Stormwater Report

On behalf of:

Buckland Road Plan Change.

301 & 303 Buckland Road
Pukekohe

16 December 2021
BSL Ref: 5275
Revision B

REPORT PREPARED BY	REPORT REVIEWED BY	REPORT AUTHORISED BY
		
KELLY BOSGRA REGISTERED PROFESSIONAL SURVEYOR	SIR WILLIAM BIRCH REGISTERED PROFESSIONAL SURVEYOR	SIR WILLIAM BIRCH

DATE: 16 DECEMBER 2021

BIRCH SURVEYORS LTD

Property House

2A Wesley Street, Pukekohe

PO Box 475, Pukekohe 2340, New Zealand

Telephone: 64 9 237 1111 Facsimile: 64 9 238 0033

Website: www.birchsurveyors.co.nz Email: Pukekohe@BSLnz.com

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1 INTRODUCTION

1.1 PROJECT

The report comprises a Stormwater Assessment to support a proposed plan change at 301 & 303 Buckland Road, Pukekohe. This site is currently zoned "Future Urban" under the operative Auckland Unitary Plan with a proposed Business - Light Industry zone under the Pukekohe Paerata Structure Plan. The proposed plan change seeks to change the current zoning to "Business – General Business" to allow development for commercial and retail activities at the site. Indicative layout and connectivity plans are included in Appendix A.

1.2 LEGAL DESCRIPTION

The legal description of the Land parcels are as follows-

Appellation: Pt Lot 1 DP 3363 & Lot 1 DP 64805

Title Reference: CFR's NA56A/559 & NA21A/288

Plan Change Area: 7.85Ha

1.3 SITE DESCRIPTION

The site is located just South of the intersections of Manukau, Kitchener & Buckland Roads. and has multiple access points to Buckland Road. It is bordered by existing Rural areas to the west, Buckland Road to the East and Future Urban zoned properties to the south.

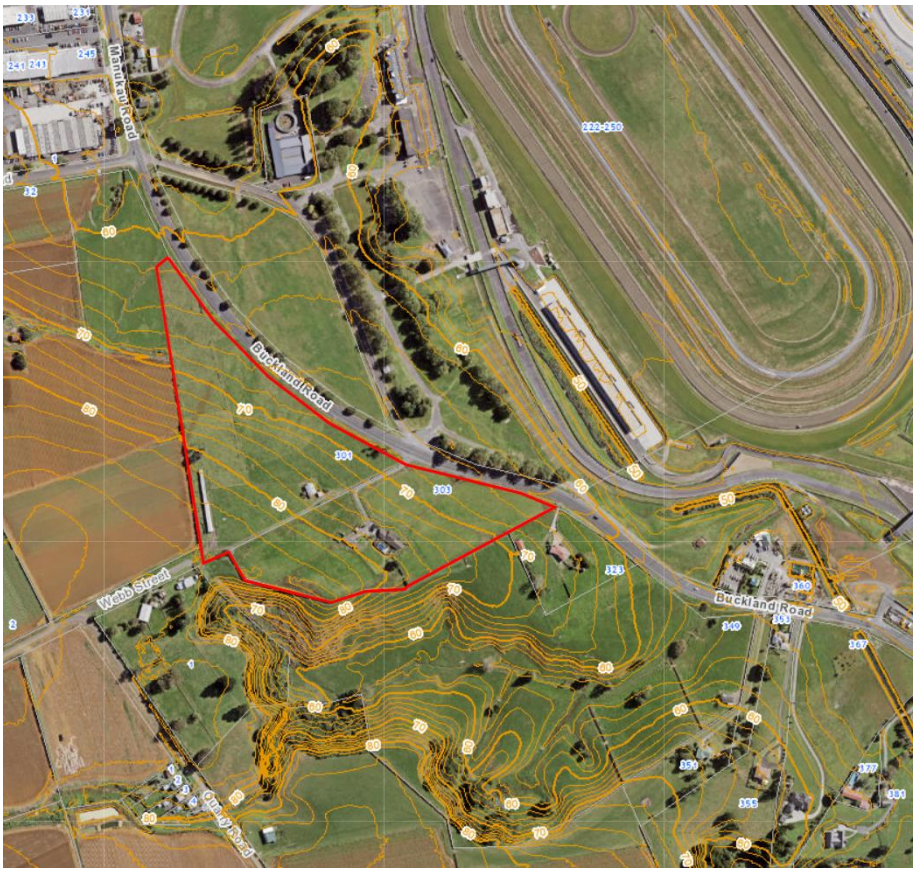


Figure 1: The plan change site in red. (Source: Birch Surveyors)

The site has a moderate contour, from south-west to north-east, sloping to Buckland Road. There are no public network connections, and surface water is generally via sheet flow to the road drains and is conveyed either north or south via existing drains to discharge into the Tutaenui Stream which flows into the Whakapipi Stream, into the Waikato River and eventually to the Tasman Sea.

There are no existing hydrological features within the site, however historic aerials show there was a shallow gully that was filled when SH22 was deviated to its current position. This is now identified as an overland flowpath on Auckland Council GIS.

The site contains a dwelling on each property and also contains a number of accessory farm related buildings having access from both Buckland Road & Webb Street. The Site is currently in Grass and is being grazed.

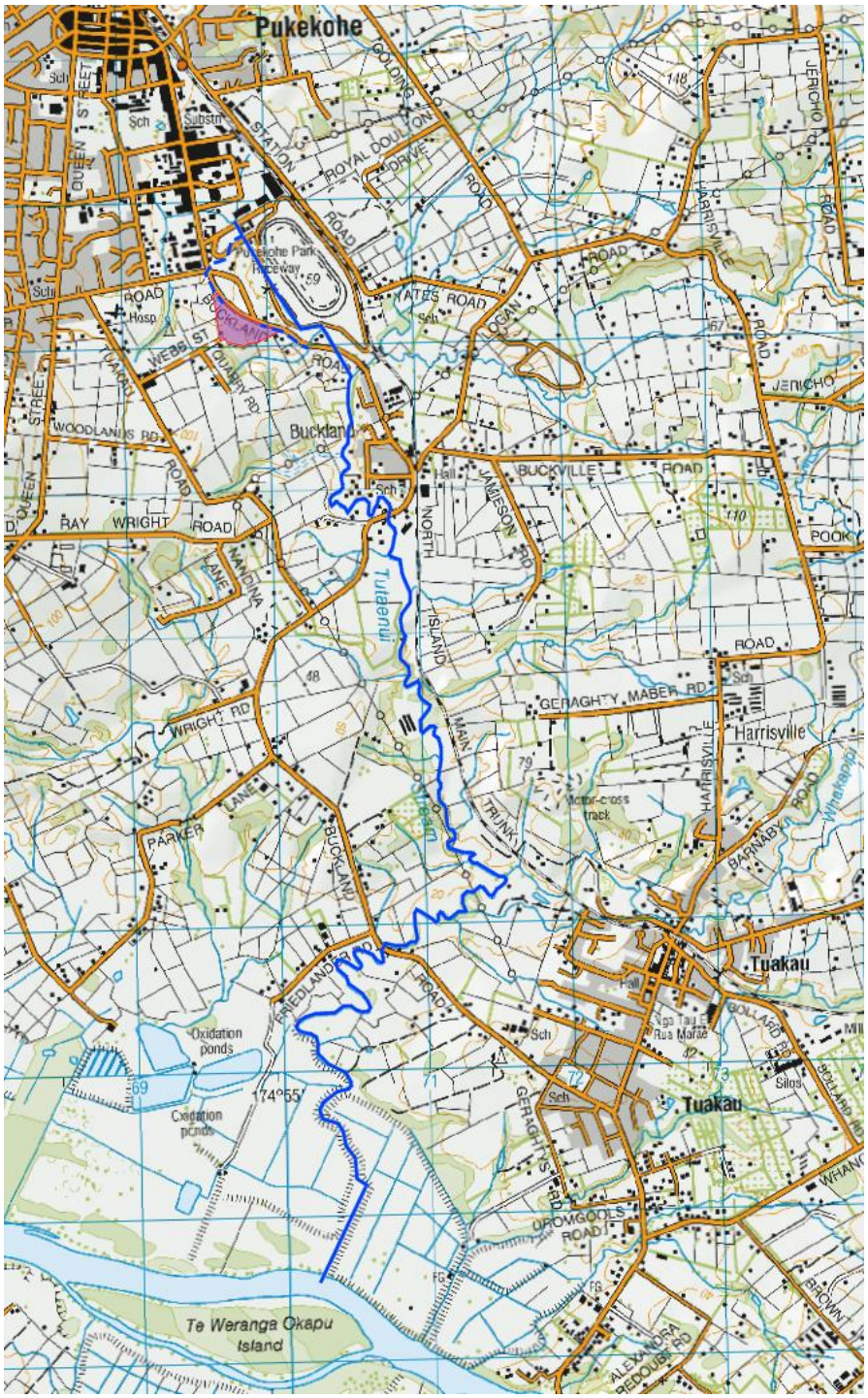
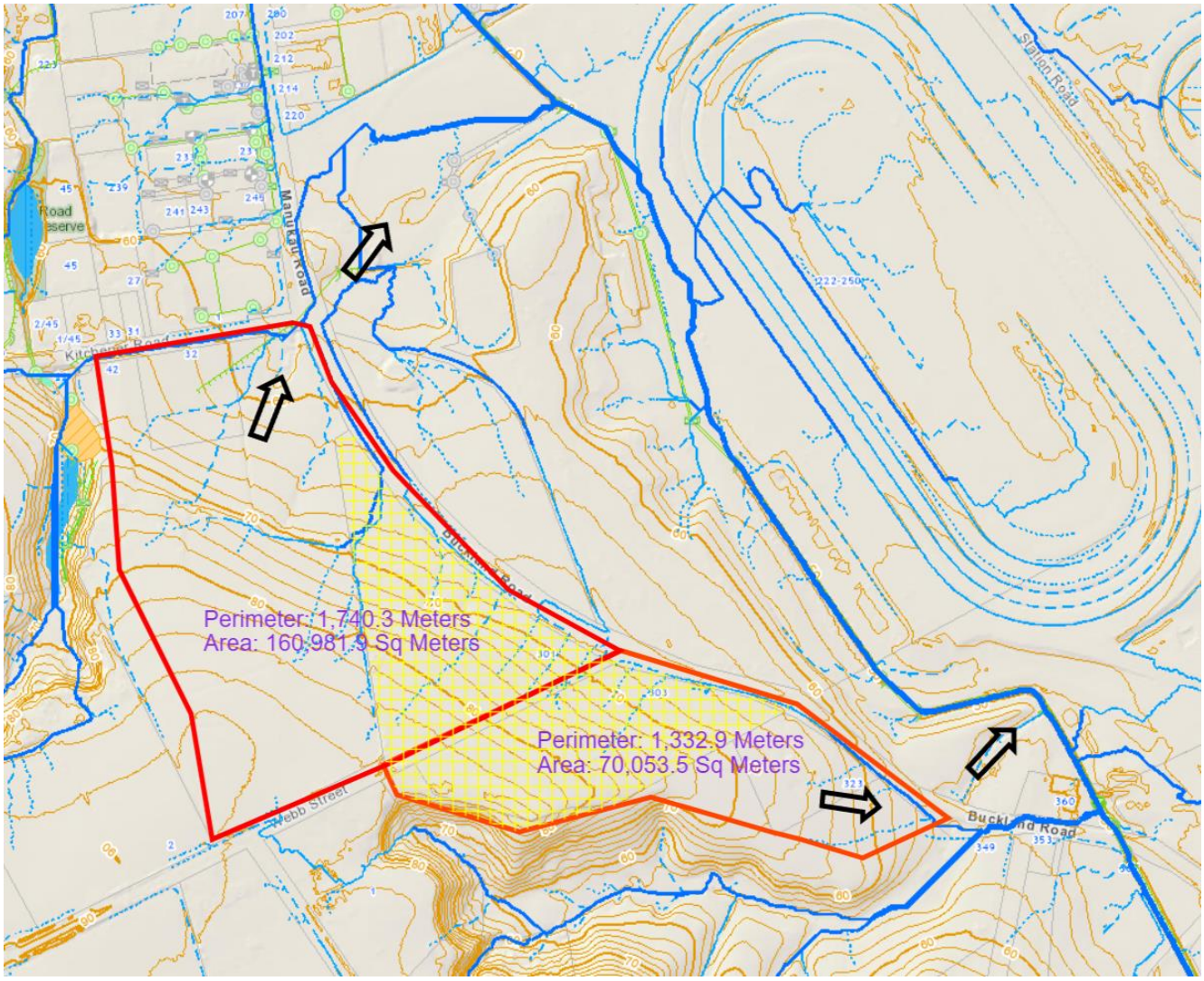


