- Trees should be carefully chosen and sited. Fast growing trees e.g. Poplar close to the motorway are expensive to remove, have relatively short life cycles and are prone to falling over in high winds, a safety issue. Central Motorway Junction, Kauri trees have been planted within a few metres of the carriageway. These will become traffic hazards that will require additional protection to be installed. Kauri requires an appropriate location to ensure survival. Highbrook Drive, Totara have been planted 4m from the road intersection, in future these will require removal as they will affect intersection sight lines.
- Not everything needs to be planted. Concrete or similar materials can look “interesting” (e.g.) gore areas.
- Watering of landscaping should not be required after handover.
- No weed mat on the network as it effects plant growth, can bake small plants, affects soil moisture and prevents germination of wanted plant species. Weed mat becomes an eye sore once the canopy is established as it becomes tattered, and is an expensive exercise to remove. Mulch is a very effective substitute provided the plant density is sufficient to create a canopy that will prevent weeds. Weed mat should not be used unless it biodegrades in less than two years. Biodegradable matting and good mulch depth will assist establishment. Mulch if not properly retained runs off and blocks drains.
- Appropriate species that do not drop large quantities of leaf litter or fronds should be used adjacent carriageways. This includes indigenous species. Flax is not recommended. Trees or shrubs that shed leaves could block nearby stormwater systems or create a hazard adjacent the carriageway. Totara shed their leaves in a self cleaning process. Select appropriate sites for such species.
- Cabbage trees cause significant damage to mowing blades and other machinery due to the tough leaves they frequently drop. Where cabbage trees are used, they should be within a planted plot, surrounded by a buffer of less troublesome vegetation such as Manuka.
- Central Motorway Junction, close to 50% of the canopy is Whau which has a life expectancy of 5 years. These are starting to die off (2009) leaving vast gaps in the canopy, where weeds can establish and take over, and leaving a large dead tree to be removed. These are also present on Highbrook Drive area. This is a considerable renewal/maintenance cost. To avoid this, consider the longevity of species chosen and
include follow-up planting in landscape designs so that a dense vegetative cover is formed quickly and is able to be maintained.

- Any grass strips planned should be greater than 2m wide. A swale is additional to this 2m. Grass strips should be avoided in median areas between carriageways.
- Steep batters, including small steep batters, are costly and troublesome to maintain (e.g. weed eater has to be used). This encourages inappropriate management such as using herbicide to control grass rather than mechanical means. Native grasses, and other species that do not require mowing, establish a dense cover, and help stabilise slopes should be considered.
- Maintenance at the top of drop hazards should be avoided. These areas should be hard landscaped.
- Care should be taken to ensure any compost used is from a reliable source and unlikely to grow mushrooms. (People stopping to pick mushrooms have been a Police issue in the past.)
- Planting in areas with difficult access should be avoided, or use low maintenance dense cover species.
- The site should be handed over with the landscaping established with no pest plants.
- Landscaping agreements with stakeholders should only include plant species that will grow in a particular environment and are not likely to become a safety hazard.

Below is an example of poor vegetation design, difficult and expensive to maintain grassed area, where safety of maintenance crews is compromised:
Note the drop at the top of the Keystone retaining wall. Area above wall is grassed.

It is expected that landscape designers will allow for:

- Consider the neighbours when trees are removed from property boundaries. When trees are replanted as early as possible, they may already provide some screening when the road opens.
- Some tree species may become a hazard – consider their size and distance from the motorway, fence damage, dropping limbs, leaves clogging drains.
- Provide a programme and methodology for vegetation maintenance during the defects period. This will enable the network operations and maintenance organisations to plan a smooth transition without things falling into disrepair.
- When providing a list of proprietary products used, it would be useful to include a planting schedule so that plants can also be replaced with the same type, if needed.
- The preference is always for native plants. Plants indigenous to the region are generally more likely to flourish. Check existing corridors to see which plantings have survived and flourished. Safety requirements within clear zones and the need to maintain sight distances;
  - Location of trees
  - Trees and plants that shed leaves, (e.g. cabbage trees, totara trees) that may be safety hazards (leaves on the carriageway, blocked stormwater systems causing surface flooding)
  - Potential for trees to fall onto carriageway
- Whole of life concepts (cost to maintain, replant, traffic management) when designing landscaping. This includes intangible costs such as delays to motorists from traffic management (TM).
- The motorists’ visual experience
- NZTA’s environmental objectives, e.g. indigenous planting objectives.
- Maintenance around other assets in the corridor such as signs, structures, barriers, gantries.
- Noise walls
  - Maintenance in front and behind them
The Guidelines for Highway Landscaping SPM020, applicable to all State Highways, should be used as a guide.

The network operations and maintenance organisations are willing to discuss these issues with designers to assist them to determine the optimal outcome from the project.

**Grass**

Grass represents significant regular maintenance costs. Grass can be mown by tractor mowers relatively efficiently. Grass maintained by weed eaters or smaller mowers is time consuming and costly, especially where management traffic is required.

Planting grass under crash barriers makes for difficult maintenance. Low maintenance solutions, e.g. concrete, are needed. Similarly gore areas with small planted/grassed areas.

