Final Report

Lincoln Road Corridor Improvements Stormwater Assessment

Prepared for Auckland Transport

May 2016

MWH

BUILDING A BETTER WORLD

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Executive Summary

This report forms part of Auckland Transport's (AT) Notice of Requirement for the Lincoln Road Corridor Improvements (LCRI) project. The LRCI project aims to improve the efficiency of Lincoln Road, Henderson, improve public transport reliability in this area, and improve safety for all road users.

The LRCI Project applies to a 1.3 kilometre length of Lincoln Road, between its intersection with Te Pai Place / Pomaria Road to the south and the State Highway 16 on-ramp to the north. The Project will upgrade Lincoln Road through the provision of additional transit lanes, dedicated cycle lanes and footpaths in each direction whilst maintaining two lanes for general traffic in each direction. Additional or longer turning lanes will be constructed at controlled intersections to improve capacity and a raised median will be installed along the centre of the road, with right turning and U-turns provided for at controlled intersections. The improvements will be integrated with the New Zealand Transport Agency's upgrades at SH16 at the Lincoln Road Interchange.

The LRCI Project also involves the collection and treatment of stormwater generated from the road at 312 Lincoln Road and discharge to a new coastal outfall at Daytona Strand (the resource consents necessary to undertake this part of the project will be applied for at a later date). There will be a new public road formed to the rear of 300-312 Lincoln Road, which will provide access to Daytona Reserve and existing properties that will be unable to access directly from Lincoln Road.

In order to construct the improvements, the existing road reserve will be widened by varying amounts on each side (generally around 2m to 3m, up to approximately 8m). A greater area of land is required in the vicinity of intersections. Further details of the LRCI Project proposals are provided in the Assessment of Environmental Effects which supports the Notice of Requirement.

This Stormwater Assessment report focusses on the assessment of the proposed stormwater system changes for the upgraded road corridor.

The result of the stormwater options assessment in MWH's Stormwater Options Report is the selection of a preferred option for the LRCI stormwater system. The preferred option involves construction of new stormwater reticulation to collect runoff from the widened road corridor and discharging this runoff to a new coastal outfall at Daytona Strand. Treatment of runoff from the equivalent of the new impervious area is proposed by means of a structural filtration device located at 312 Lincoln Road.

This stormwater assessment has been completed using the high-level concept design of potential stormwater system options undertaken by MWH, which is based on the preliminary road design. Detailed design of the stormwater collection, conveyance, treatment and discharge infrastructure for the widened road corridor has not yet been undertaken. A number of elements that form part of this stormwater assessment cannot be quantified in detail in this report

This assessment of the proposed stormwater system for the LRCI project includes the following:

- Description of the existing built and receiving environments
- Description of the existing stormwater system
- Discussion of the regulatory framework
- Description of the quantity and quality of stormwater which will result from the Project
- Description of the proposed stormwater system, including options assessed, alternatives considered and the best practicable option
- Assessment of the suitability, efficiency and effectiveness of the proposed stormwater system
- Assessment of the proposed stormwater system against relevant Planning Rules
- Discussion of stormwater management during construction

The proposed stormwater system described above is considered to be the Best Practicable Option (BPO) for stormwater management for the LRCI project, based on assessment against the BPO criteria set out in the RMA. Given the constraints on land availability within the road corridor and the current status of applicable regional and district planning documents, the proposed system is considered to be the best balance between minimising adverse effects on the built and receiving environments and the capital and operational cost of providing stormwater infrastructure.

Potential adverse effects and proposed mitigation are summarised in the table in section 7 below.

Auckland Transport

Lincoln Road Corridor Improvements

Technical Advisor - Stormwater

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1 Introduction

1.1 Purpose

This report forms part of Auckland Transport's (AT) Notice of Requirement for the Lincoln Road Corridor Improvements (LCRI) project. The LRCI project aims to improve the efficiency of Lincoln Road, Henderson, improve public transport reliability in this area, and improve safety for all road users.

The LRCI Project applies to a 1.3 kilometre length of Lincoln Road, between its intersection with Te Pai Place / Pomaria Road to the south and the State Highway 16 on-ramp to the north. The Project will upgrade Lincoln Road through the provision of additional transit lanes, dedicated cycle lanes and footpaths in each direction whilst maintaining two lanes for general traffic in each direction. Additional or longer turning lanes will be constructed at controlled intersections to improve capacity and a raised median will be installed along the centre of the road, with right turning and U-turns provided for at controlled intersections. The improvements will be integrated with the New Zealand Transport Agency's upgrades at SH16 at the Lincoln Road Interchange.

The LRCI Project also involves the collection and treatment of stormwater generated from the road at 312 Lincoln Road and discharge to a new coastal outfall at Daytona Strand (the resource consents necessary to undertake this part of the project will be applied for at a later date). There will be a new public road formed to the rear of 300-312 Lincoln Road, which will provide access to Daytona Reserve and existing properties that will be unable to access directly from Lincoln Road.

In order to construct the improvements, the existing road reserve will be widened by varying amounts on each side (generally around 2m to 3m, up to approximately 8m). A greater area of land is required in the vicinity of intersections.

Further details of the LRCI Project proposals are provided in the Assessment of Environmental Effects which supports the Notice of Requirement.

This Stormwater Assessment report focusses on the assessment of the proposed stormwater system changes for the upgraded road corridor.

1.2 Background

The possible approaches to stormwater management and assessment of potential options for stormwater collection, treatment and discharge have been assessed and were documented in the 'Stormwater Options Report' in Appendix D.

In summary, the options assessed include:

- Provision of Low Impact Design (LID) devices for treatment within the road corridor
- Various stormwater collection options with treatment and discharge at more than one location
- Stormwater collection and conveyance to a single treatment and discharge location
- Various treatment device and location options for discharge at a single location

The recommendations of the Stormwater Options Report included:

- LID techniques are not feasible for full stormwater treatment, for this project, particularly given the land use constraints that apply in this case.
- Runoff from the widened road corridor should be collected and drained to a single discharge location at the north end of Lincoln Road.
- Structural filtration should be implemented as the preferred treatment method, located at either the Triangle Road Bridge or 312 Lincoln Road.

The result of the stormwater options assessment was the selection of a preferred option for the LRCI stormwater system. The preferred option involves construction of new stormwater reticulation to collect runoff from the widened road corridor and discharging this runoff to a new coastal outfall at Daytona Strand. Treatment of runoff from the equivalent of the new impervious area is to be provided by means of a structural filtration device located at 312 Lincoln Road.

1.3 Assessment Approach

This assessment of the proposed stormwater system for the LRCI project includes the following:

- Description of the existing built and receiving environments
- Description of the existing stormwater system
- Discussion of the regulatory framework
- Description of the quantity and quality of stormwater which will result from the Project
- Description of the proposed stormwater system, including options assessed, alternatives considered and the best practicable option
- Assessment of the suitability, efficiency and effectiveness of the proposed stormwater system
- Assessment of the proposed stormwater system against relevant Planning Rules
- Discussion of stormwater management during construction

This stormwater assessment has been completed using the high-level concept design of potential stormwater system options undertaken by MWH, which is based on the preliminary road design. Detailed design of the stormwater collection, conveyance, treatment and discharge infrastructure for the widened road corridor has not yet been undertaken. A number of elements that form part of this stormwater assessment cannot be evaluated in detail in this report.

1.4 Key Documents in Appendices

The following documents are included in the appendices of this report.

Catchment Boundary Plans (Appendix A) – these are based on the catchment boundary drawings produced by GHD during concept design. Boundaries have been adjusted by MWH to include areas that may contribute runoff from outside of the road corridor (desktop assessment only). Final catchment boundaries for the widened road will be produced as part of detailed design.

Existing Stormwater Drainage Path and Discharge Points Plan (Appendix B) – this plan illustrates the existing drainage path and discharge location for each subcatchment. Existing treatment devices are shown where applicable.

Proposed Stormwater System Scheme Plan and Proposed Stormwater System Discharge Route Plan (Appendix C) – these plans illustrate the location of key infrastructure for the preferred stormwater option.

Stormwater Options Report (Appendix D) – identification and assessment of high-level concept options for management of stormwater from the widened road corridor.

2 Existing Environment

2.1 Built Environment

The LRCI project area - the northern section of Lincoln Road – is an arterial route linking the North-western motorway and a number of Auckland's western suburbs. The road is heavily trafficked, particularly during peak hours. The road corridor is lined on both sides with properties for the full length of the LRCI area. The properties are mainly commercial, including large retail developments, with a number of residential sites at the northern and southern ends.

This section of Lincoln Road is classified as a 'High Use Road' in the Proposed Auckland Unitary Plan (PAUP), with approximately 40,000 vehicle movements per day.

2.2 Receiving Environment

Stormwater runoff from the various subcatchments that make up the LRCI area currently drains to a number discharge points (see Section 3 of this report). Most discharges are directly to an estuarine environment, either at Henderson Creek to the west, or to the estuarine areas to the east of Lincoln Road. However, runoff from subcatchments H and J (see the Catchment Boundary Plans in Appendix A) currently discharge to freshwater streams that eventually flow into the Coastal Marine Area (CMA). Subcatchments A and B drain to the North-western motorway corridor. Drainage paths and discharge locations are illustrated on the 'Existing Stormwater Drainage Paths and Discharge Points Plan' in Appendix B.

Short sections of the Lincoln Road corridor are within or discharge into a Stormwater Management Area – Flow (SMAF) under the Proposed Auckland Unitary Plan, as illustrated by the blue 'cross' hatching on the GIS[1] snapshot in Figure 2-1 below.. Once widened, a strip of Lincoln Road from Pomaria Road north will also be within the SMAF and under PAUP requirements will require volume management if it discharges into the SMAF area.

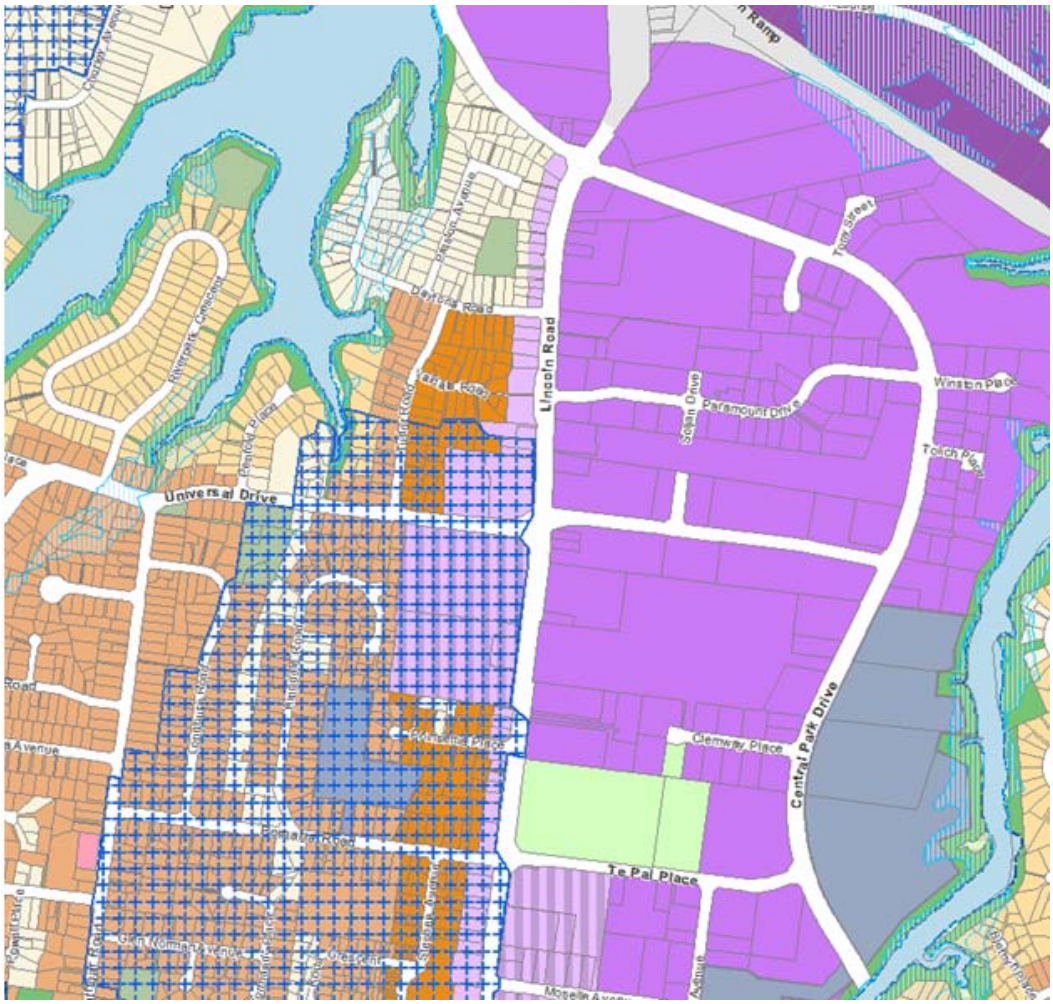


Figure 2-1 : Stormwater Management Area (Flow 2) under PAUP (Auckland Council GIS)

2.3 Existing Flooding Issues

A snapshot of Auckland Council GIS, illustrating flood plains (solid mid-blue colour) and flood prone areas (hatched areas) is shown in Figure 2-2 below. The GIS indicates that large sections of the estuarine environment both sides of Lincoln Road, and a number of residential properties, are within flood plain areas. Sections of Te Pai Reserve, at the southern end of the LRCI area are also shown within the flood plain. Flood prone areas are shown on private property to the east of Lincoln Road, south of the Universal Drive intersection.

Flooding to private property has been identified adjacent to Daytona Strand, which is the proposed location for stormwater discharge in the preferred stormwater management option. GIS maps[1] produced to support the PAUP indicate that this is caused by coastal inundation, rather than freshwater flooding.

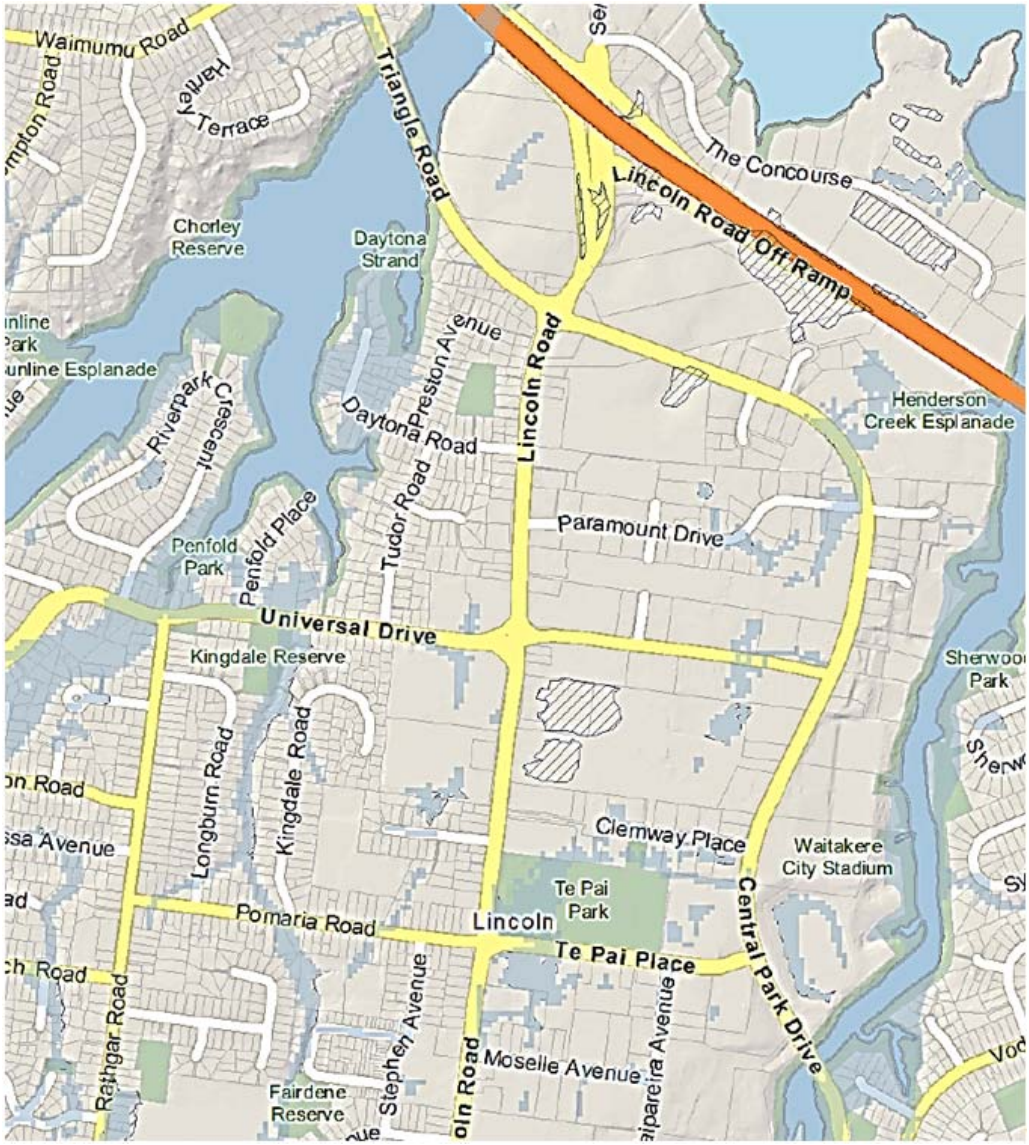


Figure 2-2 : Flood Plains and Flood Prone Areas (Auckland Council GIS)

[1] Auckland Council Proposed Unitary Plan GIS viewer, updated June 2015. http://acmaps.aucklandcouncil.govt.nz/unitaryplan/FlexViewer/index.html

3 Existing Stormwater System

3.1 Catchments

The LRCI project area comprises ten existing drainage catchments and extends from the SH16 interchange to the Te Pai / Pomaria intersection – a total length of approximately 1.3 kilometres. This section of Lincoln Road travels along a ridgeline, with very little stormwater runoff contributed from areas outside of the road corridor. The catchment has a general slope from south to north, with local high-points at the Triangle Road / Central Park Road intersection, just north of the Universal Drive intersection and at the Te Pai Place / Pomaria Road intersection.

The stormwater runoff from the Lincoln Road corridor drains to the Lincoln Catchment to the west and the Central Park Catchment to the east. There are currently two main discharge points and a number of smaller discharge points from the various subcatchments. The subcatchments are described below and shown on the plan in Appendix B.

The LRCI area currently has ten subcatchments discharging to seven existing stormwater discharge points. Subcatchment descriptions are included in Section 2 of the MWH Stormwater Options Report.

Approximate subcatchment boundaries are illustrated on the Catchment Boundary Plans' in Appendix A and existing subcatchment drainage paths are shown on the 'Existing Stormwater Drainage Paths and Discharge Points Plan' in Appendix B.

Existing subcatchment details are based on an assessment by GHD. A desktop assessment of the subcatchment boundaries undertaken by MWH has identified impervious areas outside of the immediate road corridor that may contribute runoff to the LRCI catchment (the areas are illustrated by coloured hatching on the plans in Appendix A).

Catchment boundaries have not been assessed in detail on site and some changes to boundaries can be expected as the LRCI improvement works design progresses. Refinement of catchment boundaries and impervious areas during design development will be minor and will not affect the land take required for stormwater management (collection, conveyance and treatment).

Existing subcatchment details are summarised in Table 3-1 below.

3.2 Reticulation

Lincoln Road is currently served by pit and pipe reticulation. The existing reticulation was likely designed for flow from a 1:5 year storm event (at best) and will be undersized to meet current design standards (flow from a 1:10 storm event, including climate change).

3.3 Discharge

As noted in Section 2 above, all discharges from the existing road corridor are to an estuarine environment, either at Henderson Creek to the west, or to the estuarine areas to the east of Lincoln Road. Subcatchments H and J currently discharge to freshwater streams that eventually flow into the Coastal Marine Area (CMA). Subcatchments A and B drain to the North-western motorway corridor.

Drainage paths and discharge locations are illustrated on the 'Existing Stormwater Drainage Paths and Discharge Points Plan' in Appendix B.

3.4 Treatment

As noted in Table 3-1 below, runoff from only two small subcatchments (C and E) currently receive stormwater treatment in a stormwater pond adjacent to the Henderson Creek. Preliminary assessment indicates that runoff from the remainder of the impervious areas does not receive treatment prior to discharge.

Table 3-1: Subcatchment Summary

Subcatchment Name	Existing Impervious Area (ha)	Proposed Impervious Area (ha)	New Impervious Area (ha)	Peak Flow Rate 10 yr ARI (m3/s) – Proposed Impervious Area	Current Discharge Location	Treatment Currently Provided?
A	0.085	0.088	0.003	0.0235	Motorway corridor	N
B	0.178	0.215	0.037	0.0553	Motorway corridor	N
C	0.130	0.165	0.035	0.0393	Henderson Creek	Y
D	1.414	1.759	0.345	0.398	CMA at Daytona Strand	N
E	0.061	0.066	0.005	0.0195	Henderson Creek	Y
F	1.355	1.547	0.192	0.2849	Henderson Creek	N
G	0.296	0.296	0	0.0661	Henderson Creek	N
H	0.474[2]	0.451	0.05[3]	0.0995	Freshwater Stream, then CMA west of Tudor Road[4]	N
I	0.194	0.215	0.021	0.0523	Henderson Creek (via subcatchment F)[3]	N
J	0.147	0.151	0.004	0.0474	Freshwater Stream, then CMA west of Tudor Road	N
TOTAL	4.334	4.953	0.692	1.086		

The area and flow figures in Table 3-1 are as calculated by GHD, with the exception of the amendments described in the footnotes below.

[2] The catchment area figures in the GHD subcatchment calculations do not look to be consistent with the Catchment Plan drawings i.e. the existing impervious area is greater than the total catchment area. This will affect the quantum of the assessment but not the outcomes of it. Catchments will be finalised as part of detailed design.
[3] Assumed value for optioneering – an increase in impervious area is illustrated on the GHD Catchment Plans (see note 1 above).
[4] Subcatchment boundaries (and therefore areas and flow rates) for subcatchments H and I have been adjusted following production of the Stormwater Options Report. Drainage paths / discharge locations for sub-catchments H and I have also been modified following further assessment.

4 Regulatory Framework

An assessment of operative and proposed legislation by Hill Young Cooper (HYC) has identified the planning / consenting considerations outlined below. Regional consent applications will be made at a later date, and applicable consent requirements will be reassessed at that time. This section provides an indication of stormwater consenting requirements, based on the currently applicable legislative context and the proposed stormwater option described in section 5 below.

4.1 Legislative Context

The two relevant planning documents at the time of this assessment are:

- Operative Plan – Auckland Regional Council 'Air, Land and Water Plan' (ARP:ALW or ALWP).
- The notified version of the Proposed Auckland Unitary Plan (PAUP), currently in hearings stage.

4.2 Stormwater Rules

ALWP: consent would be required for new impervious surfaces greater than 5,000m² (Rule 5.5.3). Requirement to treat discharge from additional (new) impervious surfaces to TP10 Standards (75% Total Suspended Solids removal).

PAUP: Stormwater Discharge - consent would be required for new road impervious surface greater than 5,000m² (Rule H4.14(1.1)).

PAUP: Stormwater Flow (SMAF) - flow and volume management (e.g. detention / retention) in specified areas. The existing discharges to freshwater streams from subcatchments H and J are within a proposed SMAF 2 area and would have required volume control under the PAUP if the existing discharge locations were retained. Some small new areas of impervious surface will be constructed within the SMAF 2 area. Consent would be required (Rule H4.14(2.1)) on the following basis:

- Impervious area less than or equal to 1000m² within a SMAF 1 or 2 that meet the hydrology mitigation requirements – permitted
- Impervious areas greater than 1000m² and less than or equal to 5000m² within a SMAF 1 or 2 that meet hydrology mitigation requirements – controlled
- Impervious areas within a SMAF 1 or 2 that do not meet the permitted and controlled activity (as listed in controls 2.2.1 and 2.2.2) – restricted discretionary

In accordance with H4.14 Table 2, the hydrological mitigation required for SMAF 2 includes:

- Provide detention (temporary storage) with a volume equal to the runoff volume from the 90th percentile, 24 hour rainfall event for the impervious area for which hydrology mitigation is required; and
- Provide retention (volume reduction) of 8mm, 24 hour event for the impervious area for which hydrology mitigation is required.

It is noted that under the proposed stormwater option runoff from the new impervious areas within the SMAF will not be discharged to the watercourses that the SMAF aims to protect.

PAUP: Stormwater Quality - consent would be required for redevelopment of a high use road (Rule H4.14(3.1)). In accordance with H4.14 Tables 3 and 4, the requirement for stormwater treatment is for 90% of the annual rainfall, with the following specific requirements:

- Metals - zinc < 30µg/L and copper < 10µg/L;
- Sediment - total suspended solids < 20mg/L; and
- Temperature – 25°C

Note that the temperature rule only applies to discharges to a river or stream environment, and therefore does not apply to discharges to the CMA.

The PAUP has a 'claw back' requirement – seeking treatment for both the existing impervious areas of a redeveloped high use road as well as new impervious areas.

4.3 Construction in the Coastal Marine Area

A coastal permit may be required under the ARP: C (Coastal Plan) and the PAUP for construction activities if the outfall structure is constructed within the Coastal Marine Area. These applications for resource consent will be lodged at a later date if required.

4.4 Summary

4.4.1 Relevant Project Effects

The total impervious area in the LRCI catchment area is estimated at 4.95 hectares, including the new impervious area (estimated at 0.69 hectares), which is greater than the 0.5 hectare consent trigger noted in Section 4.2 above.

The increase in the runoff associated with the widened road will be relatively minor, as it is a small increase in terms of the overall size of catchment.

The quality of the stormwater discharged at Daytona Strand will be similar to that of the stormwater discharges that currently occur from the road as a whole. A contaminant load assessment has been undertaken using the Auckland Council's Contaminant Load Model and the results from this assessment are included in Appendix E.

4.4.2 Consent Requirements

A summary of likely stormwater consent requirements is included in Table 4-1.

Table 4-1: Stormwater Consenting Summary

	Operative Plan (ARP:ALW)	PAUP
Consent activity status	Restricted discretionary	Stormwater discharge - Restricted discretionary Stormwater flow - restricted discretionary Stormwater quality - restricted discretionary
Area to be managed	New impervious surface areas	Redeveloped areas (new plus existing carriageway)
Treatment potentially required	75% TSS removal	Metals, sediment

5 Proposed Stormwater System Development

5.1 Introduction

Determination of the proposed approach to stormwater management and assessment of potential options for stormwater collection, treatment and discharge took place in mid-2015 and was documented in the MWH Stormwater Options Report in Appendix D. A summary of the alternatives considered, proposed approach, options assessment and resulting 'best practicable option' is included below. The final design of the stormwater system is not completed at the time of writing this report and is assumed to comply with the outcome of the stormwater options assessment.

5.2 Option Assessments

5.2.1 Initial Studies (GHD)

Stormwater management was considered at a relatively high-level in initial design work (carried out by GHD, 2011/12) for the LRCI project. The initial design work was also carried out prior to the PAUP being notified and therefore did not include consideration of the PAUP provisions. These initial assessments concluded that the use of LID devices was not recommended for this project as they are not practical and it is not affordable to acquire the additional land required to implement LID.

