Carrington Road Improvements Project

Assessment of Stormwater Effects

Prepared for Auckland Transport
Prepared by Beca Limited

14 February 2025

Contents

Appendices

Revision History

Revision N°	Prepared By	Description	Date
	Dale Paice / Finn Palmer	Initial issue	14 February 2025

Document Acceptance

Action	Name	Signed	Date
Prepared by	Dale Paice / Finn Palmer		14 February 2025
Reviewed by	Hamish McLean		14 February 2025
Approved by	Colin McArthur		
on behalf of	Beca Limited		

1 Introduction and Scope

1.1 Purpose of this report

This report has been prepared by Beca Limited (Beca) on behalf of Auckland Transport (AT) (the Applicant) to inform the Assessment of Effects on the Environment (AEE) for the Carrington Road Improvements Project (the Project). Specifically, this report considers the actual and potential effects associated with the construction and operation of the Project on the environment as it relates to stormwater; and recommends measures that may be implemented to avoid, remedy, and/or mitigate these effects.

1.2 Assessment Scope

1.2.1 Construction Effects

The construction phase stormwater effects for the Project will be permitted activities under the provisions of Chapters E4 and E11 of the Auckland Unitary Plan Operative in Part (AUP:OP) (see Section 4 of the Assessment of Effects on the Environment (AEE) for the full rule citations).

The consenting approach for the Project assumes that stormwater effects from construction will be managed through Erosion and Sediment Control Plans (ESCP) prepared by the Contractor to suit staging and construction methodology. Plan revisions will be submitted periodically for Council approval. The plans will be prepared following the August 2023 version of GD2016/005 *"Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region*" (GD05).

1.2.2 Operational Effects of Stormwater Discharge

The consenting approach for the Project assumes that activities relating to stormwater networks, connections, and discharges will be authorised under the Auckland Council Regionwide Stormwater Network Discharge Consent (NDC), rather than being consented under the provisions of Chapter E8 of the AUP:OP. However as Carrington Road is a high use road, it is noted that resource consent will still be required as a controlled activity under Chapter E9 of the AUP:OP (see Section 4 of the AEE).

Accordingly, this assessment focuses on demonstrating how the Project will meet the relevant performance standards as set out in Schedule 4 of the NDC for transport projects; and in doing so that the Project will avoid, remedy, or mitigate its stormwater effects. It also demonstrates how the Project will meet the relevant controlled activity assessment criteria in Chapter E9 of the AUP:OP.

Under the NDC, the Project is bound by the connection requirements for transport projects set out in Schedule 4; and specifically, the requirements applying to the development of new/redevelopment of impervious area for existing high use roads with a new impervious area of >1,000m^2. Schedule 4 sets out requirements under each of the following categories:

- Catchments / Areas
- Water Quality
- Stream Hydrology
- Flooding
- Assets

Each of these requirements, as applies to the Carrington Road Upgrade Project is summarised separately in Sections 4.1 to 4.5 along with the assessment method and results.

1.2.3 Effects of Works in Areas prone to Flood Hazard

The effects of undertaking works in areas subject to flood hazard was considered under Chapter E36 “Natural hazards and flooding” of the AUP:OP. There is one area of the project (within Segar Avenue) where works may be carried out within a **Floodplain** and / or where they would redirect an **Overland Flow Path** per the Auckland Unitary Plan definition of those terms.

2 Project description

2.1 General

Carrington Road is an arterial road located on the ridge between the Te Auaunga Oakley Creek (to the west) Meola Creek Catchment (to the east). The works are described in detail in the Carrington Road Improvements Project Preliminary Design Report (December 2024) and preliminary drawing set with a summary of relevant stormwater design criteria included below in Table 1. The extent of works is indicated in Figure 1.

The tables below set out total catchment and impervious areas that apply, respectively, including catchment changes from the proposed project.

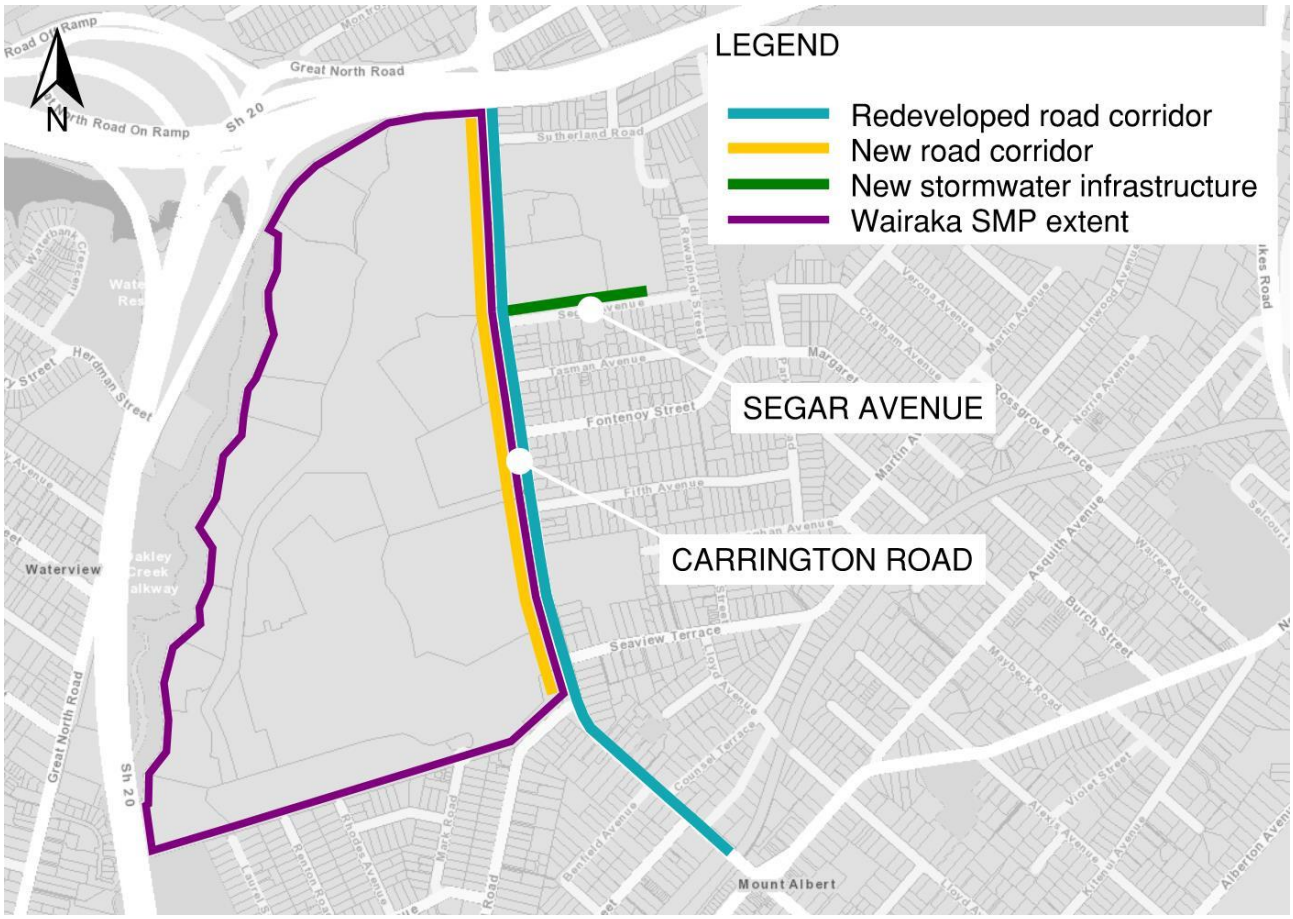


Figure 1 – Extent of works.

Elements of the works that affect stormwater are:

- A change in the proportion of impervious area within the road corridor.
- Widening of the road corridor along the western boundary; converting land current previously zoned for education purposes or residential development to road corridor.
- Installation of new stormwater quality treatment devices to capture and remove contaminants from road runoff.

- Installation of new drainage infrastructure (catchpits, pipes, manholes, gutters) and changes to overland flow paths to suit new road, footpath and cycleway arrangements.

Table 1 – Adopted design criteria (Carrington Road Improvements Project Preliminary Design Report, December 2024)

Item	Criteria	Detail
Design event allowances		
Hydrological method	Auckland Regional Council 1998, Technical Publication 108 'Guidelines for stormwater runoff modelling in the Auckland Region'. Auckland Council Code of Practice v4 (March 2024) for climate change adjustments to hyetograph and rainfall depths.	
Rainfall (24 hour depth)	1% AEP 10% AEP 50% AEP 95th percentile	190mm + C.C. adjustment 130mm + C.C. adjustment 80mm + C.C. adjustment 35mm + C.C. adjustment
Upstream development	Road reserve Residential sites Commercial sites	100% impervious 70% impervious 90% impervious
Design criteria		
Retention	Not applicable	
Detention	Not applicable	
Quality	All road carriageway	Treatment of runoff to achieve 75% total suspended solids removal. Preference for vegetated treatment systems.
Conveyance	Primary	10% AEP with 300mm freeboard to ground.
	Secondary	1% AEP less primary network capacity.
Flood risk	Offsite properties	No increase to nuisance flooding properties in up to the 10%AEP event.
	Offsite buildings	No increase to inundation of buildings in up to the 1% AEP event. 0.3m freeboard from habitable floors to 1% AEP overland flow.

2.2 Catchment and impervious area changes

The design reporting (and this assessment) considers the project in six separate sub-catchments, each with two potential receiving environments being Te Auaunga Oakley Creek (to the west) and Meola Creek (to the east) as shown in Figure 2 and Table 2 below.

Figure 2 – Project sub-catchments

Table 2 – Project sub-catchments

Sub-catchment	Primary Discharge Locations (actual and potential)	
	Oakley (west)	Meola (east)
1	*Gate 1 Road Network	Sutherland Road Network. Some potentially to soakage.
2	*Gate 1 Road Network	Sutherland Road Network
3	*Gate 2 Road Network	Segar Avenue Network
4	*Gate 3 / Farm Road Network	Fontenoy Street (combined sewer) Network / Fifth Avenue Network
5	Gate 4 / Woodward Road Network	None
6	None	Carrington-New North Road Network

* Within Wairaka Precinct Stormwater Management Plan (SMP) area adopted under the Auckland Regional Stormwater Network Discharge Consent (NDC).

This project includes widening of the road corridor towards Oakley Creek (west) in sub-catchments 1,2,3 and 4 and a very small amount of sub-catchment 5. The proposed areas in the table below include this widening. The exact dimensions of that widened corridor may need to be updated at a later stage of the project to match the finalised corridor width.

Table 3 – Sub-catchment areas – road corridor

Sub-catchment	Primary drainage		Secondary drainage	
	Oakley (west)	Meola (east)	Oakley (west)	Meola (east)
Existing				
1	*0m^2	3381m^2	*1634m^2	1747m^2
2	*608m^2	3427m^2	*2065m^2	1970m^2
3	*470m^2	5996m^2	*3476m^2	2990m^2
4	*560m^2	6232m^2	*3602m^2	3190m^2
5	5643m^2	3282m^2	5691m^2	3234m^2
6	0m^2	3940m^2	0m^2	3940m^2
Proposed				
1	*0m^2	3996m^2	*2249m^2	1747m^2
2	*5540m^2	0m^2	*3570m^2	1970m^2
3	*0m^2	8628m^2	*5638m^2	2990m^2
4	*8795m^2	0m^2	*5605m^2	3190m^2
5	8978m^2	0m^2	5744m^2	3234m^2
6	0m^2	3940m^2	0m^2	3940m^2
Change				
1	*0m^2	+615m^2	+615m^2	0m^2
2	*4932m^2	-3427m^2	+1505m^2	0m^2
3	*-470m^2	2632m^2	+2162m^2	0m^2
4	*+8235m^2	-6232m^2	+2003m^2	0m^2
5	+3335m^2	-3282m^2	+53m^2	0m^2
6	0m^2	0m^2	0m^2	0m^2

* Within Wairaka Precinct Stormwater Management Plan (SMP) area.