The placement of signs and structures can make maintenance of those areas difficult and/or costly. Mowing strips around the base designed for tractor mowers can reduce maintenance costs.

Moving signs a small distance will generally still comply with standards and can often make a huge difference to the ability of a tractor mower to mow. Placing sign posts adjacent to recessed catchpits can work.

Grass between a barrier and a paling fence that can not be tractor mown is expensive to maintain. Planting in these areas will provide an additional benefit in obscuring the fence which is liable to be graffiti vandalised.

Consider access for grass maintenance. Mowers may not fit in tight spaces behind barriers. Weed-eaters should not have to be lifted over barriers, and they may not work well in tight spaces.

Similarly, thin sloping strips between the top of a barrier and a fence should not be planted in grass as they are difficult to mow and represent a hazard to the contractor and drivers when they are adjacent to a live lane.

Many swales and open drains in grassed areas are difficult to efficiently maintain because of their design.
Cabbage tree leaves blown or falling onto grassed areas cause mower problems.

Plantings or hard landscape looks better than mowing strips in the central median and need no mowing.

Slow growing grass has yet to be proven despite recent trials.
Appendix 3 – Other Corridor Considerations

Stormwater/drainage
- All-weather tracks provide ideal access to ponds (SH01 Orewa to Puhoi has some good examples).
- Swale drains need to have grass strike and be stable when the road is opened. Otherwise, there is high potential for erosion (and thus non-compliance with consents), and the drainage capacity may be compromised.
- Consider the effectiveness of unique stormwater solutions. The easiest things to maintain are those which are accessible and consistent.
- If maintenance of stormwater assets is complicated, or the process is unclear, this will make consent compliance difficult.

General maintenance
- Service lids in or near the carriageway mean that access is difficult. Putting these behind barriers and/or away from live lanes will help.
- Locate road furniture (such as signs and cameras) behind barriers where possible. This gives them added protection, and also makes maintenance safer, cheaper and easier.
- The harder it is to maintain, the less likely that the project will reflect well on its designers and constructors.
- Consider how complicated the maintenance is for any one item? Consider that there will be many personnel changes over the asset life, and it will not be possible for each individual to be trained by the designer or constructor.
- Consider whether “unique solutions” such as special light poles or barriers are necessary. They may be more expensive to maintain, and replacements may be more difficult to source when needed.
- If you have to abseil/helicopter in to install something, then the network operations and maintenance organisations will have to do the same to maintain it.
- Any documents provided should be ready for use ‘as is’ – i.e. the network operations and maintenance organisations should not have to add anything further. For example, maintenance checklists are great, and ideally the crews will be able to take copies and use them right away. Consider the audience of these documents – not everyone is a designer and field crews prefer clear work instructions with diagrams.
- Maintenance should only require standard or readily available equipment, e.g. lid lifters and other plant.
- Be reasonable with equipment requirements – e.g. it should not require ten strong men or a Hiab just to lift the lid on a stormwater device.
Appendix 4 - Graffiti Management

Objectives

- To reduce opportunities for graffiti vandalism in an holistic design process
- To coat selected surfaces with approved products by approved methods at the time of construction
- To have QA processes in place to ensure the above is achieved
- To promptly and efficiently remove all graffiti vandalism starting with the contractor’s establishment on site without adverse impacts on structures, travel efficiency, safety, and other client objectives.

Graffiti is one of the main causes of dissatisfaction with the motorway network. It needs to be removed quickly. Graffiti requiring traffic management (TM) is generally done on a once a week basis when two attenuator trucks are regularly booked. Graffiti therefore can stay in public gaze for up to a week which can lead to complaints. Work has to be carried out at off peak hours under lights.

Graffiti is purposely placed where the public can see it. Graffiti complaints start when construction activities begin. E.g. the contractor’s shed.

Protection coatings should be in accordance with NZTA requirements. Refer to NZTA and the network operations and maintenance organisations. This is applied to both quality of product and application. Currently, 2009, there is one approved product for the network, and for new capital projects the network operation and maintenance organisations will carry out coating application for capital projects.

Designing Capital Projects should be a holistic process based on whole of life considerations. This includes consideration of:

- What structures will be graffiti protected?
  - Natural/clear protected coatings
  - Painted protected coating – e.g. NZTA grey
  - Painted e.g. acrylic paint
  - No protection
- How do we respond when e.g. unprotected barriers are graffiti vandalised?
  - During construction
  - After handover
- How will quality be confirmed?
  - Random testing?
  - Contractor’s QA records?
- Lifespan of protective coatings above 5-10 years at best?
  - Non-complying products/application methods gives shorter lifespans
- How will access be obtained e.g. we do not want TM
  - Being able to safely park is good.
  - Removing graffiti over motorways is expensive
- Consideration of other access issues:
  - E.g. access to the 17m high wall on SH20 Mt Roskill extension project
- Painting over graffiti
- Removal of graffiti during construction through inappropriate methods has resulted in structural damage (e.g. high pressure water blasters quickly remove graffiti from concrete but can also damage concrete)

**Alternative Coatings**
A methodology has been established (2009) to evaluate alternative coatings to the approved product. The network operations and maintenance organisations can advise on the procedures for this evaluation and the independent assessment process involved.