The initial assessment considered the following options for the treatment and discharge of stormwater from the widened road:

1. Northern section of Lincoln Road conveyed to a new treatment pond (wetland) on the edge of the CMA at the Triangle Road Bridge to treat areas discharging to the Lincoln Road Catchment.
2. Northern section of Lincoln Road conveyed to a new treatment pond (wetland) located in 297-310 Lincoln Road (identified in the CMP) to treat areas discharging to the Central Park Catchment.
3. Southern section of Lincoln Road – upgrade the existing pipe across Laidlaw College land and construct a treatment device somewhere on this discharge path.
4. Construct a new discharge pipe down Universal Drive to the east and find a suitable location for a treatment device prior to discharge to Henderson Creek.

5.2.2 Options considered by MWH

5.2.2.1 Low Impact Design

Low impact design (LID) typically requires an equivalent area of up to 8%[5] of the impervious area contributing runoff that needs to be treated. On this basis, an area of approximately 4,000m^2 would be required to implement LID for treatment of all of the impervious area within the road corridor. Assuming that 50% of the road length cannot be used for LID devices due to the presence of intersections, junctions, vehicle crossings, etc. this equates to a 6m wide treatment area alongside the carriageway.

LID devices are hydraulically designed to treat runoff from the full width of the road corridor contributing to them. Two separate collection systems would be required to hydraulically separate runoff from the existing and new impervious areas, therefore it is considered impractical to provide LID to treat the new impervious areas only.

The Lincoln Road corridor is constrained on both sides and the additional width required to implement LID devices would substantially increase land acquisition and the impact of the road widening works on property owners and businesses would be substantial. Therefore, LID devices are not considered to be a feasible solution for full stormwater management of the widened Lincoln Road corridor.

[5] Auckland Council TR2013/035, Auckland Unitary Plan Stormwater Management Provisions: Technical Basis of Contaminant and Volume Management Provisions.

5.2.2.2 Stormwater Management Approach

Given the impracticability of a Low Impact Design approach down the length of the LRCI project, the proposed approach for stormwater management for the LRCI project is to a) collect and convey runoff to a treatment device/s and discharge outside of the road corridor, rather than implement LID down the corridor, and b) minimise the number of stormwater discharge locations.

To simplify the consenting and management of discharges from the upgraded road corridor all runoff from the widened road will be collected and conveyed to either a single discharge point at the north end of the catchment or two discharge points – one for the southern section of the catchment and one for the northern section. This would avoid the need for multiple pipe upgrades (often through private property) and potentially multiple treatment systems. This approach also avoids discharge to the area identified as SMAF 2 area under the PAUP (see Figure 2-1 above).

Desktop assessment has identified that a critical 910mm diameter concrete lined steel watermain runs down the centre of Lincoln Road and one side of Triangle Road (section of the North Harbour No.1 Watermain). The presence of the watermain will be a significant obstacle to construction of new stormwater reticulation, particularly where laterals cross from one side of the road to the other. To simplify design of reticulation for the widened road corridor, a twin collector approach was proposed – one collector pipe on each side of the road corridor. This will negate the need for laterals crossing the road, except for a single pipe at the downstream end.

A key consideration for design of the stormwater treatment assets for the LRCI project is whether to treat runoff from the new impervious areas only, as required under the ALWP, or to treat runoff from all impervious areas (existing and new) in the upgraded Lincoln Road corridor area to ensure compliance with the PAUP. This decision will significantly affect the amount of runoff that must be treated and therefore the size and cost (capital and operational) of the treatment system.

The catchment area and the 10% AEP peak flow rate (TP108) for all impervious areas and new impervious areas are noted below for comparison purposes:

- All impervious area – 4.95 ha; 1.15 m^3/s
- New impervious area only – 0.69 ha; 0.16 m^3/s

A number of treatment options were identified. These options included meeting the PAUP permitted activity ‘claw back’ requirement to treat existing impervious areas in addition to new impervious areas. They also included an ALWP compliant option of treating an equivalent area to the increase in impervious surfaces.

All treatment options were targeted to provide quality treatment by means of removing 75% of total suspended solids to meet ALWP requirements.

5.2.2.3 Treatment Options Considered

The options in Table 5-2 were identified and assessed, based on the proposed management approach set out above:

- Minimise the number of discharge points and treatment locations
- Minimise pipe upgrades
- Minimise work in private land
- Avoid discharge to the SMAF 2 area
- Centralise treatment to one location outside the road corridor for ease of maintenance.

The potential post-upgrade discharge catchments considered are listed in Table 5-1 below.

The assessment included options that seek to comply with treatment requirements under the ALWP and/or the PAUP. Options that comply with the PAUP are also compliant with the ALWP. The options that comply with the ALWP only (not the PAUP) provide treatment of new impervious areas only in smaller treatment devices.

Auckland Transport has indicated that, due to the capital and operational costs associated with the claw back provisions that they have a strong preference to target treatment of runoff from new impervious areas only (ALWP compliant) at this point in time.

Table 5-1: Post-upgrade Discharge Catchments

Catchment Name	GHD Subcatchments Served	Discharge Location	Existing Discharge Pipe	Existing Pipe Sufficient for Discharge?
Northern	A, B, C, D, E	CMA at Triangle Road	No	N/a
		CMA at Daytona Strand	Yes (Subcatchment D)	No
Southern	F, G, H, I, J	Henderson Creek	Yes (Subcatchment F)	No
All Catchments	All	CMA at Triangle Road	No	N/a
		CMA at Daytona Strand	Yes (Subcatchment D)	No

Table 5-2: Stormwater Treatment Option Summary

Option	Discharge Location	Treatment Device	Advantages	Disadvantages	Relative Capital Cost	Relative Maintenance Cost	Consenting Risk
1	Henderson Creek (Southern) and CMA at Triangle Road or Daytona Strand (Northern)	Structural Filtration (Southern) and Treatment Wetland or Structural Filtration (Northern)	Smaller conveyance pipework (reticulation) in Lincoln Road than for single discharge options Opportunity to collaborate with AC for pipe upgrade to Henderson Creek	Same disadvantages as below for Triangle Road and Daytona Reserve discharges High cost associated with pipe (flat gradient) and treatment device (land purchase) in Laidlaw College land	Highest (two discharge pipes and treatment devices, likely to be more expensive than one)	Highest (maintenance of two treatment devices, likely to be more expensive than one)	Two separate discharge locations to consent
2A	All runoff to Triangle Road	Wetland	No impact on private properties (except for Radio NZ land required for this option) Upgrade of the existing drainage path through Laidlaw College land not required	High construction risk in CMA with no geotechnical information Longest pipe route / pipe route in high use road Land purchase required (Radio NZ) Limited access to wetland site for construction and maintenance	Highest capital cost of constructing wetland Likely more expensive than Daytona Strand wetland due to site topography and longer pipe route	Generally lower annual maintenance cost than filtration device, but high-cost activities potentially required at 10 and 20 year intervals	Difficulties associated with consenting works in the CMA
2B	All runoff to Triangle Road	Structural filtration (Triangle Road bridge)	No impact on residential properties (both for construction and maintenance activities) Less work in the CMA than Option 2A Upgrade of the existing drainage path through Laidlaw College land not required	Longer pipe route / pipe route in high use road Land purchase required (Radio NZ) Regular maintenance of filters required	Likely lower capital cost than wetland Likely more expensive than filtration device in 312 Lincoln Road due longer pipe route and cost of land purchase	Limited suppliers for maintenance – pricing may reflect fact that there is no competition for services	Less risky (limited work in CMA – possibly outfall only in CMA)

Option	Discharge Location	Treatment Device	Advantages	Disadvantages	Relative Capital Cost	Relative Maintenance Cost	Consenting Risk
3A	All runoff to Daytona Strand	Wetland	Shorter pipe route / pipe route in low use road Added amenity possible Existing access to wetland site Potentially easier construction than at Triangle Road Opportunity to treat runoff from wider catchment as added benefit Upgrade of the existing drainage path through Laidlaw College land not required	Impact on residents during construction and maintenance Pipe route through one private property Working areas required in two private properties during construction of discharge pipeline Flooding to be considered Wastewater pipeline across estuary to be considered Initial feedback from Auckland Council is they would not be looking to help fund construction.	High capital cost of constructing wetland	Generally lower annual maintenance cost than filtration device, but high-cost activities potentially required at 10 and 20 year intervals	Difficulties associated with consenting works in the CMA
3B	All runoff to Daytona Strand	Structural filtration (312 Lincoln Road)	Shorter pipe route / pipe route in low use road Minimal work in the CMA Upgrade of the existing drainage path through Laidlaw College land not required	Land purchase required (but already planned) Pipe route through one private property Working areas required in two private properties during construction of discharge pipeline Regular maintenance of filters required, Potential impact of noise and vehicle movements during maintenance activities	Likely lower capital cost than wetland	Limited suppliers for maintenance – pricing may reflect fact that there is no competition for services	Least risky (no work in CMA other than outfall)

A high-level assessment of the perceived relative advantages and disadvantages of the stormwater management options identified Options 2B, 3A and 3B as the most suitable.

Following identification of the most suitable management options, a qualitative comparison of treatment devices was undertaken – see Table 5-3 below. The black diamonds indicate which option is considered to be preferred for each criterion.

Table 5-3: Stormwater Treatment Device Comparison Summary

Option	Land Take	Hydraulic constraints	Constructability	Maintainability	Environmental constraints	Added amenity value	Benefits to wider catchment	Consentability	Cost - Capital	Cost - Operational	Cost - NPV
Wetland						◆	◆			◆	
Structural Filtration	◆	◆	◆	◆	◆			◆	◆		◆

Based on this comparison, structural filtration is the preferred treatment device. It is likely to be easier to construct, maintain and consent, and have a lower whole life cost than a wetland, but lacks the potential amenity benefits and ability to treat the wider catchment. Initial discussions with Auckland Council officers identified that Council has no drivers that would lead to it funding the increased cost of a wetland at this time.

5.2.3 Selection of Preferred Option

Based on the information available and the high-level option assessment undertaken, the top three stormwater treatment options, ranked in order preference, were:

1. Structural filtration device at 312 Lincoln Road (Option 3B in Table 5-2)
2. Structural filtration device at the Triangle Road bridge (Option 2B in Table 5-2)
3. Wetland at Daytona Strand (Option 3A in Table 5-2)

The relatively high cost of wetland construction, plus the other relative merits noted above, makes a filtration device more attractive than a wetland. 312 Lincoln Road is considered to be a marginally better location for a filtration device, as the process for land acquisition is more defined and the capital cost of constructing conveyance pipework is lower than the Triangle Road bridge location. Therefore, provision of a structural filtration device at 312 Lincoln Road (Option 3B) was selected as the preferred option.

The preferred option will treat runoff from an area greater than the equivalent to the NEW impervious areas. Given the impracticality of collecting and treating runoff from the very small, widely spread sections of impervious area that will be added during the LRCI project, treatment for an ‘equivalent area’ of the upgraded Lincoln Road corridor is provided. The area proposed to be treated as ‘equivalent area’ includes the section of the LRCI catchment located to the north of the proposed device at 312 Lincoln Road (see Figure 5-1 below). This equivalent area has an area of approximately 9 hectares, which is greater than the new impervious areas (0.69 hectares).

The ‘equivalent area’ illustrated in Figure 5-1 has been selected due to the LRCI area topography. There is a natural low point adjacent to 312 Lincoln Road, with the road sloping down towards this low point from the north and the south, making this a logical location in which to drain stormwater from the road.

In order to treat a portion of the runoff from the LRCI area, a separate stormwater reticulation network is required to convey flow to the treatment device, with runoff from the other areas bypassing the device in a separate pipe. Splitting the extent of the stormwater reticulation networks as close to the point that stormwater is drained from the catchment as possible is the most practical solution, as it negates the need for duplicate pipework.

Figure 5-1 : Area Proposed to Receive Treatment

5.3 Proposed Stormwater System

5.3.1 Development of the Preferred Option

The preferred option described above is described in greater detail below.

Runoff from the widened road corridor will be collected in catchpits and conveyed by local reticulation to stormwater collector pipes that will run down both sides of Lincoln Road to the head of the discharge pipeline at 312 Lincoln Road. Runoff from an area of approximately 9000m^2 at the northern end of the LRCI project, will be collected by catchpits and conveyed by a separate local reticulation network draining to a proprietary structural filtration device (Stormfilter or approved equivalent) located at 312 Lincoln Road. Treated and untreated runoff combines in a discharge pipeline that conveys the stormwater to a new outfall structure at Daytona Strand.

The structural filtration device has been sized to treat runoff from the equivalent area to remove 75% suspended solids on a long term annual average. This has been sized by the suppliers as requiring 20 standard full height cartridges. The cartridges would be installed in a chamber approximately 6m long by 2.5m wide. Auckland Council has approved the StormFilter device as compliant with the treatment requirements set-out in the ALWP. The ability of proprietary treatment devices to meet the PAUP Quality requirements has not yet been established - Auckland Council have advised that this process will not be completed until after the Unitary Plan has been finalised. However the Stormfilter has been verified by the Washington Department of Ecology, the New Jersey Department of Environmental Protection and the USEPA's Environmental Technology Verification program.

Access for construction and maintenance of the structural filtration device at 312 Lincoln Road will be available via the service lane proposed to give access to the adjacent properties once the LRCI works are completed.

The discharge structure at Daytona Strand will consist of a reinforced concrete wingwall unit located in the existing embankment. Discharge of runoff will be at the edge of the CMA – the outfall structure will be located just outside the CMA boundary. Energy dissipation and erosion protection measures will be implemented to minimise the velocity of the stormwater discharges and potential for scour at the outfall. The proposed discharge location is adjacent to an existing channel in the CMA - discharging to a channel / body of water will assist with energy dissipation.

The location of major pipework, structural filtration treatment device and discharge structure are illustrated on the 'Proposed Stormwater System Scheme Plan' and 'Proposed Discharge Route Plan' in Appendix C.

5.3.2 Best Practicable Option

The proposed stormwater system described above is considered to be the Best Practicable Option (BPO) for stormwater management for the LRCI project, based on assessment against the BPO criteria set out in the RMA.

In considering the BPO, regard has been given to:

- The nature of the discharge – this is a high use road with elevated contaminant loads from vehicular traffic. Vehicle usage and hence contaminant load is expected to increase (design increase from 42,000 vehicles per day in 2015 to 51,000 vehicles per day in 2026). Treatment provided under the preferred option will help to off-set the increase in contaminant load associated with this increase in vehicle movements.
- The sensitivity of the receiving environment to adverse effects – this issue is addressed in the Marine Ecology Report prepared by Boffa Miskell.
- The financial implications – this includes the land purchase, construction and maintenance costs. Alternative devices and treatment areas and their relative costs are considered in the stormwater Options Report in Appendix D.
- The disruption to adjacent land owners – the use of at source treatment options or LID along the length of the LRCI project would require the purchase of significant further land to widen the corridor. This will have adverse impacts, in some cases significant to adjacent land owners in this highly developed area.

- The effects on the environment, of that option when compared with other options – this issue is addressed in the AEE prepared by Hill Young Cooper.
- The current state of technical knowledge and the likelihood that the option can be successfully applied – the proposed use of the Stormfilter treatment system is a tried and known treatment system that is proven as a treatment system to reduce contaminant loads discharging of high use road corridors.

Given the constraints on land availability within the road corridor and the current status of applicable regional and district planning documents, the proposed system is considered to be the best balance between minimising adverse effects on the built and receiving environments and the capital and operational cost of providing stormwater infrastructure.

The proposed system will provide for an increased area of stormwater treatment for the LRCI area as only a very small portion of the LRCI area currently receives any form of quality treatment. Under the project, a small area of existing impervious area will also be treated in addition to an area the equivalent to the new impervious area.

The quality of the stormwater discharged at Daytona Strand will be similar to that of the stormwater that is currently discharged.

6 Suitability, Efficiency and Effectiveness of Proposed Stormwater System

6.1 Primary System

The primary reticulation system will be designed to meet relevant design standards and codes of practice, including Auckland Council's Stormwater Code of Practice (SW CoP), Auckland Transport's Code of Practice for Road Drainage and the Austroads road engineering guidelines.

For reticulation, this will include sufficient capacity for a 1 in 10 year storm event including an allowance for climate change. Catchpits will be located so as to provide sufficient inlet capacity to drain design storm event flows and comply with minimum spacing requirements set out in the SW CoP. Pipes will be sized to provide sufficient capacity at acceptable velocities and to meet cover and access requirements set out in the SW CoP.

The primary system will also be designed to meet Austroads standards in relation to levels of service for road users and pedestrians, including requirements for volume, width and velocity of stormwater flows within the road corridor.

This is considered to be an improvement on the existing situation in the LRCI area, where the primary network is likely sized at best for a 1 in 5 year storm event. Designing for a larger storm event will reduce the frequency and quantity of ponding within the catchment, as well as the frequency and magnitude of overland flows leaving the road corridor.

Treatment will be provided for runoff from an area that is greater than the equivalent of new impervious areas. Stormwater will be treated by a proprietary treatment device to achieve a 75% reduction in total suspended solids. Auckland Council has approved the 'StormFilter' device as compliant with the treatment requirements set-out in the ALWP. The ability of proprietary treatment devices to meet the PAUP Quality requirements has not yet been established - Auckland Council have advised that this process will not be completed until after the Unitary Plan has been finalised.

Since completion of the Stormwater Options, Auckland Council have expressed interest in the potential use of the 'Jellyfish Filter' treatment device, which is new to the market and is considered to have a number of benefits over the StormFilter. The local supplier for both devices has advised that the Jellyfish filter has a smaller footprint (while providing a slightly higher level of treatment), therefore in the event of selection of this device during design development the area required for the stormwater treatment device for this project would not impacted.

Conservative calculations of the contaminant load from the LRCI project area have been made using the Auckland Council's Contaminant Load model. A summary of these calculations are included within Appendix E. These calculations show that there is a small increase in the overall contaminant load delivered from the road (TSS, TZn, TCu, TPH) with the proposed treatment system. Treatment of the whole road area can deliver significant reductions in the total contaminant load.

6.2 Secondary System

The secondary system is the flow of stormwater runoff overland, in a rainfall event that is larger than the design storm event for the primary reticulation (or if there is a blockage within the primary system).

Existing overland flowpaths in the LRCI area are shown on the GIS snapshot in Figure 6-1 below.

The effect of the proposed stormwater system for the widened road on overland flow paths is expected to be minimal as road alignment and geometry will be similar to existing. Local variations in level and barriers to overland flow may result in slight changes to local overland flow paths, but the impact on the overall area secondary system will be insignificant.

Construction of the proposed piped stormwater system will have a positive effect on overland flow, as the capacity of the primary system will increase the nominal 20%AEP capacity (without climate change)

in the current arrangement to a 10%AEP with climate change, thus reducing the volume, frequency and magnitude of runoff that will flow overland in larger storm events.

The detailed impacts on overland flow at a local level can only be assessed once detailed design of the road widening has been undertaken.

6.3 Discharge

Runoff from the widened road corridor will be discharged via a single outlet structure located at the edge of the CMA at Daytona Strand. This will reduce the number of discharge points from this section of Lincoln Road to the estuarine environment from seven to one. These discharge points are shown in Appendix B.

Having a single discharge location at Daytona Strand provides an opportunity to consolidate discharges that require treatment and may help to reduce flooding in other areas of the catchment as flow from Lincoln Road is removed from these sections of the stormwater system. It provides the opportunity to set aside land that can be used to treat both the increased impervious areas, but also provides for the opportunity to increase the area treated in the future, on the same land. Removing discharges to freshwater stream in the proposed SMAF 2 area will mitigate the need for volume control.

The volume of runoff discharged at Daytona Strand will be increased by the consolidation of discharge locations. It is noted that runoff from approximately 35% (1.4Ha) of the LRCI area is already discharged at Daytona Strand, in addition to runoff from land (approximately 6Ha) outside of the road corridor. An initial ecological assessment by Boffa Miskell[6] indicates that the Daytona Strand area '*has low ecological values*' and that '*discharge of treated stormwater is likely to have less than minor adverse effects on marine ecological values'*.

The potential effects of the increased volume on erosion of the receiving environment, must be managed. Velocities at the outlet structure will be minimised in the design of the stormwater pipework leading to the outfall, with suitable pipe sizes and gradients (including drop manholes, where appropriate). Energy dissipation and erosion protection measures will also be incorporated into the design of the discharge structure. The proposed discharge location is adjacent to an existing channel in the CMA - discharging to a channel / body of water will assist with energy dissipation.

The potential effect of the increased flow rate on properties in the discharge area must also be considered, as an increase in the level of the receiving waterbody could exacerbate any existing flooding. Given the width of the receiving estuarine area at Daytona Strand (around 25m wide at the proposed discharge location), the increase in discharge rates (from around 3.145 m^3/s to 3.288 m^3/s will have minimal effect on the water levels in the CMA.

[6] 'Assessment of Effects on Marine Ecological Values', Boffa Miskell, September 2015.

Figure 6-1 : Overland Flow Paths (Auckland Council GIS)

7 Stormwater Effects

While the stormwater discharges will be the subject of separate resource consent applications at a later date, an assessment of stormwater effects is provided in Table 7-1 to demonstrate that the effects of the stormwater discharge can be appropriately managed, and obtaining consent for the discharges is feasible. In undertaking this assessment regard has been had to the relevant stormwater assessment criteria in the ALWP and PAUP.

Figure 7-1: Potential Adverse Effects and Proposed Mitigation

Potential Adverse Effect	Proposed Mitigation
The proposed discharge at Daytona Strand has potential to cause scouring of the estuarine area if not properly managed (operational).	Design of discharge pipework and discharge structure to be developed to ensure acceptable velocities and include energy dissipation and erosion protection measures. Velocities at the outlet structure will be minimised in the design of the stormwater pipework leading to the outfall, with suitable pipe sizes and gradients (including drop manholes where appropriate). Energy dissipation and erosion protection measures will also be incorporated into the design of the discharge structure. The proposed discharge location is adjacent to an existing channel in the CMA - discharging to a channel / body of water will assist with energy dissipation. The width of the estuary at the proposed discharge location will allow the stormwater discharge to spread quickly. The potential for scouring at the point of discharge can be managed though good design.
Lack of temporary management of stormwater during construction causes flooding of road corridor or adjacent properties (construction)	Stormwater management during construction will be undertaken to ensure that a primary system is in place at all times. Existing reticulation will remain operational until new reticulation has been constructed, with connections between old and new systems managed to minimise potential for loss of capacity. It is recommended that the discharge pipe and the outfall structure are constructed as advanced works in order for them to be available for use as new reticulation comes online.
The proposed discharge at Daytona Strand has potential to affect existing flooding at Daytona Strand and Te Pai Park (operational).	Auckland Council GIS indicates that properties at Daytona Strand are within the flood plain. This matches coastal inundation maps on the PAUP GIS. Given the width of the receiving estuarine area at Daytona Strand, the flow rate and volume associated with the proposed discharge will have an insignificant effect on the water levels in the CMA.

Potential Adverse Effect	Proposed Mitigation
	The effect on water levels and therefore available freeboard to properties in the Daytona Strand area will be insignificant. Flooding on Lincoln Road is not identified as a hazard on Council's GIS information, with the exception of a small patch of flooding adjacent to Te Pai Park. The effect on flooding are expected to be minor as there will be no reduction in flood storage and the upgrade works will not increasing flood potential (the road will have stormwater reticulation).
Existing overland flow paths have the potential to be modified by the project	Effects on existing overland flow paths are expected to be minimal or positive, as the LRCI area is located on a ridgeline and the post-works road alignment and geometry will be similar to existing. Overall, the scheme is expected to have a positive effect on overland flow, as the capacity of the primary system will be increased, thus reducing the frequency duration, peak flow rate and volume of runoff that will flow overland in larger storm events. No new overland flowpaths will be created as a consequence of the works.
Erosion and transportation of sediment during construction impacts infrastructure and receiving environments (construction)	Erosion and sediment control measures, in compliance with Auckland Council Technical Publication 90 (TP 90), will be planned, installed and managed to minimise erosion potential and transportation of sediment during construction.
Insufficient maintenance of stormwater infrastructure causes loss of capacity or effects quality of receiving environment (operational)	Responsibilities for operation and maintenance activities are clearly defined and budgeted and documented in an agreement between Auckland Transport and Auckland Council. Operation and maintenance activities will include checking and cleaning of catchpits, inspection of reticulation and the discharge structure, and inspection and maintenance of the structural treatment device (annually or as required). Auckland Transport will ensure appropriate operation and maintenance of the stormwater system is undertaken in accordance with their normal operation procedures and will document proposed responsibilities and funding arrangements.
Treated and untreated stormwater from road containing contaminants discharged to coastal environment at Daytona Strand (operational)	A structural treatment device will be provided at 312 Lincoln Road which will remove suspended solids and heavy metals from stormwater. The preferred option involves the treatment of the equivalent of the new impervious areas (the area shown on Figure 5-1), however there is space available to increase the level of treatment provided, should this be required through the consent process in order to address adverse effects on the coastal environment.

Potential Adverse Effect	Proposed Mitigation
	Structural filtration is an accepted and widely used method for treating stormwater runoff and will have minimal impact on land owners / residents in comparison with alternative treatment devices (wetlands). Conservative calculations of the contaminant load show that there is a small increase (7% TSS, TZn 9%, 6% TCu, 3% TPH) in the total contaminant load delivered from the road with the proposed treatment system. Treatment of the whole road area can deliver significant reductions in the total contaminant load. The proposed treatment solution is compliant with the requirements of the ALWP. See Marine Ecology report for assessment of ecological effects.

8 Construction Management

8.1 Construction Sequencing

It is proposed that construction of the LRCI works will be completed in stages to minimise impact on road users. The proposed sequencing of the construction stages is to start at the northern end of the project area (the Lincoln / Triangle intersection) and work southwards to the Lincoln / Te Pai intersection, to achieve optimum traffic flow during construction.

Typically the stages (eight total) run between two major signalised intersections. This allows relatively long runs, which will allow improved construction efficiency and minimise the number of joints and temporary connections on new services. One side of the road will be worked on at a time, with the western (northbound) side first followed by the eastern (southbound) side, including the raised median.

Services, including stormwater reticulation, will be constructed in the same staged manner, starting from the downstream (Northern) end. By starting at the downstream end it will be possible to switch over to the new reticulation on completion of each stage, rather than waiting for the whole stormwater system to be completed. New catchpits and leads, plus local property connections, will be constructed ready for the switch over to the new reticulation.

It is proposed that the new service road adjacent to Daytona Reserve is constructed as part of the first stage of the works. This will allow the structural filtration device to be constructed and be operational early in the project.

In order to use the new section of stormwater reticulation and the treatment device once they are constructed, the discharge pipe between 312 Lincoln Road and Daytona Strand must be in place to convey runoff to the discharge location. It is recommended that this discharge pipe and the outfall structure are constructed as advance works in order for them to be available for use as new reticulation comes online. Temporary access and working areas will be required on private property during construction of the discharge pipe, particularly in 46 Preston Avenue and one property located between Preston Avenue and Daytona Strand (22 Preston Avenue is considered the most suitable).

Further details of the proposed construction sequencing are included in the Construction Sequencing and Traffic Management Technical Note included as part of the Notice of Requirement package.

8.2 Temporary Stormwater Management

Stormwater management during construction will be undertaken to ensure that a primary system is in place at all times. Existing reticulation will remain operational until new reticulation has been constructed, with connections between old and new systems managed to minimise potential for loss of capacity.