Figure 2: Location within Regional Catchment

1.4 BACKGROUND

The site straddles two catchments, and is situated at the top or side of them both with offsite drainage ensuring there is virtually no upstream catchments. #301 Buckland is at the top end of a small catchment of 16.1Ha that drains north to Manukau Road, through a culvert under Manukau Road to a short length of open drain, and then is piped some 200m to empty into the Tutaenui Stream. #303 Buckland is at the upper end of a 7.0Ha catchment draining south via open road drains/channels to join the adjacent 132Ha catchment at a common drainage point, being the head of a culvert under Buckland Road, which drains to the Tutaenui via a modified natural Channel.



There are no upstream catchments, nor does the area contain any Public Stormwater Infrastructure. The site and the surrounding area are serviced by open drains, natural channels (mostly highly modified) culverts and some historic private pipes that directs surface water to the Stream.

The Catchments Downstream from the site have existing flood and drainage issues and any development must take this into account.

The proposal and its immediate Catchment area fall within the Auckland wide Stormwater Network Discharge Consent (NDC) and within the area formerly contained in the Pukekohe South Stormwater Network Discharge Consent. The NDC regulates Stormwater Treatment and Disposal for the areas it covers.

1.5 Proposed Development

The Proposal is to change the Underlying Zone from Future Urban (Business – Light Industry) to Business-General Business Use to allow development of the sites.

1.6 Plan Change Request

A Plan Change request is being sought from Auckland Council and this assessment supports that application.

2 STORMWATER REPORT

2.1 STORMWATER DISPOSAL

In determining the appropriate Stormwater Treatment and Disposal for the proposed Activity, we anticipate a design that achieves consistency with the objectives and policies of the Auckland Unitary Plan as well as Auckland Council's Guideline Documents, the current Stormwater Network Discharge Consent and industry best practice options.

This will establish a cohesive approach to the management of stormwater runoff by specifying controls on the quality and quantity of the runoff and requiring ecological enhancements including:

- Identify Best Practice Options for Stormwater treatment for the development area
- Promote Water Sensitive Design to mitigate adverse effects of development on the receiving environment
- Minimise discharge of contaminants into the receiving environment
- Not worsen downstream flooding

Proposed methodologies to achieve the above outcomes include:

- Provide for SMAF-1 equivalent hydrology treatment for all impervious areas.
    - Retention will be achieved using the following methods in order of preference
        - Ground Soakage if conditions permit
        - Reuse if practical and feasible
        - Added to Detention Volume
    - For Roads and other access ways, should the ground soakage prove unsuitable, the detention volume will be increased by the retention component within the on-site or communal Raingarden or Wetland
    - Attenuated and treated stormwater discharge points shall be to Stabilised and/or Green Outlets as best suits the discharge point and immediate receiving environment
- Provide stormwater treatment at source or within centralised Raingardens or Wetlands.
- Inert Roofing Materials to be installed to all covered structures.
- Additional treatment may be required by future businesses to treat specific contaminants (eg Gross Pollutant Traps, Oil Grit Separators etc - depending upon actual site use).
- Provide attenuation to ensure peak runoff is not increased up to and including the 100yr ARI Rainfall event.

Buckland Road Plan Change Stormwater Toolbox:

Area of Interest/Zone	Runoff Source	Stormwater Targets				Best Practice Options
		Water Quality	Hydrology Mitigation	Flood Attenuation	Water Sensitive Design	
		GD01	SMAF-1 Equivalent	Post Dev Flows ≈ Pre-Development Flows for all Storm Event	GD04	
Business: General Business Zone	Roof	✗	✔	✔	✔	Inert Roofing Materials Hydrology Mitigation Retention: Soakage or Reuse Communal Raingardens or Wetland for hydrology mitigation and limited attenuation Communal Attenuation Basis attenuation of larger storm events
	Driveway/Access	✔	✔	✔	✔	Contaminant Specific pre-treatment using Cesspits or Gross Pollutant Traps or Oil/Grit Separators or Hydrodynamic Separators depending upon activity Communal Raingardens or Wetland for hydrology mitigation and limited attenuation Communal Attenuation Basis attenuation of larger storm events

Buckland Road Plan Change Stormwater Management Approach					
Area of Interest/Zone	SW Component	SW Outcome	At Source	Communal Device	Other Requirements
Business: General Business Zone	Water Quality	Eliminate or minimise generation of contaminants	✔ Inert Roofing Materials ✔ Driveway and Yard runoff to private treatment device (Raingarden, Tree Pit, Swale, Gross Pollutant Traps, Oil/Grit separators or hydrodynamic separators for contaminant specific treatment)	✔ Runoff directed to Communal Raingarden or Wetland for treatment and attenuation	Where Soakage or re-use is not feasible, Retention made up as Detention in Tanks or Communal Raingarden/Wetland
	Hydrological Mitigation	SMAF-1 Equivalent hydrological mitigation Flow Mitigation up to the 100yr ARI	✔ Retention via Soakage or Re-use Tanks ✔ Detention Tanks (SMAF-1 equivalent) ✔ Attenuation to provide requisite flow attenuation up to the 10yr ARI	✔ Runoff directed to Communal Raingarden or Wetland for treatment and attenuation ✔ Runoff directed to Communal Attenuation Basin for storm events larger than 10yr ARI	
Roading	Water Quality	Eliminate or minimise generation of contaminants	✔ Tree Pits / Raingardens Designed to SMAF-1 equivalent and attenuate 50% AEP Rainfall ✔ Swales and filter strips ✔ Gross Pollutant Traps	✔ Runoff directed to Communal Raingarden or Wetland for treatment and attenuation ✔ Runoff directed to Communal Attenuation Basin for storm events larger than 10yr ARI	Where Soakage is not feasible, Retention made up as Detention in Tanks or Communal Raingarden/Wetland
	Hydrological Mitigation	SMAF-1 Equivalent hydrological mitigation and required flow mitigation		✔ Runoff directed to Communal Raingarden or Wetland for treatment and attenuation	

Birch surveyors

A way of achieving the above stormwater goals is to treat Carpark runoff in Bioretention Swales to suitably treat the runoff, designed with sufficient Retention & Detention capacity to provide both SMAF-1 treatment and attenuate runoff up to the 100yr ARI Storm event. If the latter is not possible in the same device, a separate device can be utilised to provide attenuation up to the 100yr ARI Storm event.

The roofs of all buildings will be constructed from inert materials; consequently, the roof runoff can be considered clean. The runoff can be attenuated via sub-surface stormwater devices, either under the buildings or adjacent access to provide SMAF-1 treatment and to attenuate runoff up to the 100yr ARI Storm event. As all buildings in the Business- General Business Zone require resource consent for a restricted discretionary activity - this can be imposed as a condition of consent at the time of development.

TP108 was used as the basis for Stormwater Calculations and the results of these are attached in **Appendix B.** Although the Hydrology of the rezoning to General Business will allow almost full impervious coverage, we have allowed for a Post Development Hydrology of 90% impervious area, allowing 10% pervious area for anticipated Surface based Stormwater Treatment devices such as swales and wetlands/raingardens as well as allowance for soft landscaping. The Curve Numbers used in the TP108 Calculations are Group B (Alluvial), consistent with the published Soil Maps and associated Data.

The TP108 assessment shows that the proposal will increase both Peak Flows and Volumes for all Storm Events. These will be attenuated to provide the Required Treatment as required by the NDC.

It is proposed to utilise Detention in the form of sub-surface Stormwater Cells for future buildings either under the floor Slab or under adjacent hardstand areas (parking/access), with strategically located outlets to achieve the desired Stormwater Controls. The Cells will be designed for the contributing catchment and it is expected that they will have a treatment area of 70m² for every 1000m² roof area. Refer to **Appendix B** for Calculation Details. The future building sizes are unknown, and the size of the Stormwater Management Device can be determined at the time of Building Consent on a pro-rata basis. The example proposed allows for the SMAF-1 Retention and Detention as well as the 10yr ARI storm attenuation released via orifice at flowrates not exceeding the pre-development flowrates.

A similar type of system can be utilised to manage the Stormwater runoff from sealed or unsealed carpark and access, except the surface water will be directed to vegetated swales to treat the water before flowing into the stormwater cells. Raingardens or Wetlands can be used as an alternative treatment for both treatment and attenuation. Swale & Raingarden Calculations are attached in **Appendix B** and it is anticipated that a vegetated swale of 3m wide, a length of 30m is required to treat the stormwater for up to a 2000m² impervious area with the treated runoff being directed to Stormwater Cells or similar under the carpark to ensure the required attenuation is achieved. A

Raingarden of approximately 80m² per 1000m² catchment is an alternative solution to provide both treatment and attenuation.

The devices will be connected to a new internal Stormwater Network designed to convey the attenuated 10% AEP flows to the existing Road Swales and to the receiving environment. Selected widening of these swales may be required and can be assessed at time of future development.