Assisting Graffiti Vandals to ply their trade

New Bridge over motorway

Cost to remove graffiti in above photograph:

- Remove graffiti $50 basic removal cost plus:
  - Height access equipment e.g. cherry picker
  - Two attenuators
  - Loss of NZTA image /complaints while graffiti present – Up to a week
  - Potential traffic delays
- Total Cost can be significant – consider this with design alternatives.
- There are potentially a number of design alternatives that could have been used, and meet other objectives e.g. safety of maintenance operations.
Appendix 5 - Asset Owners Manual – Landscaping

General
This section amplifies the general highway requirements of Z/15, PSG/15 and PSF 3g in respect to operation, renewal and maintenance of corridor assets. This includes consideration of similar activities related to other assets likely to be carried out at the same time such as maintenance of landscaping surrounding stormwater management ponds and maintenance of swales.

The following should be included in the AOM or referred to in the O&M Manual (as appendices to AOM).

Contents
The AOM should be written to inform the client and their maintenance contractor of any issues, agreements, and conditions that are relevant to the ongoing maintenance of the assets that a good maintenance contractor familiar with NZTA standards would not be expected to know. (E.g. It was agreed with Council that a higher maintenance standard would be applied to the section of highway between 'a' and 'b' because .....)

It should be assumed that the maintenance contractor will have one team covering “vegetation maintenance”. It should be clear in the AOM what attributes will require vegetation maintenance and include the maintenance as line items in the programme above. E.g. roundabouts with planting will require vegetation maintenance and maybe plant replacement over the 20 year period of the Plan.

The manual writer should consider how the maintenance contractor will maintain the assets and provide a 20 year vegetation forward works/maintenance programme with costs based on the whole of life analysis used in determining the landscaping design. This will be used to update the client’s Asset Management Plan. Any assumptions used should be clearly stated. E.g. Drainage maintenance is carried out at the same time as corridor vegetation maintenance.

The above information should be provided in excel format to enable it to be aggregated.

The Attributes in PSG/15 should be used as a guide for headings noting that other headings may be required for a particular project.

The ongoing maintenance requirements of the other Attributes including aesthetic assets also need to be included. This includes graffiti and ‘wow’ factors.

The following should be included or referred to in the O&M manual:

- A schedule of all surfaces at risk from graffiti vandalism and their treatments.
- Clear identification of non structural assets attached to structural assets. E.g. fancy panels
- Boundary noise design details e.g. dB(A) Leq 24 hrs at boundaries
- All agreements other than consents as covered above which have ongoing potential relevance such as agreements regarding fence maintenance with individual owners and Councils.
- Reasons why particular species have been planted, e.g. being a consequence of a consultation process.
- Information to assist repair of special features which may suffer some form of vandalism, such as the reptiles at Gillies Ave ramps SH01, e.g. where to get the tiles from.
- Financial data.
  a. Estimated O&M costs for managing the landscaped area as above
  b. Valuation data
Appendix 6 - Asset Owners Manual – Stormwater Management

Asset Owners Manual (AOM)

It is most important that the delivery intent (e.g. specific planning, design, & construction considerations) is conveyed to the operator and that the document is reviewed and approved by the operators (as well as the consenting authority). The document should provide focus on the exceptions or any special/unique elements and project specific operational requirements such as innovations. Also consider the “boots to suits” scenario for asset ownership and operations when preparing the operators manual and information. Operations and maintenance field staff prefer clear work instructions with diagrams to outline the routine maintenance activity requirements. Good plans and drawings are great. The Stormwater Management information should be presented in a specific Operational Monitoring and Maintenance (O&M) document as part of the total AOM, and should provide a clear linkage to other asset elements (e.g. corridor landscape, and structural elements).

Key Content Information

- Purpose. Outline of intent;
- Document Status (e.g. draft; final) including QA verification;
- Document Application (implementation & review statements);
- Project Overview (executive summary, introduction, and key background information);
- Site Plan. Overview and specific including points of operational access;
- Ownership – Maintenance Boundaries. Clearly defined (and shown on schedule and plans) particularly for pipe networks or management devices that are shared with others like councils or adjacent developers. Include definition of the operational interface (roles, responsibilities, and any agreements);
- Collection and Conveyance System (All key parameters for the basis of design, and the operational objectives, what, where, condition, design performance, and functionality, including description of any system specific regular & reactive intervention practices);
- Waterway Crossings/Major Culverts (All key parameters for the basis of design, and the operational objectives, what, where, condition, design performance, and functionality, including description of specific regular & reactive intervention practices) Include clear linkage to the bridge and structures management plan;
- Stormwater Management - Treatment & Attenuation (All key parameters for the basis of design, and the operational objectives, what, where, condition, design performance, and functionality, including description of specific regular & reactive intervention practices);
- Monitoring and Maintenance Action Schedule (basis of design for the nature & frequency for regular and reactive, including interventions, and emergency procedures);
- Emergency Procedures (specific procedures, and network interception/containment points for managing environmental incidents such as spill, from designation to receiving environment);
- Risk & Opportunity Management Strategy/Register. Through the planning, design, and construction phases, an awareness of operational risks, liabilities, and opportunities will be raised and considered. A register including the likelihood, consequence, monitoring, and operational management strategy should be supplied;
- Contact details for key personnel associated with delivery and intended operation of the Stormwater Management Asset. This should include Project Manager, Designer, Contractor, Council, NZTA, Emergency Services, any specific Special interest parties (e.g. DOC).
Key Appendices