Erosion and sediment control measures, in compliance with Auckland Council Technical Publication 90 (TP 90), will be planned, installed and managed to minimise erosion potential and transportation of sediment during construction.

Runoff entering open excavations will be contained and treated prior to discharge. There may be opportunity to use the structural filtration device at 312 Lincoln Road to treat sediment laden runoff subject to assessment of the impact on filter cartridge operation and maintenance.

The physical works contractor will be responsible for the detailed planning and implementation of stormwater management during construction. It is recommended that provision of an Erosion and Sediment Control Plan (ESCP) for the works by the contractor prior to commencement of construction activities is included in consent conditions for the works. An Outline ESCP will be included as part of the resource consent package of information.

8.3 Overland Flow

As the LRCI area is located on a ridgeline, construction activities are not expected to have a significant effect on existing overland flow paths outside of the road corridor. Overland flow within the road corridor will be managed through staging of works and ensuring that capacity of the primary system is retained at all times.

An assessment of local overland flow during construction, particularly where there is potential to effect flood prone land and private properties, will be completed as part of the detailed design.

9 Conclusions

Following assessment of alternatives and various options the preferred option for the LRCI stormwater system is construction of new reticulation to collect runoff from the widened road corridor and discharging this runoff to a new coastal outfall at Daytona Strand. Treatment of runoff from the equivalent of the new impervious area to comply with the operative ALWP is provided by means of a structural filtration device located at 312 Lincoln Road.

The proposed stormwater system described above is considered to be the Best Practicable Option (BPO) for stormwater management for the LRCI project, based on assessment against the BPO criteria set out in the RMA. Given the constraints on land availability within the road corridor and the current status of applicable regional and district planning documents, the proposed system is considered to be the best balance between minimising adverse effects on the built and receiving environments and the capital and operational cost of providing stormwater infrastructure.

The primary reticulation system will be designed to meet relevant design standards and codes of practice, including Auckland Council's Stormwater Code of Practice (SW CoP), Auckland Transport's Code of Practice for Road Drainage and the Austroads road engineering guidelines. This is considered to be an improvement on the existing situation in the LRCI area, where the primary network is nominally sized for a 1 in 5 year storm event. Designing for a larger storm event will reduce the frequency and quantity of ponding / overland flow within the catchment.

The effect of the proposed stormwater system for the widened road on overland flow paths is expected to be minimal and positive, as road alignment and geometry will be similar to existing and the frequency and magnitude of flows will be reduced due to the increase in primary system capacity. Local variations in level and barriers to overland flow may result in slight changes to local overland flow paths, but the impact the overall area secondary system will be insignificant.

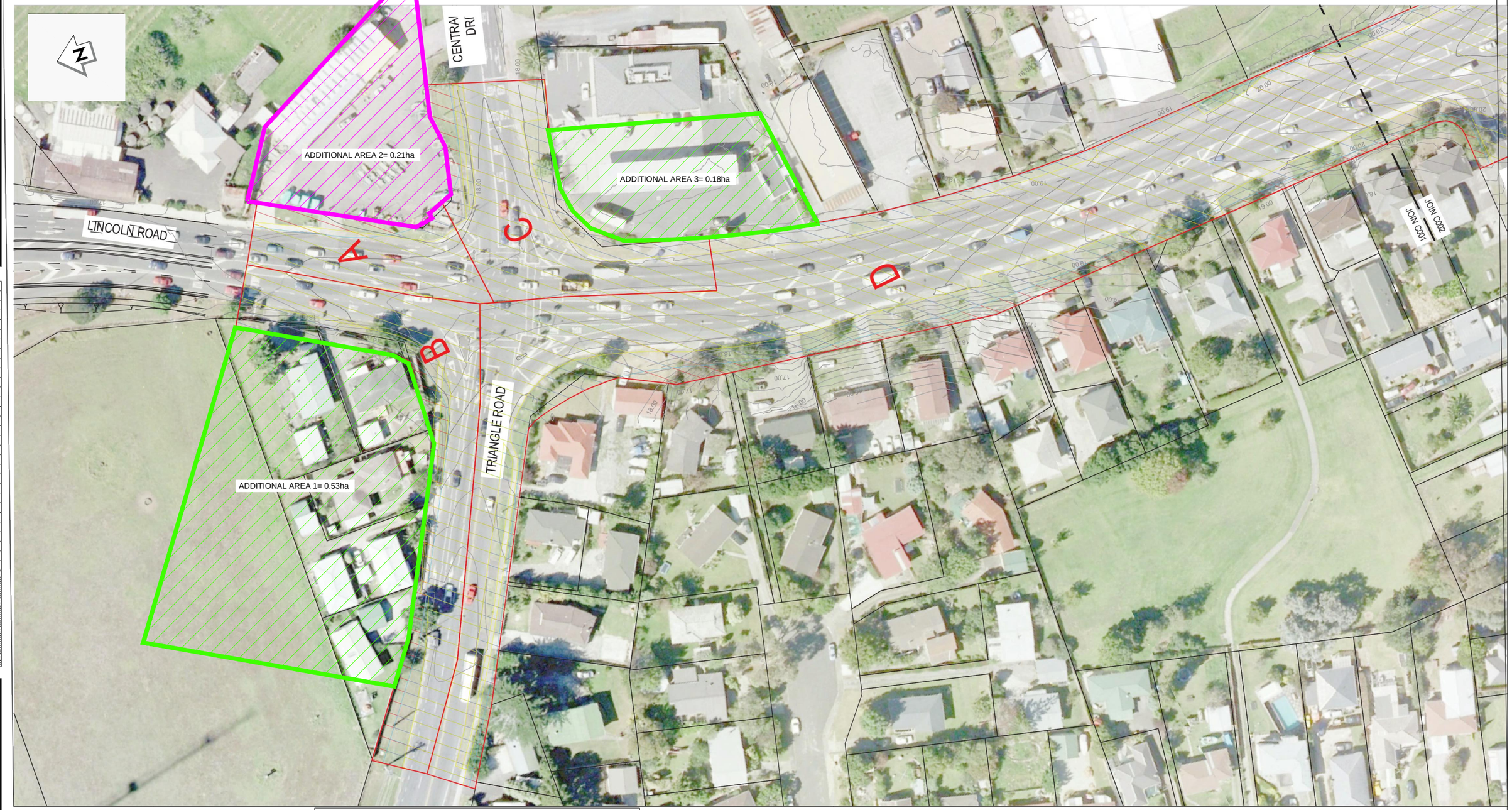
Treatment of an equivalent area to the new impervious areas as well as a relatively small area of existing road is compliant with the operative ALWP. Should a higher level of treatment be required through the resource consent process, there is space available to accommodate cartridges to treat the stormwater from the full widened LRCI corridor.

Given the width of the receiving estuarine area at Daytona Strand, the increase water level associated with the proposed discharge will have an insignificant effect on the water levels in the CMA. Runoff from a large stormwater catchment currently discharges to the CMA at Daytona Strand - post-development flow from the LRCI area will represent only a small increase in the overall discharge from this area.

Potential adverse effects and proposed mitigation are summarised in Section 7 above.

It is noted that this stormwater assessment has been completed using the high-level concept design of potential stormwater system options undertaken by MWH, which is based on the preliminary road design. Detailed design of the stormwater collection, conveyance, treatment and discharge infrastructure for the widened road corridor has not yet been undertaken. A number of elements that form part of this stormwater assessment cannot be quantified in detail in this report. However it is considered that there is enough information to confirm the extent of land required for the management of stormwater discharges.

Appendix A Catchment Boundary Plans



GHD CATCHMENT LEGEND

- TOTAL CATCHMENT BOUNDARY
- EXISTING IMPERVIOUS AREA
- PROPOSED IMPERVIOUS AREA

ADJUSTMENTS TO GHD DESIGN

- POSSIBLY CONTRIBUTES TO CATCHMENT
- PROBABLY CONTRIBUTES TO CATCHMENT
- SUBCATCHMENT BOUNDARY ADJUSTMENT
- REMOVED BOUNDARY

NOTE:
THE BASE CATCHMENT BOUNDARIES WERE DEFINED BY GHD IN PRELIMINARY DESIGN CATCHMENT BOUNDARY DRAWING NUMBER 51-29887-C001 TO 51-29887-C004

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
01	FOR STORMWATER ASSESSMENT REPORT	GM	JP	GS	08/15

SURVEYED	-	-
DESIGNED	M WILLIAMS	08/15
DRAWN	G MURRAY	08/15
CAD REVIEW	J. PETTIGREW	08/15
DESIGN CHECK	J. PEVERIL	08/15
DESIGN REVIEW	A. LEAHY	08/15
APPROVED	G. STANTON	08/15
PROF REGISTRATION:		

MWH

Client:

AUCKLAND TRANSPORT
LINCOLN ROAD CORRIDOR IMPROVEMENTS

ADJUSTED PRELIMINARY STORMWATER CATCHMENT PLAN
SHEET 1 OF 4

Status Stamp: WORKING PLOT
Date Stamp: 25/08/2015
Scales: 1:500 Datum: NZTM
Drawing No.: 80507651 - SK121 Rev.: 01

Last modified: Jun 26 2014 By George Homan
ORIGINAL SIZE A1
DO NOT SCALE - IF IN DOUBT, ASK
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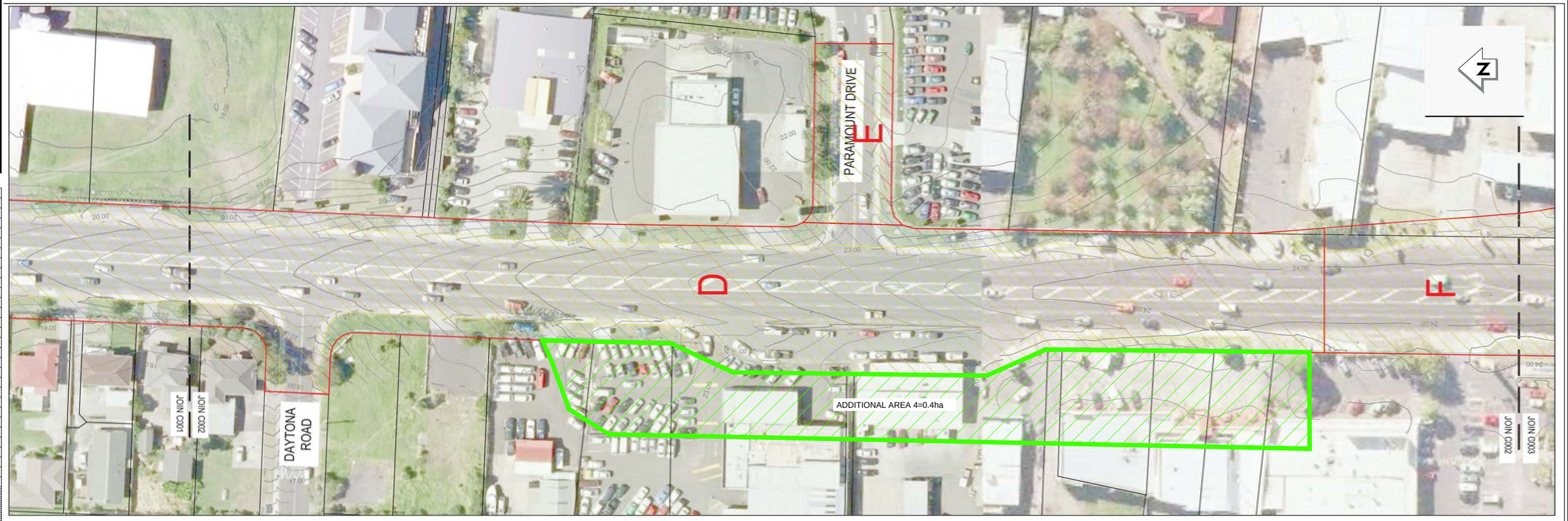

GHD CATCHMENT LEGEND

- TOTAL CATCHMENT BOUNDARY
- EXISTING IMPERVIOUS AREA
- PROPOSED IMPERVIOUS AREA

ADJUSTMENTS TO GHD DESIGN

- POSSIBLY CONTRIBUTES TO CATCHMENT
- PROBABLY CONTRIBUTES TO CATCHMENT
- SUBCATCHMENT BOUNDARY ADJUSTMENT
- REMOVED BOUNDARY

NOTE:
THE BASE CATCHMENT BOUNDARIES WERE DEFINED BY GHD IN PRELIMINARY DESIGN CATCHMENT BOUNDARY DRAWING NUMBER 51-29887-C001 TO 51-29887-C004

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SURVEYED	-	-
DESIGNED	M WILLIAMS	08/15
DRAWN	G MURRAY	08/15
CAD REVIEW	J. PETTIGREW	08/15
DESIGN CHECK	J. PEVERIL	08/15
DESIGN REVIEW	A. LEAHY	08/15
APPROVED	G. STANTON	08/15
PROF REGISTRATION:		

MWH

Client:

AUCKLAND TRANSPORT
LINCOLN ROAD CORRIDOR IMPROVEMENTS

ADJUSTED PRELIMINARY STORMWATER CATCHMENT PLAN
SHEET 2 OF 4

Status Stamp: WORKING PLOT
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Datum: NZTM
Drawing No.: 80507651 - SK122
Rev.: 01

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GHD CATCHMENT LEGEND

- TOTAL CATCHMENT BOUNDARY
- EXISTING IMPERVIOUS AREA
- PROPOSED IMPERVIOUS AREA

ADJUSTMENTS TO GHD DESIGN

- POSSIBLY CONTRIBUTES TO CATCHMENT
- PROBABLY CONTRIBUTES TO CATCHMENT
- SUBCATCHMENT BOUNDARY ADJUSTMENT
- REMOVED BOUNDARY

NOTE:
THE BASE CATCHMENT BOUNDARIES WERE DEFINED BY GHD IN PRELIMINARY DESIGN CATCHMENT BOUNDARY DRAWING NUMBER 51-29887-C001 TO 51-29887-C004

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
01	FOR STORMWATER ASSESSMENT REPORT	GM	JP	GS	08/15

SURVEYED	-	-
DESIGNED	M WILLIAMS	08/15
DRAWN	G MURRAY	08/15
CAD REVIEW	J. PETTIGREW	08/15
DESIGN CHECK	J. PEVERIL	08/15
DESIGN REVIEW	A. LEAHY	08/15
APPROVED	G. STANTON	08/15
PROF REGISTRATION:		

MWH

Client:

AUCKLAND TRANSPORT
LINCOLN ROAD CORRIDOR IMPROVEMENTS

ADJUSTED PRELIMINARY STORMWATER CATCHMENT PLAN
SHEET 3 OF 4

Status Stamp: WORKING PLOT
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ORIGINAL SIZE A1
Last modified: Jun 26 2014 By George Homan

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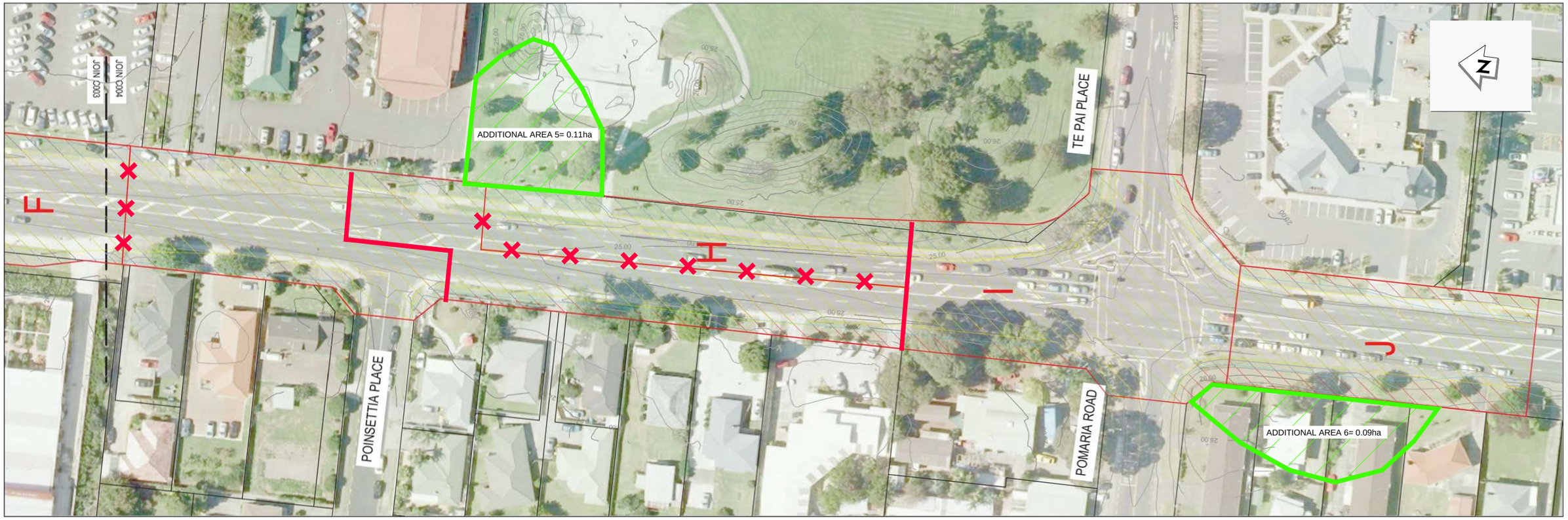

GHD CATCHMENT LEGEND

- TOTAL CATCHMENT BOUNDARY
- EXISTING IMPERVIOUS AREA
- PROPOSED IMPERVIOUS AREA

ADJUSTMENTS TO GHD DESIGN

- POSSIBLY CONTRIBUTES TO CATCHMENT
- PROBABLY CONTRIBUTES TO CATCHMENT
- SUBCATCHMENT BOUNDARY ADJUSTMENT
- REMOVED BOUNDARY

NOTE:
CATCHMENT BOUNDARIES DEFINED BY GHD IN PRELIMINARY DESIGN CATCHMENT BOUNDARY DRAWING NUMBER 51-29887-C001 TO 51-29887-C004

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
01	FOR STORMWATER ASSESSMENT REPORT	GM	JP	GS	08/15

SURVEYED	-	-
DESIGNED	M WILLIAMS	08/15
DRAWN	G MURRAY	08/15
CAD REVIEW	J. PETTIGREW	08/15
DESIGN CHECK	J. PEVERIL	08/15
DESIGN REVIEW	A. LEAHY	08/15
APPROVED	G. STANTON	08/15
PROF REGISTRATION:		

MWH

Client:

AUCKLAND TRANSPORT
LINCOLN ROAD CORRIDOR IMPROVEMENTS

ADJUSTED PRELIMINARY STORMWATER CATCHMENT PLAN
SHEET 4 OF 4

Status Stamp: WORKING PLOT
Date Stamp: 25/08/2015
Scales: 1:500
Datum: NZTM
Drawing No.: 80507651 - SK124
Rev.: 01

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ORIGINAL SIZE A1
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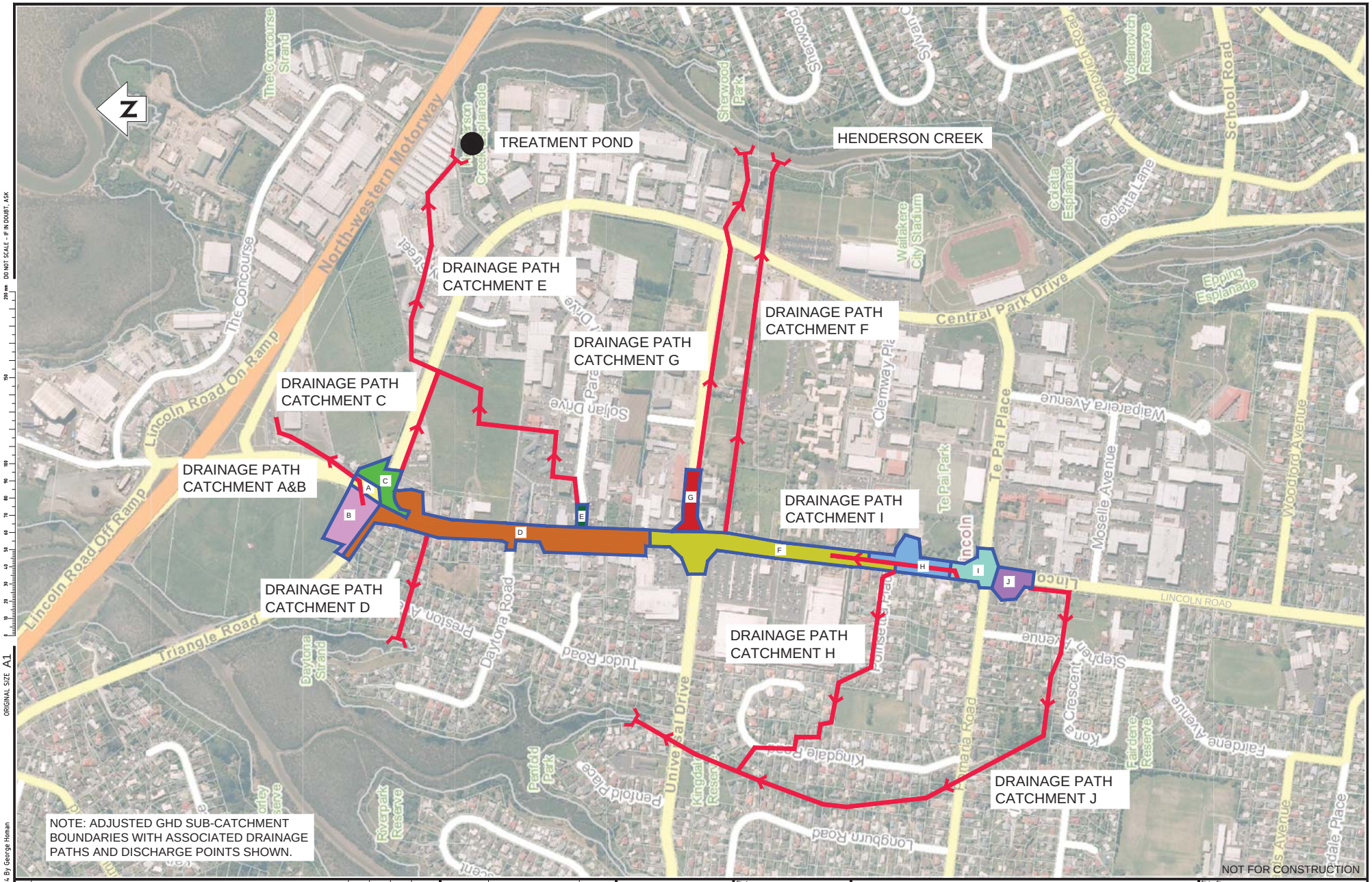
Appendix B Existing Stormwater Drainage Path and Discharge Points Plan



NOTE: ADJUSTED GHD SUB-CATCHMENT BOUNDARIES WITH ASSOCIATED DRAINAGE PATHS AND DISCHARGE POINTS SHOWN.

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
01	FOR STORMWATER ASSESSMENT REPORT	GM	JP	GS	08/15

SURVEYED	-	-
DESIGNED	M WILLIAMS	08/15
DRAWN	G MURRAY	08/15
CAD REVIEW	J. PETTIGREW	08/15
DESIGN CHECK	J. PEVERIL	08/2015
DESIGN REVIEW	A. LEAHY	08/15
APPROVED	G. STANTON	08/15
PROF REGISTRATION:		

MWH

Client: AT

AUCKLAND TRANSPORT
LINCOLN ROAD CORRIDOR IMPROVEMENTS

EXISTING STORMWATER DRAINAGE PATH AND DISCHARGE POINTS PLAN

Status Stamp: WORKING PLOT
Date Stamp: 25/08/2015
Scales: NTS
Datum: NZTM
Drawing No.: 80507651 - SK05
Rev.: 01

ORIGINAL SIZE A1
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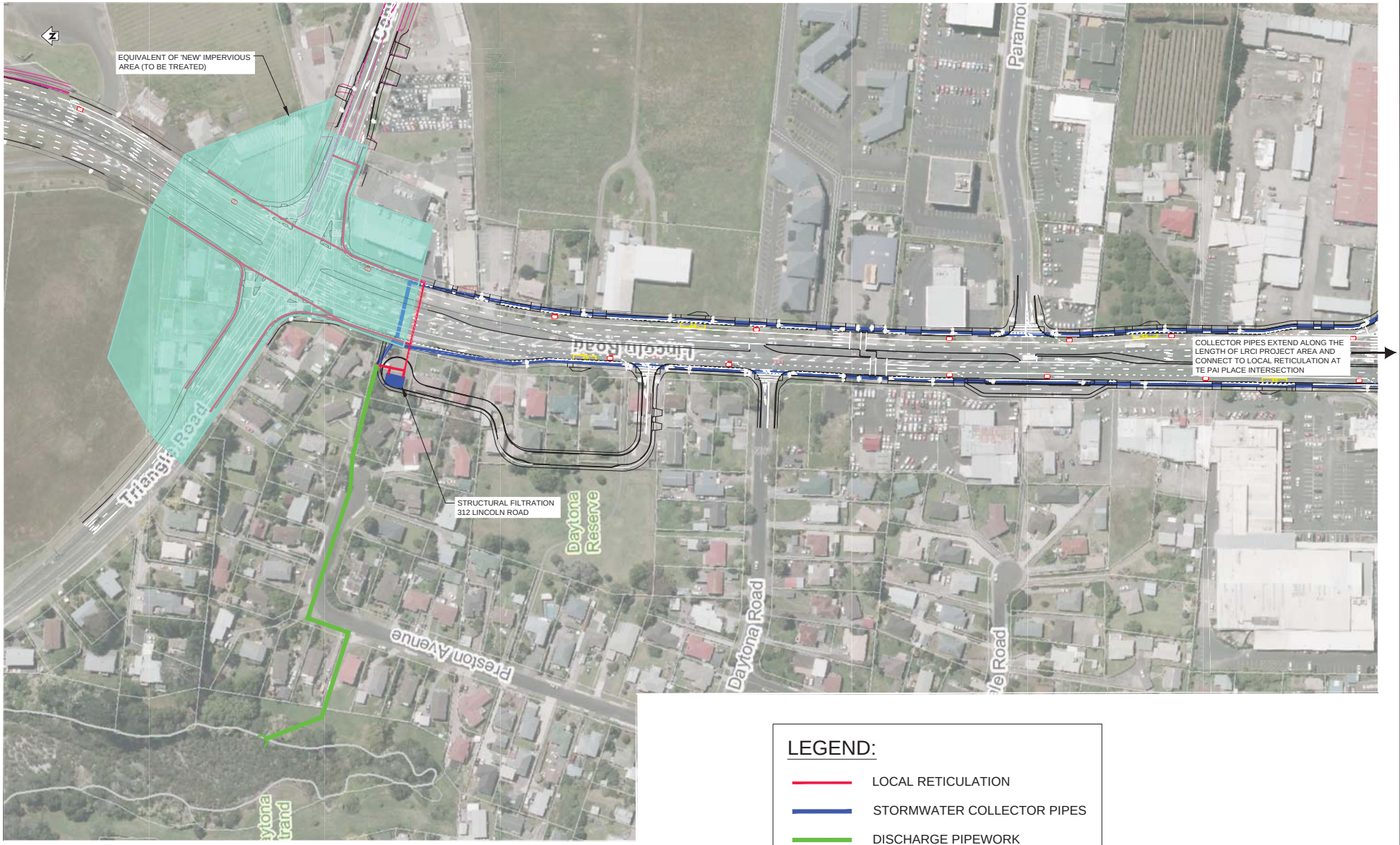
Appendix C Proposed Stormwater System Scheme Plan & Proposed Discharge Route Plan