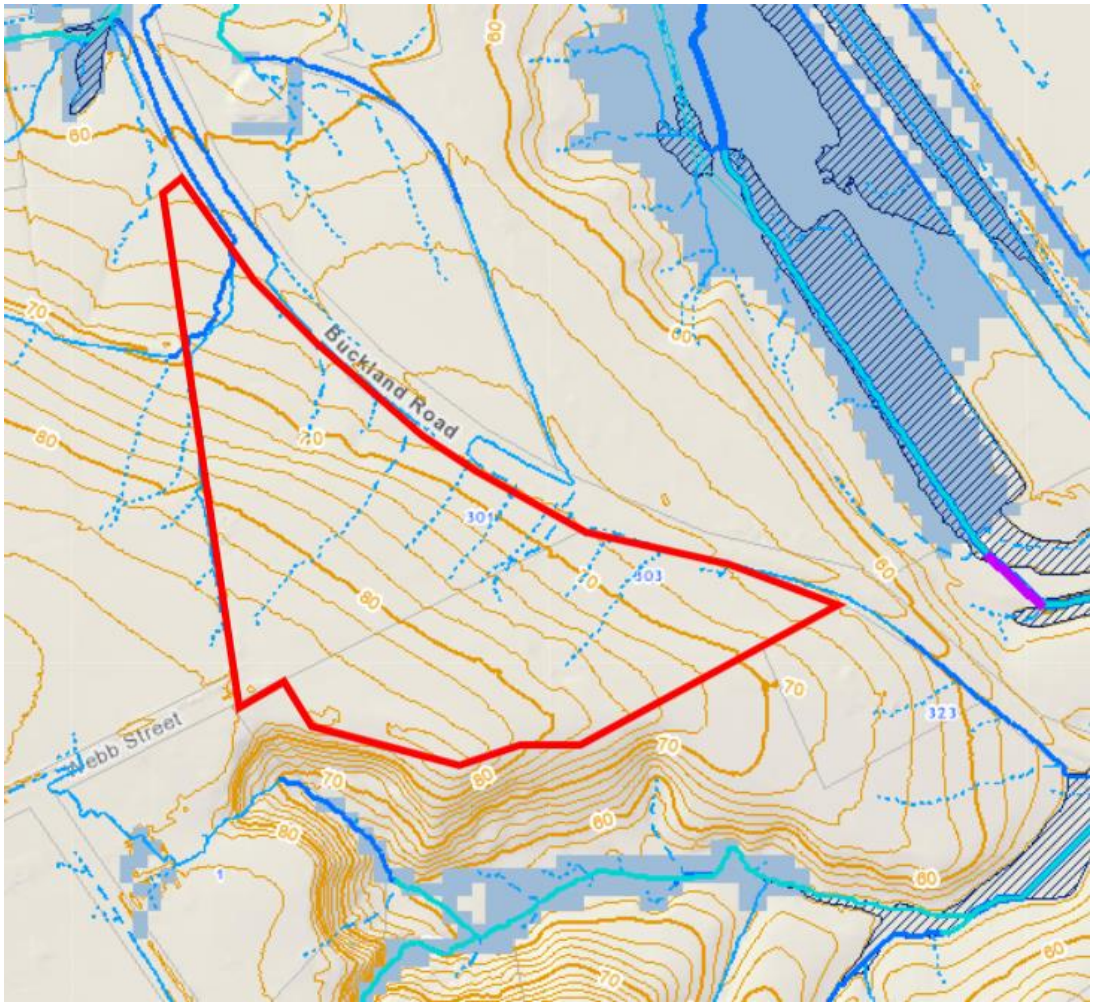
Any new Stormwater Infrastructure will need to convey the anticipated flows from the contributing catchment. There is no upstream catchment, so any proposed infrastructure need only provide for the full developed site works. The NDC identifies that developments must maintain flows to pre-development rates. Therefore, the design criteria for any new Public Stormwater Network will be to convey the existing 10% AEP runoff from all directly contributing catchments. Conceptual Plans showing a possible layout and detail of the Stormwater Devices are attached in **Appendix A**.

The combination of the Swales and sub-surface detention, Raingardens and Detention will ensure the runoff from any proposed buildings and associated parking and access are appropriately treated and the flow rates are mitigated to pre-development conditions.

2.2 Overland Flow

In assessing the proposed Activity, Council must be satisfied that the locations of proposed new buildings, access and infrastructure are safe & stable and not prone to be inundated.

The contours indicate that the surface runoff will predominantly be sheet flows, not being concentrated into overland flowpaths. The Auckland Council GIS identified overland flowpaths are minor and do not follow natural depressions, indicating these are minor to insignificant in nature. It is anticipated that the future development of the site will be undertaken holistically and will manage the surface flows in compliance with the NDC in regards to the surface water discharge flow and location and to actual site development.


Buckland Road
Webb Street
60
70
80
301
303
323

3 LOW IMPACT DESIGN

We have considered the use of Low Impact Design (LID) with the primary objectives being to limit impervious surfaces and to both treat the surface runoff before entering the stormwater network and to reduce the impact of impervious surfaces by retaining and or detaining runoff from the increased impervious surfaces that development invariably creates.

Guidance Document 2015/004 *Water Sensitive Design for Stormwater* sets out objectives, anticipated outcomes and early design considerations within Sections A-D and Concept Design in Section E outlining the Stormwater Treatment Train and types of devices used to treat and mitigate the Stormwater Runoff.

We have previously investigated a number of options and had proposed bioretention swales to treat the carpark runoff and stormwater detention tanks to mitigate the roof runoff. The roofing materials for all future buildings are to be constructed with inert materials so the runoff can be considered as clean or non-contaminated, allowing mitigation via retention and detention only.

In further consideration and application of the Stormwater Treatment Train and LID under GD2015/004, the proposed on-site stormwater management incorporates LID devices. The Soil Maps indicate that soakage is possible, and further investigation will be required. Based on the Hydrological Soil Class, the site soakage will achieve the minimum soakage rates for SMAF-1 Retention within Raingardens and thus contributing to ground water recharge. The presence of soakage also makes raingardens (bioretention) a more viable and successful stormwater treatment option; however, on-site reuse of rainwater is an option that is available.

Other LID options including living walls and roofs were investigated, but deemed impractical as the environmental benefits required can be achieved using raingardens, which are more cost effective and simpler and more economic to construct and maintain for future owners. Porous pavements were also investigated. Future carparking will be classified as high-contaminant yielding, and it is likely that the porous pavement will require more frequent maintenance using specialised equipment to ensure the environmental benefit is maintained. The maintenance regime for swales and raingardens are easier understood and simpler for future owners, ensuring better functioning of the device and therefore greater environmental efficiency. Limiting impervious areas in a business zone will depend on the future use and development design. Increasing the proposed impervious areas will also increase raingarden sizing, and by extension, the pervious area.

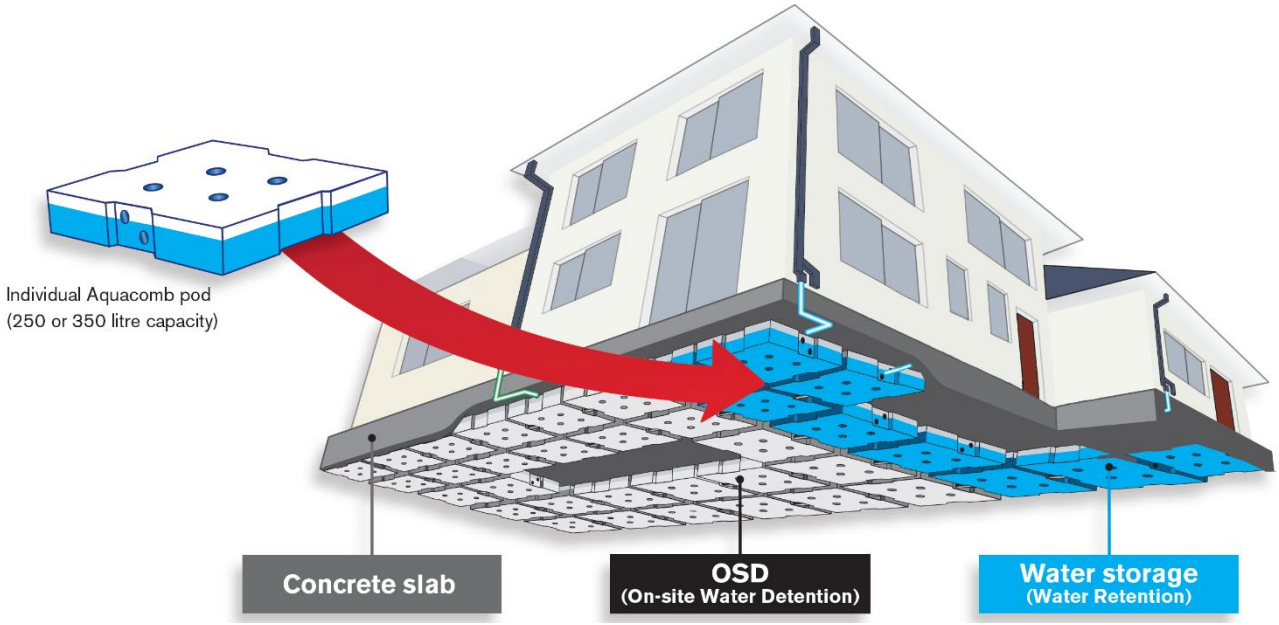
The proposed stormwater treatment will include retention & detention devices, soakage and bioretention (raingardens or bioswales). These devices are sized to soak away the SMAF 1 retention volume of 5mm, to provide detention of the 95% storm and release ensure over 24hours, and to provide detention of the 10yr ARI Storm event to pre-development flows or less and to attenuate the 100yr ARI Storm Event.

It proposed that retention & detention tanks and soak holes are used to manage the roof runoff, and bioretention is used to manage the surface water runoff from future carparks, access and outdoor storage areas.

3.1 STORMWATER DISPOSAL - BUILDINGS

Stormwater Calculations including allowance for SMAF 1 mitigation are attached in **Appendix B.** These typical calculations are sized for a 1000m² roof area and are scalable depending upon building size.

The proposed system consists of retention tanks installed within the floor slab, similar to AquaComb series and allows for retention and detention based on the pipe configuration:



All downpipes will be directed to the water retention component. The open base will allow for ground water recharge, and a ≈20mm orifice will control the SMAF-1 detention, being the slow release of the 95% rain event. Additional detention where a ≈75mm orifice will control the primary outlet to provide flood mitigation for the 10% AEP Storm, ensuring post development flows are consistent with pre development flows. Refer to **Appendix B** for a schematic layout of this proposal.

The proposal for every 1000m² contributing roof catchment, it will be anticipated that 30m³ of storage will be needed to allow for 5m³ retention and a total detention of ≈23m³ for SMAF-1 & the 10yr ARI storm to ensure flows are reduced to pre-development flowrates.

Further detention to mitigate up to the 100yr ARI storm may be required if not provided above, and this can be incorporated into attenuation basins, downstream communal devices or a combination of both to achieve the outcomes required by the NDC. All treated and attenuated flows will be conveyed to Tutaenui Stream via a combination of downstream channels and a new on-site stormwater network.

3.2 STORMWATER DISPOSAL – OTHER IMPERVIOUS (CARPARK, ACCESS & HARD STAND)

The most practicable option to treat the surface runoff from carparks and other impervious surfaces is via Raingardens. This affords stormwater treatment and ground water recharge, with the design also providing a measure of attenuation due to the increased storage volume afforded by the proposed design parameters.