Table 4 - Sub-catchment areas – impervious area of road corridor

Sub-catchment	Primary drainage		Secondary drainage	
	Oakley (west)	Meola (east)	Oakley (west)	Meola (east)
Existing				
1	*0m^2	3157m^2	*1410m^2	1747m^2
2	*324m^2	2926m^2	*1408m^2	1842m^2
3	*398m^2	4465m^2	*2066m^2	2797m^2
4	*390m^2	4783m^2	*2175m^2	2998m^2
5	4286m^2	3022m^2	4334m^2	2974m^2
6	0m^2	3799m^2	0m^2	3799m^2
Proposed				
1	*0m^2	3500m^2	*1827m^2	1673m^2
2	*5229m^2	0m^2	*3308m^2	1921m^2
3	*0m^2	7895m^2	*5001m^2	2894m^2
4	*8444m^2	0m^2	*5346m^2	3098m^2
5	8383m^2	0m^2	5234m^2	3149m^2
6	0m^2	3840m^2	0m^2	3840m^2
Change				
1	*0m^2	+343m^2	*+417m^2	-74m^2
2	*+4905m^2	-2926m^2	*+1900m^2	+79m^2
3	*-398m^2	+3430m^2	*+2935m^2	+97m^2
4	*+8054m^2	-4783m^2	*+3171m^2	+100m^2
5	+4097m^2	-3022m^2	+900m^2	+175m^2
6	0m^2	+41m^2	0m^2	+41m^2

* Within Wairaka Precinct Stormwater Management Plan (SMP) area.

Table 5 - Sub-catchment areas – road carriageway only

Sub-catchment	Primary drainage		Secondary drainage	
	Oakley (west)	Meola (east)	Oakley (west)	Meola (east)
Existing				
1	*0m^2	1951m^2	*1016m^2	935m^2
2	*341m^2	1882m^2	*1123m^2	1100m^2
3	*255m^2	3233m^2	*1831m^2	1657m^2
4	*262m^2	3393m^2	*1825m^2	1830m^2
5	2525m^2	2153m^2	2525m^2	2153m^2
6	0m^2	2753m^2	0m^2	2753m^2
Proposed				
1	*0m^2	1980m^2	*1245m^2	735m^2
2	*3390m^2	0m^2	*2446m^2	944m^2
3	*0m^2	5285m^2	*3690m^2	1595m^2
4	*5965m^2	0m^2	*4146m^2	1819m^2
5	5752m^2	0m^2	3562m^2	2190m^2
6	0m^2	2753m^2	0m^2	2753m^2
Change				
1	*0m^2	+29m^2	*+229m^2	-200m^2
2	*+3049m^2	-1882m^2	*+1323m^2	-156m^2
3	*-255m^2	+2052m^2	*+1859m^2	-62m^2
4	*+5703m^2	-3393m^2	*+2321m^2	-11m^2
5	+3277m^2	-2153m^2	+1037m^2	+37m^2
6	0m^2	0m^2	0m^2	+0m^2

* Within Wairaka Precinct Stormwater Management Plan (SMP) area.

3 Method of Assessment

3.1 Method - Construction Effects

A set of plans will be included as part of consent application package to demonstrate how GD2016/005 *"Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region"* compliant mitigation measures can be accommodated within the corridor for the works proposed. Application of GD05 to projects of this nature is an accepted method in the Auckland Region to avoid, remedy, or mitigate stormwater effects of works adequately and therefore no specific assessment of effects has been prepared.

3.2 Method - Operational Effects of Stormwater Discharge

The method for assessing each of the effects matters set out in Schedule 4 of the Regionwide Stormwater Network Discharge Consent (NDC) were assessed as summarised below.

- **Water quality.** Water quality effects were assessed for this project using two methods being:
    - A comparison of total impervious area treated for existing and proposed conditions against TP10/GD01 guidance (refer Section 4.2.1), and
    - A continuous simulation model using MUSIC software (refer Section 4.2.3).
- **Stream hydrology.** Stream hydrology effects of development in these catchments were assessed previously in the following studies. These were sufficient to draw conclusions on level of effect and mitigation.
    - Wairaka Precinct: Stormwater Management Plan (SMP) (May 2021)
    - Oakley Catchment Management Plan (June 2013)
    - Stormwater Management Areas – Flows (SMAF) layers (AUP:OP)
- **Flooding.** Flood risk and network capacity effects of development in these catchments were assessed previously in the following studies. For the most part, review of these studies was sufficient to draw conclusions on level of effect and mitigation:
    - Oakley Floodplain Re-mapping (July 2016)
    - Meola Catchment Modelling System Performance Assessment (December 2014).
    - Carrington Development Backbone Works – Civil Design Report (December 2022)

  In one location (Segar Avenue), additional analysis was undertaken due to the complexity of stormwater upgrades proposed. This comparative assessment of network capacity was undertaken to calculate the change in flood frequency from those works (refer Section 4.4).

3.3 Method - Works in Flood Hazard areas

These effects covered in the Segar Avenue assessment of pipe network capacity and review of overland flow ponding capacity (refer Section 5.3).

4 Assessment

- **Construction effects.** Application of GD05 to projects of this nature is an accepted method in the Auckland Region to avoid, remedy, or mitigate stormwater effects of works adequately and no further analysis has been prepared.

- **Operational effects of stormwater discharge.** Assessment against the requirements of Auckland Regional Stormwater Network Discharge Consent (NDC) Schedule 4 is set out in Section 4.1 to Section 4.5 below. The controlled activity resource consent matters under Chapter E9 of the AUP:OP are included where relevant.

- **Works in flood hazard area.** Analysis of flood hazard is effects is covered by the comparative assessment of network capacity presented

4.1 Catchments / Areas

Issue/receiving environment	Small projects – up to 1,000m² of new impervious area	Off-road pedestrian and cycling facilities and ferry terminal facilities. New impervious area greater than 1,000m²	Development of new/ redevelopment of impervious area for: existing high use roads [1] - that includes new impervious area greater than 1,000m² other roads that includes new impervious area greater than 5,000m² rail corridor projects with new impervious area greater than 1,000m²	Development/redevelopment of a high contaminant generating carpark [16] (new/redeveloped area greater than 1,000m² [2])
CATCHMENTS/AREAS				
Within area covered by adopted SMP (Schedule 10)	• Stormwater management or connection requirements in accordance with the SMP Note that where specifically addressed in a SMP these requirements supersede any performance requirements below.			
In other areas	• General performance requirements - No new/additional habitable floor affected by flooding in 1% AEP event and no increase in frequency of existing flooding - No significant increase in risk to the operation and structural integrity of other infrastructure in 1% AEP event - No increase in inundation that affects a building on a property in 10% AEP - No loss in overland flow path capacity, unless provided by other means. Where these requirements cannot be met, a SMP that includes supporting information to justify an alternative as the BPO for the given project is required.			

Figure 3 – Schedule 4 AT/NZTA/Railways transport projects Connection Requirements (Catchments/Areas)

The NDC requires the following performance requirements to be considered, depending on the location of works within the project:

- The adopted Wairaka Precinct Stormwater Management Plan (May 2021).
- The performance requirements set out in the NDC Schedule 4 table above.

Review of the adopted design criteria (refer Table 1 above) the design itself against both the Wairaka SMP and the general performance criteria above shows that the relevant requirements have all been adopted.

On this basis, per the Schedule 4 requirements, there is no requirement for an *"SMP* [Stormwater Management Plan] *that includes supporting information to justify an alternative as the BPO* [Best Practicable Option] *for the given project"* and the requirements in this part of the schedule are met.

4.2 Water quality

Issue/receiving environment	Small projects – up to 1,000m² of new impervious area	Off-road pedestrian and cycling facilities and ferry terminal facilities. New impervious area greater than 1,000m²	Development of new/ redevelopment of impervious area for: existing high use roads [15] – that includes new impervious area greater than 1,000m² other roads that includes new impervious area greater than 5,000m² rail corridor projects with new impervious area greater than 1,000m²	Development/redevelopment of a high contaminant generating carpark [16] (new/redeveloped area greater than 1,000m²)
WATER QUALITY (Note: these apply in addition to general performance requirements above) Where the existing road corridor is constrained off-setting within the same catchment may form part of the mitigation approach.				
All receiving environments	No requirements.	No requirements.	• Treatment of new road area and any existing road area directed to same point by a water quality device designed in accordance with GD01/ TP 10 for the relevant contaminants. Or • Treatment of equivalent area of high use road within same catchment by a water quality device designed in accordance with GD01/TP 10 for the relevant contaminants Or • An alternative level of mitigation determined through a SMP that: - applies an Integrated Stormwater Management Approach (as per above); - meets the NDC Objectives and Outcomes in Schedule 2; - is the BPO for the given project.	• Treatment of new/redeveloped area (or all carpark area where it is >50% of the site) by a water quality device designed in accordance with GD01/ TP 10 for the relevant contaminants. Or • Treatment of equivalent area within same catchment by a water quality device designed in accordance with GD01/TP 10 for the relevant contaminants Or • An alternative level of mitigation determined through a SMP that: - applies an Integrated Stormwater Management Approach (as per above); - meets the NDC Objectives and Outcomes in Schedule 2; - is the BPO for the given project.

Figure 4 - Schedule 4 AT/NZTA/Railways transport projects Connection Requirements (Water Quality)

The NDC requires treatment of runoff from new impervious areas in industry standard devices, and for treatment devices to be designed in accordance with GD01 guidelines. Similarly, Chapter E9 of the AUP:OP requires development of a new or redevelopment of an existing high use road of >5,000m^2 to treat stormwater runoff from impervious area (excluding cycle lanes, footpaths and ancillary areas)to be treated with stormwater management device(s) sized and designed in accordance with GD01.

Table 4 sets out a breakdown of the changes in area by sub-catchment. Table 6 sets out a review of each of the devices in the project against those standards to demonstrate that the requirements will be met.

The design guidelines (TP10 and GD01) referred to in the NDC provide sizing and detailing criteria for treatment devices, the key measurable objective being to achieve 75% Total Suspended Solids (TSS) reduction on a long term annual average basis. Further to the NDC, the adopted project design criteria seek to achieve treatment of all impervious area (that is, existing plus new) on Carrington Road (refer Table 4) to the 75% TSS reduction standard. This was assessed using eWater's Model for Urban Stormwater Improvement Conceptualisation (MUSIC) continuous simulation water quality modelling software. This assessment is described in Section 4.2.3 below.