PIPEWORK AND STRUCTURES NOT TO SCALE

LEGEND:

- LOCAL RETICULATION
- STORMWATER COLLECTOR PIPES
- DISCHARGE PIPEWORK

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
01	FOR STORMWATER ASSESSMENT REPORT	GM	JP	GS	08/15

SURVEYED	-	-
DESIGNED	M WILLIAMS	08/15
DRAWN	G MURRAY	08/15
CAD REVIEW	J. PETTIGREW	08/15
DESIGN CHECK	J. PEVERIL	08/15
DESIGN REVIEW	A. LEAHY	08/15
APPROVED	G. STANTON	08/15
PROF REGISTRATION:		

MWH

Client:

AUCKLAND TRANSPORT
LINCOLN ROAD CORRIDOR IMPROVEMENTS

PROPOSED STORMWATER SYSTEM SCHEME PLAN

Status Stamp: WORKING PLOT
Date Stamp: 25/08/2015
Scales: NTS
Datum: NZTM
Drawing No.: 80507651 - SK06
Rev.: 01

Last modified: Jun 26 2014 By George Homan
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LEGEND:

- LOCAL RETICULATION
- STORMWATER COLLECTOR PIPES
- DISCHARGE PIPEWORK

PIPEWORK AND STRUCTURES NOT TO SCALE

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
01	FOR STORMWATER ASSESSMENT REPORT	GM	JP	GS	08/15

SURVEYED	-	-
DESIGNED	M WILLIAMS	08/15
DRAWN	G MURRAY	08/15
CAD REVIEW	J. PETTIGREW	08/15
DESIGN CHECK	J. PEVERIL	08/15
DESIGN REVIEW	A. LEAHY	08/15
APPROVED	G. STANTON	08/15
PROF REGISTRATION:		

MWH

Client: AT

AUCKLAND TRANSPORT
LINCOLN ROAD CORRIDOR IMPROVEMENTS

PROPOSED STORMWATER SYSTEM - DISCHARGE ROUTE PLAN

Status Stamp: WORKING PLOT
Date Stamp: 25/08/2015
Scales: NTS
Datum: NZTM
Drawing No.: 80507651 - SK07
Rev.: 01

Last modified: Jun 26 2014 By George Homan
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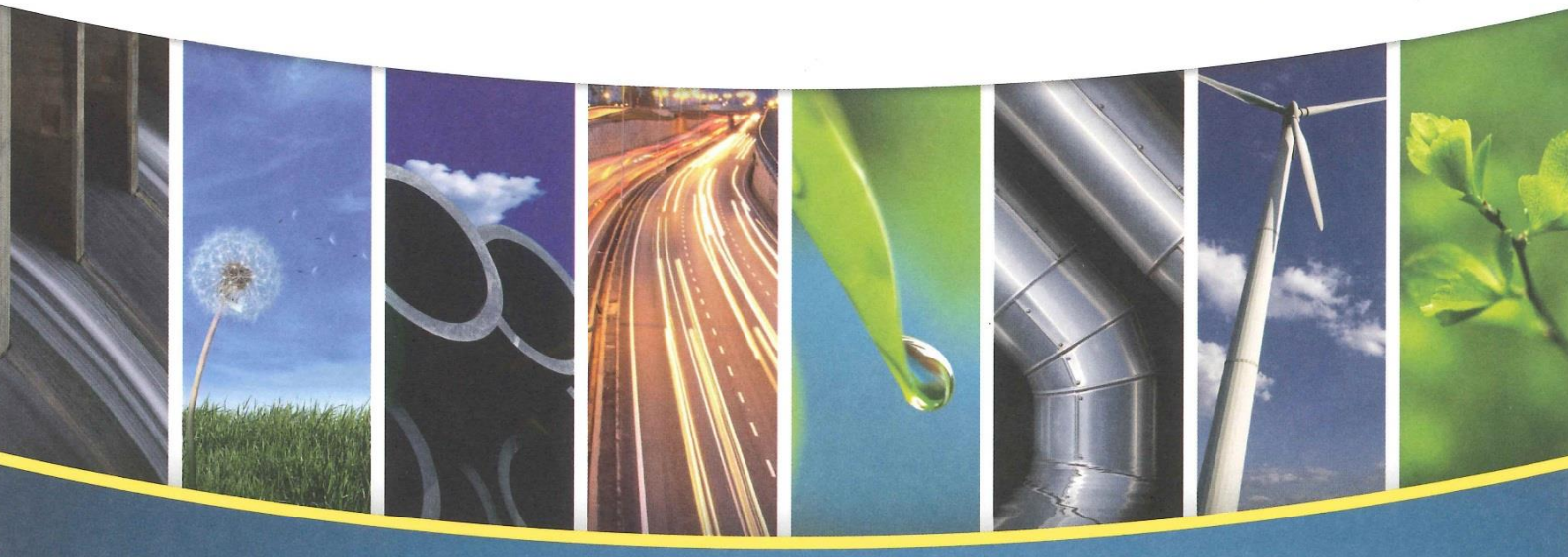
Appendix D Stormwater Options Report

Lincoln Road Corridor Improvements
Stormwater Options Report

Prepared for Auckland Transport

May 2015



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BUILDING A BETTER WORLD

QUALITY STATEMENT

PROJECT MANAGER	PROJECT TECHNICAL LEAD
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REVISION SCHEDULE

Rev No	Date	Description	Signature or Typed Name (documentation on file).			
			Prepared by	Checked by	Reviewed by	Approved by
01	06/03/15	For Issue	JP	AL	AL	GS
02	14/04/15	Final	JP	AL	AL	GS
03	29/05/15	FINAL	JP	AL	AL	GS

Executive Summary

MWH have been engaged by Auckland Transport to undertake detailed design of the Lincoln Road Corridor Improvements (LRCI) project. The scope of the LRCI project includes the provision of a Transit lane in each direction and a shared cycle / footpath on both sides of Lincoln Road, in addition to intersection, median and landscaping improvements. The LRCI site extends from the SH16 interchange to the Te Pai Place / Pomaria Road intersection – a total length of approximately 1.3 kilometres.

From a stormwater perspective, the widening of Lincoln Road will increase the impervious area associated with the road corridor. Previous work relating to management of stormwater for the widened road corridor has been limited to specific areas of the site. This Stormwater Options Report documents at a high level the stormwater management options that have been considered during the early stage of detailed design to aid further consultation with stakeholders and confirm the option to be taken forward for detailed design.

The report summarises catchment information, legislative requirements (based on assessments by Hill Young Cooper) and issues and constraints that have been identified in relation to the construction of stormwater management infrastructure.

The proposed approach for stormwater management for the LRCI project is to collect and convey runoff to a treatment device outside of the road corridor (not implement LID down the corridor); and to minimise the number of discharge locations.

Options for stormwater treatment to comply with the Operative Air, Land and Water Plan (ALWP) or the Proposed Auckland Unitary Plan (PAUP) are presented, including a high-level assessment of relative merits and an indicative cost comparison of treatment devices.

The following recommendations are an outcome of the assessment:

- LID is not considered feasible as an appropriate technique for full stormwater treatment
- Runoff from the widened road corridor is collected and drained to a single discharge location at the north end of Lincoln Road
- That structural filtration is implemented as the preferred treatment method, located at either the Triangle Road bridge or 312 Lincoln Road

The top three stormwater treatment options, ranked in order of preference, are:

- Structural filtration device at 312 Lincoln Road
- Structural filtration device at the Triangle Road bridge
- Wetland at Daytona Strand

Auckland Transport's preference is to provide a treatment device sized to treat runoff from the new impervious areas only, as required under the ALWP, rather than to treat runoff from all impervious areas (existing and new) in the upgraded Lincoln Road corridor area to ensure compliance with the PAUP. This preference is based on the current uncertainty regarding legislative requirements and the capital and operational cost savings associated with treating runoff from new impervious areas only.

The following 'next steps' are recommended in order to progress the design of stormwater assets for the LRCI project:

- Auckland Transport to confirm the design approach to be adopted
- Carry out preliminary design of location options to confirm costs and impacts
- Select treatment / discharge location
- Complete detailed design of stormwater collection, conveyance and treatment infrastructure in conjunction with the road design.

Auckland Transport

Lincoln Road Corridor Improvements

Stormwater Options Report

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APPENDICES

1 Introduction

1.1 Purpose

MWH have been engaged by Auckland Transport to undertake detailed design of the Lincoln Road Corridor Improvements (LRCI) project. The scope of the LRCI project includes the provision of a Transit lane in each direction and a shared cycle / footpath on both sides of Lincoln Road, in addition to intersection, median and landscaping improvements. The LRCI site extends from the SH16 interchange to the Te Pai Place / Pomaria Road intersection – a total length of approximately 1.3 kilometres.

From a stormwater perspective, the widening of Lincoln Road to implement the LRCI project will increase the impervious area associated with the road corridor. Previous work relating to management of stormwater for the widened road corridor has been limited to specific areas of the site. This Stormwater Options Report documents at a high level the stormwater management options that have been considered during the early stage of detailed design to aid further consultation with stakeholders and make recommendations for a concept to be taken forward to preliminary and detailed design.

1.2 Key Documents

Salient information from the key documents that affect stormwater management for the LRCI project is noted below.

Preliminary Design (GHD)

Preliminary design of the road corridor widening works has been undertaken by GHD. The preliminary design defines the scope and layout of the proposed widening works, including the extent of impervious areas.

Stormwater Memos (GHD)

The following stormwater memorandums were prepared during preliminary design:

- Stormwater LID Devices memorandum – July 2011
- Preliminary Design – Stormwater Treatment Options memorandum – August 2011
- Triangle Road Stormwater Disposal memorandum – October 2012

The LID devices memo is a high-level assessment of the potential for the use of low impact design (LID) devices for the widened road corridor. The conclusion of this assessment is that LID is not recommended for this project as the additional land required to implement LID is not practical or affordable. This is largely due to the increased land take required to implement at source LID options.

The stormwater treatment options memo sets out potential stormwater treatment and discharge options for the Lincoln Road corridor. This assessment identifies stormwater subcatchment areas, flows and existing discharge points. Stormwater treatment options are identified for the main subcatchments only.

The Triangle Road stormwater disposal memo presents options for construction of a treatment pond within the Coastal Marine Area (CMA) adjacent to Triangle Road. The pond is proposed to treat stormwater runoff from the northern half of the LRCI catchment (north of Universal Drive), including runoff from all impervious areas, rather than just new impervious areas. Issues, options and constraints for the rest of the road are not discussed in this memo.

Catchment Management Plans

There are two Catchment Management Plans (CMP) that cover the LRCI area – Lincoln Catchment and Central Park Catchment. Both CMP's have been prepared and lodged with the former ARC; however there is no network discharge consent for either catchment. Thus the outcomes recommended in the CMPs must be treated as advisory only.

These CMPs have yet to be supplied for the LRCI project.

Land Requirement Plan

A plan illustrating proposed land acquisition has been prepared as part of the preliminary design process.

A sketch plan indicating proposed service road provisions in the row of properties to the east of Daytona Reserve was provided by Auckland Transport on 23rd March 2015. A copy of this plan is included in Appendix A.

Hill Young Cooper – Planning Strategy

Hill Young Cooper (HYC) have been engaged by Auckland Transport to provide lead planning services for the LRCI project.

HYC have produced a Planning Strategy report (November 2014) to assist Auckland Transport in determining the best approach for obtaining planning permission for the widening of the road. The recommended approach is as follows:

- Stormwater mitigations for the project to be confirmed as a priority
- That Auckland Transport provides for all of the road widening works (and potentially also the stormwater mitigation works) through a designation that covers all of the affected land.
- That Auckland Transport provides for the whole project through an integrated application package including a Notice of Requirement (with sufficient detail to waive the Outline Plan of Works) and the necessary regional consents.

The HYC report also indicates that there is no quality treatment for any of the current stormwater discharges from Lincoln Road.

Hill Young Cooper - Gap Analysis

HYC have completed a gap analysis (November 2014) to:

- Identify information requirements in terms of the statutory context of the project
- Identify potential consenting risks to the project
- Support decisions in relation to the planning strategy for the project

The gap analysis acknowledges that '*effects of stormwater discharge from the widened road is a potentially significant planning issue as the PAUP regional rule controlling stormwater discharge, flow and quality have legal effect. This will trigger a need to mitigate effects associated with flow and quality*'.

2 Lincoln Road Catchment

2.1 Catchment Description

The LRCI catchment extends from the SH16 interchange to the Te Pai / Pomaria intersection – a total length of approximately 1.3 kilometres. This section of Lincoln Road travels along a ridgeline, with very little stormwater runoff contributed from areas outside of the road corridor. The catchment has a general slope from south to north, with local high-points at the Triangle Road / Central Park Road intersection, just north of the Universal Drive intersection and at the Te Pai Place / Pomaria Road intersection.

The stormwater runoff from the Lincoln Road corridor drains to the Lincoln Catchment to the west and the Central Park Catchment to the east. There are currently two main discharge points and a number of smaller discharge points from the various subcatchments. The subcatchments are described below.

2.2 Existing Subcatchments

The LRCI area currently has ten subcatchments discharging to eight existing stormwater discharge points. The extent of the subcatchments draining to each discharge point, as determined by GHD during preliminary design, is shown on the Catchment Boundary plans in Appendix B. The subcatchment areas and details are summarised in Table 2-1 below. MWH has confirmed the discharge points with the available information, but notes that some changes to catchment boundaries and areas will be required as part of preliminary and detailed design to account for areas outside the corridor that drain to it.

Future management of discharges from the widened road corridor is considered later in this report.

Subcatchment A

A short section of the east side of the Lincoln Road carriageway, located north of the Triangle Road / Central Park Drive intersection.

The contours and stormwater reticulation shown on Council GIS indicate that this subcatchment currently drains to the north, discharging to the SH16 motorway corridor (owned by NZTA). As-built drawings from the recent Lincoln Road / SH16 interchange upgrade works will require review during preliminary and detailed design to confirm reticulation details, discharge points and treatment.

Subcatchment B

A short section of the west side of the Lincoln Road carriageway, located to the north of the Triangle Road / Central Park Drive intersection, plus a section of the north side of the Tringle Road carriageway.

The contours and stormwater reticulation shown on Council GIS indicate that this subcatchment currently drains to the north, discharging to the SH16 motorway corridor (owned by NZTA). As-built drawings from the recent Lincoln Road / SH16 interchange upgrade works will require review during preliminary and detailed design to confirm reticulation details, discharge points and treatment.

Subcatchment C

A short section of the Lincoln Road carriageway and Central Park Drive carriageway.

This subcatchment currently drains to the stormwater network in Central Park Drive, which discharges to CMA at Henderson Creek to the east of Lincoln Road.

Subcatchment D

A large subcatchment consisting of the Lincoln Road carriageway between the Triangle Road / Central Park Drive intersection and 253 Lincoln Road, just north of the Universal Drive intersection.

This subcatchment currently drains to a low point on Lincoln Road adjacent to 312 / 325 Lincoln Road. The stormwater network at this point falls to the west, passing down adjacent to Daytona Reserve, under Preston Avenue and discharges to the CMA at Daytona Strand. Sections of this discharge path are open channel, rather than piped network.

Subcatchment E

A short section of the Paramount Drive carriageway.

This subcatchment currently drains to the stormwater network in Paramount Drive, which discharges to Henderson Creek.

Subcatchment F

A large subcatchment consisting mostly of the Lincoln Road carriageway between 253 Lincoln Road and 207-209 Lincoln Road.

This subcatchment currently drains to a low point adjacent to the north west corner of 225 Lincoln Road. The stormwater network at this point falls to the east, following the property boundary on Laidlaw College land, under Central Park Drive and discharges to Henderson Creek.

Subcatchment G

A short section of the Universal Drive carriageway to the east of the intersection with Lincoln Road.

This subcatchment currently drains to the stormwater network in Universal Drive, which discharges to Henderson Creek.

Subcatchment H

A short section of the Lincoln Road carriageway between 207-209 Lincoln Road and a point just north of the Te Pai Place / Pomaria Road intersection.

This subcatchment currently drains to a section of the stormwater network which connects to subcatchment F and discharges to the Henderson Creek.

MWH inspections suggest that the boundaries of this subcatchment may be different to those determined by GHD during preliminary design. The potential impact on impervious area and flow would have minimal effect on the treatment options identified later in this report.

Subcatchment I

A short section of the Lincoln Road carriageway adjacent to Te Pai reserve and the Te Pai Place / Pomaria Road intersection area.

This subcatchment currently drains to a section of the stormwater network which passes down Poinsetta Place and discharges to the CMA to the west of Tudor Road.

MWH inspections suggest that the boundaries of this subcatchment may be different to those determined by GHD during preliminary design. The potential impact on impervious area and flow would have minimal effect on the treatment options identified later in this report.

Subcatchment J

A short section of the Lincoln Road carriageway between Te Pai Place / Pomaria Road intersection and 148 Lincoln Road.

This subcatchment currently drains in a southerly direction to a section of the stormwater network which passes down between 136 / 142 Lincoln Road, before discharging to an open drain in 26 Pomaria Road and eventually discharging to the CMA to the west of Tudor Road.

2.3 Existing Subcatchment Summary

The existing and proposed impervious subcatchment areas, 10 year ARI flow rate (proposed impervious areas) and existing discharge locations are summarised in Table 2-1 below. Catchment areas and flow data is based on calculations completed by GHD during the preliminary design stage and is subject to refinement during design development. MWH have found some areas where flows drain onto the LRCI site that are not included within these catchment areas; so it is expected that some flows will increase slightly in size.

Table 2-1: Subcatchment Summary

Subcatchment Name	Existing Impervious Area (ha)	Proposed Impervious Area (ha)	New Impervious Area (ha)	Peak Flow Rate 10 yr ARI (m3/s) – Proposed Impervious Area	Current Discharge Location
A	0.085	0.088	0.003	0.0235	Motorway corridor
B	0.178	0.215	0.037	0.0553	Motorway corridor
C	0.130	0.165	0.035	0.0393	Henderson Creek
D	1.414	1.759	0.345	0.398	CMA at Daytona Strand
E	0.061	0.066	0.005	0.0195	Henderson Creek
F	1.355	1.547	0.192	0.2849	Henderson Creek
G	0.296	0.296	0	0.0661	Henderson Creek
H	0.474[1]	0.451	0.05[2]	0.0995	Henderson Creek (via subcatchment F)
I	0.194	0.215	0.021	0.0523	CMA west of Tudor Road
J	0.147	0.151	0.004	0.0474	CMA west of Tudor Road
TOTAL	4.334	4.953	0.692	1.086	

[1] The catchment area figures for 'Existing Dev' in the GHD sub-catchment calculations do not look to be consistent with the Catchment Plan drawings i.e. the existing impervious area is greater than the total catchment area.
[2] Assumed value for optioneering – an increase in impervious area is illustrated on the GHD Catchment Plans (see note 1 above).

3 Stormwater Management Framework

An initial assessment of operative and proposed legislation by Hill Young Cooper (HYC) has identified the following planning / consenting considerations:

Legislative Context

Operative Plan – Auckland Regional Council 'Air, Land and Water Plan' (ARP:ALW or ALWP).

The Proposed Auckland Unitary Plan (PAUP) is currently in hearings stage.

'*The provisions in the operative regional plans currently have greater legal/statutory weight than those in the PAUP when making resource consent decisions. The PAUP provisions must be applied in full to determine the activity status of a consent application, but once that is determined, it can currently be argued that only limited regard needs to be given to achieving the full requirements of the PAUP rules*.'

Land Use - Stormwater Assets Outside of Road Corridor

For work required outside of the road corridor – '*AT must consider how such will be legally authorised and how it will get the authority to implement these works, on land that is currently not owned by AT or Council*'.

Stormwater Discharges

ALWP Requirements.
Treat discharge from additional (new) impervious surfaces to TP10 Standards (75% Total Suspended Solids removal).

PAUP Management Areas.
Stormwater Flow (SMAF) - flow and volume management (e.g. detention / retention) in specified areas.
The area to the west of Lincoln Road is identified as a SMAF (see Figure 1 below).
Stormwater Quality: (treatment to meet heavy metal, sediment and temperature parameters).

HYC note that '*….the PAUP regional rule controlling stormwater discharge, flow and quality have legal effect. This will trigger a need to mitigate effects associated with flow and quality'*.

PAUP has a 'claw back' allowance – treatment is required for both the existing impervious areas as well as new areas.

Construction in the Coastal Marine Area

'The inclusion of a stormwater wetland in the CMA will introduce a significant risk to the project, as NZCPS and Regional Coastal Plan provisions will apply'.

A coastal permit will be required under the ARP:C (Coastal Plan) and the PAUP.

'*The PAUP appears to have stricter requirements than the ARP:C, with frequent use of non-complying and even prohibited activity statuses, however some of the coastal area rules do not have legal effect at this time*.'

Summary

HYC's conclusion appears to be that the legislative requirements on stormwater management are very much dependent on the timing of consent submissions and they note that '*it appears that the operative plans support the project better at this time'*.

HYC's summary of likely stormwater requirements and consents required (LRCI project as a whole) are included in Table 3-1 and Table 3-2 respectively.

Table 3-1: HYC Stormwater Consenting Summary

	Operative Plan (ARP:ALW)	PAUP
Predicted consent activity status	Controlled or Restricted discretionary	Restricted discretionary
Area to be managed	New impervious surface areas	Redeveloped areas (new plus existing)
Treatment potentially required	75% TSS removal	Metals, sediment, temperature and quantity (retention, detention)

Table 3-2: HYC Summary of Consents Required

Consent Type	Activity	Plan
Land use consent (s9(2) RMA)	The use of land for land disturbing activities, including earthworks, roading, tracking and trenching and associated discharges	ARP:SC and PAUP
Discharge permit (s15 RMA)	The discharge of stormwater from the road	ARP: ALW and PAUP
Discharge permit (s15 RMA)	Discharge of contaminants from land containing elevated levels of contaminants that is undergoing remediation or land disturbance	ARP: ALW and PAUP
Coastal permit (s12 RMA)	Occupation of the CMA, discharge to the coastal waters	ARP:C and PAUP
Land use consent (s9(2) RMA)	Stormwater - The use of land for impervious area (flow)	PAUP
Land use consent (s9(2) RMA)	Stormwater - The use of land for a high use road (quality)	PAUP
Land use consent (s9(1) RMA)	Disturbing the soil of a piece of land with concentrations of contaminants above standards	NES Soil

4 Issues and Constraints

The following issues and constraints have been identified in relation to the construction of stormwater management infrastructure for the LRCI project:

- Road corridor is highly developed and constrained on both sides by existing commercial and residential property.
- Topography is flat to the east of Lincoln Road, which limits hydraulic head available.
- Critical 910mm diameter concrete lined steel watermain runs down the centre of Lincoln Road and edge of Triangle Road (section of the North Harbour No.1 Watermain).
- Limited availability of land near corridor for stormwater treatment devices. Land purchase likely to be contentious.
- Existing discharge paths (pipes) likely designed for 1:5 year flow (at best) and will be undersized to take runoff from the increased impervious area.
- Currently there are no Network Discharge Consents for discharges from the Lincoln Road catchment.
- Legislative requirements for stormwater discharge are in a state of flux with the introduction of the Proposed Auckland Unitary Plan.
- Areas considered for treatment devices are shown as being within flood plain on Council's GIS. Matches coastal inundation in PAUP GIS.
- Area to the west of Lincoln Road is identified as SMAF in PAUP (see Figure 1 below). Increased flows – discharge into these areas to include volume management.

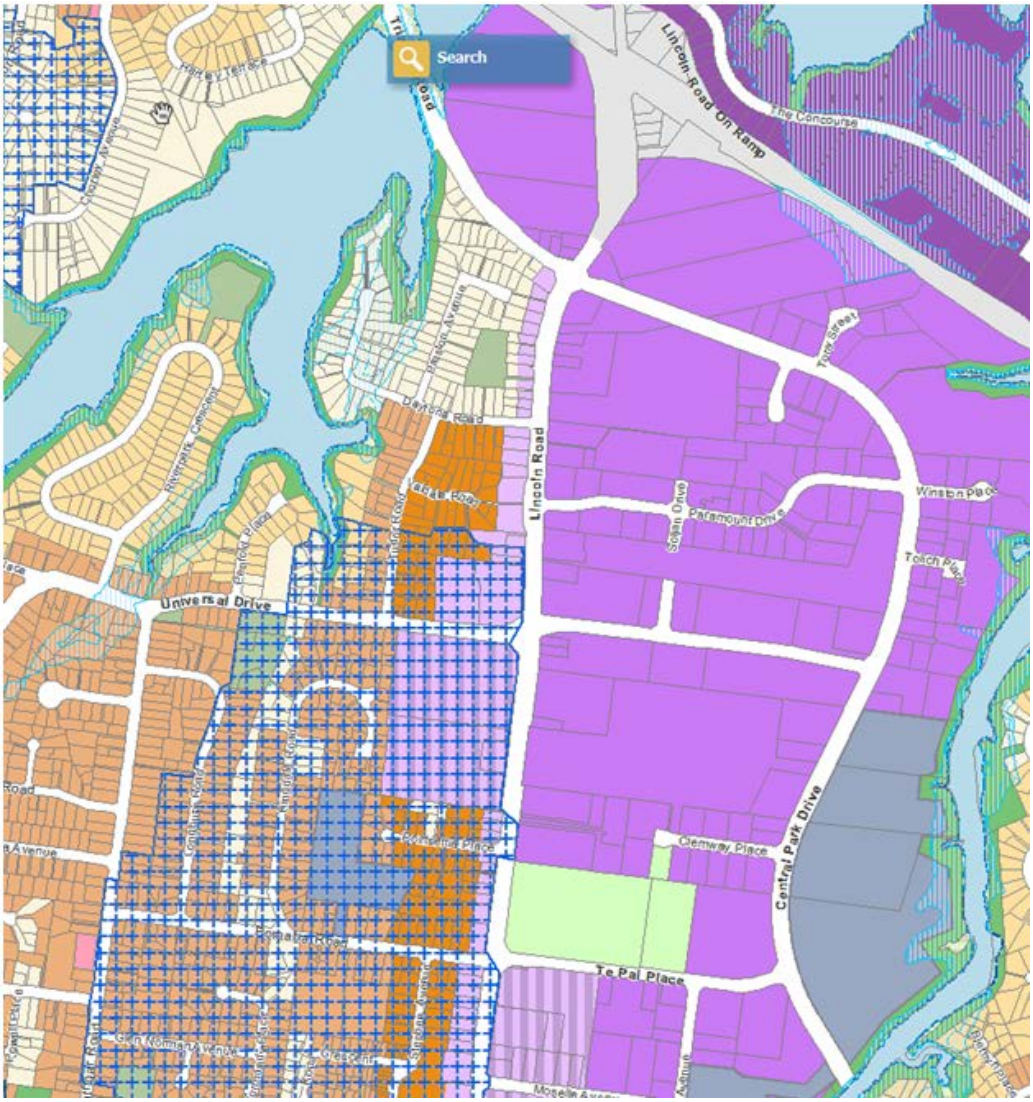


Figure 1 Stormwater Management Area (Flow) under PAUP

5 Stormwater Management Options

5.1 Previous Studies

Stormwater management has been considered at a relatively high-level in the preliminary design (GHD) for the LRCI project and was also carried out prior to the PAUP being notified. It therefore does not consider PAUP provisions. The assessment concluded that the use of low impact design devices is not recommended for this project as it is not practical or affordable to acquire the additional land required to implement LID.