- Consents (Resource and Building) and conditions of consents including reporting linkage to operational requirements and/or environmental agreements (e.g. special conditions) to facilitate the delivery of ‘compliance’. Include ARC approval of the Operational Monitoring and Maintenance Documentation.
- Plans showing mapped catchment zones of permeable and impermeable runoff discharging to the asset (i.e. areas draining to the collection and conveyance network, areas and parameters of catchments discharging to major waterway and network crossings, and areas draining to stormwater treatment devices);
- As-built plans of all elements of the stormwater management asset including associated structural elements (e.g. catchpits, pipe network) and ‘natural’ elements (e.g. swales, ponds, waterways). Include clear identification of all elements of the stormwater management system (new and existing network). Flood maps should also be produced to show the extent and level of ponding upstream of the culvert structures. The flood maps for the zone of works shall be drawn contour plans with contour lines at maximum 0.2m intervals.
- Specific landscaping planting plans, schedule & specifications (e.g. Swales, Ponds, Biodetention, Riparian Margins, Special Areas of Biodiversity, Stabilisation Planting; Drought/Saline tolerant situations). Include clear linkage to corridor management plan;
- Mapping of any known Cultural features in relation to the stormwater management asset (e.g. wahi tapu, taonga, waterways identified as traditional sources of food);
- Schedule of specific asset inventory, valuation, & condition. The schedule is to uniquely identify existing and new stormwater asset that constitutes the total stormwater asset for the zone of works. This should also include any assumptions on design life, and valuation;
- Operational monitoring, maintenance & asset valuation estimate.
- Specific operational monitoring and maintenance checklists (i.e. any proprietary or bespoke devices or procedures);
- Engineering Standards (any departures and associated design and approval information);
- Specifications (e.g. for special soil/sand mixes; unique materials or asset items);
- Photos for record of condition and to present asset element situation (e.g. devices, ponds, waterways, discharges, special features);
- Special Terms and Conditions (e.g. any specific Council proformas for Stormwater);
- Any producer statements (e.g. for multi-plate culverts, or proprietary treatment devices).
- Any agreements and conditions (e.g. permits, service agreements, landowner consents)

Operations and Maintenance Schedule

The following schedule outlines typical requirements to be included.
### Stormwater Management Asset - Schedule, and Operational Monitoring & Maintenance Overview