4.2.1 Water quality assessment – area comparison

Table 6 - Treated carriageway areas

Sub-catchment	Oakley (west)		Meola (west)	
	Treated Catchment Area	Device (Size)	Treated Catchment Area	Device (Size)
Existing				
1	0m^2	-	0m^2	-
2	0m^2	-	0m^2	-
3	0m^2	-	0m^2	-
4	0m^2		0m^2	-
5	2342m^2	Unitec wetland (n/a)	0m^2	-
6	0m^2	-	0m^2	-
Proposed				
1	0m^2	-	1250m^2	Raingarden No. 1A-1D (107m^2)
2	2454m^2	Raingarden No. 2 (74m^2)	0m^2	-
3	0m^2	-	1710m^2 5290m^2	Raingarden No. 3 (56m^2) Raingarden No. 3 and Segar Avenue swale (n/a)
4	5965m^2	Unitec wetland (n/a)	0m^2	-
5	834m^2 5752m^2	Raingarden No. 5A-5B (47m^2) Raingarden No. 5A-5B and Unitec wetland (n/a)	0m^2	-
6	0m^2	-	0m^2	-
Change				
1	0m^2	-	+1250m^2	Raingarden No. 1A-1D (107m^2)
2	+2454m^2	Raingarden No. 2 (74m^2)	0m^2	-
3	0m^2		1710m^2 5290m^2	Raingarden No. 3 (56m^2) Raingarden No. 3 and Segar Avenue swale (n/a)
4	+5965m^2	Unitec wetland (n/a)	0m^2	-
5	+3410m^2	Raingarden No. 5A-5B (47m^2), Unitec wetland (n/a)	0m^2	-
6	0m^2	-	0m^2	-

In total, impervious carriageway area will increase from 18,748m^2 to 25,125m^2 (an increase of 6,377m^2). The impervious carriageway area treated will increase from 2,342m^2 to 20,711m^2 (an increase of 18,369m^2). Therefore, the proposed works will:

- Provide treatment for all new impervious areas.
- Provide an improvement in treatment compared to the existing situation.

The above conclusions are valid overall and for Meola and Oakley Creek catchments individually.

4.2.2 Water quality assessment – T10/GD01 compliance

Table 7 - Compliance of proposed treatment to TP10 / GD01

Device	Status	Catchment	TP10 / GD01 compliance	
Unitec Wetland	Existing	9306m^2	No	This device was designed and constructed in 1991, prior to the publication of TP10. It does meet many of the TP10 criteria, however, de-silting maintenance is significantly overdue, so performance is not currently compliant **
Segar Avenue Swale	Proposed	4990m^2	Yes	Designed to GD01 as part of this project.
Raingarden No. 1A-1D	Proposed	1250m^2	Yes	Designed to GD01 as part of this project.
Raingarden No. 2	Proposed	2454m^2	Yes	Designed to GD01 as part of this project.
Raingarden No. 3	Proposed	1450m^2	Yes	Designed to GD01 as part of this project.
Raingarden No. 5A-5B	Proposed	4610m^2	Yes	Designed to GD01 as part of this project.

* Carrington Development Backbone Works – Civil Design Report (December 2022)

** Unitec Stormwater Treatment Pond Study (October 2022).

4.2.3 Water quality assessment – MUSIC modelling

eWater's Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software tool has been used to assess the performance of the stormwater treatment devices listed in Table 7 above. The model takes meteorological data, soil characteristics, catchment sizes, ground perviousness, contaminant concentrations, and specific treatment device parameters as inputs.

The MUSIC treatment model for the pre-development scenario (where there is minimal treatment provided for the road corridor) includes only one treatment device, the Unitec wetland. The inputs entered into the MUSIC model align with the existing physical condition of the wetland, which is currently treating 40.5 hectares of the surrounding urban catchment and the current treatment volume reflecting accumulated sediment

The proposed treatment model includes:

- Proposed raingardens.

- The proposed Segar Avenue treatment swale, and
- Adjusted Unitec wetland inputs aligned with proposed forebay and pond upgrades detailed in the Unitec Stormwater Treatment Pond Study (2022). This includes an increase of catchment area from 40.5 hectares to 41.5 hectares and an increase in treatment volume to reflect planned de-silting works.

The raingardens proposed along the upgraded Carrington carriageway were calibrated in the MUSIC model by comparing to GD01 treatment standards. The MUSIC inputs show that a raingarden sized at 2% of its upstream catchment following GD01 guidelines provides 83% annual mean TSS removal. The swale located within the northern berm on Segar Avenue has been designed in accordance with GD01 and Auckland Transport's Swale Design Guidelines, with the relevant inputs entered into the MUSIC model.

The results of the MUSIC model indicate:

- The total TSS load generated from the modelled catchment areas is approximately 70,000 kg / year in the pre-development case. This is made up of 3,700 kg / year from the project area and 66,300 kg / year from the wider catchment area that passes through the Unitec wetland. In the existing situation, 69.6% TSS removal is achieved overall, all of that in the Oakley Catchment through the wetland resulting in a total of approximately 21,300 kg / year of TSS released.

- The total TSS load generated from the modelled area catchment areas is increased slightly to approximately 72,500 kg / year in the post-development case. With all the additional treatment devices added, the model indicates that the TSS removal overall will increase to 75% with a reduction in total TSS released to 18,100 kg / year.

It should be noted that MUSIC modelling is intended for comparative purposes only and that absolute values of contaminants are very high-level indications only.

4.3 Stream hydrology

Issue/receiving environment	Small projects – up to 1,000m² of new impervious area	Off-road pedestrian and cycling facilities and ferry terminal facilities. New impervious area greater than 1,000m²	Development of new/redevelopment of impervious area for: existing high use roads [17] - that includes new impervious area greater than 1,000m² other roads that includes new impervious area greater than 5,000m² rail corridor projects with new impervious area greater than 1,000m²	Development/redevelopment of a high contaminant generating carpark [18] (new/redeveloped area greater than 1,000m²)
WATER QUALITY (continued)				
All receiving environments	No requirements.	No requirements.	Or • Treatment of equivalent area of high use road within same catchment by a water quality device designed in accordance with GD01/TP 10 for the relevant contaminants Or • An alternative level of mitigation determined through a SMP that: - applies an Integrated Stormwater Management Approach (as per above); - meets the NDC Objectives and Outcomes in Schedule 2; - is the BPO for the given project.	Or • Treatment of equivalent area within same catchment by a water quality device designed in accordance with GD01/TP 10 for the relevant contaminants Or • An alternative level of mitigation determined through a SMP that: - applies an Integrated Stormwater Management Approach (as per above); - meets the NDC Objectives and Outcomes in Schedule 2; - is the BPO for the given project.
STREAM HYDROLOGY	Where the existing road corridor is constrained off-setting within the same catchment may form a part of the mitigation approach.			
With a SMA	No additional requirements to those of AUP and general requirements above.			
Where discharge is to a stream via public stormwater network outside of SMAF	No additional requirements to those of AUP and general requirements above.			

[17] See AUP definition: A road, motorway or state highway that carries more than 5000 vehicles per day, excluding cycle lanes, footpaths and ancillary areas that do not receive stormwater runoff from the road carriageway.
[18] See AUP Definition: Carpark that is exposed to rainfall and is designed for a total of more than 30 vehicles.

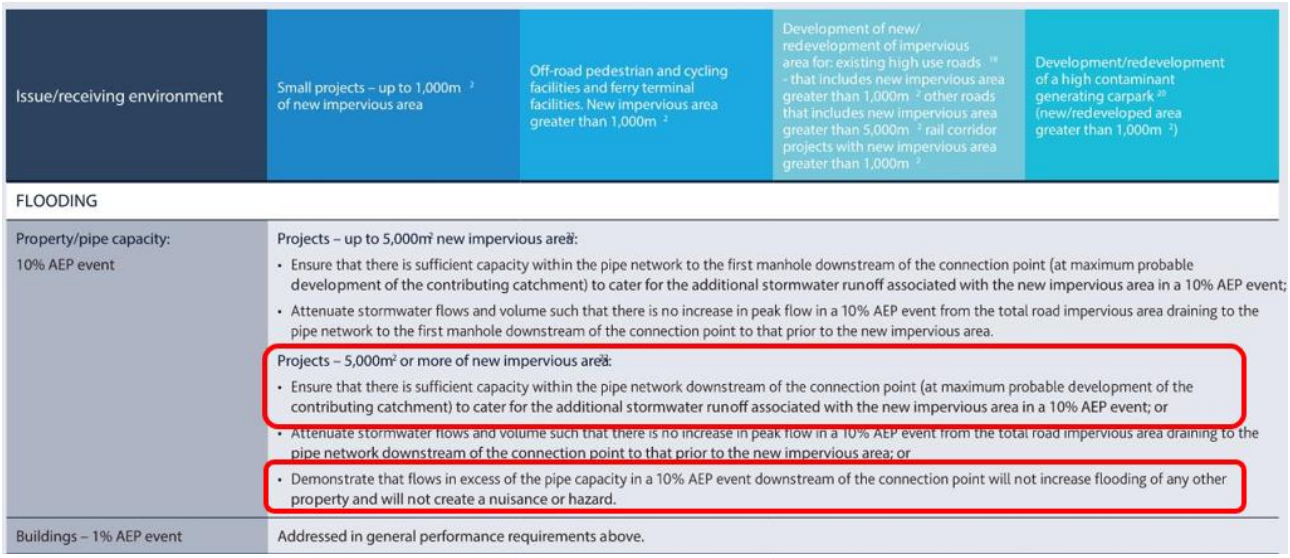
Figure 5 - Schedule 4 AT/NZTA/Railways transport projects Connection Requirements (Water Quality)

Detailed in Chapter E10 of the Auckland Unitary Plan, Stormwater Management Areas – Flows (SMAFs) are mapped areas that drain to streams which have been identified as being particularly sensitive to changes in stormwater flows, have high natural values, and are at potential risk from an increase in impervious area associated with future development. SMAF 1 areas generally have low levels of existing development with streams that have high natural values and are sensitive to increased stormwater flows, while SMAF 2 areas typically have greater levels of existing development and streams that have moderate to high natural values and sensitivity to increases in stormwater flows.

Te Auaunga Oakley Creek, including the Wairaka Precinct, has not been identified as a SMAF area within the Unitary Plan and E10 rules do not apply, as outlined in the Wairaka SMP. The use of hydrological mitigation is deemed to not be required within the Wairaka Precinct and lower Oakley Catchment due to the low risk of erosion at the downstream outfall within Te Auaunga Oakley Creek's reach. Prompt discharge of stormwater to avoid coinciding flow from the Precinct with peak flows in the main channel will provide a better outcome for managing erosion in Te Auaunga Oakley Creek.

The lower reaches of the Meola catchment, including the downstream receiving environment of eastward runoff from Carrington Road, have not been identified as a SMAF area within the Unitary Plan. Hence, E10 rules do not apply.

4.4 Flooding



Issue/receiving environment	Small projects – up to 1,000m² of new impervious area	Off-road pedestrian and cycling facilities and ferry terminal facilities. New impervious area greater than 1,000m²	Development of new/ redevelopment of impervious area for: existing high use roads[19] - that includes new impervious area greater than 1,000m² other roads that includes new impervious area greater than 5,000m² rail corridor projects with new impervious area greater than 1,000m²	Development/redevelopment of a high contaminant generating carpark[20] (new/redeveloped area greater than 1,000m²)
FLOODING				
Property/pipe capacity: 10% AEP event	Projects – up to 5,000m² new impervious area[21]: • Ensure that there is sufficient capacity within the pipe network to the first manhole downstream of the connection point (at maximum probable development of the contributing catchment) to cater for the additional stormwater runoff associated with the new impervious area in a 10% AEP event; • Attenuate stormwater flows and volume such that there is no increase in peak flow in a 10% AEP event from the total road impervious area draining to the pipe network to the first manhole downstream of the connection point to that prior to the new impervious area. Projects – 5,000m² or more of new impervious area[21]: • Ensure that there is sufficient capacity within the pipe network downstream of the connection point (at maximum probable development of the contributing catchment) to cater for the additional stormwater runoff associated with the new impervious area in a 10% AEP event; or • Attenuate stormwater flows and volume such that there is no increase in peak flow in a 10% AEP event from the total road impervious area draining to the pipe network downstream of the connection point to that prior to the new impervious area; or • Demonstrate that flows in excess of the pipe capacity in a 10% AEP event downstream of the connection point will not increase flooding of any other property and will not create a nuisance or hazard.			
Buildings – 1% AEP event	Addressed in general performance requirements above.			