The assessment considered the following options for the treatment and discharge of stormwater from the widened road:

1. Northern section of Lincoln Road conveyed to a new treatment pond (wetland) on the edge of the CMA at the Triangle Road bridge to treat areas discharging to the Lincoln Road Catchment.
2. Northern section of Lincoln Road conveyed to a new treatment pond (wetland) located in 297-310 Lincoln Road (identified in the CMP) to treat areas discharging to the Central Park Catchment.
3. Southern section of Lincoln Road – upgrade the existing pipe across Laidlaw College land and construct a treatment device somewhere on this discharge path.
4. Construct a new discharge pipe down Universal Drive to the east and find a suitable location for a treatment device prior to discharge to Henderson Creek.

Option 1 considers part of the northern section of the LRCI catchment only. The land outside of the CMA is currently owned by Radio NZ Limited (publically owned). HYC have noted that '*this wetland appears to be technically feasible, but has consenting difficulties due to being partially in the CMA and other sensitive planning zones*…..'. Locating a treatment pond at the Triangle Road bridge has been taken forward into the treatment options discussed below.

Option 2 considers part of the northern section of the LRCI catchment only. 297-310 Lincoln Road is under private ownership. A consent to develop this land was under appeal of the Environment Court at the time of the preliminary design assessment. This option has not been taken forward for further consideration.

Option 3 would treat the majority of the southern part of the LRCI catchment. The land to the east of Lincoln Road in this area is very flat, therefore, scope to increase the capacity of this drainage path and to install a treatment device is limited. Land acquisition would also be required in order to construct and maintain a treatment device. Upgrading the existing drainage path across Laidlaw College land and installing a treatment device on this discharge has been taken forward as an option for the southern catchment.

Option 4 has not been taken forward for further consideration, given the uncertainty around the suitability and ownership of potential treatment sites.

5.2 Low Impact Design (High Level Assessment)

Low impact design (LID) typically requires up to 8% of the impervious area contributing runoff that needs to be treated. On this basis, an area of approximately 4500m^2 would be required to implement LID. This equates to a 6.5m wide treatment area alongside the carriageway, assuming that 50% of the road length cannot be used for LID devices due to the presence of intersections, junctions, vehicle crossings, etc.

The Lincoln Road corridor is constrained on both sides and the additional width required to implement LID devices would increase land acquisition and the impact of the road widening works on property owners and businesses would be substantial. MWH agree with GHD's recommendation that LID devices are not a feasible solution for full stormwater treatment on the widened Lincoln Road corridor. Using LID devices to treat a portion of the runoff in selected areas may be a feasible compromise – this can be explored further in detailed design.

5.3 Proposed Approach

Given the issues and constraints identified above, the proposed approach for stormwater treatment for the LRCI project is to a) collect and convey runoff to a treatment device/s and discharge outside of the road corridor – not implement LID down the corridor, and b) minimise the number of stormwater discharge locations.

To simplify the consenting of discharges from the upgraded road corridor, it is proposed that all runoff from the widened road is collected and conveyed to either a single discharge point at the north end of the catchment or two discharge points – one for the southern section of the catchment and one for the northern section. This avoids the need for multiple pipe upgrades (often through private property) and potentially multiple treatment systems.

This approach will mitigate the need to assess the impact on and carry out upgrades to the wider stormwater network, e.g. reticulation in the SH1 corridor and the side roads off Lincoln Road, and will consolidate the number of discharge locations that require consent to a maximum of two. It will also avoid discharge to the area identified as a SMAF under the PAUP. Discharge of all, or part, of runoff to existing subcatchment discharge points can be revisited in detailed design, during which the capacity of existing conveyance and treatment assets can be assessed in greater detail, if desired.

The proposed post-upgrade discharge catchments are listed in Table 5-1 below. Catchments, in addition to existing discharge paths and treatment device locations, are illustrated in Figure 2 below.

A key consideration for design of the stormwater treatment assets for the LRCI project is whether to treat runoff from the new impervious areas only, as required under the Operative Plan (ALWP), or to treat runoff from all impervious areas (existing and new) in the upgraded Lincoln Road corridor area to ensure compliance with the expected PAUP conditions. This decision will significantly affect the volume of runoff that must be treated and therefore the size (and cost) of the treatment system.

A number of treatment options have been identified in this report that treat runoff from all impervious areas. These options include for the potential PAUP 'claw back' requirement to treat existing impervious areas in addition to new impervious areas. It also includes an ALWP compliant option of treating an equivalent area to the increase in impervious surfaces.

All options aim to provide quality treatment by means of removing 75% of total suspended solids.

Table 5-1: Post-upgrade Discharge Catchments

Catchment Name	GHD Subcatchments Served	Discharge Location	Existing Discharge Pipe	Existing Pipe Sufficient for Discharge?
Northern	A, B, C, D, E	CMA at Triangle Road	No	N/a
		CMA at Daytona Strand	Yes (Subcatchment D)	No
Southern	F, G, H, I, J	Henderson Creek	Yes (Subcatchment F)	No
All Catchments	All	CMA at Triangle Road	No	N/a
		CMA at Daytona Strand	Yes (Subcatchment D)	No

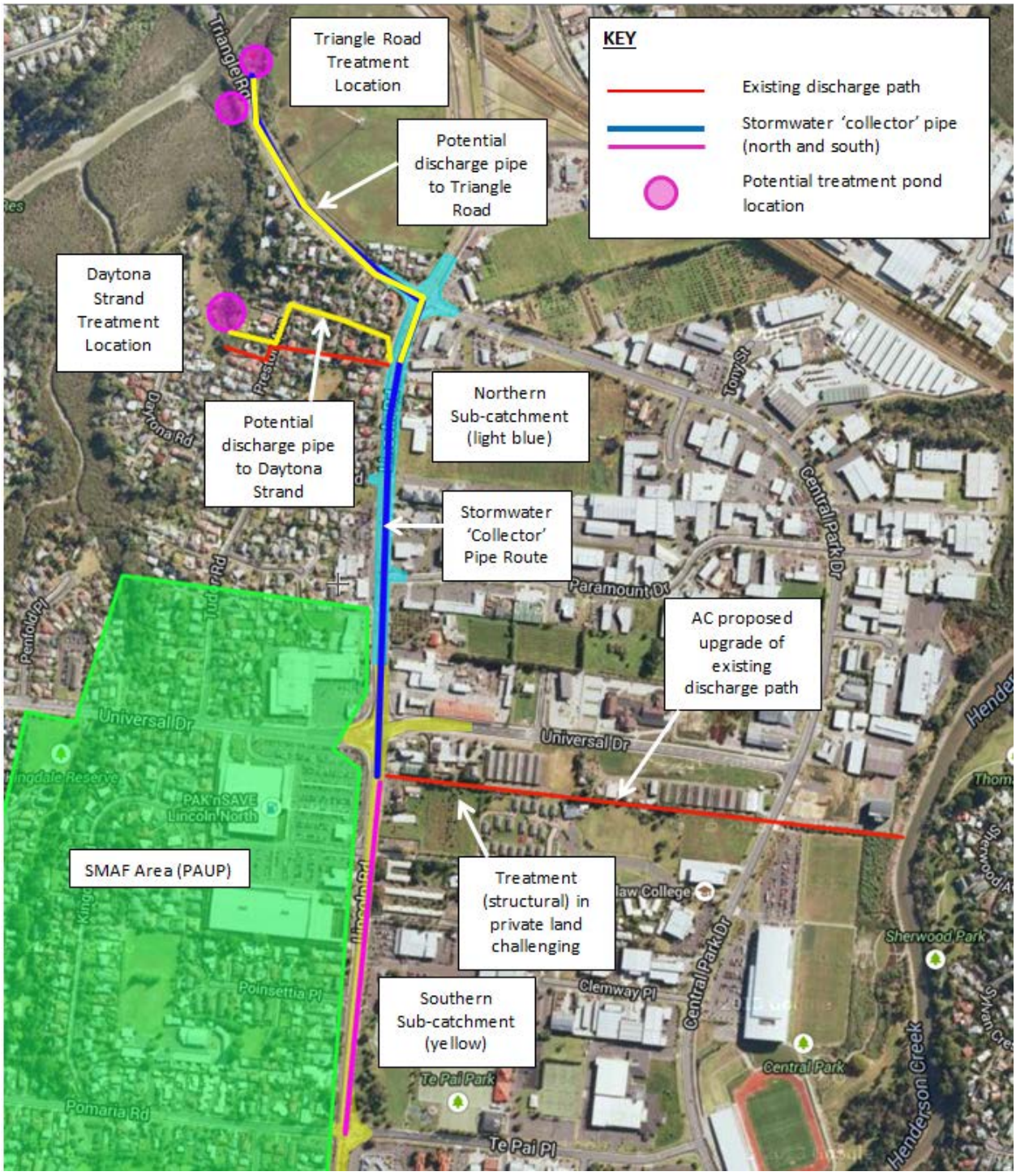


Figure 2 Lincoln Road Stormwater Summary Plan

5.4 Treatment Options (PAUP Compliant)

5.4.1 Option 1 – Separate Discharges for Northern and Southern Catchments

Stormwater treatment Option 1 consists of conveying runoff to separate discharge pipes / treatment devices / discharge points for each of the northern and southern catchments.

Southern Catchment

In this option the existing pipe / open drain through Laidlaw College land would be upgraded to take the southern catchment runoff. A treatment device could be constructed in Laidlaw College land, near the top of the existing drainage path.

There is very little fall on this discharge path east of Lincoln Road. Therefore, the hydraulic head available for installation of new pipework and a treatment device is limited. Purchase of private land is also required. A structural treatment device, such as cartridge filtration, would likely be preferred given the head and land purchase issues.

Provisional sizing provided by Stormwater 360 for establishment of a StormFilter device indicates that approximately 145 cartridges would be required if the 'Low Drop' cartridges are selected to minimise headloss through the filtration device. The headloss associated with the StormFilter cartridges is illustrated in Figure 3 below. The cartridges would be installed in a chamber approximately 11m long by 6m wide.

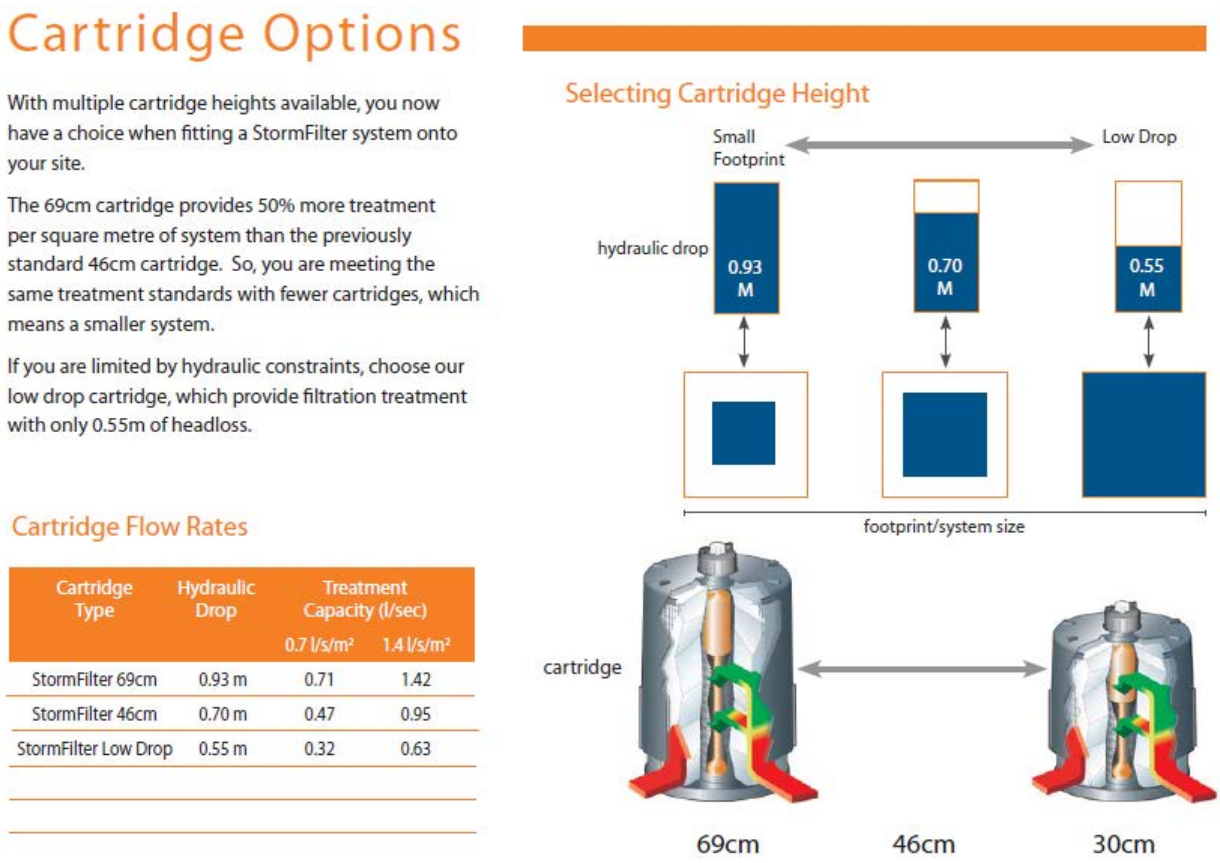


Figure 3 StormFilter Cartridge Options and Headloss

Auckland Council has engaged Thomas Civil & Environmental Consultants to undertake a study into upgrading the existing drainage path through Laidlaw College land to accommodate local development and Lincoln Road drainage. Initial discussion with Council and Thomas Civil has indicated that one of the upgrade options currently under development would likely have sufficient capacity and hydraulic head to convey and treat the runoff off from the Lincoln Road Southern Catchment with standard full-height cartridges. There is opportunity for Auckland Transport to collaborate with Council to develop an upgrade that suits both parties. Conversely, if all runoff was conveyed to the northern end of the Lincoln

Road for treatment and discharge, upgrade of the existing drainage path through Laidlaw College land would not be required, saving Council between $0.6M and $1.4M based on Thomas Civil's preliminary cost estimates. Further consultation with Council / Thomas Civil is required to fully understand the implications of pursuing this option, should it be considered further.

An **alternative location** for a structural filtration device to treat the Southern Catchment is at the downstream end of the existing drainage path, within the Waitakere City Stadium site. The fall in this area is greater and therefore it may be possible to use full height filter cartridges. Availability of suitable sites, which do not impact on the use of playing surfaces and car parking, is limited. Work may also be required to separate runoff from the LRCI areas and other catchments that currently drain to the open drain, if the treatment device is constructed at the downstream end of the drainage path.

Northern Catchment

A new discharge pipe would be constructed from the northern end of Lincoln Road to a treatment device either at the Triangle Road bridge or Daytona Strand. Concept design of a pond at the Triangle Road site has been undertaken by GHD during preliminary design, with their preferred option consisting of treatment assets on both sides of Triangle Road. Preliminary sizing indicates that a treatment wetland at Daytona Strand would be approximately 600m^2 if treating the road catchment only (2,400m^2 if also treating the wider urban catchment currently draining to the Daytona Strand inlet).

Considerations for a treatment pond are similar at both sites – construction in the CMA presents a number of consenting and physical challenges. The Daytona Strand site is considered to have greater potential benefits, including amenity for local residents and (likely) slightly better ground conditions. There is also potential to treat stormwater runoff from the wider catchment that currently discharges to Daytona Strand, if desired, achieving an improved environmental outcome. An additional advantage of the Daytona Strand option is the shorter pipe route and lower road use between the contributing catchment and discharge location. A disadvantage of this option is the need to pass through one private property. However, there are routes available which will have minimal impact.

Costs

Construction of a structural filtration device to treat the Southern Catchment, combined with upgrading the existing drainage path through Laidlaw College land and constructing a wetland or filtration device to treat the Northern Catchment is expected to be signifincalty more costly than the single treatment device options discussed in the sections below.

Indicative cost (treatment assets only, land cost not included):

- Filtration device in Laidlaw College land (treating runoff from Lincoln Road corridor Southern Catchment only) - **$375k**
- Wetland at Daytona Strand (treating Northern Catchment) - **$2.6M** or filtration device at 312 Lincoln Road - **$425k**
- **Total Capital Cost - $0.8M to $3M**

The cost of maintaining two separate treatment devices will likely also be significantly higher than the costs associated with one device, but has not been estimated here.

5.4.2 Option 2 – Single Discharge to Triangle Road

Option 2 conveys all runoff to the northern end of Lincoln Road via a 'collector pipe'. Initial assessment indicates that this is achievable with reasonable pipe gradients / sizes / depth, as the topography along Lincoln Road has a general slope to the northern end. High points along this route are limited. The reticulation at the bottom end of the catchment would be a little larger than that required for Option 1.

The presence of the 910mm diameter watermain running down the centre of Lincoln Road will be a significant obstacle to construction of new stormwater reticulation, particularly where laterals cross from one side of the road to the other. As-built drawings of the watermain indicate that the existing laterals cross over the top of the watermain with minimal cover between pipes. To simplify design of reticulation for the widened road corridor, a twin collector approach is proposed – one collector pipe on each side of the road corridor. This will negate the need for laterals crossing the road, except for a pipe at the downstream end. An initial check indicates that taking a stormwater pipe that is designed to convey half of the full catchment runoff under the watermain at a depth that does not prohibit connection to a

treatment device outside of the corridor is possible; however, this pipe crossing will need to be specifically designed.

A new discharge pipe could then be constructed in Triangle Road to a treatment pond at the Triangle Road bridge. Treatment can be provided by a treatment pond (wetland) or a structural treatment device (filtration).

The wetland would be significantly larger than the wetland proposed in Option 1, as it would treat the full LRCI catchment, rather than the Northern Catchment only. The wetland has been indicatively sized at 1,500m^2 to provide the required Water Quality Volume (WQV) for the full LRCI catchment, plus the stretch of Triangle Road from the Triangle Road / Lincoln Road intersection to the treatment device location at the Triangle Road bridge. Treatment pond locations and stormwater collector pipe details are illustrated on the Stormwater Collector Pipe Plan in Appendix C.

The wetland would be situated partially within the CMA, which is likely to increase resource consent requirements. Significant earthworks would be required to construct bund walls around the forebay and wetland ponds.

The structural filtration option has been indicatively sized as requiring 150 standard full height cartridges (StormFilter). The cartridges would be installed in a chamber approximately 12m long by 6.5m wide. It is likely that the chamber could be constructed outside of the CMA, within land currently owned by Radio NZ. An indicative plan sketch of the filtration device at the Lincoln Road bridge is included in Appendix D.

Auckland Transport have identified an **alternative location** for a structural filtration device – within land that they are proposing to purchase for the corridor widening works at the north west corner of the Triangle Road / Lincoln Road intersection. Although technically feasible, this location is considered less desirable due to the topography (this land is at a higher elevation than Triangle Road, requiring deep structures and pipework) and potential access issues associated with future land use.

5.4.3 Option 3 – Single Discharge to Daytona Strand

Option 3 is similar to Option 2, with runoff conveyed to the northern end of Lincoln Road via collector pipes. A new discharge pipe would then be constructed to a discharge point in the CMA at Daytona Strand, west of Preston Avenue. A potential route for a new discharge pipe between the low point in Lincoln Road (adjacent to 312 Lincoln Road) to this discharge point has been identified – illustrated on the sketch in Figure 4 below. The route crosses private property at 22 Preston Avenue, where a reasonably wide, open path through the property is available for pipework installation. Working areas would also be required in 314 Lincoln Road and 46 Preston Avenue to provide access for construction of the pipe within the narrow footpath between 35 and 46 Preston Avenue.

Figure 4 Daytona Strand Discharge Pipe and Treatment Locations

As with Option 2, treatment can be provided by a treatment pond (wetland) or a structural treatment device (filtration). The shape of the natural inlet at Daytona Strand would be a good basis for the construction of a wetland. Urban design in consultation with local interest groups could ensure that the wetland would add amenity value to the area.

The wetland has been indicatively sized at 3,000m^2 to provide the required Water Quality Volume (WQV) for the full LRCI catchment, plus a the wider urban catchment currently draining to the Daytona Strand inlet. Treating this additional catchment area would be an additional benefit to the environment. An indicative plan sketch of the wetland at Daytona Strand is included in Appendix E.

Flooding to private property has been identified just upstream of the Daytona Strand discharge area around 12A / 14A Preston Avenue. Auckland Council GIS also identifies this area as within a flood plain, however the GIS supporting the PAUP indicate that this is attributed to coastal inundation. A treatment wetland would need to be designed so as not to increase property flooding. This could be achieved by excavating down into the alluvial soils to retain the existing water level.

The presence of a 750mm diameter wastewater pipe crossing the mouth of the inlet is also a potential design constraint to a wetland in this location. As-built drawings of the pipe show that it has been constructed below ground, however, there is little or no cover over this pipe and it may be restricting flow of water from the inlet to the estuary. This is not considered a 'deal-breaker' for this option, but must be carefully considered during design development if it is selected as the preferred treatment option.

The preferred site for a structural treatment device is 312 Lincoln Road. Auckland Transport propose to purchase this property to enable construction of a new access road to service the row of properties between Lincoln Road and Daytona Reserve, which will not be accessible directly from the widened Lincoln Road corridor (illustrated in the plan in Appendix A). 312 Lincoln Road is earmarked for use as a turning facility at the end of the service road.

The site of 312 Lincoln Road is considered a suitable location for a filtration device, given its proximity to both the low point in Lincoln Road and the proposed discharge pipe route to the Daytona Strand area.

The filtration device has been indicatively sized as requiring 130 standard full height cartridges (StormFilter). The cartridges would be installed in a chamber approximately 11m long by 6m wide. An indicative site plan for a StormFilter chamber in 312 Lincoln Road is included in Appendix F. A plan illustrating vehicle tracking for a StormFilter maintenance vehicle is also included in Appendix F.

Alternative locations for treatment devices on a new discharge pipe to **Daytona Strand** have been discounted as follows:

- Wetland within Daytona Reserve - indicative sizing indicates that the wetland would take up almost the entire Reserve, due to the sloping topography; constructing a large water retaining structure above private property increases risk of flooding / damage; construction of a pipe existing the Reserve would be difficult given the density of housing on the west side of the Reserve.
- Filtration device within Daytona Reserve – loss of Reserve land; restricted maintenance access; construction of a pipe existing the Reserve would be difficult given the density of housing on the west side of the Reserve.
- Filtration device in the turning head at the end of Preston Avenue – impact of construction and maintenance activities on access to private properties.

5.4.4 Option Comparison

A high-level assessment of the perceived relative advantages and disadvantages of the PAUP compliant stormwater treatment options identified above is included in Table 5-2 below.

Options 2B, 3A and 3B are considered to be the most suitable, based on the high-level assessment.

Table 5-2: Stormwater Treatment Option Summary

Option	Discharge Location	Treatment Device	Advantages	Disadvantages	Relative Capital Cost	Relative Maintenance Cost	Consenting Risk
1	Henderson Creek (Southern) and CMA at Triangle Road or Daytona Strand (Northern)	Structural Filtration (Southern) and Treatment Wetland or Structural Filtration (Northern)	Smaller conveyance pipework (reticulation) in Lincoln Road than for single discharge options Opportunity to collaborate with AC for pipe upgrade to Henderson Creek	Same disadvantages as below for Triangle Road and Daytona Reserve discharges High cost associated with pipe (flat gradient) and treatment device (land purchase) in Laidlaw College land	Highest (two discharge pipes and treatment devices, likely to be more expensive than one)	Highest (maintenance of two treatment devices, likely to be more expensive than one)	Two separate discharge locations to consent
2A	Triangle Road	Wetland	No impact on private properties Upgrade of the existing drainage path through Laidlaw College land not required	High construction risk in CMA with no geotechnical information Longest pipe route / pipe route in high use road Land purchase required (Radio NZ) Limited access to wetland site for construction and maintenance	Highest capital cost of constructing wetland Likely more expensive than Daytona Strand wetland due to site topography and longer pipe route	Generally lower annual maintenance cost than filtration device, but high-cost activities potentially required at 10 and 20 year intervals	Difficulties associated with consenting works in the CMA
2B	Triangle Road	Structural filtration (Triangle Road bridge)	No impact on private properties (both for construction and maintenance activities) Less work in the CMA Upgrade of the existing drainage path through Laidlaw College land not required	Longer pipe route / pipe route in high use road Land purchase required (Radio NZ) Regular maintenance of filters required	Likely lower capital cost than wetland Likely more expensive than filtration device in 312 Lincoln Road due longer pipe route and cost of land purchase	Limited suppliers for maintenance – pricing may reflect fact that there is no competition for services	Less risky (limited work in CMA – possibly outfall only in CMA)
3A	Daytona Strand	Wetland	Shorter pipe route / pipe route in low use road Added amenity possible Existing access to wetland site Potentially easier construction than at Triangle Road Opportunity to treat runoff from wider catchment as added benefit Upgrade of the existing drainage path through Laidlaw College land not required	Impact on residents during construction and maintenance Pipe route through one private property Working areas required in two private properties during construction of discharge pipeline Flooding to be considered Wastewater pipeline across estuary to be considered Initial feedback from Auckland Council is they would not be looking to help fund construction.	High capital cost of constructing wetland	Generally lower annual maintenance cost than filtration device, but high-cost activities potentially required at 10 and 20 year intervals	Difficulties associated with consenting works in the CMA
3B	Daytona Strand	Structural filtration (312 Lincoln Road)	Shorter pipe route / pipe route in low use road Minimal work in the CMA Upgrade of the existing drainage path through Laidlaw College land not required	Land purchase required (but already planned) Pipe route through one private property Working areas required in two private properties during construction of discharge pipeline Regular maintenance of filters required, Potential impact of noise and vehicle movements during maintenance activities	Likely lower capital cost than wetland	Limited suppliers for maintenance – pricing may reflect fact that there is no competition for services	Least risky (no work in CMA other than outfall)

5.5 Treatment Option (ALW Plan Compliant)

Option 4 is designed to be compliant with the Operative Plan (ALWP), but does not meet all quality requirements proposed under the PAUP. Treatment is provided for runoff from an area equivalent to the NEW impervious areas only. Given the impracticality of collecting and treating runoff from the very small, widely spread sections of impervious area that will be added during the LRCI project, Option 4 provides treatment for an 'equivalent area' of the upgraded Lincoln Road corridor. The area assumed includes the section of the LRCI catchment located to the north of the proposed device at 312 Lincoln Road.

Option 4 is similar to Option 3B, with runoff collected from the full LRCI catchment and conveyed to the low point in Lincoln Road adjacent to 312 Lincoln Road. The discharge pipe route and point of discharge at Daytona Strand are also the same as Option 3B. Treatment is provided by structural filtration located at 312 Lincoln Road.

The combined 'new' impervious areas, as illustrated in Table 2-1 above, total an area of approximately 0.69 hectares. The combined areas of sub-catchments A, B, C and the section of subcatchment D to the north of 312 Lincoln Road total approximately 0.7 hectares, slightly greater than the 'equivalent area' required. It is proposed that treatment is provided for runoff from the section of the LRCI catchment located to the north of the low point in Lincoln Road (adjacent to 312 Lincoln Road). The section to the south of this low point will receive no treatment. This spilt between 'treated' and 'non-treated' area is considered a practical arrangement on a road corridor.