The anticipated construction will be in accordance with Guidance Document 2017/001

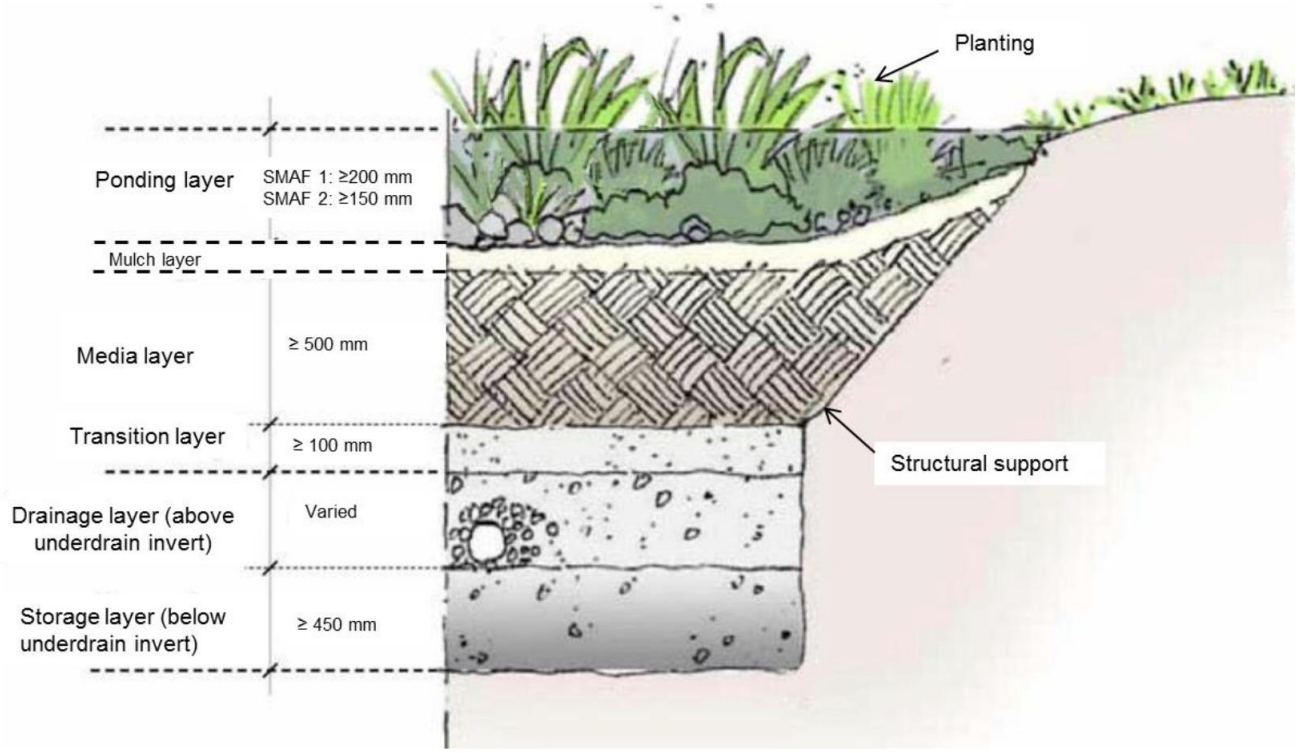


Figure 3 Raingarden (source GD2017/001)

From previous Geotechnical Investigations, the groundwater table was not encountered and this would be fairly representative of the site being elevated and on the side of a broad ridge. The proposed sizing for the raingarden to treat and mitigate the non-roof impervious surfaces is to provide a raingarden surface area of approximately 8% of the contributing catchment. This means that for every 1000m² contributing impervious catchment, a raingarden sizing of up to 80m² is anticipated. Typical raingarden calculations are attached in **Appendix B.** We note that this sizing exceeds the minimum guideline of 5%, with the larger size being required to achieve the retention volume storage at the base of the raingarden. We note that a raingarden of this size provides a Detention volume of 36m³, some 16m³ greater than the required SMAF 1 mitigation requirement of 19.4m³. This excess is necessarily provided to ensure the raingarden construction conforms to GD2017/001 and the extra storage will provide attenuation for storm events up to the 1% AEP Storm Event. This is inferred by cross referencing with the detention tank calculations, where a detention volume of 13m³ is required to attenuate the 10yr ARI storm for a 1000m² catchment. This will give

Council a level of comfort that the raingarden will treat the SMAF-1 rainfall events and will continue to treat and attenuate runoff up to the 10yr ARI storm event and even up to the 100yr ARI storm.

Alternative edge details for the Raingarden is shown:

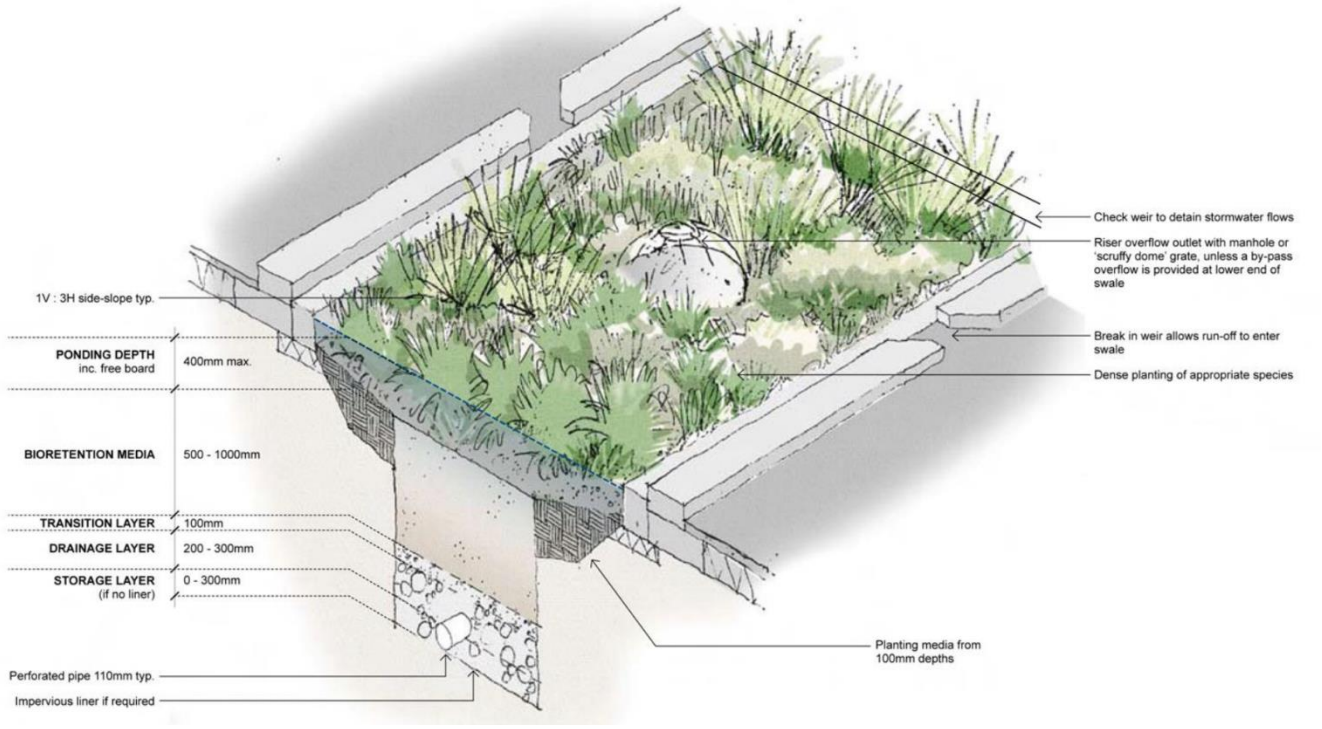


Figure 4 Raingarden BioSwale (source GD2017/001)

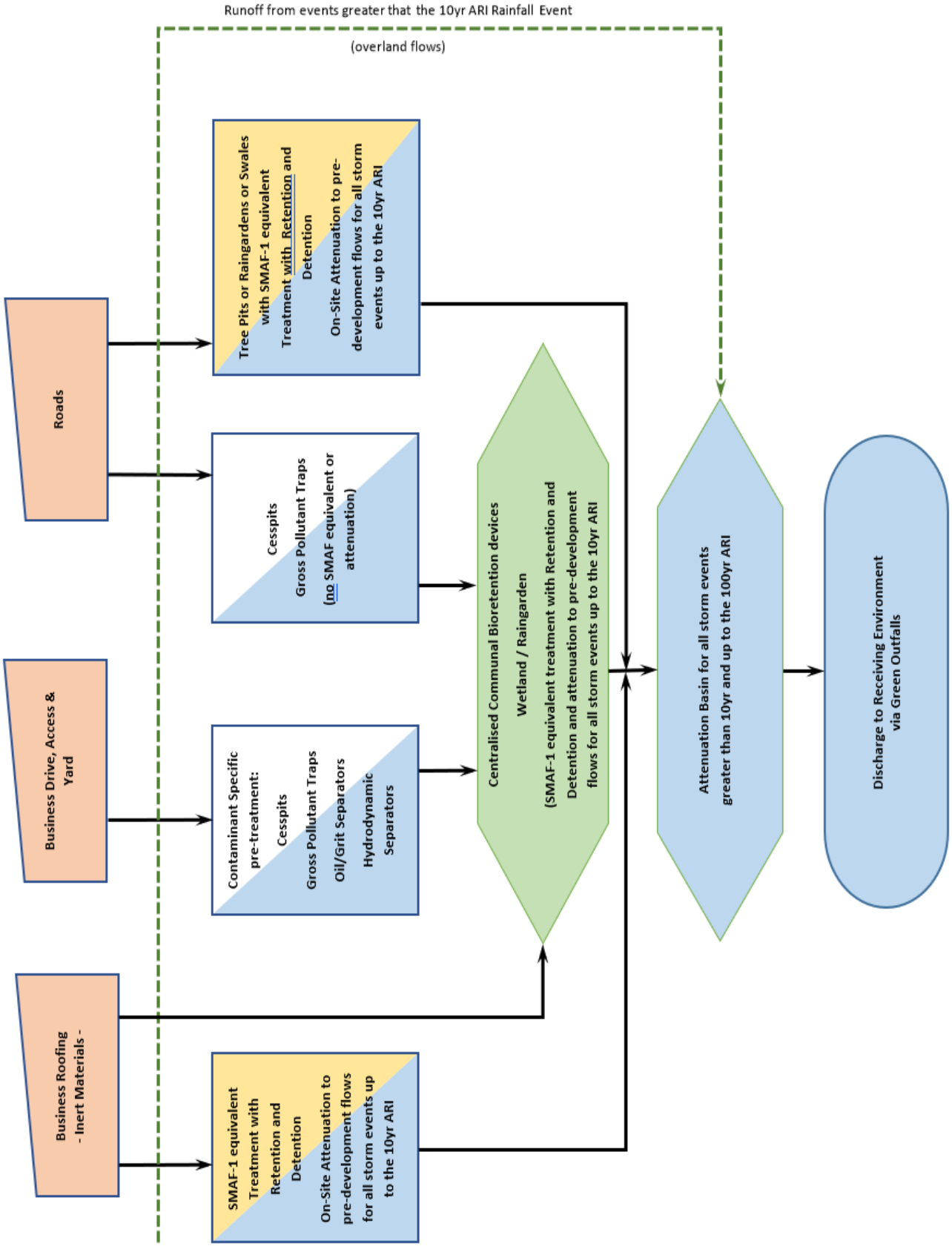
The anticipated raingarden outlets will be to a new on-site Stormwater Network, and with careful design, the outlets and overflows can be incorporated into the overall environment with minimal pipework and enhancing the pervious areas. We note that the final design and layout is site specific and will be determined upon development of the site.