Figure 6 - Schedule 4 AT/NZTA/Railways transport projects Connection Requirements (Flooding)

The flooding assessment focussed only on the sub-catchments where additional runoff is directed, as shown in Table 8.

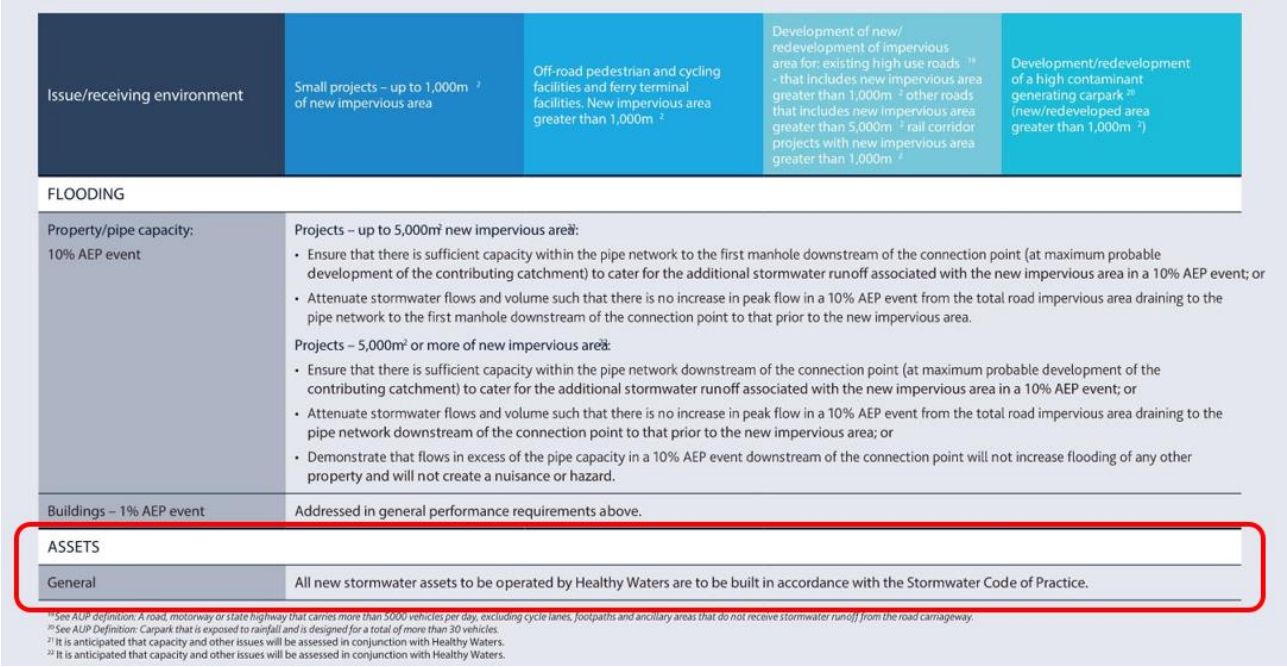
Table 8 - Change in carriageway catchment areas between pre- and post-development

Sub-catchment	Primary drainage		Secondary drainage	
	Oakley (west)	Meola (east)	Oakley (west)	Meola (east)
Change				
1	*0m²	+615m²	*+615m²	0m²
2	*+4932m²	-3427m²	*+1505m²	0m²
3	*-470m²	+2632m²	*+2162m²	0m²
4	*+8235m²	-6232m²	*+2003m²	0m²
5	+3335m²	-3282m²	+53m²	0m²
6	0m²	0m²	0m²	0m²
Assessment method applied				
	Increased runoff from these catchments (for both primary and secondary drainage) was assessed in the design of infrastructure recently built in the Wairaka Precinct and the infrastructure was designed and built to accommodate it. This is covered in the Carrington Development Backbone Works – Civil Design Report (Beca, December 2022). The exact increased flow will be re-assessed for the detailed design to confirm. This is particularly relevant for catchment 5 where there is a split in discharge location between Woodward Road and directly into the new Backbone infrastructure.			
	Increased runoff from these catchments was assessed against the published flood models and network capacity assessments for Meola and Oakley Creek. It was inferred from that review that the existing networks (primary and secondary) have sufficient capacity for the proposed increases.			

Sub-catchment	Primary drainage	Secondary drainage
	A specific catchment analysis and hydraulic grade line assessment comparing pre and post development conditions has been carried out for Segar Avenue. A description of this analysis in included in Appendix B.	

4.5 Assets

All new assets proposed as part of the works have been designed and will be built in accordance with the Stormwater code of practice.



Issue/receiving environment	Small projects – up to 1,000m² of new impervious area	Off-road pedestrian and cycling facilities and ferry terminal facilities. New impervious area greater than 1,000m²	Development of new/ redevelopment of impervious area for: existing high use roads [19] - that includes new impervious area greater than 1,000m² other roads that includes new impervious area greater than 5,000m² rail corridor projects with new impervious area greater than 1,000m²	Development/redevelopment of a high contaminant generating carpark [20] (new/redeveloped area greater than 1,000m²)
FLOODING				
Property/pipe capacity: 10% AEP event	Projects – up to 5,000m² new impervious area[21]: • Ensure that there is sufficient capacity within the pipe network to the first manhole downstream of the connection point (at maximum probable development of the contributing catchment) to cater for the additional stormwater runoff associated with the new impervious area in a 10% AEP event; or • Attenuate stormwater flows and volume such that there is no increase in peak flow in a 10% AEP event from the total road impervious area draining to the pipe network to the first manhole downstream of the connection point to that prior to the new impervious area. Projects – 5,000m² or more of new impervious area[22]: • Ensure that there is sufficient capacity within the pipe network downstream of the connection point (at maximum probable development of the contributing catchment) to cater for the additional stormwater runoff associated with the new impervious area in a 10% AEP event; or • Attenuate stormwater flows and volume such that there is no increase in peak flow in a 10% AEP event from the total road impervious area draining to the pipe network downstream of the connection point to that prior to the new impervious area; or • Demonstrate that flows in excess of the pipe capacity in a 10% AEP event downstream of the connection point will not increase flooding of any other property and will not create a nuisance or hazard.			
Buildings – 1% AEP event	Addressed in general performance requirements above.			
ASSETS				
General	All new stormwater assets to be operated by Healthy Waters are to be built in accordance with the Stormwater Code of Practice.			

[19] See AUP definition: A road, motorway or state highway that carries more than 5000 vehicles per day, excluding cycle lanes, footpaths and ancillary areas that do not receive stormwater runoff from the road carriageway.
[20] See AUP Definition: Carpark that is exposed to rainfall and is designed for a total of more than 30 vehicles.
[21] It is anticipated that capacity and other issues will be assessed in conjunction with Healthy Waters.
[22] It is anticipated that capacity and other issues will be assessed in conjunction with Healthy Waters.

Figure 7 - Schedule 4 AT/NZTA/Railways transport projects Connection Requirements (Assets)

5 Conclusion and recommendations

5.1 Construction Effects

Construction will have a **minor effect** on stormwater discharge and meet permitted activity standards assuming that GD2016/005 *"Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region*" compliant mitigation measures are applied through construction management plans.

5.2 Operational Effects of Stormwater Discharge

The proposed works meet the standards set out in Schedule 4 of the Regionwide Stormwater Network Discharge Consent (NDC). Effects were assessed as summarised below.

- Water quality effects will be **positive** (due to the very low water quality treatment offered now) and will be managed line with NDC standards.
- Stream hydrology effects are managed in line with NDC standards and will be **minor.**
- Flood risk effects are managed in line with NDC and other relevant standards and will be **less than minor** in most sub-catchments a **positive** at one location on Segar Avenue where flood risk to residential properties will be reduced.

5.3 Effect of Works in Flood Hazard Areas

The proposed works within Segar Avenue, where flood hazards are predicted, will increase flood conveyance capacity and / or storage capacity and therefore will have a small **positive** impact.

5.4 Recommended mitigation

It is recommended that consent conditions be imposed as following:

1. Typical erosion and sediment control planning conditions aligned with construction methods and staging and GD2016/005 *"Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region*".
2. A requirement to de-sludge and upgrade the Unitec Treatment Pond prior to AT diverting stormwater runoff from Carrington Road into the Wetland.
3. Requirements for long term inspections and maintenance of new treatment devices (raingardens and Segar Avenue treatment swale).

A

Appendix A – Carrington Road MUSIC modelling

Memorandum

To:	Hamish McLean	**Date:**	14 February 2025
From:	Finn Palmer	**Our Ref:**	3230635
Copy:	Dale Paice	**:**	
Subject:	Carrington Road - Stormwater Treatment Modelling Results (MUSIC Software)		