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<tbody>
<tr>
<td>1</td>
<td>Collection and Conveyance Network (1)</td>
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<tr>
<td>a</td>
<td>Slot/gore Drains</td>
<td>m</td>
<td>(4)</td>
<td>NRB 1977 &amp; Austroads</td>
<td>6 month</td>
<td>1-2 years</td>
<td>Visual monitoring assessment during regular drive over and any apparent blockages, accumulated debris, vegetation or damage to be cleared and made good (sweep/flush as required). Include Traffic Barrier slot flushing. The inventory verification record required is to include location, type (materials &amp; size), and general condition rating.</td>
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<td>b</td>
<td>Surface channel (e.g. vee channel, or dish channel drains)</td>
<td>m</td>
<td></td>
<td>NRB 1977 &amp; Austroads</td>
<td>6 month</td>
<td>1-2 years</td>
<td>Visual monitoring assessment during regular drive over and any apparent blockages or damage to be cleared and made good (sweep/flush as required). Note: Does not include 'traditional' Kerb and Channel, or edge nib works, which are considered part of the pavement &amp; surfacing solution. K&amp;C is only used at Motorway interchange areas typically at the local road interface (lower speed environments). The inventory verification record required is to include location, type (materials &amp; size), and general condition rating.</td>
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<td>c</td>
<td>Catchpits</td>
<td>No.</td>
<td></td>
<td>NRB 1977, Austroads, &amp; Local Authority Standards</td>
<td>6 month</td>
<td>1-2 years</td>
<td>Visual monitoring and inspection records (as per the network operations and maintenance organisations catchpit schedule supplied). Vacuum clean, flush and clear as required. Catchpits types include single, double, side entry, superpits, maxpits, splay pits, recessed catchpits, and manhole-type cess pits. The inventory verification record required is to include location, type (materials &amp; size), and general condition rating.</td>
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<td>d</td>
<td>Pipes (&lt;225mm)</td>
<td>m</td>
<td></td>
<td>CPAA &amp; Austroads</td>
<td>2-5 years</td>
<td>as required</td>
<td>CCTV monitoring, inspection, flush, clear and make good as required (reactive). The pipe network inventory verification record required needs to include size, material, and condition rating.</td>
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<tr>
<td>e</td>
<td>Pipes (225mm-600mm dia)</td>
<td>m</td>
<td></td>
<td>CPAA &amp; Austroads</td>
<td>2-5 years</td>
<td>as required</td>
<td>CCTV monitoring, inspection, flush, clear and make good as required (reactive). The pipe network inventory verification record required needs to include size, material, and condition rating.</td>
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<td>f</td>
<td>Pipes (&gt; 600mm dia)</td>
<td>m</td>
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<td>CPAA &amp; Austroads</td>
<td>2-5 years</td>
<td>as required</td>
<td>CCTV monitoring, inspection, flush, clear and make good as required (reactive). The pipe network inventory verification record required needs to include size, material, and condition rating.</td>
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<td>g</td>
<td>Manholes/Junctions</td>
<td>No.</td>
<td></td>
<td>Austroads</td>
<td>Annual</td>
<td>2-5 years</td>
<td>Visual monitoring inspection, vacuum, flush, clear and make good as required (reactive). The manhole inventory verification record required needs to include size (including depth), pipe connections, and condition rating.</td>
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<td></td>
<td>Waterways (ephemeral)</td>
<td>m</td>
<td>Austroads</td>
<td>6 month</td>
<td>Annual</td>
<td>Visual monitoring inspection for erosion, scour, debris blockage and overgrown vegetation. Make good. The inventory of the ephemeral waterways (seasonal flowing waterways) needs to include the location, details of the general profile and condition.</td>
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<td>i</td>
<td>Waterways (perennial)</td>
<td>m</td>
<td>Austroads</td>
<td>6 month</td>
<td>Annual</td>
<td>Visual monitoring inspection for erosion, scour, debris blockage and overgrown vegetation. Make good. The inventory of the perennial waterways (flowing all year round) needs to include the location, details of the general profile and condition.</td>
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<tr>
<td>j</td>
<td>Artificial Channels</td>
<td>m</td>
<td>Austroads</td>
<td>6 month</td>
<td>2-5 years</td>
<td>Visual monitoring inspection for debris blockage, erosion, scour or damage. Make good. The inventory of the artificial channels (e.g. concrete drains, gabion wall drains) along the motorway alignment needs to include the general profile and condition.</td>
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<td>k</td>
<td>Entryway Crossings (SH Access)</td>
<td>No.</td>
<td>Austroads</td>
<td>6 month</td>
<td>2-5 years</td>
<td>Visual monitoring inspection for debris blockage, erosion, scour or damage. Make good. The inventory of the culvert/crossing systems (i.e. State Highway driveway access locations crossing waterways/open channels within the designation - none allowed at Motorway) needs to include details of the location, crossing description, and condition rating.</td>
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<td>l</td>
<td>Pipe Inlets</td>
<td>No.</td>
<td>various</td>
<td>6 month</td>
<td>Annual</td>
<td>Visual monitoring inspection for debris blockage, erosion, scour or damage. Make good. The inventory of pipe inlets needs to include details of the location, inlet description, physical dimensions, and condition rating.</td>
<td></td>
</tr>
<tr>
<td>m</td>
<td>Pipe Outlets</td>
<td>No.</td>
<td>various</td>
<td>6 month</td>
<td>Annual</td>
<td>Visual monitoring inspection for debris blockage, erosion, scour or damage. Make good. The inventory of pipe outlets needs to include details of the location, outlet type description, physical dimensions, and condition rating.</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>Erosion Protection</td>
<td>sq. m</td>
<td>Austroads, MOW &amp; various</td>
<td>6 month</td>
<td>Annual</td>
<td>Visual monitoring inspection for debris blockage, erosion, scour or damage. Make good. The inventory of specific erosion protection measures needs to include details of the location, type description (e.g. rip-rap, geogrids, reno matress, and gabions), physical dimensions, and condition rating.</td>
<td></td>
</tr>
<tr>
<td>o</td>
<td>Energy Dissipation</td>
<td>No.</td>
<td>Austroads, MOW &amp; USBR</td>
<td>6 month</td>
<td>Annual</td>
<td>Visual monitoring inspection for debris blockage, erosion, scour or damage. Make good. The inventory of specific energy dissipation measures needs to include details of the location, type description (impact type energy dissipaters, specific masonry block work, or rip-rap), physical dimensions, and condition rating.</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>Tidal Control (valves or gates)</td>
<td>No.</td>
<td>various</td>
<td>6 month</td>
<td>Annual</td>
<td>Visual monitoring and operational inspection (e.g. check gate hinge operational and grease if required, as well as check seal and repair or make good as required). The monitoring inspection needs to include clearing of any debris, overgrown vegetation, and observations of any damage. The inventory of tidal (non return) gates or valves to include details of the location, type description (e.g. Hume-king, Baycast, Tideflex, and specific design), physical dimensions, and condition rating.</td>
<td></td>
</tr>
<tr>
<td>q</td>
<td>Soakage Disposal</td>
<td>No.</td>
<td>ACC/MCC Soakage Design</td>
<td>6 month</td>
<td>Annual</td>
<td>Visual monitoring and inspection records (as per the network operations and maintenance organisations 'soakage disposal' schedule supplied). Vacuum clean, flush, clear, and rejuvenate as required. The inventory verification record required needs to include location, type (e.g. rockbore, manhole, and chamber), physical dimensions and condition rating.</td>
<td></td>
</tr>
<tr>
<td>r</td>
<td>Secondary Flow Paths</td>
<td>No.</td>
<td>Austroads</td>
<td>6 month</td>
<td>Annual</td>
<td>Visual monitoring inspection for erosion, scour, debris blockage, overgrown vegetation, or obstructions. Make good by clearing and reinstating a stable flow path (or notify if say new fence or earth filling). The inventory of Secondary Flow Paths (SFPs) needs to include the location, details of the general profile and condition. Insufficient information is currently available to identify all specific locations. Locations are to be marked up on GIS base plan as part of 'delivery' briefing information.</td>
<td></td>
</tr>
<tr>
<td>s</td>
<td>Pump Stations</td>
<td>No.</td>
<td>various</td>
<td>Quarterly</td>
<td>Annual</td>
<td>Visual monitoring and inspection records (as per the specific network operations and maintenance organisations Pump Station schedules supplied). The monitoring inspection needs to include specific operational inspections, clearing of any debris, and observations of any damage. Make good. Specific Pump Station inventory and rating information to be verified. The Auckland Motorways pump stations are: SH1 Mt Wellington Highway; SH16 Newton Eastbound; SH22 Butchers Rd Underpass at Paerata.</td>
<td></td>
</tr>
<tr>
<td>t</td>
<td>Bridge deck drainage</td>
<td>m</td>
<td>none</td>
<td>6 month</td>
<td>Annual</td>
<td>Visual monitoring assessment during regular drive over and any apparent blockages, accumulated debris, vegetation or damage to be cleared and made good (sweep/flush as required). Include Traffic Barrier slot flushing. The inventory verification record required is to include location, type (materials &amp; size), and general condition rating. Currently covered by Structures team. Develop system with Structural team to define optimal operational monitoring and maintenance procedures.</td>
<td></td>
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<tr>
<td>o</td>
<td>others?</td>
<td>tbc</td>
<td>tbc</td>
<td>tbc</td>
<td>Others (miscellaneous). Specific asset and management requirements to be confirmed (asset type, quantity, dimensions, standards, condition, monitoring &amp; maintenance requirements, and inventory details).</td>
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<tr>
<td>2</td>
<td>Major Waterway &amp; Network Crossings®</td>
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<td></td>
<td></td>
<td><strong>Major Culvert Crossings (Waterways and Local Authority Pipe Network)</strong></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Culverts</td>
<td>No.</td>
<td>Austroads &amp; MOW</td>
<td>6 month</td>
<td>as required</td>
<td>Visual monitoring and inspection records (as per 'Waterway &amp; Network Crossing' schedule supplied). Clear and make good as required (reactive). The culvert inventory verification record required needs to include size, material, and condition rating.</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>Headwall (i.e. upstream)</td>
<td>No.</td>
<td>Austroads &amp; MOW</td>
<td>6 month</td>
<td>as required</td>
<td>Visual monitoring inspection for debris, erosion, scour, overgrown vegetation, or structural damage. Clear and make good as required. The inventory of culvert inlet headwalls needs to include details of the location, type (prefab or specific) inlet description (e.g. massblock, gabions, and geogrid), physical dimensions, and condition rating.</td>
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</tr>
<tr>
<td>c</td>
<td>Debris Grill</td>
<td>No.</td>
<td>Austroads &amp; MOW</td>
<td>6 month</td>
<td>Annual</td>
<td>Visual monitoring inspection for debris, overgrown vegetation, or damage. Clear and make good as required. The inventory of debris grills needs to include details of the location, type, materials, physical dimensions, and condition rating. At upstream limit some culverts have debris grills either attached at headwall, or within stream. Inventory records to verify</td>
<td></td>
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</tbody>
</table>
### d Wingwall (i.e. downstream)