3.3 Other Considerations

The sites have a gentle to moderate slope, and commercial development is likely to require earthworks to create level pads to undertake activities and create building platforms. The nature and quantity of the earthworks are as yet unknown; however all earthworks will be undertaken under the supervision of a Geotechnical Expert, and all fill will be engineered and certified. The Stormwater devices that rely on soakage will need to be carefully managed to ensure they both function and do not compromise any fill. It is anticipated that the design of the earthworks and stormwater will be carefully managed to ensure practicality and feasibility of development

We reiterate once again, the actual type and extent of development including the size and location of buildings, size and location of associated carparking and access and quantity of fill to be placed is currently unknown. The stormwater treatment devices can only be designed and constructed once the full nature and scope of the development is known, however the stormwater framework and outcomes can be anticipated and planned for.

Stormwater Runoff Treatment Flowchart – General Business Zone



4 CONCLUSIONS

Future development of the site will need to be carefully managed and the Stormwater Report shows that this can be achieved.

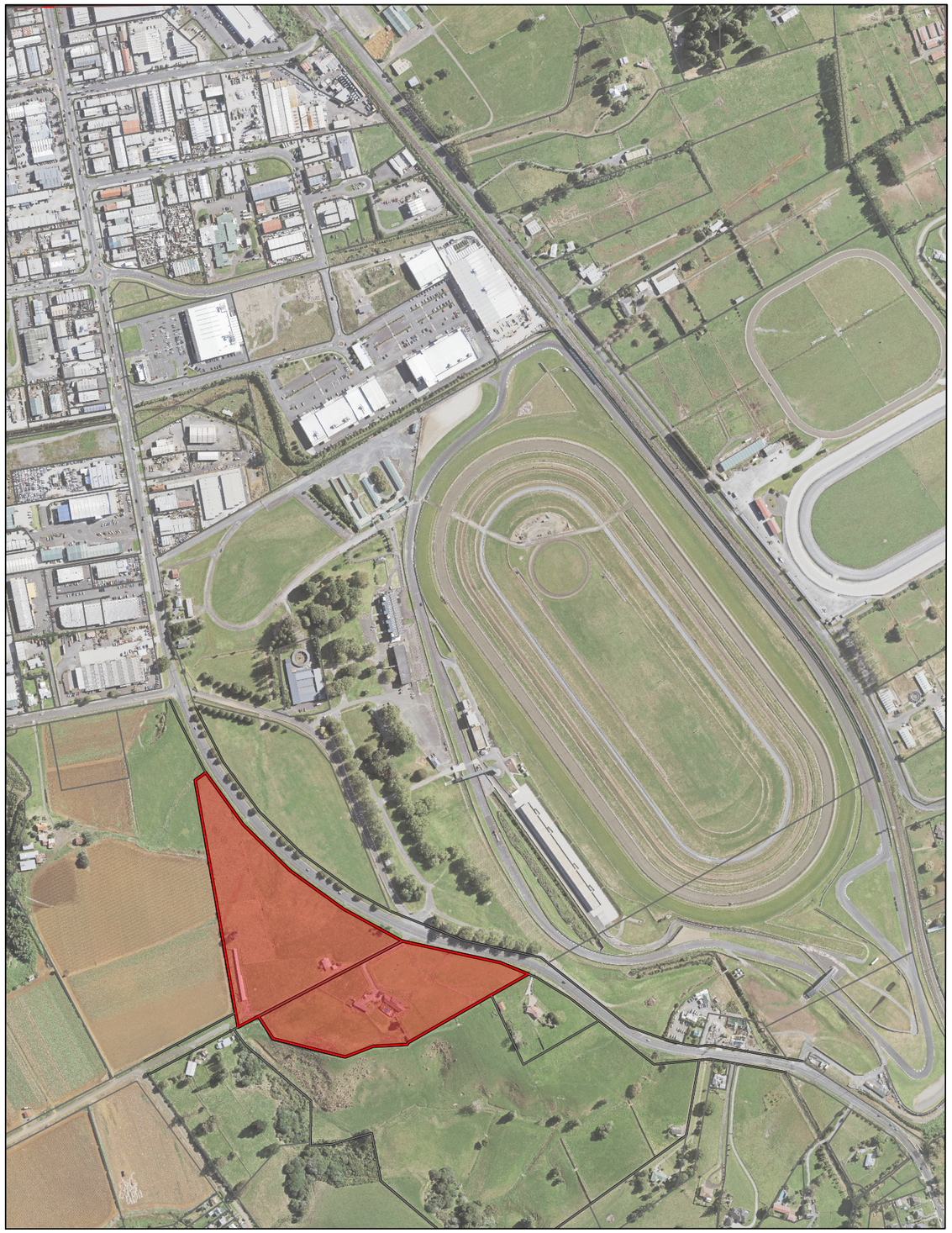
To summarise;

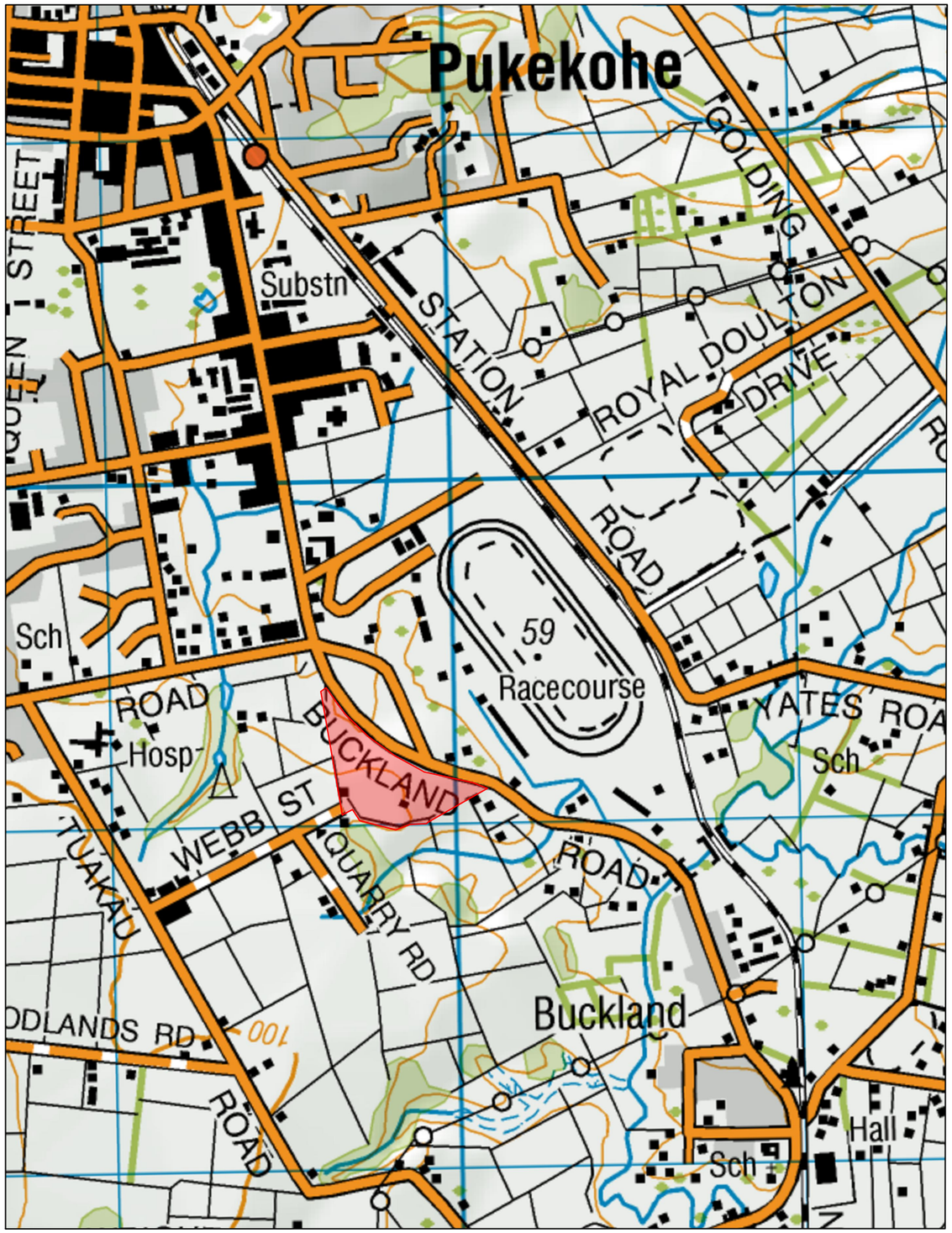
- Provide for SMAF-1 equivalent hydrology treatment for all impervious areas.
    - Retention will be achieved using the following methods in order of preference
        - Ground Soakage if conditions permit
        - Reuse if practical and feasible
        - Added to Detention Volume
    - For Roads and other access ways, should the ground soakage prove unsuitable, the detention volume will be increased by the retention component within the on-site or communal Raingarden or Wetland
    - Attenuated and treated stormwater discharge points shall be to Stabilised and/or Green Outlets as best suits the discharge point and immediate receiving environment
- Provide stormwater treatment at source or within centralised Raingardens or Wetlands.
- Inert Roofing Materials to be installed to all covered structures.
- Additional treatment may be required by future businesses to treat specific contaminants (eg Gross Pollutant Traps, Oil Grit Separators etc - depending upon actual site use).
- Provide attenuation to ensure peak runoff is not increased up to and including the 100yr ARI Rainfall event.

These considerations will provide stormwater treatment and mitigation ensure flood levels and peak flowrates are not increased onto downstream properties.