The filtration device has been indicatively sized as requiring 20 standard full height cartridges (StormFilter). The cartridges would be installed in a chamber approximately 6m long by 2.5m wide. An indicative site plan for the StormFilter chamber in 312 Lincoln Road is included in Appendix G. The plan illustrating vehicle tracking for a StormFilter maintenance vehicle in Appendix F is applicable to Option 4 also.

6 Selection of Preferred Treatment Device

6.1 Indicative Costing

A meeting was held between Auckland Transport, MWH and various Council and community stakeholders on 20th March 2015 following submission of an initial draft of this Stormwater Options Report. During this meeting, the stakeholders requested that further comparison between types of treatment devices (wetland and structural filtration) be undertaken in order to aid selection of a preferred device.

The treatment devices included in Options 3A and 3B have been developed to sufficient detail to develop a better understanding of benefits / potential constraints and enable production of indicative cost estimates. Options 3A and 3B have been selected (over inclusion of other options), as they share common conveyance and discharge pipework elements, thus allowing a direct comparison of treatment devices.

The additional benefits and potential constraints identified during option development have been included in the treatment option identification and assessment in Section 5 above.

Capital, Operational and Net Present Value (NPV) cost estimates have been produced based on the following sources:

- Draft Auckland Council costing spreadsheet based on the information in TR2013/043, Titled '*Auckland Unitary Plan Stormwater Management Provisions: Cost and Benefit Assessment*'.
- Indicative Storm Filter chamber supply and maintenance costs provided by Stormwater 360.

The indicative cost estimates are included in Appendix H and summarised in Table 6-1 below. The cost of land purchase is not included in the estimates.

Option 4 is also included in Table 6-1 for cost comparison between ALWP and PAUP compliant options.

Table 6-1: Stormwater Treatment Device Cost Estimates

Option	Construction Cost		Annual Operational / Maintenance Cost		NPV (60 years)	
	High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate
3A Wetland (PAUP)	$2.6M	$1.6M	Varies (Appendix H)	Varies (Appendix H)	$2.9M	$1.9M
3B Structural Filtration (PAUP)	$0.58M		$30k		$1.3M	
4 Structural Filtration (ALWP)	$0.29M		$5k		$0.4M	

Capital expenditure for construction of stormwater assets associated with the LRCI project will be funded by Auckland Transport. It is anticipated that the operational (maintenance) expenditure for stormwater assets will also be funded by Auckland Transport, rather than Auckland Council, where the assets are used to collect, convey and treat runoff solely from the Lincoln Road corridor.

6.2 Preferred Treatment Device

A qualitative comparison of the perceived relative merits of the treatment device options against a number of relevant criteria, including costs is summarised in Table 6-2 below.

Table 6-2: Stormwater Treatment Device Comparison Summary

Option	Land Take	Hydraulic constraints	Constructability	Maintainability	Environmental constraints	Added amenity value	Benefits to wider catchment	Consentability	Cost - Capital	Cost - Operational	Cost - NPV
Wetland						◆	◆			◆	
Structural Filtration	◆	◆	◆	◆	◆			◆	◆		◆

Based on this comparison, structural filtration is the preferred treatment device. It is likely to be easier to construct, maintain and consent, and have a lower whole life cost than a wetland, but lacks the potential amenity benefits and ability to treat the wider catchment. Initial discussions with Auckland Council officers have identified that Council have no drivers that would lead to them funding the increased cost of a wetland at this time.

6.3 Option Ranking

Based on the information available and the high-level option assessment undertaken, the top three stormwater treatment options, ranked in order preference, are:

1. Structural filtration device at 312 Lincoln Road
2. Structural filtration device at the Triangle Road bridge
3. Wetland at Daytona Strand

The relatively high cost of wetland construction, plus the other relative merits noted in Section 6.2, makes a filtration device more attractive than a wetland. 312 Lincoln Road is considered to be a marginally better location for a filtration device due to the higher capital cost of conveyance pipework and less defined land acquisition route associated with the Triangle Road bridge location.

Issues to consider in relation to the 312 Lincoln Road location include the temporary access / working areas required in private property to construct the discharge pipe and the impact of noise associated with annual maintenance.

Auckland Transport have indicated that, due to the uncertainty regarding legislative requirements and the associated capital and operational cost savings, their preference is to provide treatment of runoff from new impervious areas only (ALWP compliant) at this point in time. Therefore, Option 4 is the preferred treatment option for design development.

7 Conclusions & Recommendations

This high level stormwater options report has been produced to document the stormwater management (conveyance, treatment and discharge) options that have been identified at this early stage of design for the LRCI project. Only the options considered most feasible have been included. Options have not been developed in detail and therefore the option assessment provided is high level and used to identify key considerations and relative option merits only, to enable a decision to be made on the preferred option to pursue in design.

The following recommendations are made as an outcome of the assessment:

- LID is not considered feasible as an appropriate technique for full stormwater treatment
- Runoff from the widened road corridor is collected and drained to a single discharge location at the north end of Lincoln Road
- That structural filtration is implemented as the preferred treatment method, located at either the Triangle Road bridge or 312 Lincoln Road

The top three stormwater treatment options, ranked in order of preference, are:

- Structural filtration device at 312 Lincoln Road
- Structural filtration device at the Triangle Road bridge
- Wetland at Daytona Strand

Auckland Transport's preference is to provide a treatment device sized to treat runoff from new impervious areas only (rather than existing and new impervious areas), due to the uncertainty regarding legislative requirements and the associated capital and operational cost savings.

Next Steps

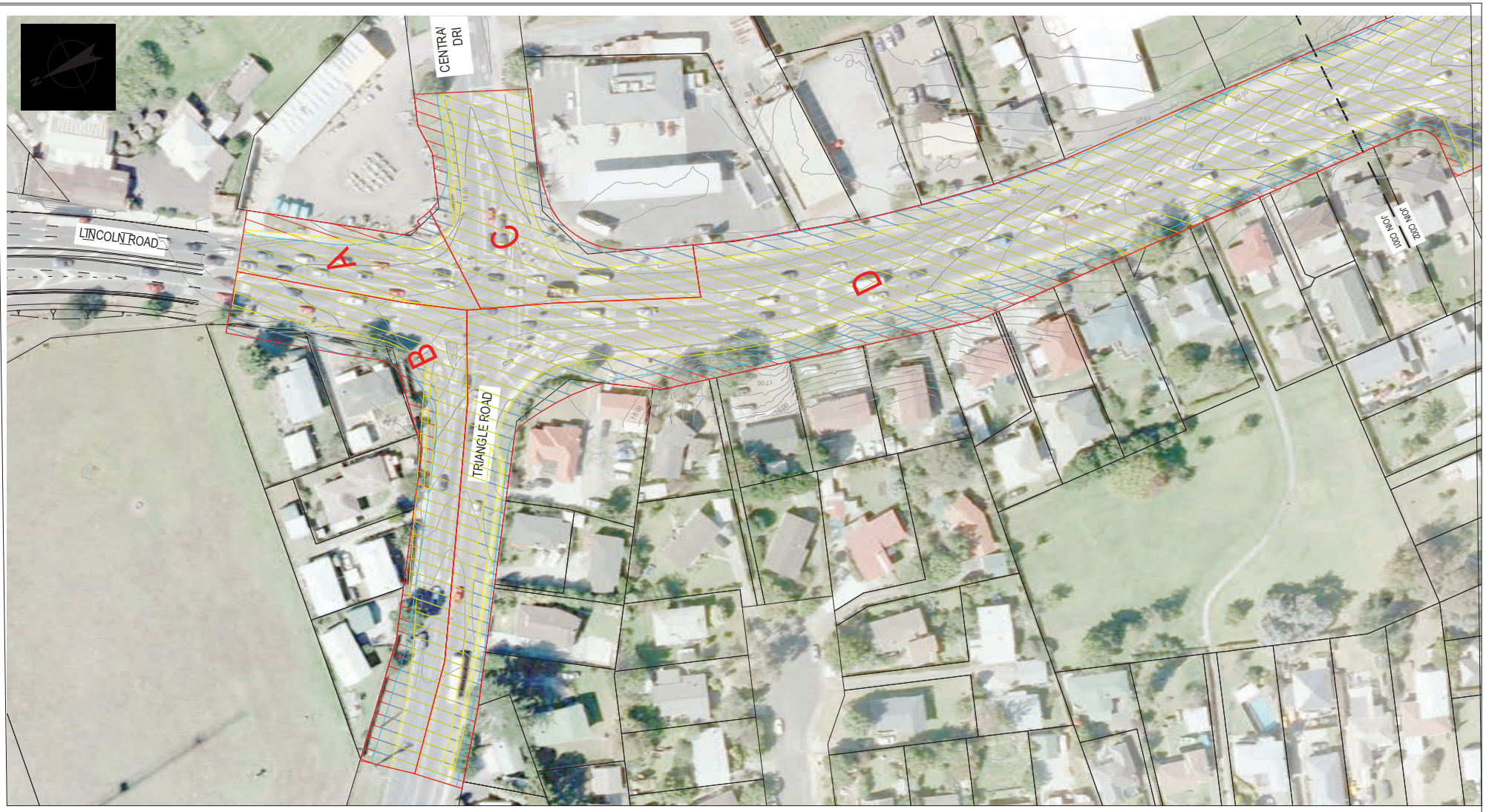
The following 'next steps' are recommended in order to progress the design of stormwater assets for the LRCI project:

- Auckland Transport to confirm the design approach to be adopted
- Carry out preliminary design of location options to confirm costs and impacts
- Select treatment / discharge location
- Complete detailed design of stormwater collection, conveyance and treatment infrastructure in conjunction with the road design.

Appendix A Plan of Proposed Service Road adjacent to Daytona Reserve


Sec. 5
Sec. 4
Sec. 3
Sec. 2
Sec. 1
Mature Oak Tree to be retained
Area to be maximised
Area to be optimised
Driveway Extensions as needed to meet minimum cross fall requirements
46
314
35
25
29
33
310
27
31
308
306
311
304A
304
302
307
300
296
296A
5
3
1C
1D
1A

Appendix B Catchment Boundary Plans



CATCHMENT LEGEND

- TOTAL CATCHMENT BOUNDARY
- EXISTING IMPERVIOUS AREA
- PROPOSED IMPERVIOUS AREA

PLAN VIEW
SCALE 1:500

0 5 10 15 20 25m
SCALE 1:500 AT ORIGINAL SIZE

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
A	PRELIMINARY		IH			

Auckland Transport
An Auckland Council Organisation

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DO NOT SCALE

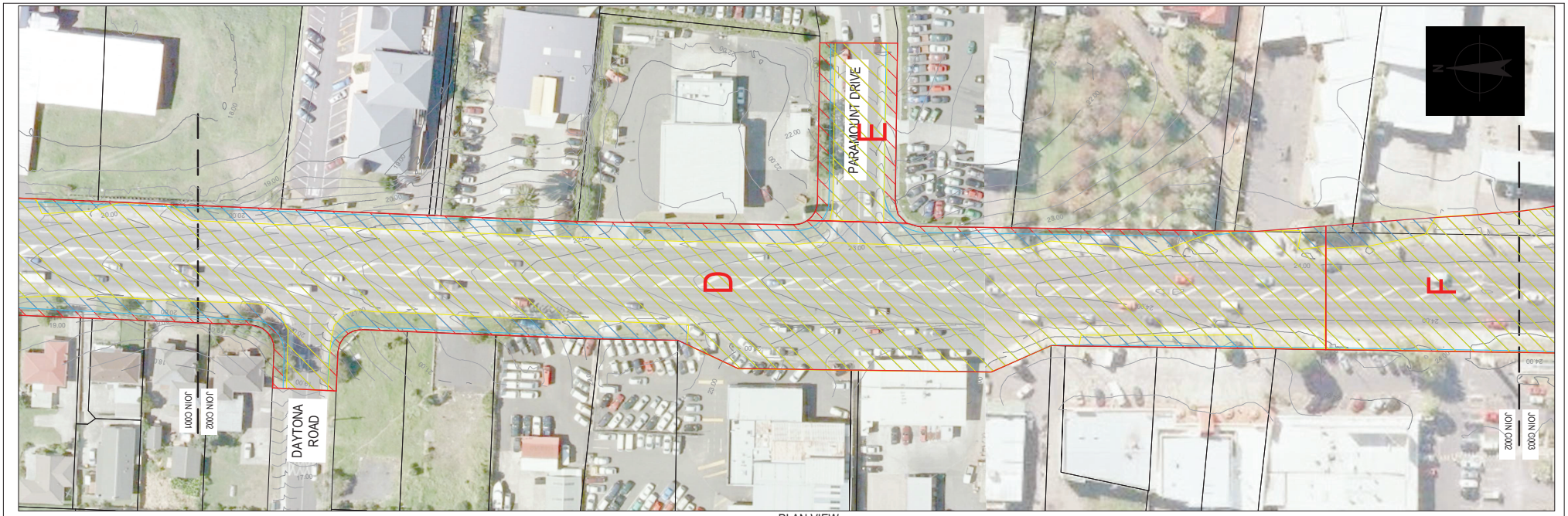
Drawn	I.HO	Designer	I.HO
Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client AUCKLAND TRANSPORT
Project LINCOLN ROAD CORRIDOR
Title PRELIMINARY DESIGN CATCHMENT BOUNDARIES

SHEET 1 OF 4

Original Size A1
Drawing No: 51-29887-C001
Rev: A

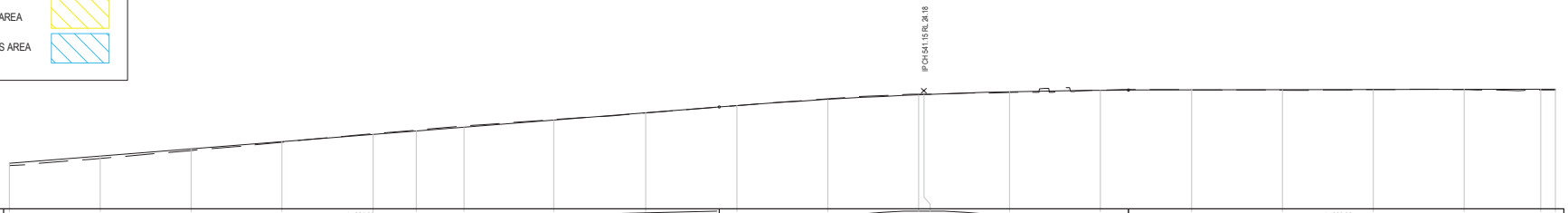
Plot Date: 12 July 2011 - 9:30 AM Plotted by: Dean Crowley/Auckland/GHD/AU Cad File No: \\ghdnet\ghd\NZ\Manukau\Projects\51\29887\01. CADD\Acad\Stormwater catchments_working_DC.dwg



PLAN VIEW
SCALE 1:500

CATCHMENT LEGEND

- TOTAL CATCHMENT BOUNDARY
- EXISTING IMPERVIOUS AREA
- PROPOSED IMPERVIOUS AREA



DATUM RL. 19.00

VERTICAL ALIGNMENT	L=284.82m G=1.59%									K=58.67 L=90m								L=336.38m G=0.05%							
HORIZONTAL ALIGNMENT	L=162.20m					L=30.21m R=-1000.00m												L=217.09m						L=81.15m R=1000.00m	
LEVEL DIFFERENCE CUT - / FILL +	0.10	0.10	0.07	0.02	-0.03	-0.04	-0.05	-0.02	0.01	0.00	-0.03	-0.02	-0.01	0.03	-0.01	-0.01	0.02	0.01	0.02	0.04	0.04				
DESIGN SURFACE LEVEL	20.989	21.307	21.624	21.941	22.259	22.410	22.576	22.860	23.211	23.527	23.797	23.989	24.009	24.133	24.199	24.213	24.233	24.254	24.264	24.253	24.255				
EXISTING SURFACE LEVEL	20.89	21.21	21.55	21.93	22.29	22.45	22.62	22.91	23.20	23.52	23.83	24.02	24.02	24.10	24.21	24.22	24.20	24.22	24.23	24.22	24.21				
CHAINAGE	340.00	360.00	380.00	400.00	420.00	429.54	440.00	459.75	480.00	500.00	520.00	541.15	560.00	580.00	600.00	620.00	640.00	660.00	676.84	680.00					

LONGITUDINAL SECTION - 340.00m - 680.00m

HORZ 1:500 VERT 1:100

SCALE 1:100 AT ORIGINAL SIZE

SCALE 1:500 AT ORIGINAL SIZE

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
A	PRELIMINARY		IH			

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135 Albert Street, Auckland New Zealand
T 64 9 307 7373 F 64 9 307 7300
E akmail@ghd.com W www.ghd.com

DO NOT SCALE

Drawn	I.HO	Designer	I.HO
Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client AUCKLAND TRANSPORT
Project LINCOLN ROAD CORRIDOR
Title PRELIMINARY DESIGN CATCHMENT BOUNDARIES

SHEET 2 OF 4

Original Size A1

Drawing No: 51-29887-C002

Rev: A

Plot Date: 12 July 2011 - 9:32 AM Plotted by: Dean Crowley\Auckland\GHD\AU Cad File No: \\ghdnet\ghd\NZ\Manukau\Projects\51\29887\01. CADD\Acad\Stormwater catchments_working_DC.dwg

CATCHMENT LEGEND

- TOTAL CATCHMENT BOUNDARY
- EXISTING IMPERVIOUS AREA
- PROPOSED IMPERVIOUS AREA

PLAN VIEW
SCALE 1:500

0 5 10 15 20 25m
SCALE 1:500 AT ORIGINAL SIZE

PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
A	PRELIMINARY		IH			

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Drawn	I.HO	Designer	I.HO
Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client AUCKLAND TRANSPORT
Project LINCOLN ROAD CORRIDOR
Title PRELIMINARY DESIGN CATCHMENT BOUNDARIES
SHEET 3 OF 4

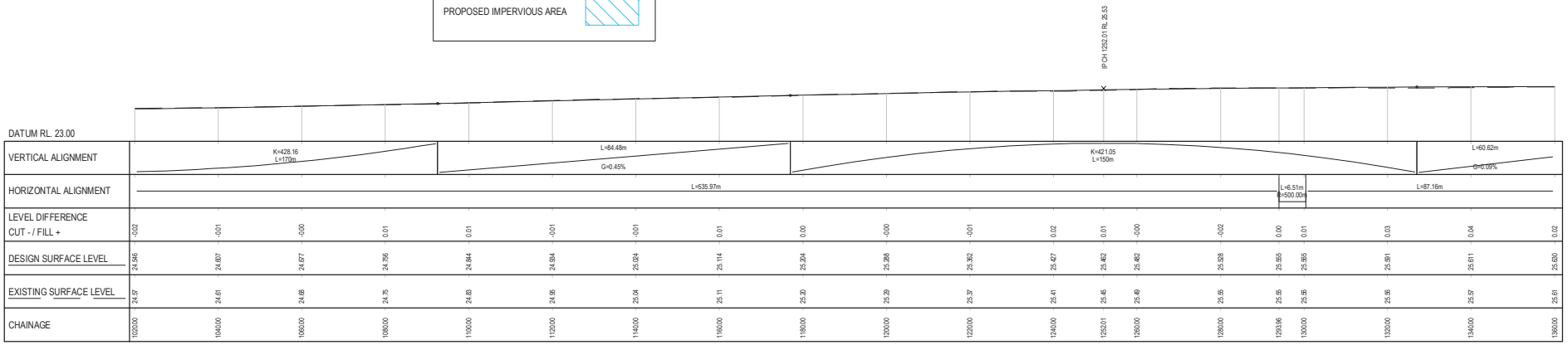
Original Size A1
Drawing No: 51-29887-C003
Rev: A

Plot Date: 12 July 2011 - 9:35 AM Plotted by: Dean Crowley/Auckland/GHD/AU
Cad File No: \\ghdnet\ghd\NZ\Manukau\Projects\51\29887\01. CADD\Acad\Stormwater catchments_working_DC.dwg

PLAN VIEW
SCALE 1:500

CATCHMENT LEGEND

- TOTAL CATCHMENT BOUNDARY
- EXISTING IMPERVIOUS AREA
- PROPOSED IMPERVIOUS AREA



LONGITUDINAL SECTION - 1020.00m - 1360.00m

HORZ 1:500 VERT 1:100

SCALE 1:100 AT ORIGINAL SIZE

SCALE 1:500 AT ORIGINAL SIZE

PRELIMINARY

No	Revision	Drawn	Job Manager	Project Director	Date
A	PRELIMINARY	IH			

Note: * indicates signatures on original issue of drawing or last revision of drawing

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DO NOT SCALE

Drawn	I.HO	Designer	I.HO
Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client: AUCKLAND TRANSPORT
Project: LINCOLN ROAD CORRIDOR
Title: PRELIMINARY DESIGN CATCHMENT BOUNDARIES

SHEET 4 OF 4

Original Size: A1

Drawing No: 51-29887-C004

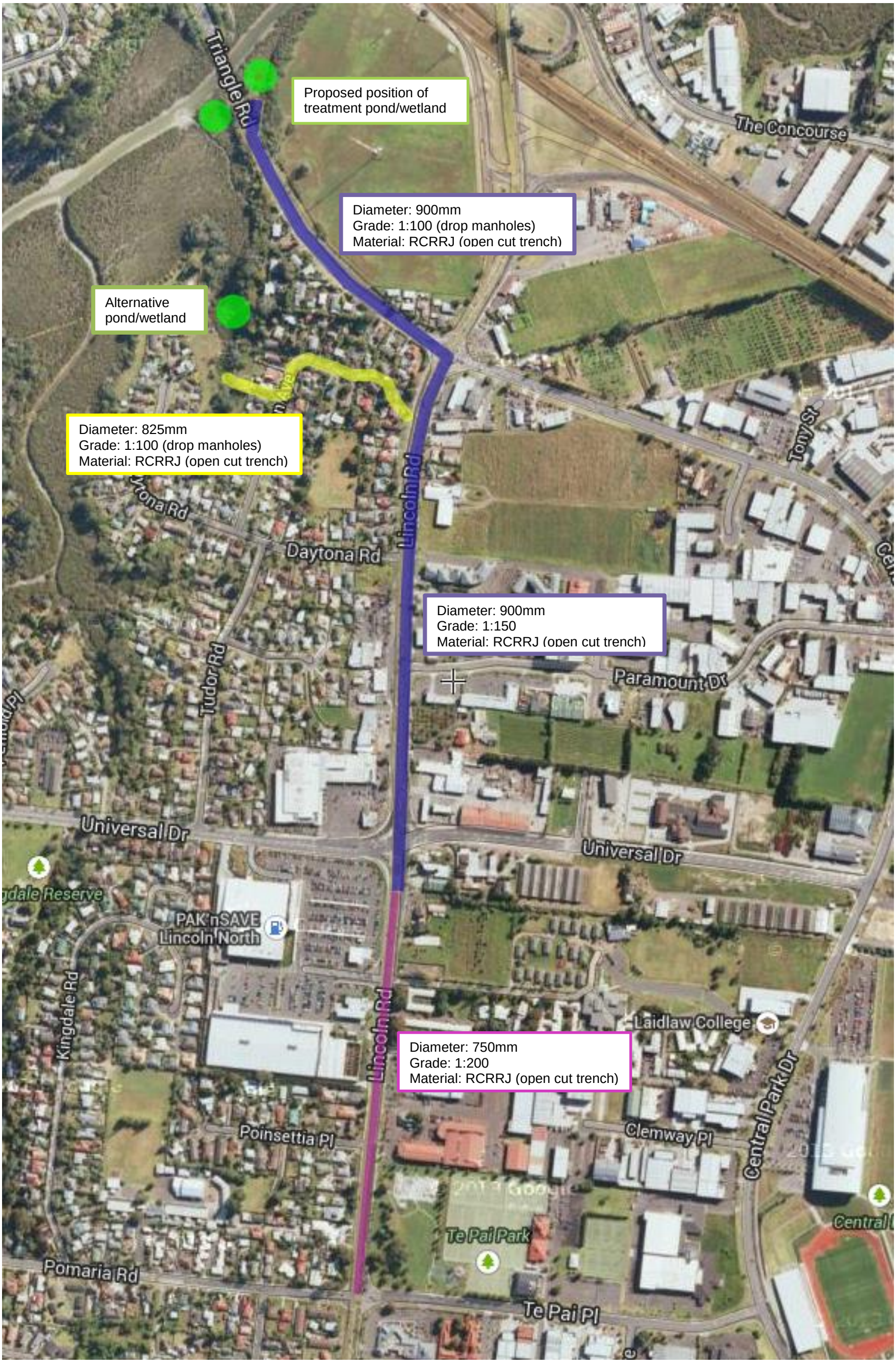
Rev: A

Plot Date: 12 July 2011 - 9:36 AM Plotted by: Dean Crowley/Auckland/GHD/AU Cad File No: \\ghdnet\ghd\NZ\Manukau\Projects\51\29887\01. CADD\Acad\Stormwater catchments_working_DC.dwg

Appendix C Stormwater Collector Pipe Plan

PROPOSED STORMWATER COLLECTOR PIPE- ALL CATCHMENTS

CONCEPT PIPE SIZING



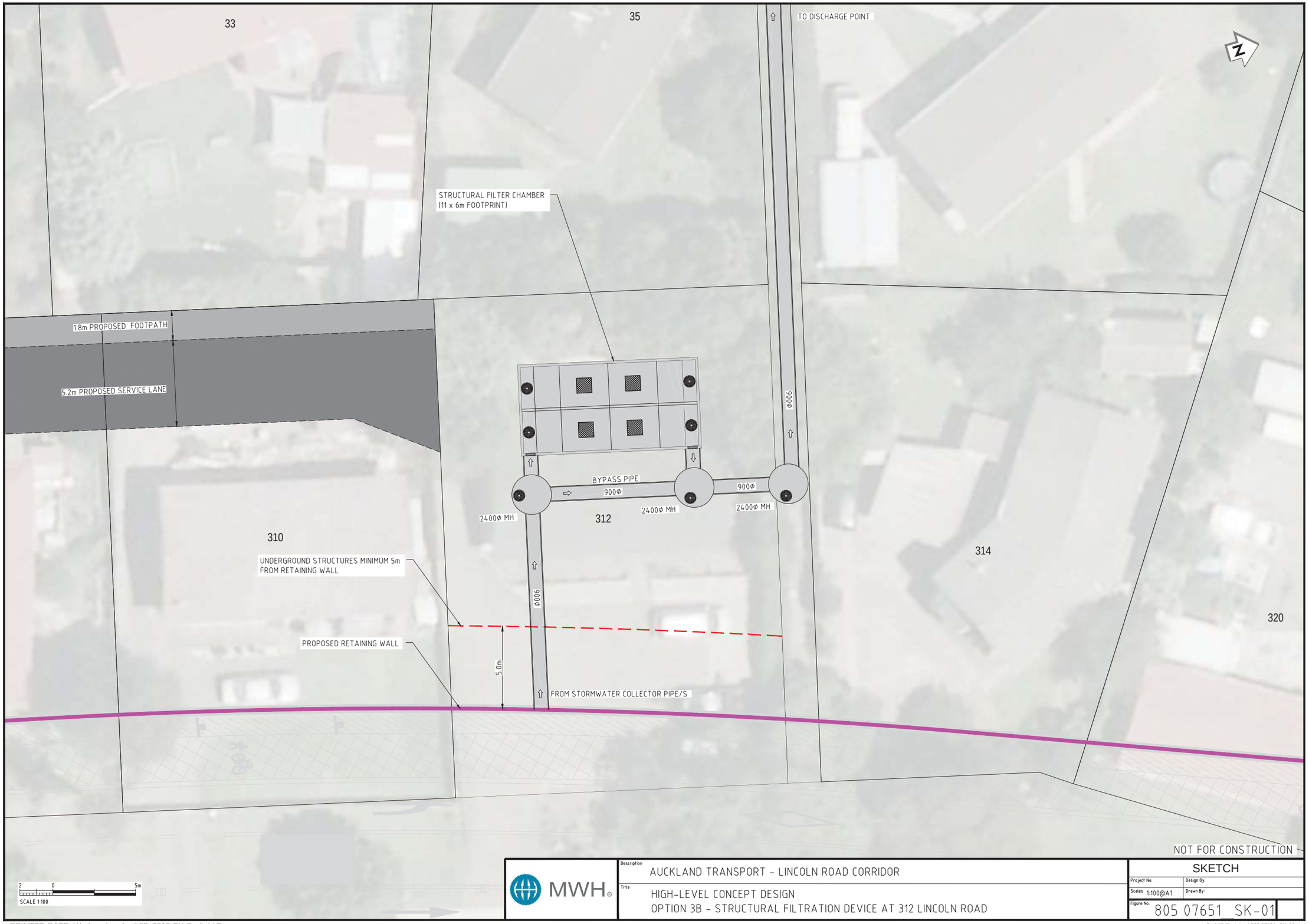
Appendix D PAUP - Triangle Road Wetland Sketch