<table>
<thead>
<tr>
<th>No.</th>
<th>Austroads &amp; MOW</th>
<th>6 month</th>
<th>as required</th>
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<tbody>
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<td></td>
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</tbody>
</table>

Visual monitoring inspection for debris, erosion, scour, overgrown vegetation, or structural damage. Clear and make good as required. The inventory of culvert wingwalls needs to include details of the location, type (prefab or specific) inlet description (e.g. massblock, gabions, and geogrid), physical dimensions, and condition rating.

### e Energy Dissipation

<table>
<thead>
<tr>
<th>No.</th>
<th>Austroads &amp; MOW</th>
<th>6 month</th>
<th>5-10 years</th>
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<tbody>
<tr>
<td></td>
<td></td>
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</table>

Visual monitoring inspection for debris, erosion, scour or damage. Make good. The inventory of specific energy dissipation measures needs to include details of the location, type description (impact type energy dissipaters, specific masonry block work, or oversized rip-rap), physical dimensions, and condition rating.

### f Junction Chambers

<table>
<thead>
<tr>
<th>No.</th>
<th>6 month</th>
<th>as required</th>
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</tbody>
</table>

Visual monitoring inspection, clear and make good as required (reactive). The junction chamber inventory verification record required needs to include, location, type, size (including depth), and condition rating.