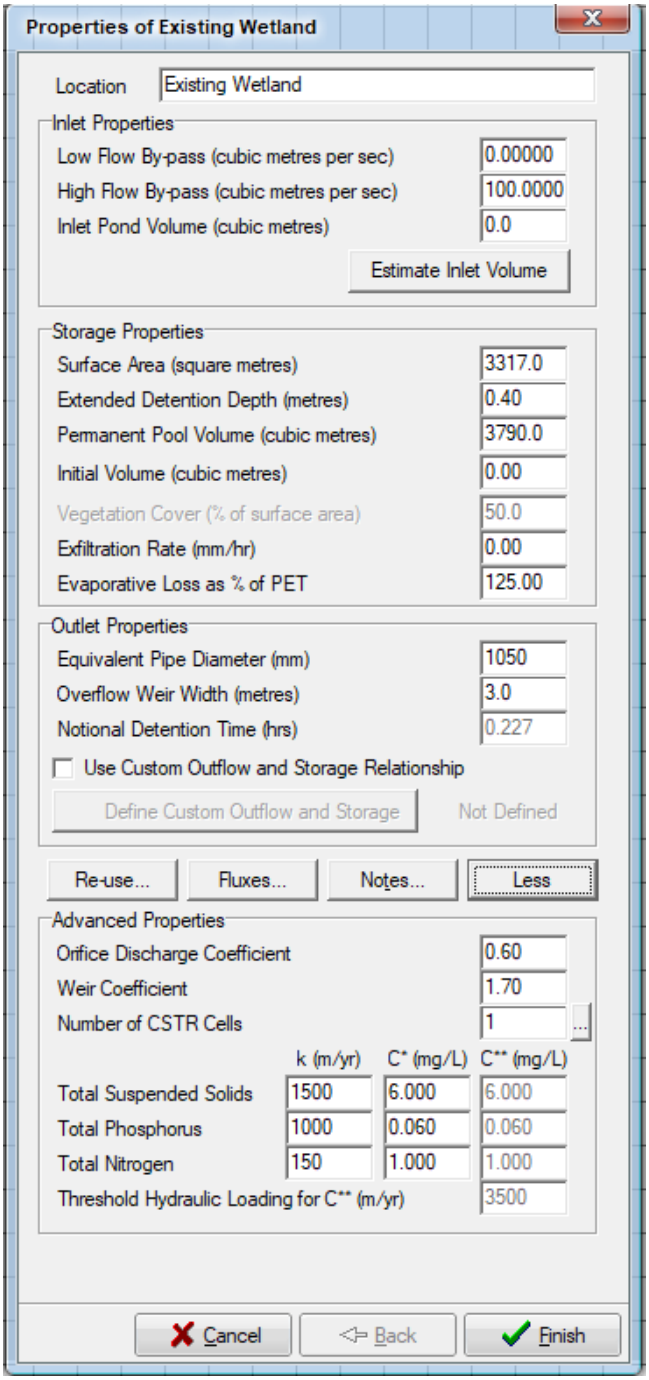
1.1 Pre Development

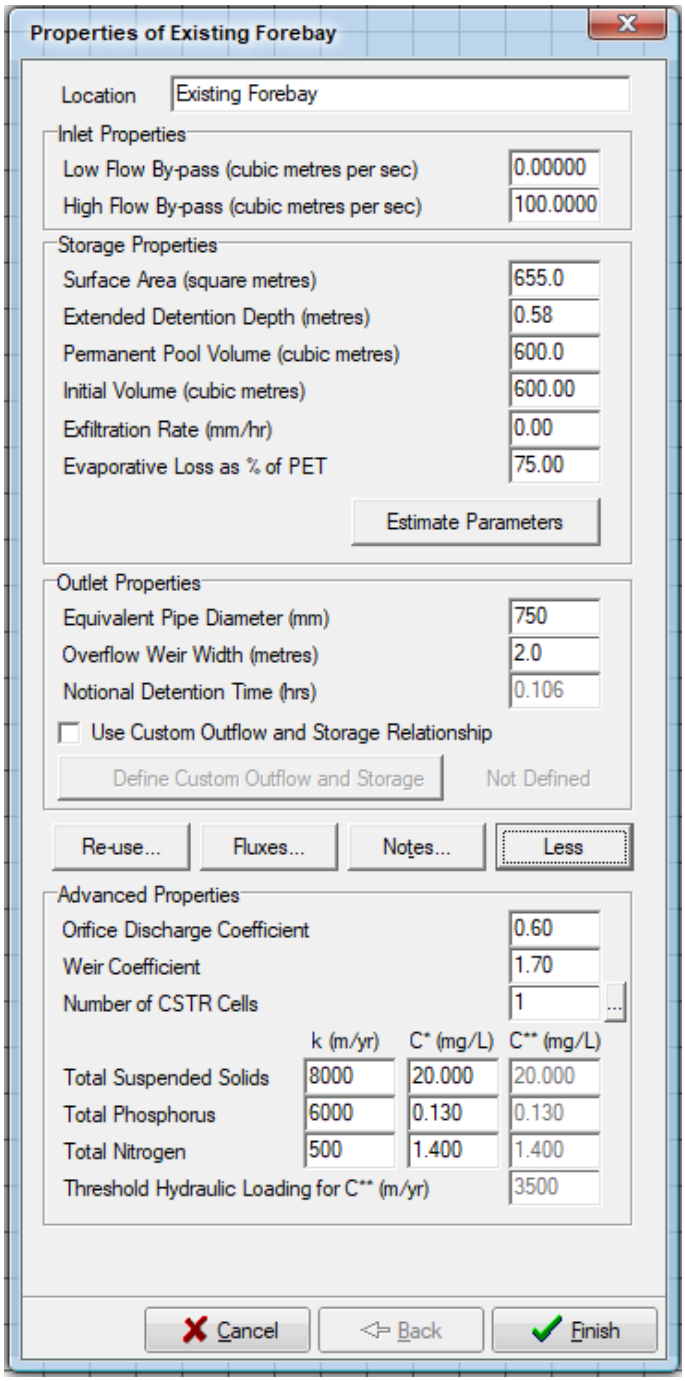
Typical values for Catchments, Wetland and Forebay

Propertries for UrbanSource Nodes

Property	Wetland Catchment	Catchment 1
General		
Location	Mixed Catchment	Catchment 1
Notes		
Fluxes - Daily		
Fluxes - Sub-Daily		
Flux unit	mm	mm
Areas		
Total Area (ha)	41.500	0.195
Impervious (%)	70	95
Pervious (%)	30	5
Rainfall-Runoff - Impervious Area		
Rainfall Threshold (mm/day)	1.00	1.00
Rainfall-Runoff - Pervious Area		
Soil Storage Capacity (mm)	90	90
Initial Storage (% of Capacity)	25	55
Field Capacity (mm)	80	45
Infiltration Capacity Coefficient - a	200.00	200.00
Infiltration Capacity Exponent - b	1.00	1.00
Rainfall-Runoff - Groundwater Properties		
Initial Depth (mm)	10	10
Daily Recharge Rate (%)	25	25
Daily Baseflow Rate (%)	5	5
Daily Deep Seepage Rate (%)	0	0
Total Suspended Solids - Base Flow Concentration		
Mean (log mg/L)	1.100	1.200
Std Dev (log mg/L)	0.170	0.170
Estimation Method	Stochastically generated	Stochastically generated
Serial Correlation (R squared)	0.00	0.00
Total Suspended Solids - Storm Flow Concentration		
Mean (log mg/L)	2.200	2.200
Std Dev (log mg/L)	0.320	0.320
Estimation Method	Stochastically generated	Stochastically generated
Serial Correlation (R squared)	0.00	0.00
Total Phosphorus - Base Flow Concentration		
Mean (log mg/L)	-0.820	-0.850
Std Dev (log mg/L)	0.190	0.190
Estimation Method	Stochastically generated	Stochastically generated
Serial Correlation (R squared)	0.00	0.00
Total Phosphorus - Storm Flow Concentration		
Mean (log mg/L)	-0.450	-0.300
Std Dev (log mg/L)	0.250	0.250
Estimation Method	Stochastically generated	Stochastically generated
Serial Correlation (R squared)	0.00	0.00
Total Nitrogen - Base Flow Concentration		
Mean (log mg/L)	0.320	0.110
Std Dev (log mg/L)	0.120	0.120
Estimation Method	Stochastically generated	Stochastically generated
Serial Correlation (R squared)	0.00	0.00
Total Nitrogen - Storm Flow Concentration		
Mean (log mg/L)	0.420	0.340
Std Dev (log mg/L)	0.190	0.190
Estimation Method	Stochastically generated	Stochastically generated
Serial Correlation (R squared)	0.00	0.00
Import Flow Properties		
Import Flow Enabled	☐	☐
Import Flow File		
Header lines	0	0
Baseflow Column	0	0
Impervious Stormflow Column	0	0
Pervious Stormflow Column	0	0
Unit	m3/s	m3/s
Catchment Area for GP (ha)	1.00	1.00

Cancel | Contract All Groups


Properties of Existing Wetland
Location
Existing Wetland
Inlet Properties
Low Flow By-pass (cubic metres per sec)
0.00000
High Flow By-pass (cubic metres per sec)
100.0000
Inlet Pond Volume (cubic metres)
0.0
Estimate Inlet Volume
Storage Properties
Surface Area (square metres)
3317.0
Extended Detention Depth (metres)
0.40
Permanent Pool Volume (cubic metres)
3790.0
Initial Volume (cubic metres)
0.00
Vegetation Cover (% of surface area)
50.0
Exfiltration Rate (mm/hr)
0.00
Evaporative Loss as % of PET
125.00
Outlet Properties
Equivalent Pipe Diameter (mm)
1050
Overflow Weir Width (metres)
3.0
Notional Detention Time (hrs)
0.227
Use Custom Outflow and Storage Relationship
Define Custom Outflow and Storage
Not Defined
Re-use...
Fluxes...
Notes...
Less
Advanced Properties
Orifice Discharge Coefficient
0.60
Weir Coefficient
1.70
Number of CSTR Cells
1
k (m/yr)
C* (mg/L)
C** (mg/L)
Total Suspended Solids
1500
6.000
6.000
Total Phosphorus
1000
0.060
0.060
Total Nitrogen
150
1.000
1.000
Threshold Hydraulic Loading for C** (m/yr)
3500
Cancel
Back
Finish


Properties of Existing Forebay
Location
Existing Forebay
Inlet Properties
Low Flow By-pass (cubic metres per sec)
0.00000
High Flow By-pass (cubic metres per sec)
100.0000
Storage Properties
Surface Area (square metres)
655.0
Extended Detention Depth (metres)
0.58
Permanent Pool Volume (cubic metres)
600.0
Initial Volume (cubic metres)
600.00
Exfiltration Rate (mm/hr)
0.00
Evaporative Loss as % of PET
75.00
Estimate Parameters
Outlet Properties
Equivalent Pipe Diameter (mm)
750
Overflow Weir Width (metres)
2.0
Notional Detention Time (hrs)
0.106
Use Custom Outflow and Storage Relationship
Define Custom Outflow and Storage
Not Defined
Re-use...
Fluxes...
Notes...
Less
Advanced Properties
Orifice Discharge Coefficient
0.60
Weir Coefficient
1.70
Number of CSTR Cells
1
k (m/yr)
C* (mg/L)
C** (mg/L)
Total Suspended Solids
8000
20.000
20.000
Total Phosphorus
6000
0.130
0.130
Total Nitrogen
500
1.400
1.400
Threshold Hydraulic Loading for C** (m/yr)
3500
Cancel
Back
Finish

Treatment Results

Mean Annual Loads - Existing Forebay

	Inflow	Outflow	% Reduction
Flow (ML/yr)	345	344	0.1
Total Suspended Solids (kg/yr)	67.7E3	36.7E3	45.8
Total Phosphorus (kg/yr)	142	97.0	31.6
Total Nitrogen (kg/yr)	986	884	10.3
Gross Pollutants (kg/yr)	11.0E3	0.00	100.0

Mean Annual Loads - Existing Wetland

	Inflow	Outflow	% Reduction
Flow (ML/yr)	344	340	1.3
Total Suspended Solids (kg/yr)	36.7E3	17.4E3	52.6
Total Phosphorus (kg/yr)	97.0	57.0	41.2
Total Nitrogen (kg/yr)	884	688	22.2
Gross Pollutants (kg/yr)	0.00	0.00	0.0

Treatment Train Effectiveness - Oakley

	Sources	Residual Load	% Reduction
Flow (ML/yr)	348	343	1.4
Total Suspended Solids (kg/yr)	68500	18300	73.3
Total Phosphorus (kg/yr)	140	57.3	59.2
Total Nitrogen (kg/yr)	1000	697	30.2
Gross Pollutants (kg/yr)	11100	113	99