STRUCTURAL FILTRATION DEVICE AT THE TRIANGLE ROAD BRIDGE - INDICATIVE LAYOUT

Appendix E PAUP - Daytona Strand Wetland Plan

DAYTONA STRAND WETLAND - INDICATIVE LAYOUT

Appendix F PAUP - 312 Lincoln Road Structural Filter Plan



MWH®

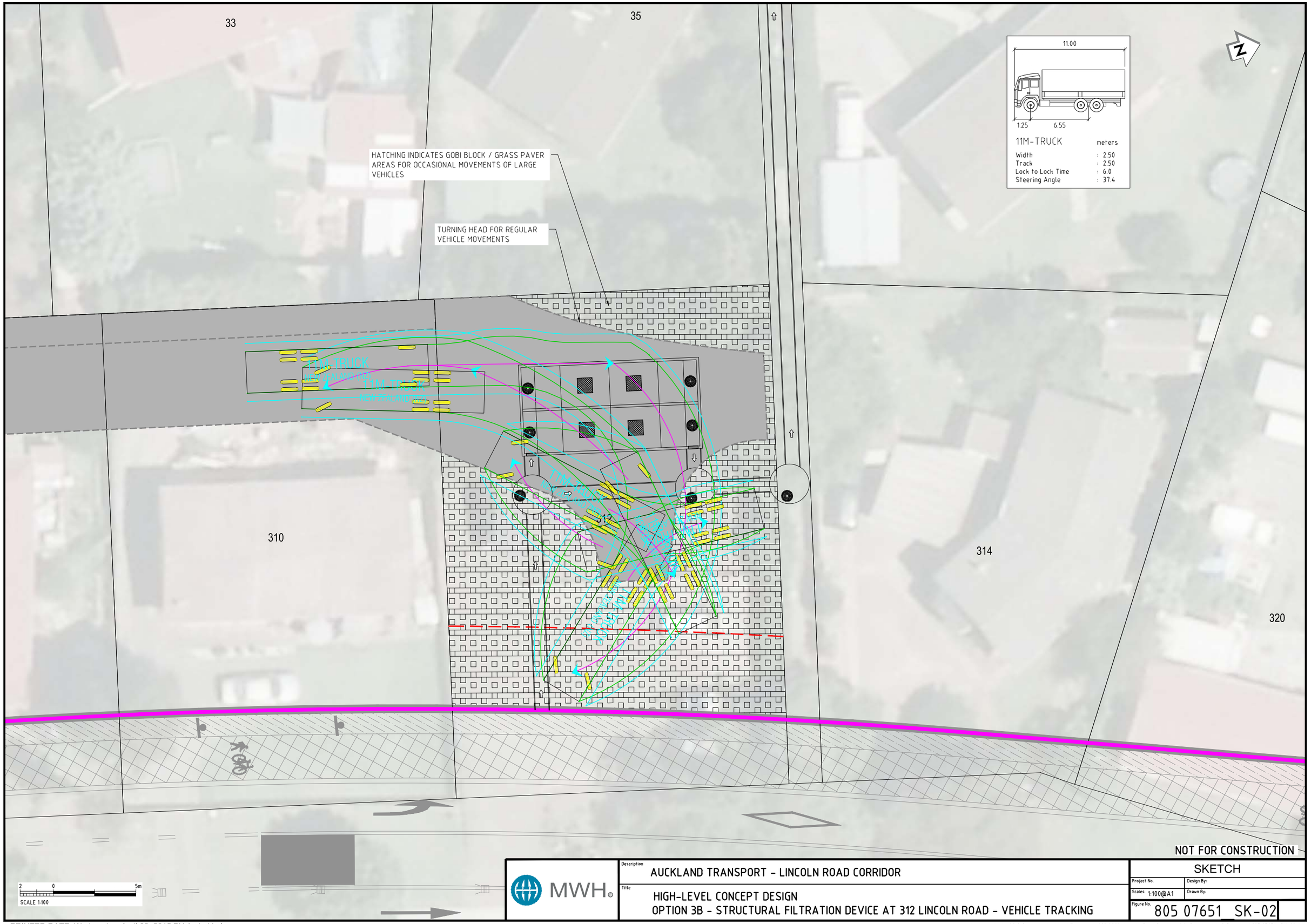
Description	AUCKLAND TRANSPORT - LINCOLN ROAD CORRIDOR
Title	HIGH-LEVEL CONCEPT DESIGN OPTION 3B - STRUCTURAL FILTRATION DEVICE AT 312 LINCOLN ROAD

SKETCH

Project No.	Design By:
Scales 1:100@A1	Drawn By:
Figure No. 805 07651 SK-01	

PRINTED DATE: Wednesday, April 08, 2015 BY Garfield Toro

D:\4.10 Sketches\805 07651_SK-01.dwg



MWH

Description: AUCKLAND TRANSPORT - LINCOLN ROAD CORRIDOR

Title: HIGH-LEVEL CONCEPT DESIGN
OPTION 3B - STRUCTURAL FILTRATION DEVICE AT 312 LINCOLN ROAD - VEHICLE TRACKING

SKETCH

Project No.

Design By:

Scales 1:100@A1

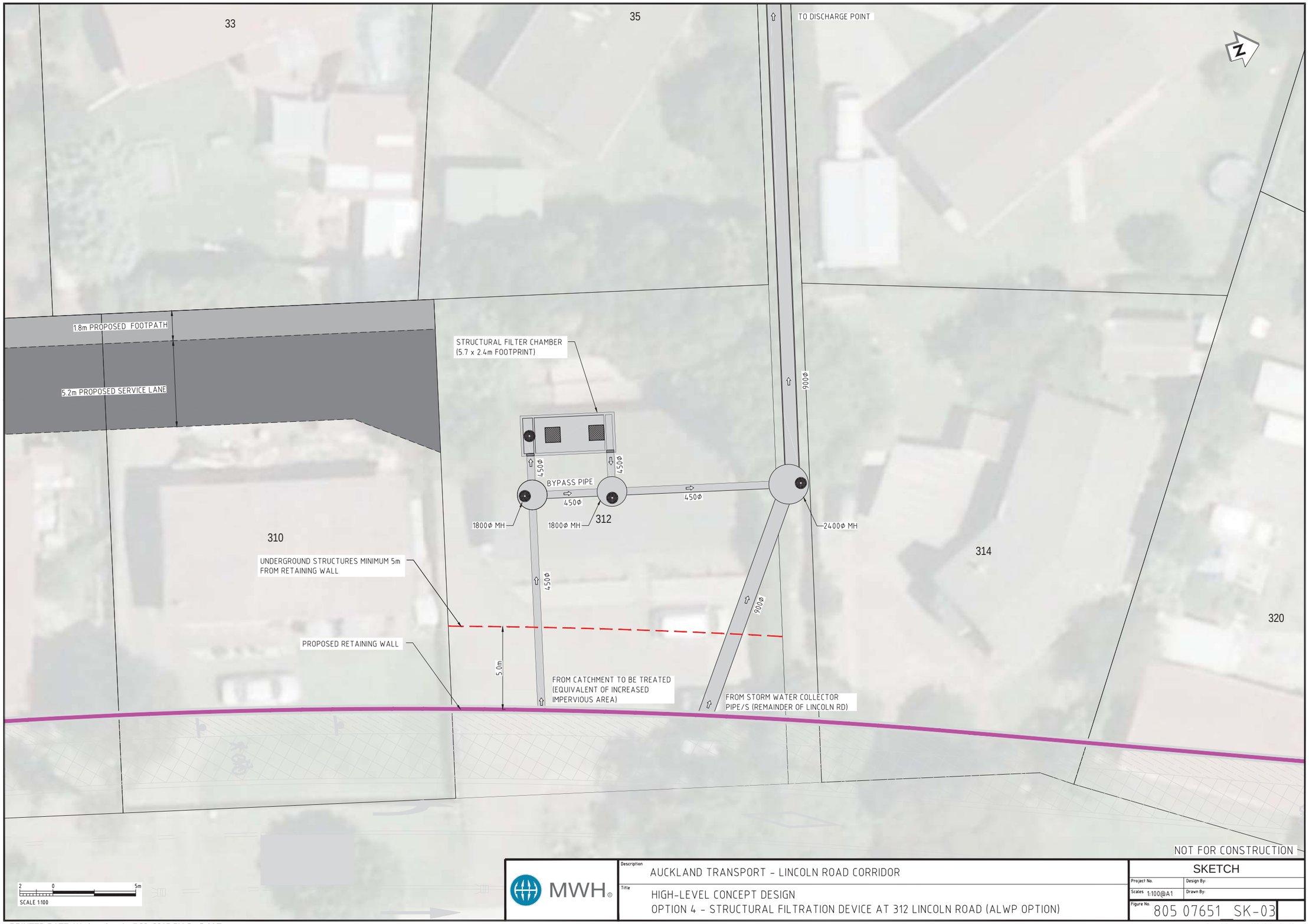
Drawn By:

Figure No. 805 07651_SK-02

PRINTED DATE: Wednesday, April 08, 2015 BY Arvind Lal

\\nzakls01\projects\2012 Onwards\Auckland Transport\805 07651 Lincoln Road Corridor\5.0 Drawings\4.10 Sketches\805 07651_SK-02.dwg

Appendix G ALWP - Structural Filter Plan


33
35
TO DISCHARGE POINT
N
1.8m PROPOSED FOOTPATH
5.2m PROPOSED SERVICE LANE
STRUCTURAL FILTER CHAMBER
(5.7 x 2.4m FOOTPRINT)
450Φ
450Φ
BYPASS PIPE
450Φ
450Φ
900Φ
1800Φ MH
1800Φ MH
312
2400Φ MH
310
314
320
UNDERGROUND STRUCTURES MINIMUM 5m
FROM RETAINING WALL
PROPOSED RETAINING WALL
5.0m
450Φ
900Φ
FROM CATCHMENT TO BE TREATED
(EQUIVALENT OF INCREASED
IMPERVIOUS AREA)
FROM STORM WATER COLLECTOR
PIPE/S (REMAINDER OF LINCOLN RD)
NOT FOR CONSTRUCTION
2 0 5m
SCALE 1:100
MWH
Description
AUCKLAND TRANSPORT - LINCOLN ROAD CORRIDOR
Title
HIGH-LEVEL CONCEPT DESIGN
OPTION 4 - STRUCTURAL FILTRATION DEVICE AT 312 LINCOLN ROAD (ALWP OPTION)
SKETCH
Project No.
Design By:
Scales 1:100@A1
Drawn By:
Figure No. 805 07651 SK-03
PRINTED DATE: Wednesday, April 08, 2015 BY Garfield Toro
D:\4.10 Sketches\805 07651_SK-03.dwg

Appendix H Indicative Cost Estimates

Unlocked	User Input
Locked	Calculated Output, or fixed attribute
Free text	User Defined

Option Description Option 3A: 3000m2 Wetland at Daytona Strand - HIGH estimate

NPV Calculation

NPV = Net Present Value	$2,881,378	Present cost (Year 0) + all future costs discounted using real discount rate to present d
Residual Value (if known)	$0	If Unknown, input = $0

I = Real Discount Rate	4%	All amounts to be entered in todays dollars.
L = Lifespan (Appraisal Period)	60 years	
M = Annual Maintenance Cost (Discounted)	$5,522.96	
M = Annual Maintenance Cost (Undiscounted)	$19,286.67	

Year	Project Capital Cost	Maintenance Description	Maintenance Cost
0	$2,550,000	E.g. None Required	$0
1	$0	Routine first 5 years	$5,800
2	$0	Routine first 5 years	$5,800
3	$0	Routine first 5 years	$5,800
4	$0	Routine first 5 years	$5,800
5	$0	Routine first 5 years	$5,800
6	$0	Routine subsequent yrs	$3,800
7	$0	Routine subsequent yrs	$3,800
8	$0	Routine subsequent yrs	$3,800
9	$0	Routine subsequent yrs	$3,800
10	$0	Plus Corr Structural 10yrs	$14,000
11	$0	Routine subsequent yrs	$3,800
12	$0	Routine subsequent yrs	$3,800
13	$0	Routine subsequent yrs	$3,800
14	$0	Routine subsequent yrs	$3,800
15	$0	Routine subsequent yrs	$3,800
16	$0	Routine subsequent yrs	$3,800
17	$0	Routine subsequent yrs	$3,800
18	$0	Routine subsequent yrs	$3,800
19	$0	Routine subsequent yrs	$3,800
20	$0	Plus Desilting 20yrs	$300,000
21	$0	Routine subsequent yrs	$3,800
22	$0	Routine subsequent yrs	$3,800
23	$0	Routine subsequent yrs	$3,800
24	$0	Routine subsequent yrs	$3,800
25	$0	Routine subsequent yrs	$3,800
26	$0	Routine subsequent yrs	$3,800
27	$0	Routine subsequent yrs	$3,800
28	$0	Routine subsequent yrs	$3,800
29	$0	Routine subsequent yrs	$3,800
30	$0	Plus Corr Structural 10yrs	$14,000
31	$0	Routine subsequent yrs	$3,800
32	$0	Routine subsequent yrs	$3,800
33	$0	Routine subsequent yrs	$3,800
34	$0	Routine subsequent yrs	$3,800
35	$0	Routine subsequent yrs	$3,800
36	$0	Routine subsequent yrs	$3,800
37	$0	Routine subsequent yrs	$3,800
38	$0	Routine subsequent yrs	$3,800
39	$0	Routine subsequent yrs	$3,800
40	$0	Plus Desilting 20yrs	$300,000
41	$0	Routine subsequent yrs	$3,800
42	$0	Routine subsequent yrs	$3,800
43	$0	Routine subsequent yrs	$3,800
44	$0	Routine subsequent yrs	$3,800
45	$0	Routine subsequent yrs	$3,800
46	$0	Routine subsequent yrs	$3,800
47	$0	Routine subsequent yrs	$3,800
48	$0	Routine subsequent yrs	$3,800
49	$0	Routine subsequent yrs	$3,800
50	$0	Plus Corr Structural 10yrs	$14,000
51	$0	Routine subsequent yrs	$3,800
52	$0	Routine subsequent yrs	$3,800
53	$0	Routine subsequent yrs	$3,800
54	$0	Routine subsequent yrs	$3,800
55	$0	Routine subsequent yrs	$3,800
56	$0	Routine subsequent yrs	$3,800
57	$0	Routine subsequent yrs	$3,800
58	$0	Routine subsequent yrs	$3,800
59	$0	Routine subsequent yrs	$3,800
60	$0	Plus Desilting 20yrs	$300,000

Lincoln Road Corridor Improvements

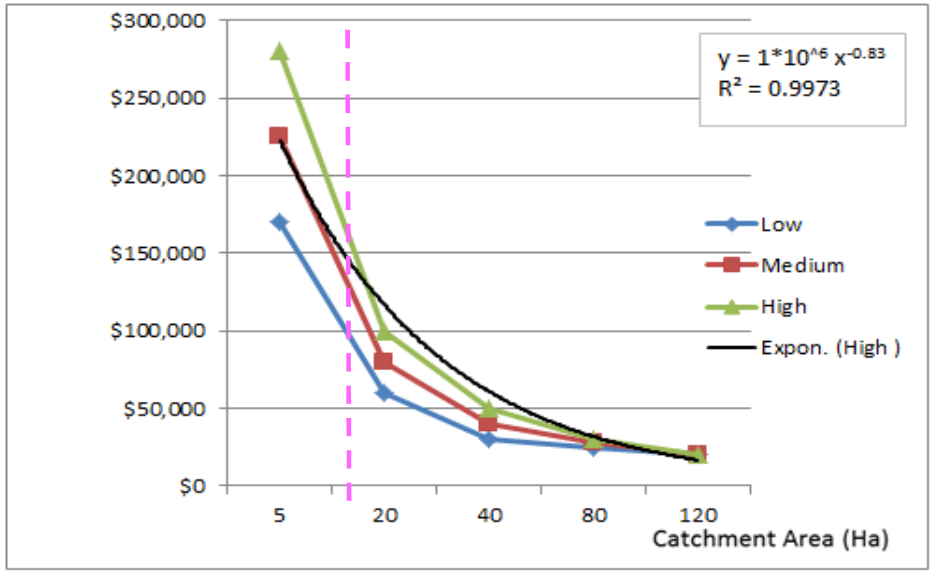
Stormwater Options Assessment

Option Description Option 3A: 3,000m^2 wetland at Daytona Strand

CAPEX *From 'Construction Cost Calculator' tab*
LAND COST EXCLUDED

Construction cost per Ha of catchment area **(excluding land)**

Catchment Area (Ha)	Water Surface Area (m^2)	Land Area (m^2)	Low	Medium	High
5	1000	2,665	$170,000	$225,000	$280,000
20	4000	6,930	$60,000	$80,000	$100,000
40	8000	11,978	$30,000	$40,000	$50,000
80	16000	21,460	$25,000	$27,500	$30,000
120	24000	30,597	$20,000	$20,000	$20,000



Capex HIGH (per Ha) = $170,000

Capex HIGH = $2,550,000

OPEX *From 'Maintenace Cost Tables'*

Routine first 5 years	$5,800
Routine subsequent yrs	$3,800
Corrective Structural maintenace every 10 years	$14,000
Total every 20 years	$300,000

Unlocked	User Input	
Locked	Calculated Output, or fixed attribute	
Free text	User Defined	

Option Description Option 3A: 3000m2 Wetland at Daytona Strand - LOW estimate

NPV Calculation

NPV = Net Present Value	$1,916,378	Present cost (Year 0) + all future costs discounted using real discount rate to present d
Residual Value (if known)	$0	If Unknown, input = $0

I = Real Discount Rate	4%	All amounts to be entered in todays dollars.
L = Lifespan (Appraisal Period)	60 years	
M = Annual Maintenance Cost (Discounted)	$5,522.96	
M = Annual Maintenance Cost (Undiscounted)	$19,286.67	

Year	Project Capital Cost	Maintenance Description	Maintenance Cost
0	$1,585,000	E.g. None Required	$0
1	$0	Routine first 5 years	$5,800
2	$0	Routine first 5 years	$5,800
3	$0	Routine first 5 years	$5,800
4	$0	Routine first 5 years	$5,800
5	$0	Routine first 5 years	$5,800
6	$0	Routine subsequent yrs	$3,800
7	$0	Routine subsequent yrs	$3,800
8	$0	Routine subsequent yrs	$3,800
9	$0	Routine subsequent yrs	$3,800
10	$0	Plus Corr Structural 10yrs	$14,000
11	$0	Routine subsequent yrs	$3,800
12	$0	Routine subsequent yrs	$3,800
13	$0	Routine subsequent yrs	$3,800
14	$0	Routine subsequent yrs	$3,800
15	$0	Routine subsequent yrs	$3,800
16	$0	Routine subsequent yrs	$3,800
17	$0	Routine subsequent yrs	$3,800
18	$0	Routine subsequent yrs	$3,800
19	$0	Routine subsequent yrs	$3,800
20	$0	Plus Desilting 20yrs	$300,000
21	$0	Routine subsequent yrs	$3,800
22	$0	Routine subsequent yrs	$3,800
23	$0	Routine subsequent yrs	$3,800
24	$0	Routine subsequent yrs	$3,800
25	$0	Routine subsequent yrs	$3,800
26	$0	Routine subsequent yrs	$3,800
27	$0	Routine subsequent yrs	$3,800
28	$0	Routine subsequent yrs	$3,800
29	$0	Routine subsequent yrs	$3,800
30	$0	Plus Corr Structural 10yrs	$14,000
31	$0	Routine subsequent yrs	$3,800
32	$0	Routine subsequent yrs	$3,800
33	$0	Routine subsequent yrs	$3,800
34	$0	Routine subsequent yrs	$3,800
35	$0	Routine subsequent yrs	$3,800
36	$0	Routine subsequent yrs	$3,800
37	$0	Routine subsequent yrs	$3,800
38	$0	Routine subsequent yrs	$3,800
39	$0	Routine subsequent yrs	$3,800
40	$0	Plus Desilting 20yrs	$300,000
41	$0	Routine subsequent yrs	$3,800
42	$0	Routine subsequent yrs	$3,800
43	$0	Routine subsequent yrs	$3,800
44	$0	Routine subsequent yrs	$3,800
45	$0	Routine subsequent yrs	$3,800
46	$0	Routine subsequent yrs	$3,800
47	$0	Routine subsequent yrs	$3,800
48	$0	Routine subsequent yrs	$3,800
49	$0	Routine subsequent yrs	$3,800
50	$0	Plus Corr Structural 10yrs	$14,000
51	$0	Routine subsequent yrs	$3,800
52	$0	Routine subsequent yrs	$3,800
53	$0	Routine subsequent yrs	$3,800
54	$0	Routine subsequent yrs	$3,800
55	$0	Routine subsequent yrs	$3,800
56	$0	Routine subsequent yrs	$3,800
57	$0	Routine subsequent yrs	$3,800
58	$0	Routine subsequent yrs	$3,800
59	$0	Routine subsequent yrs	$3,800
60	$0	Plus Desilting 20yrs	$300,000

Lincoln Road Corridor Improvements

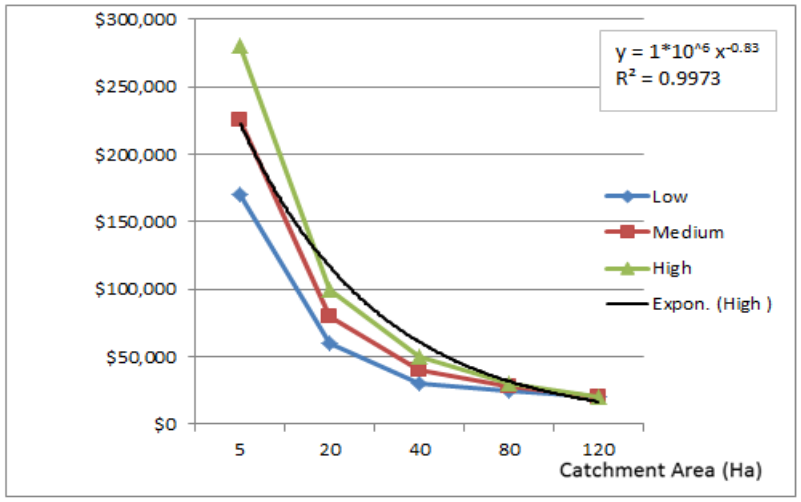
Stormwater Options Assessment

Option Description Option 3A: 3,000m^2 wetland at Daytona Strand

CAPEX *From 'Construction Cost Calculator' tab*
LAND COST EXCLUDED

Construction cost per Ha of catchment area **(excluding land)**

Catchment Area (Ha)	Water Surface Area (m^2)	Land Area (m^2)	Low	Medium	High
5	1000	2,665	$170,000	$225,000	$280,000
20	4000	6,930	$60,000	$80,000	$100,000
40	8000	11,978	$30,000	$40,000	$50,000
80	16000	21,460	$25,000	$27,500	$30,000
120	24000	30,597	$20,000	$20,000	$20,000



F1 1000000 F2 -0.83

Catchment Area (Ha)	15
Construction Cost ($/Ha)	$105,644
Total ($)	$1,584,658

OPEX *From 'Maintenace Cost Tables'*

Routine first 5 years	$5,800
Routine subsequent yrs	$3,800
Corrective Structural maintenace every 10 years	$14,000
Total every 20 years	$300,000

Unlocked	User Input	
Locked	Calculated Output	
Free text	User Defined	

Option Description Option 3B: Structural Filtration at 312 Lincoln Road - 130 catridges in a 11 x 6m chamber.

NPV Calculation

NPV = Net Present Value	$1,304,035	Present cost (Year 0) + all future costs discounted using real discount rate to present day cost
Residual Value (if known)	$0	If Unknown, input = $0
I = Real Discount Rate	4%	All amounts to be entered in todays dollars.
L = Lifespan (Appraisal Period)	60 years	
M = Annual Maintenance Cost (Discounted)	$12,150.59	
M = Annual Maintenance Cost (Undiscounted)	$32,998.33	

Year	Project Capital Cost	Maintenance Description	Maintenance Cost
0	$575,000	E.g. None Required	$0
1	$0	Routine cartridge clean	$30,550
2	$0	Routine cartridge clean	$30,550
3	$0	Routine cartridge clean	$30,550
4	$0	Routine cartridge clean	$30,550
5	$0	Routine cartridge clean	$30,550
6	$0	Routine cartridge clean	$30,550
7	$0	Routine cartridge clean	$30,550
8	$0	Routine cartridge clean	$30,550
9	$0	Routine cartridge clean	$30,550
10	$0	Routine cartridge clean	$30,550
11	$0	Routine cartridge clean	$30,550
12	$0	Routine cartridge clean	$30,550
13	$0	Routine cartridge clean	$30,550
14	$0	Routine cartridge clean	$30,550
15	$0	Routine cartridge clean	$30,550
16	$0	Routine cartridge clean	$30,550
17	$0	Routine cartridge clean	$30,550
18	$0	Routine cartridge clean	$30,550
19	$0	Routine cartridge clean	$30,550
20	$0	Routine cartridge clean	$30,550
21	$0	Routine cartridge clean	$30,550
22	$0	Routine cartridge clean	$30,550
23	$0	Routine cartridge clean	$30,550
24	$0	Routine cartridge clean	$30,550
25	$0	Routine cartridge clean	$104,000
26	$0	Routine cartridge clean	$30,550
27	$0	Routine cartridge clean	$30,550
28	$0	Routine cartridge clean	$30,550
29	$0	Routine cartridge clean	$30,550
30	$0	Routine cartridge clean	$30,550
31	$0	Routine cartridge clean	$30,550
32	$0	Routine cartridge clean	$30,550
33	$0	Routine cartridge clean	$30,550
34	$0	Routine cartridge clean	$30,550
35	$0	Routine cartridge clean	$30,550
36	$0	Routine cartridge clean	$30,550
37	$0	Routine cartridge clean	$30,550
38	$0	Routine cartridge clean	$30,550
39	$0	Routine cartridge clean	$30,550
40	$0	Routine cartridge clean	$30,550
41	$0	Routine cartridge clean	$30,550
42	$0	Routine cartridge clean	$30,550
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44	$0	Routine cartridge clean	$30,550
45	$0	Routine cartridge clean	$30,550
46	$0	Routine cartridge clean	$30,550
47	$0	Routine cartridge clean	$30,550
48	$0	Routine cartridge clean	$30,550
49	$0	Routine cartridge clean	$30,550
50	$0	Routine cartridge clean	$104,000
51	$0	Routine cartridge clean	$30,550
52	$0	Routine cartridge clean	$30,550
53	$0	Routine cartridge clean	$30,550
54	$0	Routine cartridge clean	$30,550
55	$0	Routine cartridge clean	$30,550
56	$0	Routine cartridge clean	$30,550
57	$0	Routine cartridge clean	$30,550
58	$0	Routine cartridge clean	$30,550
59	$0	Routine cartridge clean	$30,550
60	$0	Routine cartridge clean	$30,550

Lincoln Road Corridor Improvements

Stormwater Options Assessment

Option Description	Option 3B: Structural Filtration at 312 Lincoln Road - 130 catridges in a 11 x 6m chamber. LAND COST EXCLUDED	
CAPEX		
Vault	$350,000	estimate from SW 360
Site Works	$50,000	
Installation	$30,000	
Manholes and pipework	$75,000	
Reinstatement	$20,000	
Misc.	$50,000	
Total	**$575,000**	

OPEX	
Annual maintenance cost	
Cost per cartridge (estimate from SW 360)	$235
No. of cartridges	130
Total	**$30,550**

Cartridge replacement (per unit)	800
Total	104000

Unlocked	User Input	
Locked	Calculated Output	
Free text	User Defined	

Option Description Option 4 (ALWP): Structural Filtration at 312 Lincoln Road - 20 catridges in a 6 x 2.5m chamber.