If further information is required please contact, Kelly Bosgra on 09 237 0781 or by email kelly@bslnz.com

APPENDIX A
LOCALITY PLAN
EXISTING SITE PLAN
INDICATIVE STORMWATER LAYOUT PLAN





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Birch Planning Surveying Engineering
LAND DEVELOPMENT CONSULTANTS
Property House
2A Wesley Street, Pukekohe
PO Box 475,
Pukekohe 2340
Ph: 09 237 1111
Fax: 09 238 0033
pukekohe@bslnz.com
www.birchsurveyors.co.nz

LOCAL AUTHORITY	AUCKLAND COUNCIL
PLANNING MAP	-
ZONING	FUTURE URBAN
ACTIVITY	-
COMPRISED IN	NA56A/559 & NA21A/288
TOTAL AREA	7.85ha
REGISTERED OWNERS	Peterex Properties & Pukekohe Ltd

PROJECT NAME

PUKEKOHE LTD

301 & 303 BUCKLAND ROAD
PUKEKOHE

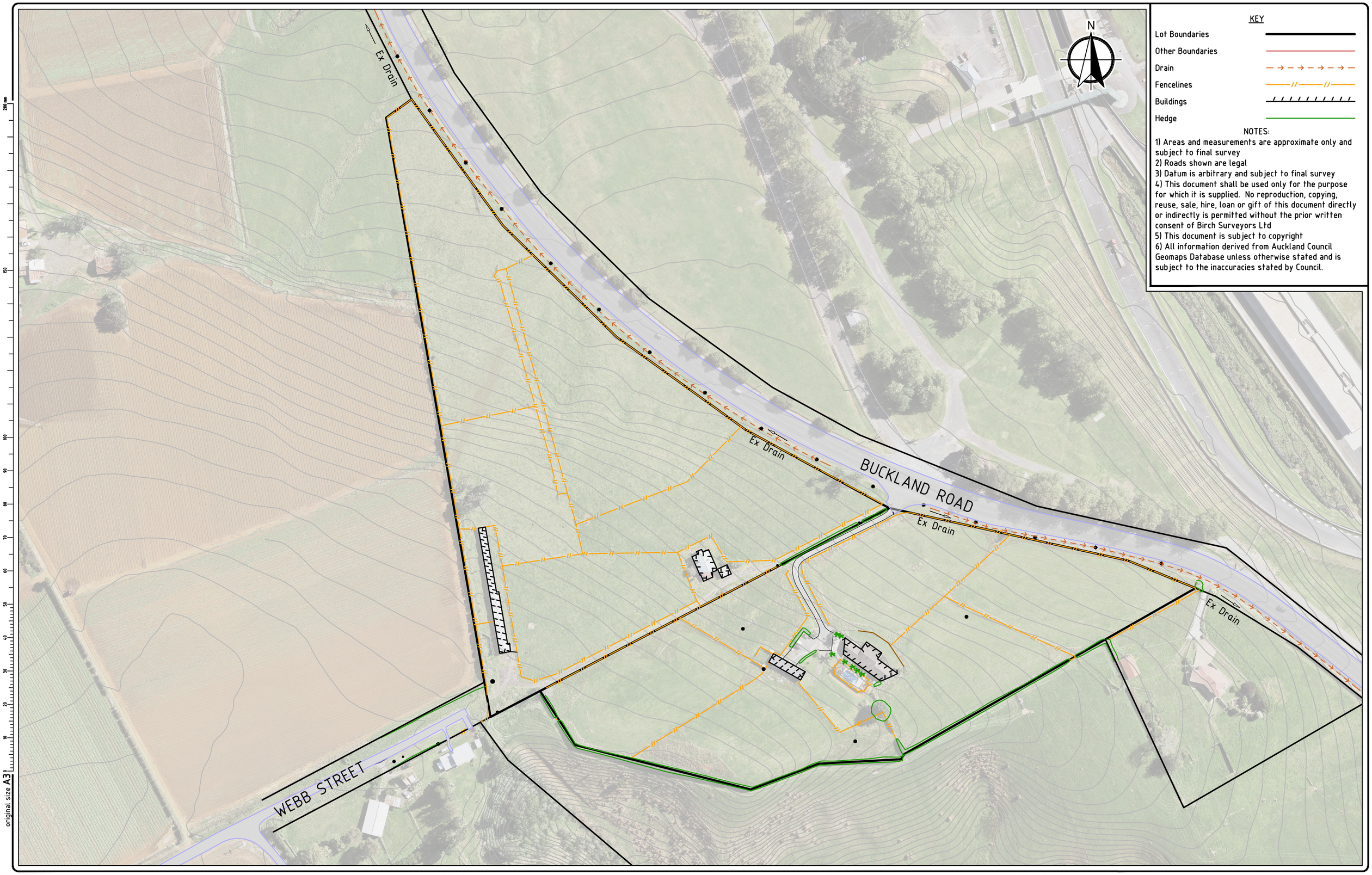
Surveyed -	Date -	Project No.	4620
Designed -	Date -	Scale	Proportional @ A3
Drawn KDB	Date 11/2021	Approved PROJECT MANAGER	Date

REV.	BY	DATE	COMMENT
A	KDB	12/21	Release

TITLE

LOCATION PLAN

Drawing Name	F:\..CAD\CP 5275 A.dwg /Locality Plan	Rev.	A



KEY

- Lot Boundaries
- Other Boundaries
- Drain
- Fencelines
- Buildings
- Hedge

NOTES:

1) Areas and measurements are approximate only and subject to final survey
2) Roads shown are legal
3) Datum is arbitrary and subject to final survey
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Birch Planning Surveying Engineering
LAND DEVELOPMENT CONSULTANTS
Property House
2A Wesley Street, Pukekohe
PO Box 475,
Pukekohe 2340
Ph: 09 237 1111
Fax: 09 238 0033
pukekohe@bslnz.com
www.birchsurveyors.co.nz

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LOCAL AUTHORITY	AUCKLAND COUNCIL
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ZONING	FUTURE URBAN
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REV.	BY	DATE	COMMENT
A	KDB	12/21	Release

TITLE

EXISTING SITE PLAN

Drawing Name	F:\..CAD\CP 5275 A.dwg /EX SITE PLAN	Rev.	A

NOTES

1) All works to comply with local authority Engineering Quality Standards latest edition and the details and specifications hereon.

2) Vertical datum is Auckland Vertical 1946.

3) Horizontal Datum is Geodetic Datum 2000, Mt Eden circuit coordinates.

4) Existing Underground Telecom cables, Fibre Optic Cables, Power cables, Gas pipes and Water Pipes are APPROXIMATELY only. Additional services may not be shown on the plans. Contractor to verify all existing services and their positions prior to commencing work.

5) All setout of the works is the responsibility of the contractor.

6) Hardfill backfill to be placed under all roads and driveways at the direction of the engineer.

7) Contractor is to arrange appropriate traffic permits and is responsible for maintaining traffic safety.

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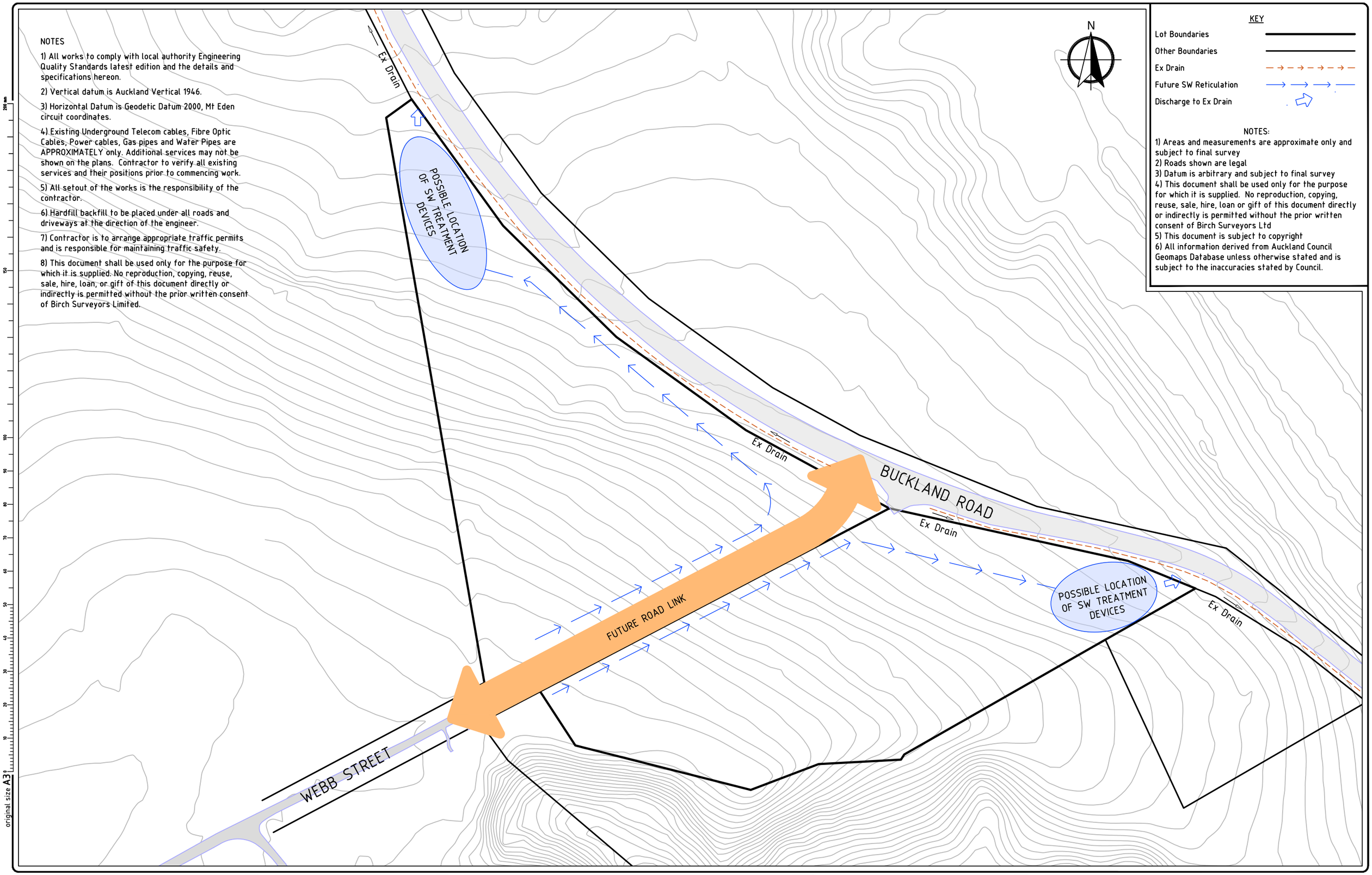

KEY

- Lot Boundaries
- Other Boundaries
- Ex Drain
- Future SW Reticulation
- Discharge to Ex Drain

NOTES:

1) Areas and measurements are approximate only and subject to final survey
2) Roads shown are legal
3) Datum is arbitrary and subject to final survey
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original size A3

Birch Planning Surveying Engineering
LAND DEVELOPMENT CONSULTANTS
Property House
2A Wesley Street, Pukekohe
PO Box 475,
Pukekohe 2340
Ph: 09 237 1111
Fax: 09 238 0033
pukekohe@bslnz.com
www.birchsurveyors.co.nz

Telarc Registered Quality ISO 9001

LOCAL AUTHORITY	AUCKLAND COUNCIL
PLANNING MAP	-
ZONING	FUTURE URBAN
ACTIVITY	-
COMPRISED IN	NA56A/559 & NA21A/288
TOTAL AREA	7.85ha
REGISTERED OWNERS	Peterex Properties & Pukekohe Ltd

PROJECT NAME

PUKEKOHE LTD

303 BUCKLAND ROAD
PUKEKOHE

Surveyed -	Date -	Project No.	5275
Designed -	Date -	Scale	Hz: 1:2000 @ A3
Drawn KDB	Date 11/2021		
Approved PROJECT MANAGER	Date		

REV.	BY	DATE	COMMENT
A	KDB	12/21	Release

TITLE

INDICATIVE SW TREATMENT LAYOUT

Drawing Name	F:\..CAD\CP 5275 A.dwg /SW	Rev.	A

APPENDIX B

SWALE CALCULATIONS

DETENTION TANK CALCULATIONS

RAINGARDEN CALCULATIONS

HYDROLOGY CALCULATIONS (TP108)