Treatment Train Effectiveness - Meola

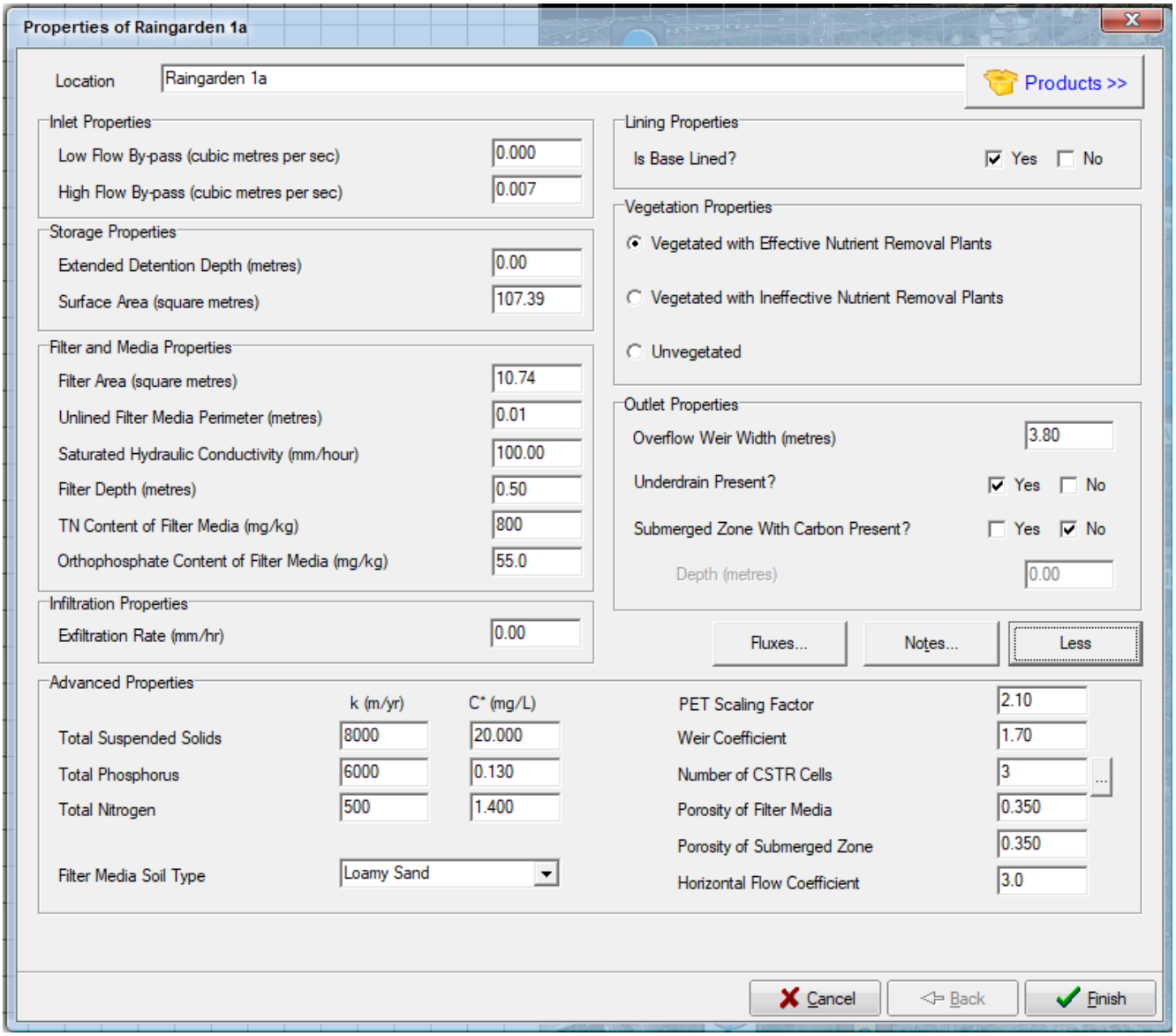
	Sources	Residual Load	% Reduction
Flow (ML/yr)	12.5	12.5	0
Total Suspended Solids (kg/yr)	2520	2520	0
Total Phosphorus (kg/yr)	7.31	7.31	0
Total Nitrogen (kg/yr)	29.7	29.7	0
Gross Pollutants (kg/yr)	404	404	0

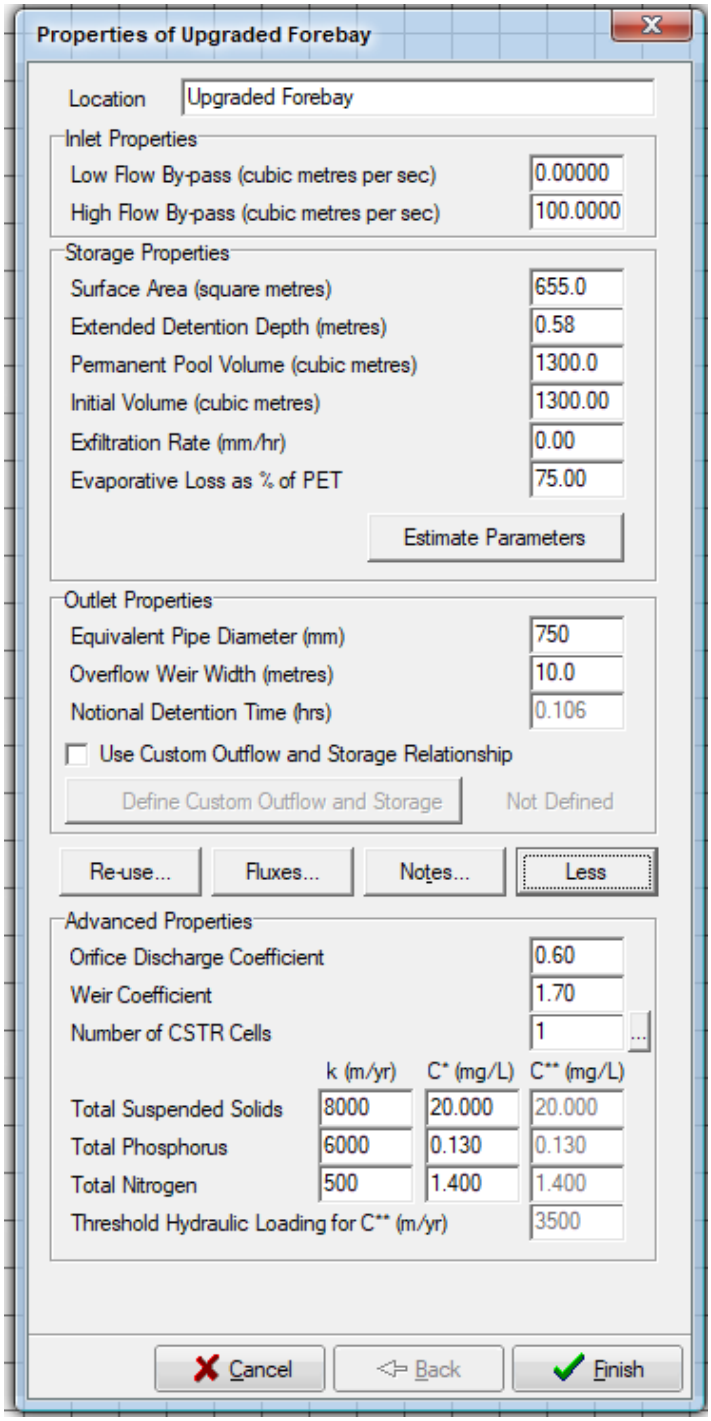
Treatment Train Effectiveness - Waitemata

	Sources	Residual Load	% Reduction
Flow (ML/yr)	361	356	1.4
Total Suspended Solids (kg/yr)	71000	20800	70.7
Total Phosphorus (kg/yr)	148	64.6	56.2
Total Nitrogen (kg/yr)	1030	727	29.4
Gross Pollutants (kg/yr)	11500	517	95.5

1.2 Post Development

Typical values for Catchments, De-silted Wetland, Forebay, Raingardens and Swale




Properties of Upgraded Forebay
Location
Upgraded Forebay
Inlet Properties
Low Flow By-pass (cubic metres per sec)
0.00000
High Flow By-pass (cubic metres per sec)
100.0000
Storage Properties
Surface Area (square metres)
655.0
Extended Detention Depth (metres)
0.58
Permanent Pool Volume (cubic metres)
1300.0
Initial Volume (cubic metres)
1300.00
Exfiltration Rate (mm/hr)
0.00
Evaporative Loss as % of PET
75.00
Estimate Parameters
Outlet Properties
Equivalent Pipe Diameter (mm)
750
Overflow Weir Width (metres)
10.0
Notional Detention Time (hrs)
0.106
Use Custom Outflow and Storage Relationship
Define Custom Outflow and Storage
Not Defined
Re-use...
Fluxes...
Notes...
Less
Advanced Properties
Orifice Discharge Coefficient
0.60
Weir Coefficient
1.70
Number of CSTR Cells
1
k (m/yr)
C* (mg/L)
C** (mg/L)
Total Suspended Solids
8000
20.000
20.000
Total Phosphorus
6000
0.130
0.130
Total Nitrogen
500
1.400
1.400
Threshold Hydraulic Loading for C** (m/yr)
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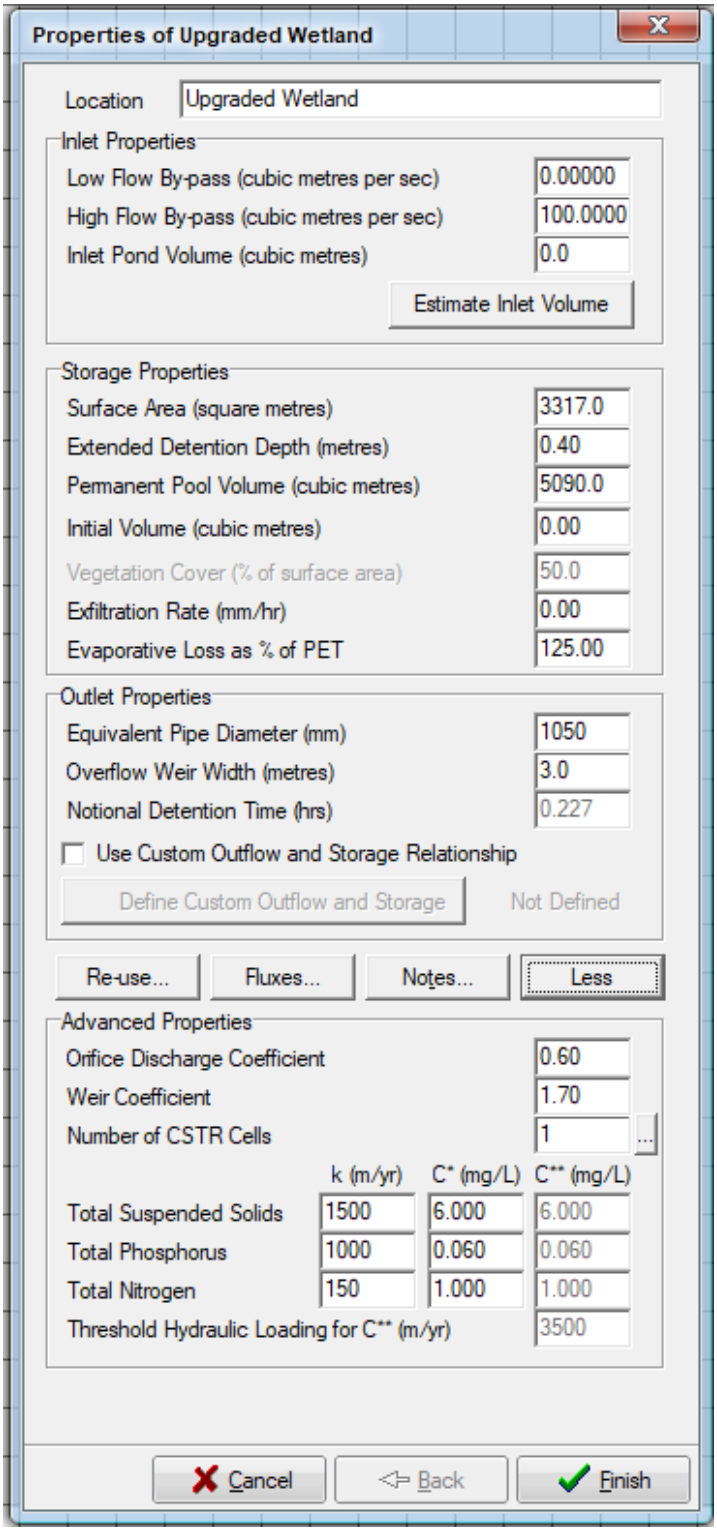
Back
Finish