### g Fish Passage

<table>
<thead>
<tr>
<th>No.</th>
<th>ARC TP131 &amp; NIWA</th>
<th>6 month</th>
<th>as required</th>
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<tbody>
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<td></td>
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</table>

Visual monitoring inspection for accumulated debris, erosion, scour or damage. Clean and make good. The inventory of fish passage measures needs to include details of the location, type description (e.g. submerged invert, grouted rip-rap, baffle blocks, timber blocks), physical dimensions, and condition rating.

### h Erosion Protection

<table>
<thead>
<tr>
<th>sq. m</th>
<th>Austroads, MOW &amp; USBR</th>
<th>6 month</th>
<th>1-2 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Visual monitoring inspection for debris, erosion, scour or damage. Make good. The inventory of specific erosion protection measures needs to include details of the location, type description (e.g. rip-rap, geogrids, reno matress, and gabions), physical dimensions, and condition rating.

### i Others?

<table>
<thead>
<tr>
<th>tbc</th>
<th>tbc</th>
<th>tbc</th>
</tr>
</thead>
</table>

Others (miscellaneous). Specific asset and management requirements to be confirmed (asset type, quantity, dimensions, standards, condition, monitoring & maintenance requirements, and inventory details).

### 3 Treatment Devices (Quality and/or Quantity Control)

<table>
<thead>
<tr>
<th>ARC TP10</th>
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</table>

### a Oil & water separators (API type)

<table>
<thead>
<tr>
<th>No.</th>
<th>ARC TP10 &amp; API</th>
<th>3 month</th>
<th>Annual</th>
</tr>
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</table>

Operational monitoring and maintenance requirements as per the network operations and maintenance organisations schedule supplied

### b Sandfilters (first principle design)

<table>
<thead>
<tr>
<th>No.</th>
<th>ARC TP10</th>
<th>3 month</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
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<td></td>
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</tbody>
</table>

Operational monitoring and maintenance requirements as per the network operations and maintenance organisations schedule supplied

### c Vaults (sediment and/or storage)

<table>
<thead>
<tr>
<th>No.</th>
<th>ARC TP10</th>
<th>3 month</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
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</table>

Operational monitoring and maintenance requirements as per the network operations and maintenance organisations schedule supplied

### d Swale

<table>
<thead>
<tr>
<th>m</th>
<th>ARC TP10</th>
<th>3 month</th>
<th>3 month</th>
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<tbody>
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</tbody>
</table>

As per schedule supplied. Note: Routine Swale maintenance (i.e. mowing, vegetation clearing); is covered by procedures outlined by corridor vegetation management and network strategy (consents and compliance) team, which include grass length requirements (typical 50mm-150mm length), and tolerances for vegetation management practices such as mowing, and spraying.

### e Vegetated Filter Strip

<table>
<thead>
<tr>
<th>sq. m</th>
<th>ARC TP10</th>
<th>3 month</th>
<th>3 month</th>
</tr>
</thead>
<tbody>
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<td></td>
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</tbody>
</table>

As per schedule supplied. Note: Routine Swale maintenance (i.e. mowing, vegetation clearing); is covered by procedures outlined by corridor vegetation management and network strategy (consents and compliance) team, which include grass length requirements (typical 50mm-150mm length), and tolerances for vegetation management practices such as mowing, and spraying.
<table>
<thead>
<tr>
<th></th>
<th>Biodetention (e.g. raingardens, or tree pits)</th>
<th>No.</th>
<th>ARC TP10</th>
<th>3 month</th>
<th>3 month</th>
<th>Operational monitoring and maintenance requirements as per the network operations and maintenance organisations schedule supplied.</th>
</tr>
</thead>
<tbody>
<tr>
<td>g</td>
<td>Infiltration Practices (e.g. trenches, or basins)</td>
<td>sq. m</td>
<td>ARC TP10</td>
<td>3 month</td>
<td>Annual</td>
<td>Operational monitoring and maintenance requirements as per ARC TP10 schedule supplied.</td>
</tr>
<tr>
<td>h</td>
<td>Ponds (e.g. wet pond, or dry detention pond)</td>
<td>No.</td>
<td>ARC TP10</td>
<td>3 month</td>
<td>5-10 years</td>
<td>Operational monitoring and maintenance requirements as per the network operations and maintenance organisations schedule supplied.</td>
</tr>
<tr>
<td>i</td>
<td>Wetland</td>
<td>No.</td>
<td>ARC TP10</td>
<td>3 month</td>
<td>5-10 years</td>
<td>Operational monitoring and maintenance requirements as per the network operations and maintenance organisations schedule supplied.</td>
</tr>
<tr>
<td>j</td>
<td>others?</td>
<td>tbc</td>
<td>tbc</td>
<td>tbc</td>
<td>Others (miscellaneous). Specific asset and management requirements to be confirmed (asset type, quantity, dimensions, standards, condition, monitoring &amp; maintenance requirements, and inventory details).</td>
<td></td>
</tr>
</tbody>
</table>