2a Wesley Street
PO Box 475
Pukekohe 2340

BIRCH SURVEYORS LTD
Land Surveyors • Resource Consultants • Planners

ph: 09 237 1111
fax 09 238 0033

SWALE DESIGN TO GD04 GUIDELINES (ARC TP10) - Half Webb St Extension

Pervious Catchment

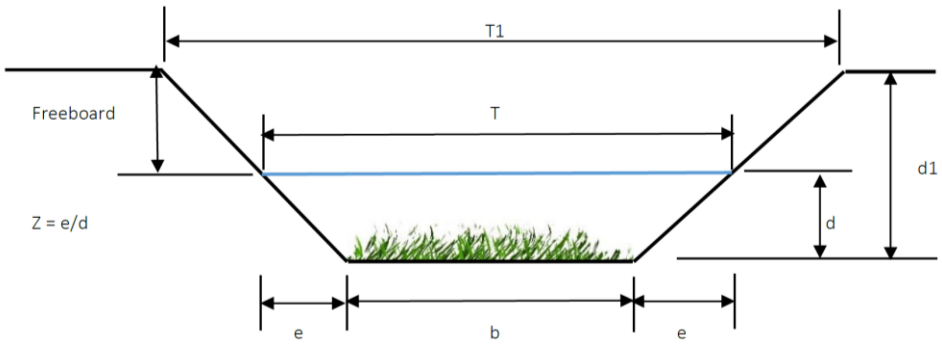
			WQV $^1/_3$ 2yr	50% AEP 2yr ARI	20% AEP 5yr ARI	10% AEP 10yr ARI	5% AEP 20yr ARI	2% AEP 50yr ARI	1% AEP 100yr ARI
Area Pervious		ha	0.0750	0.075	0.075	0.075	0.075	0.075	0.075
Hydrological Soil Group			Group_B	Group_B	Group_B	Group_B	Group_B	Group_B	Group_B
CN			61	61	61	61	61	61	61
P_{24}		mm	25.3333	76	111	136	163	187	210
Peak Rainfall		mm	17.1	51.3	74.925	91.8	110.025	126.225	141.75
Ia			5	5	5	5	5	5	5
S			162.39	162.39	162.39	162.39	162.39	162.39	162.39
c*			0.0881	0.3093	0.4181	0.4809	0.5379	0.5811	0.6170
Peak Runoff		m^3/s	0.0003	0.0033	0.0065	0.0092	0.0123	0.0153	0.0182
Peak Runoff		l/s	0.31	3.31	6.53	9.20	12.33	15.28	18.22

Impervious Catchment

Area Impervious		ha	0.1750	0.175	0.175	0.175	0.175	0.175	0.175
CN			98	98	98	98	98	98	98
P_{24}		mm	25.3333	76	111	136	163	187	210
Peak Rainfall		mm	17.1	51.3	74.925	91.8	110.025	126.225	141.75
Ia			0	0	0	0	0	0	0
S			5.18	5.18	5.18	5.18	5.18	5.18	5.18
c*			0.9157	0.9856	0.9927	0.9950	0.9964	0.9972	0.9978
Peak Runoff		m^3/s	0.0076	0.0246	0.0362	0.0444	0.0533	0.0612	0.0688
Peak Runoff		l/s	7.61	24.58	36.16	44.40	53.29	61.19	68.75
Combined Runoff		l/s	7.93	27.88	42.68	53.60	65.62	76.47	86.97
Peak Flow in Swale		l/s	7.05	24.82	37.99	47.70	58.40	68.06	77.41

STORMWATER SWALE

Swale Channel Slope	s	m/m	0.04	0.04	0.04	0.04	0.04	0.04	0.04
length of Grass		mm	75	75	75	75	75	75	75
Depth of Flow	d	m	0.053	0.082	0.093	0.101	0.107	0.113	0.117
manning n	n		0.23	0.15	0.13	0.12	0.11	0.10	0.10
Flowrate	Q	m^3/s	0.007	0.025	0.038	0.048	0.058	0.068	0.077
Side Slope	Z	1/	4	4	4	4	4	4	4
Bottom Width	b	m	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Top width	T	m	1.32	1.56	1.65	1.70	1.76	1.80	1.84
cross sectional Area		m^2	0.0589	0.1007	0.1191	0.1309	0.1421	0.1519	0.1601
flow Velocity	v	m/s	0.12	0.25	0.32	0.36	0.41	0.45	0.48
WQ Event Velocity Check			✓	✓	✓	✓	✓	✓	✓
Ultimate Velocity Check			✓	✓	✓	✓	✓	✓	✓
time of flow	t	min	9						
swale Length	l	m	64.63						
maximum available swale length		m	100.00						
Design Top width	T1	m	2.65	2.65	2.65	2.65	2.65	2.65	2.65
Design Depth of Swale	d1	mm	219	219	219	219	219	219	219
Freeboard		mm	166	137	125	118	112	106	102



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Birch surveyors

TYPICAL DETENTION CALCULATIONS - For a 2000m² Building

Client	Buckland Road Plan Change	**Analysis Date**	2-Dec-21
Address	Buckland Road, Pukekohe	**SMAF Zone**	1
Project Number	5275	**10% AEP Flood Mitigation Required**	Yes

SMAF 1 Requirements:

Provide Retention (Volume Reduction) of a 5mm 24hr rainfall event for the impervious area for which hydrology mitigation is required

Provide Detention (Temporary Storage) with a volume equal to the increase in runoff volume from the 95th percentile 24hr rainfall event for the impervious area for which hydrology mitigation is required

Site Data

New and Redeveloped Impervious Area	1000	m²	Total Site Area	1000	m²
Percentage of Total Site Area	100%		Total Site Post Development Impervious Area	1000	m²
Hydrographical Soil Group	Group_B		Impervious Area required to be Mitigated	1000	m²
95th %ile 24hr Rainfall Depth	33	mm	Pervious Area required to be Mitigated	0	m²

Pre Development

Pre Developed Area to be Mitigated		1000	m²
Curve Number	(CN)	61	
Initial Abstraction	(Ia)	5	mm
Storage	(S)	162.39	mm

		Design Storm
ARI		95th %ile 24hr Rainfall
24 Hr Rainfall depth	(P_{24})	33 mm
Runoff Depth	(Q_{24})	4.12 mm
Runoff Volume	(V_{24})	4.12 m³

Table 3.3 - Curve numbers for typical Auckland conditions

Land use	Group A Soil (volcanic granular loam)	Group B Soil (alluvial)	Group C Soil (mudstone/sandstone)
Bush, humid-climate, not-grazed	30	55	70
Pasture, lightly grazed, good grass cover	39	61	74
Urban lawns	39	61	74
Crops, straight rows, minimal vegetative cover	72	81	88
Sealed roads, roofs	98	98	98

Post Development

		Area (m²)	CN	Product
Total Impervious Area to be Mitigated		1000	98	98000
Total Pervious Area to be mitigated		0	61	0
Total		1000		98000
% Impervious		100%		
CN Weighted		98.00		
Initial Abstraction Weighted	(Ia)	0.00 mm		
Storage	(S)	5.18 mm		

Storm Event (ARI)		Storm Event Retention Storm 5mm	Storm Event Detention Storm 95th %ile 24hr Rainfall	
24 Hr Rainfall depth	(P_{24})	5	33	mm
Runoff Depth	(Q_{24})	5	28.52	mm
Runoff Volume	(V_{24})	5.00	28.52	m³

SMAF Volume Requirements

Total Detention & Retention Volume Required	24.40 m³	(Post Dev - Pre Dev)	
Minimum Retention Volume Required	5.00 m³	Soakhole	Good Soakage
Minimum Detention Volume Required	19.40 m³		
Average Outflow to Detention Volume in 24 hours	0.22 l/s	for Pipe Tank use 0.86 reduction in flow	
Peak Orifice Outflow (2x Average Flow)	0.45 l/s		0.39 l/s
Head above Orifice	0.28 m		0.28 m
Orifice discharge coefficient	0.62		0.62
Orifice Diameter (Orifice 1)	20.0 mm		18.5 mm

Flood Mitigation for 10yr Event

	Area (m2)	CN	10% AEP P_{24}	t_c	c*	q*	Q (l/s)
Pre Development (TP108 Calcs)	1000	61	120	10	0.2530	0.078	9.34

Peak Orifice Outflow (10 yr Storm - SMAF Storm)	8.9 l/s	Imp Area	1000	0.95	950	m²
Average Orifice Outflow (10yr Storm - Orifice 2)	4.4 l/s	Per Area	0	0.4	0	m²
		Reduced Area			950	m²

Detention Tank Calcs (10yr storm with CC Factor)

Time Duration (min)	Intensity (mm/hr)	Reduced Area (m²)	Flow (l/s)	Time to Fill SMAF (min)	Tank Inflow (m³)	Outflow Orifice 1 (m³)	Outflow Orifice 2 (m³)	10% AEP Storage (m³)
10	89.76	950	23.7	17.2	0.00	0.13	0.00	-0.13
20	69.36	950	18.3	22.2	0.00	0.27	0.00	-0.27
30	50.4	950	13.3	30.6	0.00	0.40	0.00	-0.40
60	40.8	950	10.8	37.8	14.36	1.11	5.93	7.32
120	27.88	950	7.4	55.3	28.57	2.49	17.27	8.81
360	10.88	950	2.9	141.7	37.61	7.79	58.27	-28.45
720	7.14	950	1.9	215.9	56.99	16.49	134.54	-94.04

Minimum Detention Storage Required for 10yr Storm Event 8.81 m3

Average Orifice Outflow (10yr Storm - Orifice 2)	4.4 l/s	for Pipe Tank use 0.86 reduction in flow	
Peak Orifice Outflow (10 yr Storm)	8.9 l/s		7.7 l/s
Head above Orifice	0.10 m		0.10 m
Orifice discharge coefficient	0.62		0.62
Orifice Diameter (Orifice 2)	80.1 mm		74.3 mm

Detention Tank Square Versitank

Tank Length	L	8.35 m	Tank Area	69.72	m²
Tank Width	W	8.35 m	Volume	30.68	m³ total
Tank Height	h	0.44 m			
Number of Tanks	n	1			

Number of Orifice Holes			2	total	
Outlet Orifice Diameter	d1	20.0 mm			
Orifice 2 Diameter	d2	80.1 mm	Height above Outlet Orifice	0.10	m
Orifice Discharge Coefficient			0.62		

Hydrology - by Rational Formula

Time of Concentration	Tc	10 min	(Building Tc)
Storm Duration	D	60 min	(Total Site Tc)

Rainfall Intensity (20% AEP for D)	40.8	mm/hr
Rainfall Intensity (20% AEP for Tc)	89.76	mm/hr

	C Value	Peak Discharge (Tc)		Storm Discharge (D)	
Roof + Connected Impervious	0.95	23.69 l/s	To Detention Tank	10.77	l/s
Rest of Site	0.40	0.00 l/s		0.00	l/s
Pre Development Site Discharge		9.34 l/s			
Maximum Allowable Tank Discharge		9.34 l/s			
Actual Tank Discharge		6.97 l/s			
Actual Tank Storage		22.63 m³			