Properties of Upgraded Wetland
Location
Upgraded Wetland
Inlet Properties
Low Flow By-pass (cubic metres per sec)
0.00000
High Flow By-pass (cubic metres per sec)
100.0000
Inlet Pond Volume (cubic metres)
0.0
Estimate Inlet Volume
Storage Properties
Surface Area (square metres)
3317.0
Extended Detention Depth (metres)
0.40
Permanent Pool Volume (cubic metres)
5090.0
Initial Volume (cubic metres)
0.00
Vegetation Cover (% of surface area)
50.0
Exfiltration Rate (mm/hr)
0.00
Evaporative Loss as % of PET
125.00
Outlet Properties
Equivalent Pipe Diameter (mm)
1050
Overflow Weir Width (metres)
3.0
Notional Detention Time (hrs)
0.227
Use Custom Outflow and Storage Relationship
Define Custom Outflow and Storage
Not Defined
Re-use...
Fluxes...
Notes...
Less
Advanced Properties
Orifice Discharge Coefficient
0.60
Weir Coefficient
1.70
Number of CSTR Cells
1
k (m/yr)
C* (mg/L)
C** (mg/L)
Total Suspended Solids
1500
6.000
6.000
Total Phosphorus
1000
0.060
0.060
Total Nitrogen
150
1.000
1.000
Threshold Hydraulic Loading for C** (m/yr)
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Cancel
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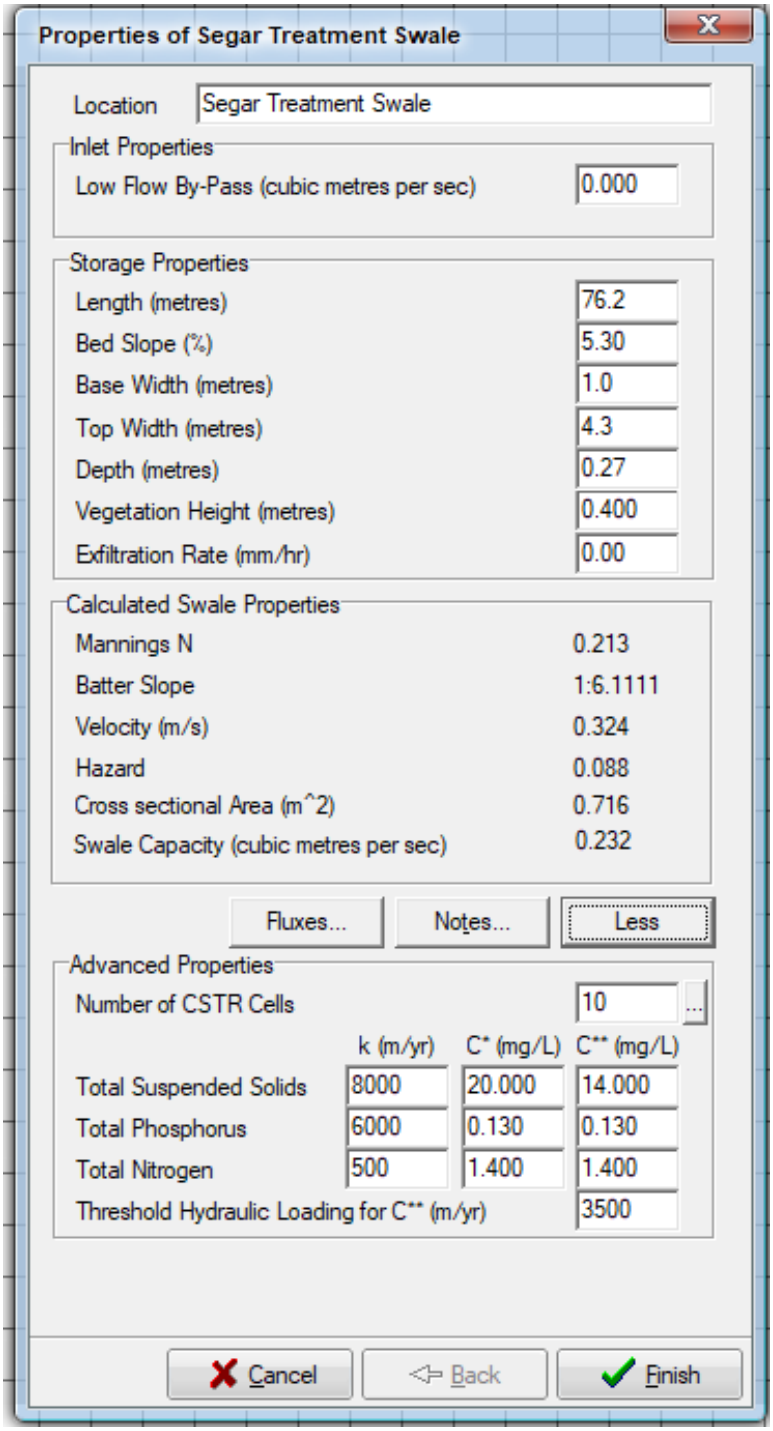
Finish


Properties of Segar Treatment Swale
Location
Segar Treatment Swale
Inlet Properties
Low Flow By-Pass (cubic metres per sec)
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Storage Properties
Length (metres)
76.2
Bed Slope (%)
5.30
Base Width (metres)
1.0
Top Width (metres)
4.3
Depth (metres)
0.27
Vegetation Height (metres)
0.400
Exfiltration Rate (mm/hr)
0.00
Calculated Swale Properties
Mannings N
0.213
Batter Slope
1:6.1111
Velocity (m/s)
0.324
Hazard
0.088
Cross sectional Area (m^2)
0.716
Swale Capacity (cubic metres per sec)
0.232
Fluxes...
Notes...
Less
Advanced Properties
Number of CSTR Cells
10
k (m/yr)
C* (mg/L)
C** (mg/L)
Total Suspended Solids
8000
20.000
14.000
Total Phosphorus
6000
0.130
0.130
Total Nitrogen
500
1.400
1.400
Threshold Hydraulic Loading for C** (m/yr)
3500
Cancel
Back
Finish

Treatment Results

Mean Annual Loads - Raingarden 1a

	Inflow	Outflow	% Reduction
Flow (ML/yr)	1.20	1.18	1.7
Total Suspended Solids (kg/yr)	245	21.4	91.3
Total Phosphorus (kg/yr)	0.696	0.168	75.9
Total Nitrogen (kg/yr)	2.84	1.55	45.6
Gross Pollutants (kg/yr)	38.6	0.618	98.4

Mean Annual Loads - Segar Treatment Swale

	Inflow	Outflow	% Reduction
Flow (ML/yr)	5.06	5.06	0.0
Total Suspended Solids (kg/yr)	735	83.9	88.6
Total Phosphorus (kg/yr)	2.26	0.706	68.8
Total Nitrogen (kg/yr)	10.9	8.98	17.8
Gross Pollutants (kg/yr)	112	0.00	100.0

Mean Annual Loads - Upgraded Forebay

	Inflow	Outflow	% Reduction
Flow (ML/yr)	354	353	0.1
Total Suspended Solids (kg/yr)	69.2E3	36.2E3	47.7
Total Phosphorus (kg/yr)	145	96.4	33.6
Total Nitrogen (kg/yr)	997	875	12.3
Gross Pollutants (kg/yr)	11.2E3	0.00	100.0

Mean Annual Loads - Upgraded Wetland

	Inflow	Outflow	% Reduction
Flow (ML/yr)	353	349	1.3
Total Suspended Solids (kg/yr)	36.2E3	16.6E3	54.3
Total Phosphorus (kg/yr)	96.4	54.6	43.4
Total Nitrogen (kg/yr)	875	673	23.0
Gross Pollutants (kg/yr)	0.00	0.00	0.0

Treatment Train Effectiveness - Oakley

	Sources	Residual Load	% Reduction
Flow (ML/yr)	357	352	1.4
Total Suspended Solids (kg/yr)	70000	16800	76
Total Phosphorus (kg/yr)	147	55.5	62.3
Total Nitrogen (kg/yr)	1010	679	32.5
Gross Pollutants (kg/yr)	11400	30.7	99.7

Treatment Train Effectiveness - Meola

	Sources	Residual Load	% Reduction
Flow (ML/yr)	10.1	10	0.3
Total Suspended Solids (kg/yr)	2040	879	56.9
Total Phosphorus (kg/yr)	5.86	3.08	47.5
Total Nitrogen (kg/yr)	24	19.6	18.3
Gross Pollutants (kg/yr)	325	124	62

Treatment Train Effectiveness - Waitemata (Combined)

	Sources	Residual Load	% Reduction
Flow (ML/yr)	367	362	1.4
Total Suspended Solids (kg/yr)	72100	17700	75.4
Total Phosphorus (kg/yr)	153	58.5	61.8
Total Nitrogen (kg/yr)	1030	699	32.1
Gross Pollutants (kg/yr)	11700	154	98.7

Memorandum

Finn Palmer

Civil Engineer

Phone Number:

Email: Finn.Palmer@beca.com

B

Appendix B – Segar Avenue Network Assessment

Memorandum

To:	Dale Paice	**Date:**	14 February 2025
From:	Hamish McLean	**Our Ref:**	3230635-776096487-8640
Copy:	Finn Palmer	**:**	
Subject:	Segar Avenue Hydraulic Grade Line Analysis		

1.1 Purpose

The purpose of this memorandum is to document the initial hydraulic analyses done to support the preliminary design of conveyance improvements proposed for Segar Avenue. The intention of this analysis was to demonstrate the benefit of the works in terms of reduced flood risk.

The proposed work diverts flow from a small (up to 375mm diameter) pipeline that passes through low lying floodprone properties towards the nearby large (up to 750mm diameter) pipeline that has spare capacity in events up to the 10%AEP event. The hydraulic grade lines produced are for peak 10%AEP flows.

It is recommended that this assessment is reviewed on completion of detailed design and when existing pipe sizes and invert level are confirmed by survey.

1.2 Catchments

Pre Development

Table 1: Pre Development Catchment Sizes

Catchment	Impervious (m^2)	Pervious (m^2)
Smaller Stormwater Line	37500	6800
Larger Stormwater Line	22100	18200