NPV Calculation

NPV = Net Present Value	$397,159	Present cost (Year 0) + all future costs discounted using real discount rate to present day cost
Residual Value (if known)	$0	If Unknown, input = $0
I = Real Discount Rate	4%	All amounts to be entered in todays dollars.
L = Lifespan (Appraisal Period)	60 years	
M = Annual Maintenance Cost (Discounted)	$1,869.32	
M = Annual Maintenance Cost (Undiscounted)	$5,076.67	

Year	Project Capital Cost	Maintenance Description	Maintenance Cost
0	$285,000	E.g. None Required	$0
1	$0	Routine cartridge clean	$4,700
2	$0	Routine cartridge clean	$4,700
3	$0	Routine cartridge clean	$4,700
4	$0	Routine cartridge clean	$4,700
5	$0	Routine cartridge clean	$4,700
6	$0	Routine cartridge clean	$4,700
7	$0	Routine cartridge clean	$4,700
8	$0	Routine cartridge clean	$4,700
9	$0	Routine cartridge clean	$4,700
10	$0	Routine cartridge clean	$4,700
11	$0	Routine cartridge clean	$4,700
12	$0	Routine cartridge clean	$4,700
13	$0	Routine cartridge clean	$4,700
14	$0	Routine cartridge clean	$4,700
15	$0	Routine cartridge clean	$4,700
16	$0	Routine cartridge clean	$4,700
17	$0	Routine cartridge clean	$4,700
18	$0	Routine cartridge clean	$4,700
19	$0	Routine cartridge clean	$4,700
20	$0	Routine cartridge clean	$4,700
21	$0	Routine cartridge clean	$4,700
22	$0	Routine cartridge clean	$4,700
23	$0	Routine cartridge clean	$4,700
24	$0	Routine cartridge clean	$4,700
25	$0	Cartridge replacement	$16,000
26	$0	Routine cartridge clean	$4,700
27	$0	Routine cartridge clean	$4,700
28	$0	Routine cartridge clean	$4,700
29	$0	Routine cartridge clean	$4,700
30	$0	Routine cartridge clean	$4,700
31	$0	Routine cartridge clean	$4,700
32	$0	Routine cartridge clean	$4,700
33	$0	Routine cartridge clean	$4,700
34	$0	Routine cartridge clean	$4,700
35	$0	Routine cartridge clean	$4,700
36	$0	Routine cartridge clean	$4,700
37	$0	Routine cartridge clean	$4,700
38	$0	Routine cartridge clean	$4,700
39	$0	Routine cartridge clean	$4,700
40	$0	Routine cartridge clean	$4,700
41	$0	Routine cartridge clean	$4,700
42	$0	Routine cartridge clean	$4,700
43	$0	Routine cartridge clean	$4,700
44	$0	Routine cartridge clean	$4,700
45	$0	Routine cartridge clean	$4,700
46	$0	Routine cartridge clean	$4,700
47	$0	Routine cartridge clean	$4,700
48	$0	Routine cartridge clean	$4,700
49	$0	Routine cartridge clean	$4,700
50	$0	Routine cartridge clean	$16,000
51	$0	Routine cartridge clean	$4,700
52	$0	Routine cartridge clean	$4,700
53	$0	Routine cartridge clean	$4,700
54	$0	Routine cartridge clean	$4,700
55	$0	Routine cartridge clean	$4,700
56	$0	Routine cartridge clean	$4,700
57	$0	Routine cartridge clean	$4,700
58	$0	Routine cartridge clean	$4,700
59	$0	Routine cartridge clean	$4,700
60	$0	Routine cartridge clean	$4,700

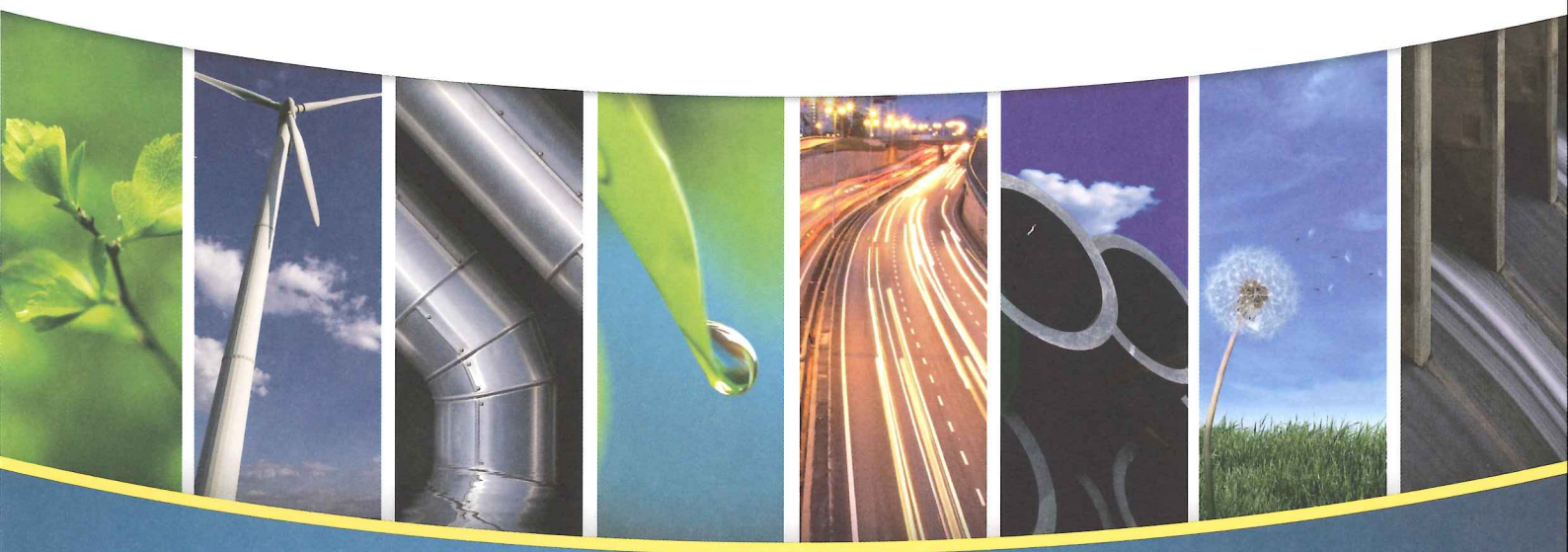
Lincoln Road Corridor Improvements

Stormwater Options Assessment

Option Description	Option 4 (ALWP): Structural Filtration at 312 Lincoln Road - 20 catridges in a 6 x 2.5m chamber. LAND COST EXCLUDED	
CAPEX		
Vault	$65,000	estimate from SW 360
Site Works	$30,000	
Installation	$20,000	
Manholes and pipework	$100,000	
Reinstatement	$20,000	
Misc.	$50,000	
Total	**$285,000**	
OPEX		
Annual maintenance cost		
Cost per cartridge (estimate from SW 360)	$235	
No. of cartridges	20	
Total	**$4,700**	
Cartridge replacement (per unit)	800	
Total	16000	

Wetland Maintenance Costs. Refer to TR2013/043 Appendix Section 7

Item	Cost (low to high)	Frequency/ Unit	Water Surface Area (m^2)		Lincoln Road Estimate for 3000m^2
			1,000	5,000	
Routine Maintenance					
Removing debris (e.g. litter, dead vegetation) from outlet and inlet structures	$40 to $137	12 per year/per pond	$480 to $1,644	$480 to $1,644	$1,000
Inspections (ducks, QA, inspection of embankments, spillways, outfalls, overall functioning of facility)	$250 to $400	1 per year/Per visit	$250 to $400	$250 to $400	$350
Scheduled Routine Mechanical Maintenance (pumps, outlets, removing mosquito breeding areas)	$320 to $550	1 per year/per pond	$320 to $550	$320 to $550	$450
Make good following vandalism	$21 to $175	12 per year/per pond	$252 to $2,100	$252 to $2,100	$15,000
Weed management (on-going) (50% planting)	$0.25 to $0.29	1 per year/m^2	$125 to $145	$625 to $725	$500
Initial Aftercare of Plants (for first 5 years) (50% planting)	$0.25 to $0.29	4 per year/m^2	$500 to $580	$2,500 to $2,900	$20,000
Annual Total – first five years			**$1,930 to $5,420**	**$4,430 to $8,320**	$5,800
			$1.93 to $5.42/$m^2$	**$0.89 to $1.66/$m^2$**	1.93/m2
Annual Total – subsequent years			**$1,430 to $4,840**	**$1,930 to $5,420**	$3,800
			$1.43 to $4.84/$m^2$	**$0.39 to $1.08/$m^2$**	1.27/m2
Corrective Maintenance					
Corrective structural maintenance	$10,000 to $16,000	10 years/per pond	$10,000 to $16,000	$10,000 to $16,000	$14,000
Replacement of parts	$1,000 to $6,000	20 years/per pond	$1,000 to $6,000	$1,000 to $6,000	$4,000
Replanting the wetland zone (500m^2 or 4,000m^2)	$9.00 to $12.50	20 years/m^2	$4,500 to $6,250	$22,500 to $31,250	$20,000
Desilting and disposal to landfill of forebay and main pond at cost of $150 to $300/$m^3$ (assume desilting depth of 0.35m, giving 350m^3 and 1,750m^3 for 1,000 and 5,000m^2 surface areas respectively)	$150 to $300/$m^3$	20 years/m^3	$52,500 to $105,000	$262,500 to $525,000	$250,000
TOTAL every 20 years (including 10 year corrective structural maintenance)			$68,000 to $133,250	$286,000 to $562,250	$300,000



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BUILDING A BETTER WORLD

Appendix E Contaminant Load Assessment

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BUILDING A BETTER WORLD

TECHNICAL NOTE

TO:	Keri Davis-Miller (Auckland Transport)	DATE:	17 December 2015
CC:	Sharon Deluca (Boffa Miskell), Zaid Essa (Auckland Transport), Graeme Stanton (MWH)	REF:	80507651
FROM:	James Peveril REVIEWED BY: Allan Leahy	MWH New Zealand Ltd	
SUBJECT:	Lincoln Road Corridor Improvements Project – Contaminant Load Assessment REVISION 2		

Purpose

This technical note documents the Contaminant Load Assessment (CLA) completed as part of the Lincoln Road Corridor Improvements project (LRCI). The CLA has been undertaken to provide an understanding of likely contaminant levels in stormwater runoff from the road corridor. The following scenarios have been assessed:

1. Runoff from the existing impervious areas of the Lincoln Road corridor that currently discharge to the Coastal Marine Area (CLA) at Daytona Strand.
2. Runoff from impervious areas of the upgraded road corridor (all of which are proposed to be discharged to the CMA at Daytona Strand). Treatment of runoff from new impervious areas only.
3. Runoff from all existing impervious areas of the Lincoln Road corridor (which currently discharge to various locations, including the CMA at Daytona Strand).
4. Runoff from impervious areas of the upgraded road corridor (all of which are proposed to be discharged to the CMA at Daytona Strand). Treatment of runoff from all impervious areas within the road corridor.

Scenarios 1 and 2 have been included in the assessment at the request of Auckland Transport / Boffa Miskell. Scenario 3 data is provided 'for information'. Auckland Transport / / Boffa Miskell have requested the inclusion of Scenario 4 following review of the first issue of this technical note.

MWH have not been asked to consider a scenario that calculates contaminant load from the full catchment area (residential area, plus road) that currently discharges to Daytona Strand, at this time. Significantly more effort is required to develop this scenario given the level of assessment required to determine the areas associated with the variety of pervious and impervious surface types within the catchment. MWH recommend that this scenario is considered in order to allow assessment of the effects of the proposed discharge scenario within the context of the existing situation.

Method

The CLA has been completed using Auckland Council's 'Contaminant Load Model' (CLM) Version 2, created in 2010. The CLM is the tool used by Council to assess contaminant loading in stormwater runoff. It is the only publically available and tested tool currently available in New Zealand.

The CLM calculates contaminant loads from a variety of sources (types of surfaces), including road corridors, which are assessed based on the number of vehicles per day (in specified ranges) that use the road.

The contaminants that are assessed in the CLM include:

- Total Suspended Solids (TSS)
- Total Zinc (TZn)
- Total Copper (TCu)
- Total Petroleum Hydrocarbons (TTPH)

The CLM includes an allowance for contaminant load reduction due to the presence of contaminant management treatment trains, with built in Load Reduction Factors for various treatment devices.

Limitations

The CLM has been developed and used by Auckland Council for assessment of contaminant loads and is a relatively 'high-level' assessment tool.

The following limitations have been identified with regard to how the contaminant source areas are represented in the CLM:

- The level of contaminant yield from a road area is calculated based on the number of 'vehicles per day' (vpd) that use the road. The tool has a number of vpd bands to choose from, e.g. 20,000-50,000. This banding is necessarily coarse, as yield values will vary significantly depending on various factors that are specific to each road.
- The 'source area' used to calculate contaminant load from roads is based on the length of the road and a pre-populated typical road width (based on the number of vpd). The width of the road cannot be manually adjusted. In order to represent the widening of the road corridor for the LRCI project (which does not change in length), and after discussion with Auckland Council technical staff, the 'road length' has been manipulated to produce a source area that matches the impervious area for each scenario.

Inputs

Inputs to the CLM for the modelled scenarios include: impervious area; contaminant management treatment trains; and load reduction factors (to over-ride the default values, where required).

The impervious areas used for the modelling are based on the initial catchment analysis competed by GHD (as documented in MWH's Stormwater Assessment Report for the LRCI project). The areas are:

- Scenario 1: 1.76 ha - subcatchment D only (subcatchments H and J currently discharge to a different inlet (not Daytona Strand) on the same estuary and have not been included as contributing area for Scenario 1).
- Scenario 2: 4.95 ha
- Scenario 3: 4.33 ha
- Scenario 4: 4.95 ha

Contaminant management treatment trains are included in the modelling as follows:

- Scenario 1: Catchpits only
- Scenario 2: Catchpits; StormFilter structural filtration device (treating runoff from new impervious areas only).
- Scenario 3: Catchpits; wet stormwater treatment pond (sub-catchments C & E only).
- Scenario 4: Catchpits; StormFilter structural filtration device (treating runoff from all impervious areas within the road corridor).

The sub-catchments referred to above are illustrated on the 'Existing Drainage Paths and Discharge Points Plan' in Attachment A.

Default load reduction factors included in the CLM have generally been retained. Factors have been manually entered for Suspended Solids, Zinc and Copper removal by the StormFilter device in Scenarios 2b and 2c, based on advice received from the supplier (Stormwater 360). Assessment using the lower and upper end of the removal efficiency range for these contaminants, as noted in SW360 general performance claim (see Figure 1 below), have been considered for comparison with results using default values.

Constituent	Removal Efficiency Range (Percent)
Total suspended solids (TSS)	50 – 85
Total zinc (T Zn)	30 – 60
Dissolved zinc	20 – 40
Total copper (T Cu)	30 – 60
Dissolved copper	20 – 40

Figure 1: StormFilter Removal Efficiency Range (Supplied by SW360)

Results

CLM results for the three scenarios that have been modelled are summarised in Figure 2 below.

Three sets of results are included for Scenario 2 and Scenario 4 – one for each set of Load Reduction Factor (LRF) values illustrated in Figure 3 below.

The outputs from the CLM are expressed as:

- Bottom of catchment outfall loads (kg per annum).
- Average yields (kg per hectare per annum).

The cells in the results tables have been colour coded, as follows:

- Green cells – results based on default LRFs.
- Blue cells – results based on manual LRFs.

Scenario		Bottom of catchment out-fall Loads (kg / annum)				Average yields (kg / hectare / annum)			
		TSS	TZn	TCu	TPH	TSS	TZn	TCu	TPH
1	Existing (sub-catchment D)	1345	4.0	1.28	29.1	764.82	2.29	0.73	16.55
2a	Proposed (runoff from new impervious areas treated) - Tool Default LRFs	3390	10.7	3.28	73.4	684.52	2.16	0.66	14.82
2b	Proposed (runoff from new impervious areas treated) - Low LRFs	3523	10.9	3.46	73.4	711.29	2.19	0.70	14.82
2c	Proposed (runoff from new impervious areas treated) - High LRFs	3337	10.4	3.31	73.4	673.81	2.10	0.67	14.82
3	Existing (all sub-catchments)	3183	9.8	3.09	71.17	734.42	2.25	0.71	16.42
4a	Proposed (all road runoff treated) - Tool Default LRFs	947	6.8	1.26	20.5	191.21	1.37	0.26	4.14
4b	Proposed (all road runoff treated) - Low LRFs	1894	7.9	2.53	20.5	382.41	1.60	0.51	4.14
4c	Proposed (all road runoff treated) - High LRFs	568	4.5	1.44	20.5	114.72	0.92	0.29	4.14

Figure 2: CLA Results

Default LRFs

Load reduction factors (LRF)		
Contaminant	Default LRF	Manual LRF
TSS	0.75	
TZn	0.40	
TCu	0.65	
TTPH	0.75	

Manual LRFs (Metals) – Low

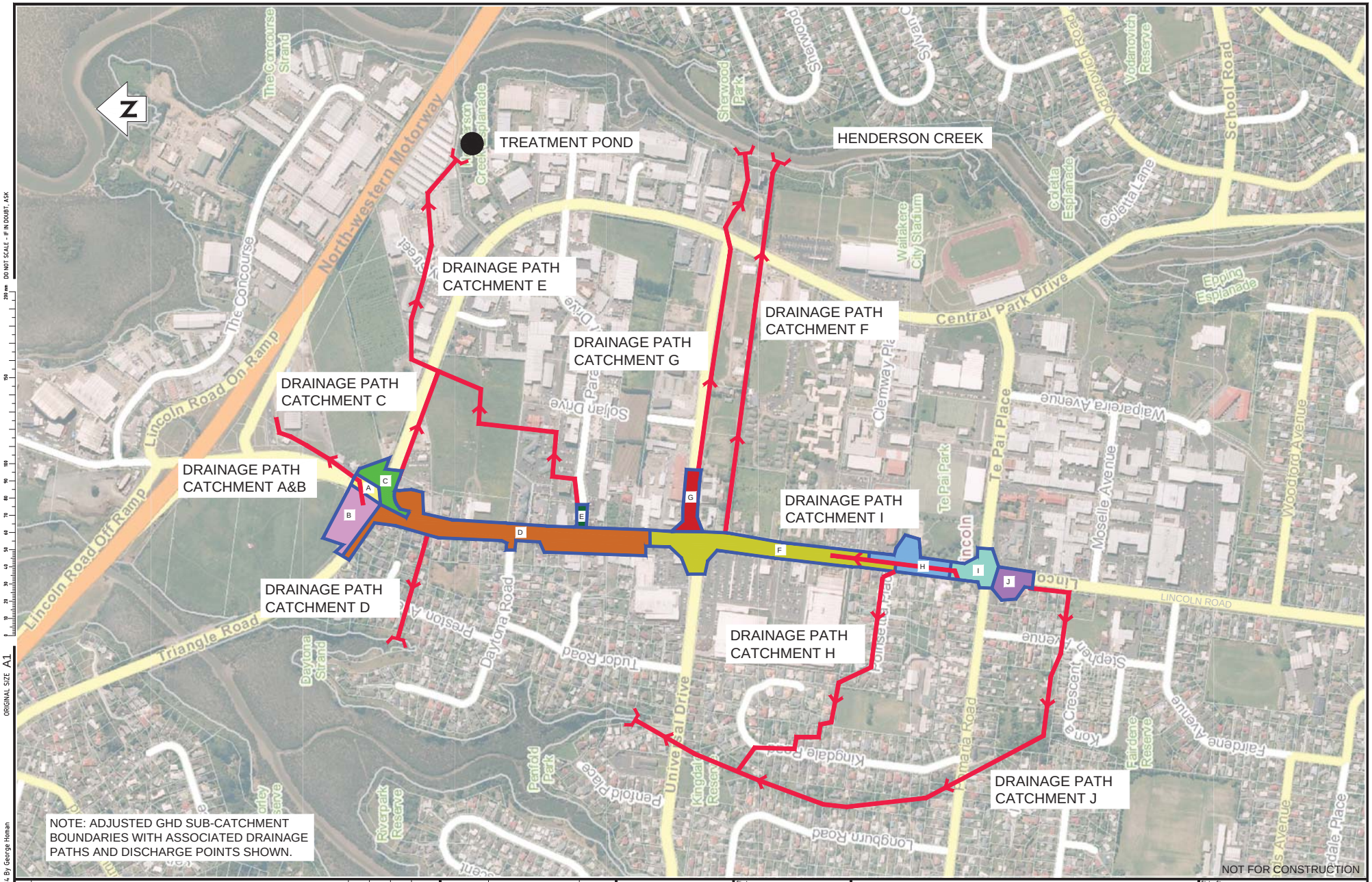
Load reduction factors (LRF)		
Contaminant	Default LRF	Manual LRF
TSS	0.75	0.50
TZn	0.40	0.30
TCu	0.65	0.30
TTPH	0.75	

Manual LRFs (Metals) - High

Load reduction factors (LRF)		
Contaminant	Default LRF	Manual LRF
TSS	0.75	0.85
TZn	0.40	0.60
TCu	0.65	0.60
TTPH	0.75	

Figure 3: Load Reduction Factors used for the StormFilter Treatment Device

ATTACHMENT A: Existing Drainage Paths and Discharge Points Plan



NOTE: ADJUSTED GHD SUB-CATCHMENT BOUNDARIES WITH ASSOCIATED DRAINAGE PATHS AND DISCHARGE POINTS SHOWN.

NOT FOR CONSTRUCTION

REV	REVISIONS	DRN	CHK	APP	DATE
01	FOR STORMWATER ASSESSMENT REPORT	GM	JP	GS	08/15

SURVEYED	-	-
DESIGNED	M WILLIAMS	08/15
DRAWN	G MURRAY	08/15
CAD REVIEW	J. PETTIGREW	08/15
DESIGN CHECK	J. PEVERIL	08/2015
DESIGN REVIEW	A. LEAHY	08/15
APPROVED	G. STANTON	08/15
PROF REGISTRATION:		

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Client: AT

AUCKLAND TRANSPORT
LINCOLN ROAD CORRIDOR IMPROVEMENTS

EXISTING STORMWATER DRAINAGE PATH AND DISCHARGE POINTS PLAN

Status Stamp: WORKING PLOT
Date Stamp: 25/08/2015
Scales: NTS
Datum: NZTM
Drawing No.: 80507651 - SK05
Rev.: 01

ORIGINAL SIZE A1
Last modified: Jun 26 2014 By George Homan
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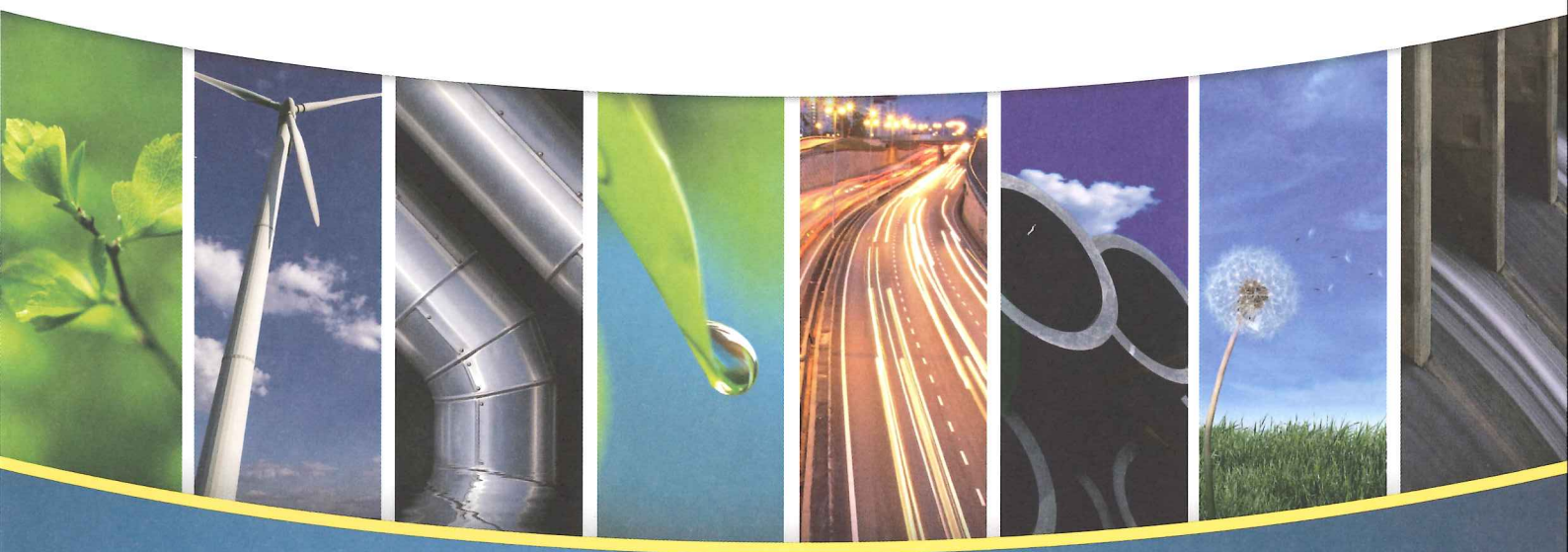

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