### Proprietary Treatment Devices (Quality Control Only)

<p>| k | Catchpit Filter Systems (i.e. Enviropods) | No. | Supplier Spec and ARC Certification | 3 month | 3 month | Operational monitoring and maintenance requirements as per suppliers specification and schedule (unless approved departure). Inventory needs to verify the location, type, and condition rating. Enviropods supplied by Stormwater 360 &amp; Hynds. Neither are fully TP10 compliant (i.e. to 75% TSS removal efficiency). Exist at some parts of the network as part of the best practicable option (BPO) treatment train. |
| l | Sand Filters | No. | Supplier Spec and ARC Certification | 3 month | Annual | Operational monitoring and maintenance requirements as per suppliers specification and schedule (unless approved departure). Inventory needs to verify the location, type, physical dimensions, and condition rating. Proprietary sandfilters are supplied by Humes and Hynds. |
| m | StormFilters | No. | Supplier Spec and ARC Certification | 3 month | Annual | Operational monitoring and maintenance requirements as per suppliers specification and schedule (unless approved departure). Inventory needs to verify the location, type, and condition rating. StormFilters are supplied by Stormwater 360, and are approved as ARC TP10 compliant. |
| n | HumeCeptors | No. | Supplier Spec and ARC Certification | 3 month | Annual | Operational monitoring and maintenance requirements as per suppliers specification and schedule (unless approved departure). Inventory needs to verify the location, type, physical dimensions, and condition rating. Supplied by Humes. Not approved as ARC TP10 compliant (i.e. to 75% TSS removal efficiency). |
| o | CDS (continuous deflective separation) | No. | Supplier Spec and ARC Certification | 3 month | Annual | Operational monitoring and maintenance requirements as per suppliers specification and schedule (unless approved departure). Inventory needs to verify the location, type, physical dimensions, and condition rating. Supplied by Skellerup. Not approved as ARC TP10 compliant (i.e. to 75% TSS removal efficiency). |</p>
<table>
<thead>
<tr>
<th>No.</th>
<th>Filter Type</th>
<th>Supplier Spec and ARC Certification</th>
<th>3 month</th>
<th>Annual</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>p</td>
<td>UpFlo Filter</td>
<td></td>
<td></td>
<td></td>
<td>Operational monitoring and maintenance requirements as per suppliers specification and schedule (unless approved departure). Inventory needs to verify the location, type, and condition rating. Supplied by Hynds, and are approved as ARC TP10 compliant for roads with less than 20,000 VPD.</td>
</tr>
<tr>
<td>q</td>
<td>Cleansall</td>
<td></td>
<td></td>
<td></td>
<td>Operational monitoring and maintenance requirements as per suppliers specification and schedule (unless approved departure). Inventory needs to verify the location, type, physical dimensions, and condition rating. Supplied by Hynds. Not approved as ARC TP10 compliant (i.e. to 75% TSS removal efficiency). Gross Pollutant Trap (GPT) only.</td>
</tr>
<tr>
<td>r</td>
<td>Downstream Defender (hydrodynamic vortex separator)</td>
<td></td>
<td></td>
<td></td>
<td>Operational monitoring and maintenance requirements as per suppliers specification and schedule (unless approved departure). Inventory needs to verify the location, type, physical dimensions, and condition rating. Supplied by Hynds. Not approved as ARC TP10 compliant (i.e. to 75% TSS removal efficiency).</td>
</tr>
<tr>
<td>s</td>
<td>Others?</td>
<td>tbc</td>
<td>tbc</td>
<td>tbc</td>
<td>Others (miscellaneous). Specific asset and management requirements to be confirmed (asset type, quantity, dimensions, standards, condition, monitoring &amp; maintenance requirements, and inventory details).</td>
</tr>
</tbody>
</table>

Notes

1. Pavement subsoil drains (TNZ F/2 type) are not included in the stormwater management collection and conveyance system and are considered to be part of the pavements and surfacing solution.
2. For waterways with a cross-section area up to 3.4m² (Above 3.4m² is covered by Bridge Structures)
3. Most stormwater management improvement devices on the network are unique designs to address specific local/regional issues such as water quality, erosion management, flood protection, and receiving environment management. A range of operational requirements apply to each system in order for the devices to retain their functionality and to deliver legislative responsibility. Whilst NZTA are currently developing specific guidelines for a nationally consistent approach to Stormwater Management Device Design, the ARC TP10 guidelines currently take precedence at the Auckland Motorways network (consent compliance)
4. Total quantum to be determined. See comprehensive Stormwater Management Asset - Schedule and Specification for route specific information (i.e. available Capital Project & RAMM information zones).
5. A range of standards and guidelines apply to the various elements of the stormwater management asset. NZTA do not have comprehensive Engineering Standards for Stormwater Management (default Austroads). THE NZTA Stormwater Treatment Design Standards (Draft July 08) should be considered for the Auckland Motorway Network, however in the interim the regional requirements will take precedence (e.g. TP10, TP90, TP124, TP131)
6. The monitoring frequencies stated are required for a minimum period of two years at which time it is anticipated that based on inspection records a pragmatically refined frequency and nature of activity can be applied. Treatment Devices inspection records will form the basis for applying for a managerial approved variation to ‘agreed’ frequencies.
7. Actual maintenance requirements are triggered by findings of the monitoring inspections. The nominated typical frequency of maintenance activities (e.g. Sand replenishment, or StormFilter cartridge media replacement) is distinct from the routine cyclic maintenance (e.g. vegetation, litter and debris removal).
8. Inventory verification inspection is required for all asset elements.