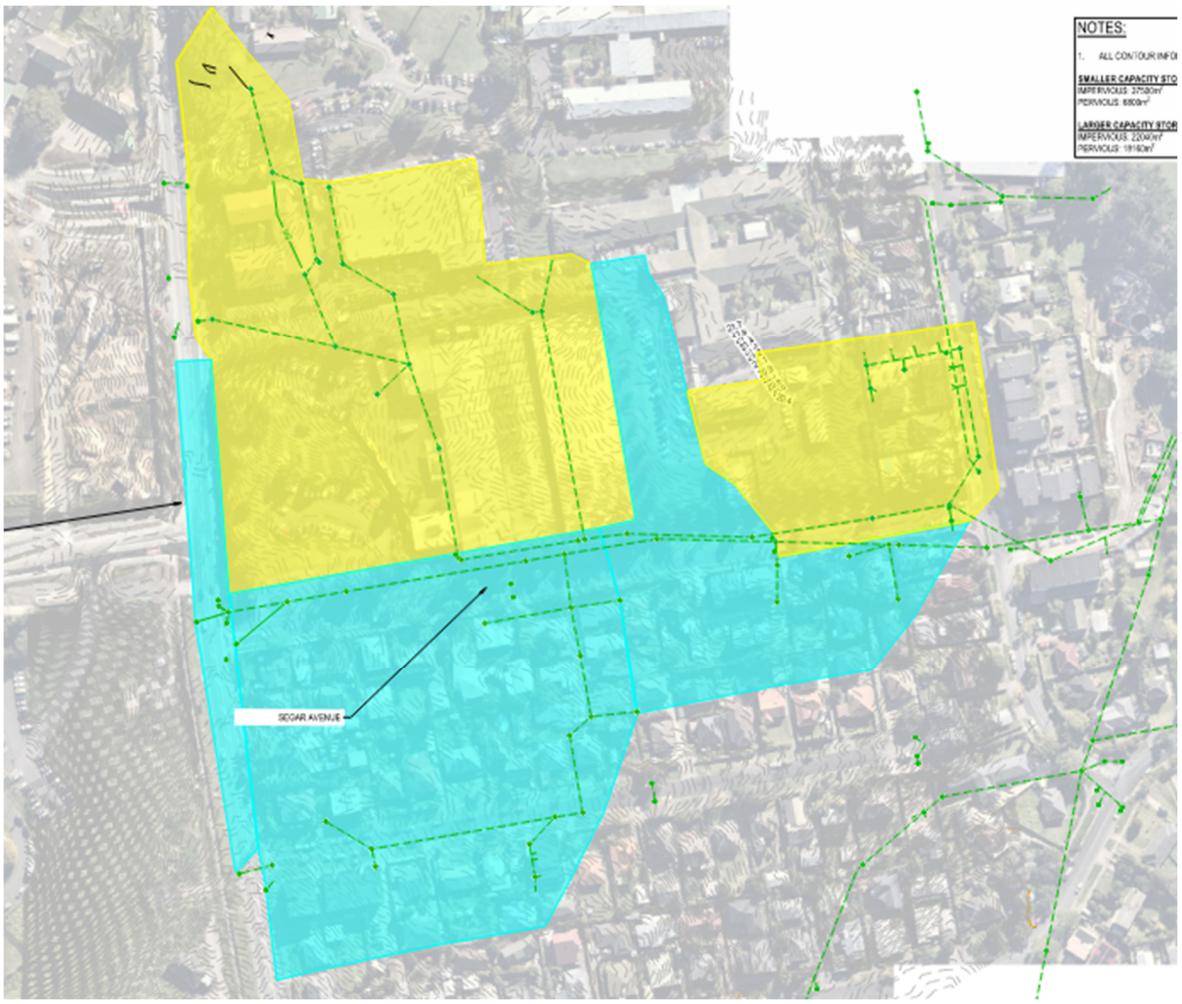


Figure 1: Pre Development Catchment (Yellow is small SW line, Blue is big SW line)

Post Development

Table 2: Post Development Catchment Sizes

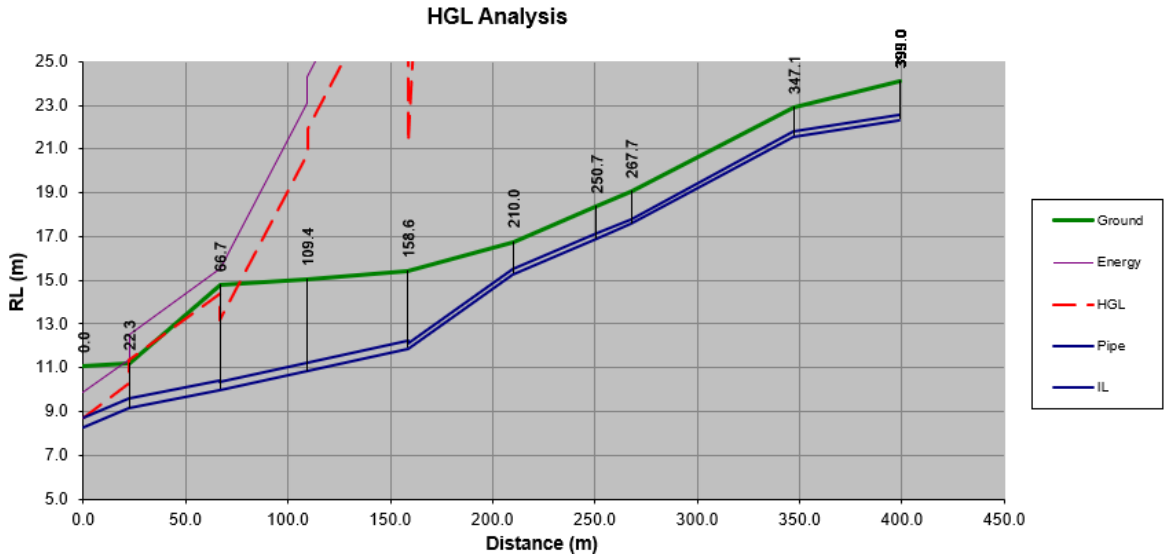
Catchment	Impervious (m^2)	Pervious (m^2)
Smaller Stormwater Line	5250	2250
Larger Stormwater Line	47800	29700

Figure 2: Post Development Catchment (Yellow is small SW line, Blue is big SW line)

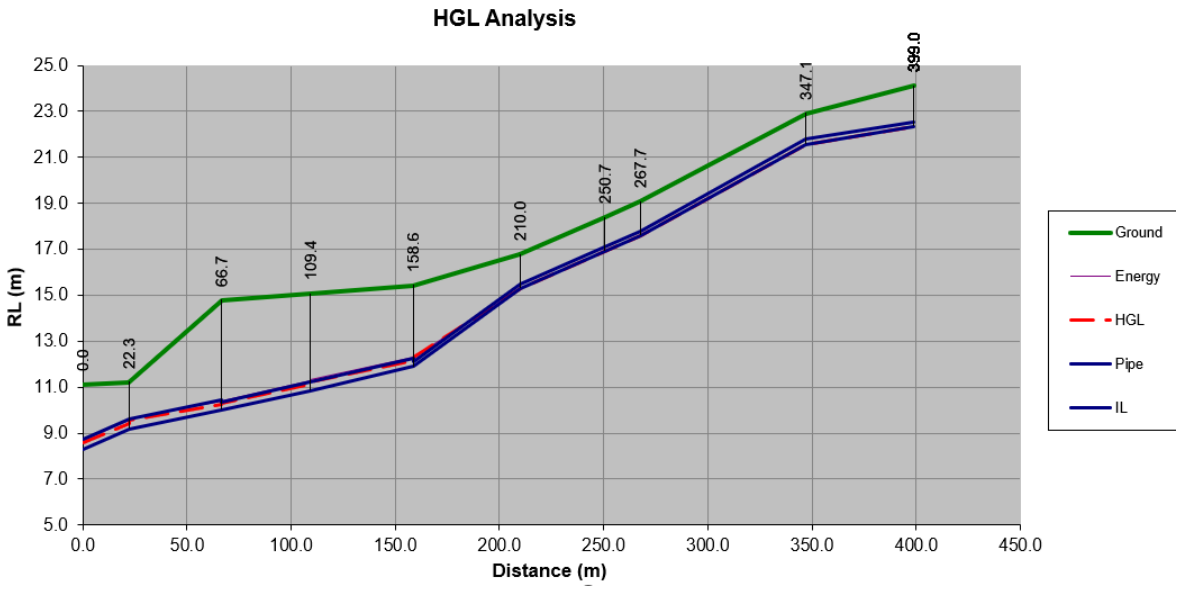
1.3 Hydraulic Grade Line Analysis

1.3.1 Small Stormwater Line

Pre Development

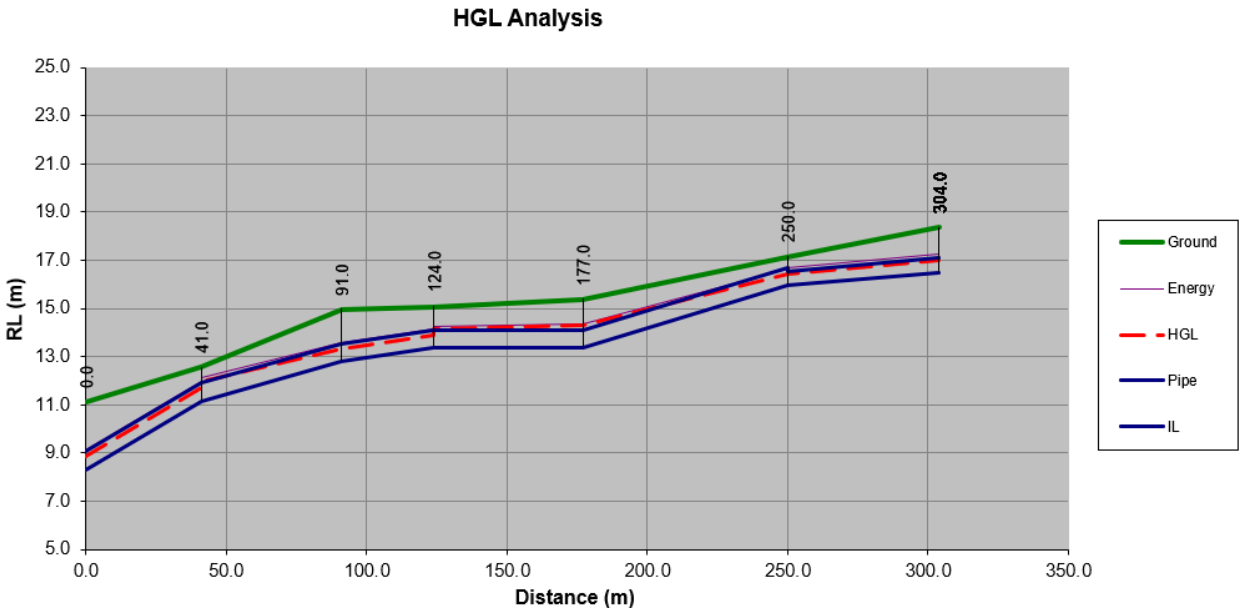


Post Development

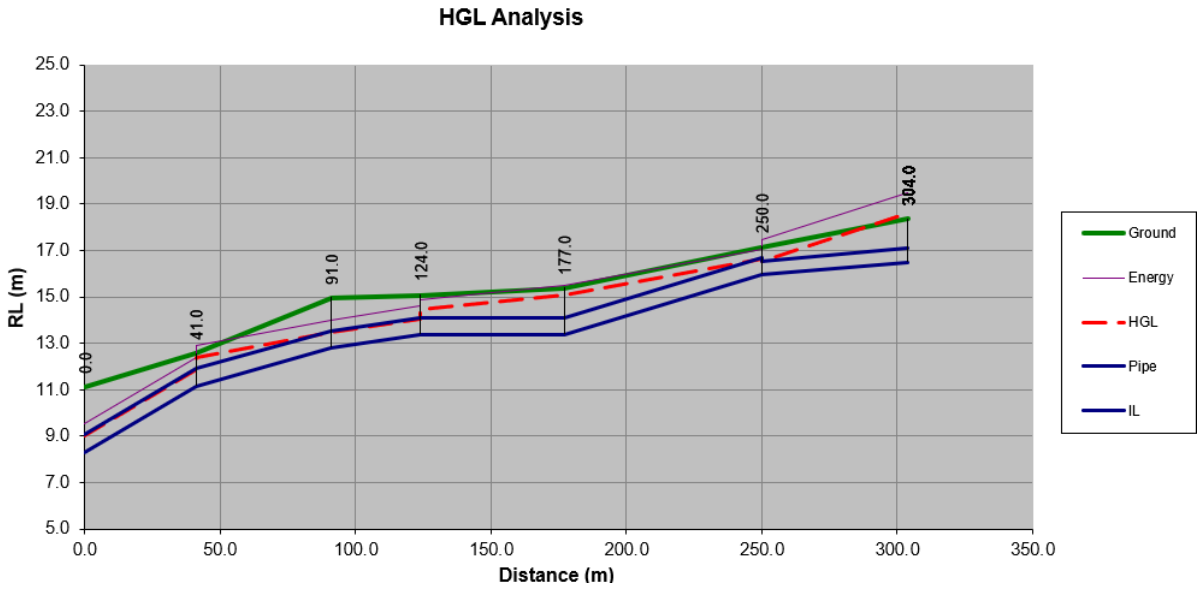


1.3.2 Large Stormwater Line

Pre Development



Post Development



Hamish McLean

Civil Engineer

Email: Hamish.McLean@beca.com