Simulation

Time Step 4 min

Time	Runoff	Tank Inflow		Tank Storage	Tank WL	Adjusted AV WL	Tank Outflow	Tank Storage	SITE RUNOFF CALC Rest of Site	Total
(mins)	l/s	l/s	m³	m³	m	m	l/s	m³	l/s	l/s
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	4.31	4.23	0.51	0.49	0.01	0.01	0.07	0.49	0.00	0.07
8	8.61	8.61	1.54	2.03	0.03	0.03	0.15	2.03	0.00	0.15
12	10.77	10.77	2.33	4.44	0.06	0.06	0.22	4.44	0.00	0.22
16	10.77	10.77	2.58	6.97	0.10	0.10	0.27	6.97	0.00	0.27
20	10.77	10.77	2.58	9.16	0.13	0.13	2.59	9.15	0.00	2.59
24	10.77	10.77	2.58	11.00	0.16	0.16	3.54	10.98	0.00	3.54
28	10.77	10.77	2.58	12.65	0.18	0.18	4.20	12.64	0.00	4.20
32	10.77	10.77	2.58	14.16	0.20	0.20	4.73	14.14	0.00	4.73
36	10.77	10.77	2.58	15.54	0.22	0.22	5.16	15.52	0.00	5.16
40	10.77	10.77	2.58	16.84	0.24	0.24	5.53	16.82	0.00	5.53
44	10.77	10.77	2.58	18.05	0.26	0.26	5.86	18.03	0.00	5.86
48	10.77	10.77	2.58	19.19	0.28	0.28	6.16	19.17	0.00	6.16
52	10.77	10.77	2.58	20.27	0.29	0.29	6.42	20.24	0.00	6.42
56	10.77	10.77	2.58	21.28	0.31	0.31	6.66	21.26	0.00	6.66
60	10.77	10.77	2.58	22.24	0.32	0.32	6.88	22.22	0.00	6.88
64	6.46	6.53	2.08	22.66	0.33	0.33	6.97	22.63	0.00	6.97
68	2.15	2.23	1.05	22.05	0.32	0.32	6.84	22.02	0.00	6.84
72	0.00	0.00	0.00	20.58	0.30	0.30	6.50	20.56	0.00	6.50
76	0.00	0.00	0.00	19.07	0.27	0.27	6.13	19.04	0.00	6.13
80	0.00	0.00	0.00	17.64	0.25	0.25	5.76	17.62	0.00	5.76
84	0.00	0.00	0.00	16.30	0.23	0.23	5.38	16.28	0.00	5.38
88	0.00	0.00	0.00	15.06	0.22	0.22	5.01	15.04	0.00	5.01
92	0.00	0.00	0.00	13.88	0.20	0.20	4.63	13.86	0.00	4.63
96	0.00	0.00	0.00	12.81	0.18	0.18	4.26	12.79	0.00	4.26
100	0.00	0.00	0.00	11.83	0.17	0.17	3.89	11.82	0.00	3.89
104	0.00	0.00	0.00	10.94	0.16	0.16	3.51	10.93	0.00	3.51
108	0.00	0.00	0.00	10.14	0.15	0.15	3.14	10.13	0.00	3.14
112	0.00	0.00	0.00	9.44	0.14	0.14	2.76	9.43	0.00	2.76
116	0.00	0.00	0.00	8.82	0.13	0.13	2.37	8.81	0.00	2.37
120	0.00	0.00	0.00	8.30	0.12	0.12	1.98	8.29	0.00	1.98
124	0.00	0.00	0.00	7.87	0.11	0.11	1.58	7.86	0.00	1.58
128	0.00	0.00	0.00	7.54	0.11	0.11	1.16	7.53	0.00	1.16
132	0.00	0.00	0.00	7.31	0.10	0.10	0.68	7.31	0.00	0.68
136	0.00	0.00	0.00	7.22	0.10	0.10	0.28	7.21	0.00	0.28
140	0.00	0.00	0.00	7.15	0.10	0.10	0.27	7.15	0.00	0.27
144	0.00	0.00	0.00	7.08	0.10	0.10	0.27	7.08	0.00	0.27
148	0.00	0.00	0.00	7.02	0.10	0.10	0.27	7.02	0.00	0.27
152	0.00	0.00	0.00	6.95	0.10	0.10	0.27	6.95	0.00	0.27
156	0.00	0.00	0.00	6.89	0.10	0.10	0.27	6.89	0.00	0.27
160	0.00	0.00	0.00	6.82	0.10	0.10	0.27	6.82	0.00	0.27
164	0.00	0.00	0.00	6.76	0.10	0.10	0.27	6.76	0.00	0.27
168	0.00	0.00	0.00	6.70	0.10	0.10	0.27	6.70	0.00	0.27
172	0.00	0.00	0.00	6.63	0.10	0.10	0.26	6.63	0.00	0.26
176	0.00	0.00	0.00	6.57	0.09	0.09	0.26	6.57	0.00	0.26
180	0.00	0.00	0.00	6.51	0.09	0.09	0.26	6.51	0.00	0.26
184	0.00	0.00	0.00	6.44	0.09	0.09	0.26	6.44	0.00	0.26
188	0.00	0.00	0.00	6.38	0.09	0.09	0.26	6.38	0.00	0.26
192	0.00	0.00	0.00	6.32	0.09	0.09	0.26	6.32	0.00	0.26
196	0.00	0.00	0.00	6.26	0.09	0.09	0.26	6.26	0.00	0.26

RESULTS

Tank Area	69.72	m²
Tank Height	0.33	m
Orifice Diameter	19.95	mm
Total Tank Volume	22.64	m³
Maximum Site Discharge	6.97	l/s

RAINGARDEN DESIGN - BASED ON GD2017/001

Instructions

Adjustable design parameters		Input yellow cells only
95th %ile Rainfall Depth (mm)	33	From Fig. 14 of TR2013/035 (SMAF 1)
Pre-development Curve Number	61	From Table 3.3 of TP108
Impervious Area (m^2)	1000	
Soil Infiltration Rate (mm/hr)	2	Use default value of 2 mm/hr unless specific infiltration data is available (e.g. via TP58 infiltration methodology)
Evapotranspiration Rate (mm/day)	3	Use default value of 3 mm/day for typical vegetation. Use higher values for trees.

Impervious Runoff (TP108)		
Storage (mm)	5.2	'S' storage using CN 98
Runoff depth (mm)	28.5	Q_{24} using Ia = 0

Pre-Development Runoff (TP108)		
Storage (mm)	162.4	'S' storage using CN61
Runoff Depth (mm)	4.1	Q_{24} using Ia = 5 for pervious surface (TP10)

Hydrology Management Runoff Depth (mm)	24.4	This is the difference in runoff when comparing green field to road surface. Pre-post…
Hydrology Management Volume (m^3)	**24.40**	Apply runoff depth over new impervious area (roof for instance) = WQV (the volume to be treated)
Detention Volume (m^3)	**19.40**	Total volume minus the retention volume which is lost due to infiltration and evapotranspiration
Retention Volume (m^3)	**5.00**	Calculated as 5mm of rainfall which is lost through the base of the rain garden

Minimum Infiltration Area Required (m^2) A_f	**32.68**	This is the infiltration area of the rain garden required to regenerate the retention volume in 72 hours

Using the calculation:

Rain Garden Design Parameters

Ponding Area (m^2)	70.00	Based on minimum infiltration area above, rounded up
Ponding Depth (mm)	300	
Media Depth - including transition layer (mm)	800	
Aggregate Depth - above underdrain invert (mm)	150	
Aggregate Depth - below underdrain invert (mm)	210	
Infiltration Area (m^2)	70.0	This must be at least as large as the value in Cell B22

Media Void Space (%)	30%	Use default value of 30%
Aggregate Void Space (%)	35%	Use default value of 35%

Ponding Volume - Detention (m^3)	21.00	200mm depth of water before overflowing to catchpit
Media Volume - Detention (m^3)	16.80	The volume of water trapped in the rain garden mix
Aggregate Volume - Detention (m^3)	3.68	The volume of water trapped above the underdrain invert
Aggregate Volume - Retention (m^3)	5.15	The volume of water trapped below the underdrain invert

Total Detention Volume Provided (m^3)	**41.48**	The volume above the underdrain invert
Total Retention Volume Provided (m^3)	**5.15**	The volume below the underdrain invert which relies on the infiltration to the soil in the base of the garden

2a Wesley Street
PO Box 475
Pukekohe 2340

BIRCH SURVEYORS LTD
Land Surveyors • Resource Consultants • Planners

ph: 09 237 1111
fax 09 238 0033

STORMWATER FLOWS - Site Catchment

Existing Pervious Area

		CN	Area	Product
Hydrological Soil Group			Group B	
Grassed		61	4.0500	247.0500
		totals	4.0500	247.0500
% Impervious			0.00%	
CN weighted			61.0000	
I_a weighted			5.0000	
Channelisation factor	(C)		1.0000	
Catchment Length	(l)		0.4120	km
Catchment Slope	(S_c)		0.0450	m/m
Runoff Factor			0.4388	
Time of Concentration	(t_c)		0.3110	hrs
Use	(t_c)		0.3110	hrs
Catchment Area			0.0405	km^2
CN			61.0000	
Storage	(S)		162.3934	mm

18.7 min
18.7 min

Buckland Road Plan Change - NW Catchment

Table 3.3 - Curve numbers for typical Auckland conditions

Land use	Group A Soil (volcanic granular loam)	Group B Soil (alluvial)	Group C Soil (mudstone/sandstone)
Bush, humid-climate, not-grazed	30	55	70
Pasture, lightly grazed, good grass cover	39	61	74
Urban lawns	39	61	74
Crops, straight rows, minimal vegetative cover	72	81	88
Sealed roads, roofs	98	98	98

			WQV $^1/_3$ 2yr	Ex. Det.	50% AEP 2yr ARI	20% AEP 5yr ARI	10% AEP 10yr ARI	5% AEP 20yr ARI	2% AEP 50yr ARI	1% AEP 100yr ARI
24 hour rainfall depth	(P_{24})	mm	23.3333	34.50	70	100	120	140	160	180
c*			0.0394	0.0701	0.1559	0.2170	0.2530	0.2858	0.3159	0.3436
q* from ARC		Approx	0.026	0.026	0.041	0.056	0.064	0.070	0.075	0.079
Peak Flowrate	(q_p)	cumecs	0.0245	0.0362	0.1175	0.2278	0.3091	0.3947	0.4838	0.5757
Peak Flowrate	(q_p)	l/s	24	36	118	228	309	395	484	576
24 hour Runoff Depth	(Q_{24})	mm	1.86	4.54	18.58	35.06	47.68	61.28	75.69	90.77
24 hour Runoff Volume	(V_{24})	cu mtr	75	184	752	1420	1931	2482	3066	3676

STORMWATER FLOWS - Site Catchment

Existing Impervious

		CN	Area	Product
Hydrological Soil Group			Group_B_Impervious	
Building		98	0.0610	5.9780
		totals	0.0610	5.9780
% Impervious			100.00%	
CN weighted			98.0000	
I_a weighted			0.0000	
Channelisation factor	(C)		1.0000	
Catchment Length	(l)		0.4120	km
Catchment Slope	(S_c)		0.0450	m/m
Runoff Factor			0.9608	
Time of Concentration	(t_c)		0.2021	hrs
Use	(t_c)		0.2021	hrs
Catchment Area			0.0006	km^2
CN			98.0000	
Storage	(S)		5.1837	mm

12.1 min
12.1 min

			WQV $^1/_3$ 2yr	Ex. Det.	50% AEP 2yr ARI	20% AEP 5yr ARI	10% AEP 10yr ARI	5% AEP 20yr ARI	2% AEP 50yr ARI	1% AEP 100yr ARI
24 hour rainfall depth	(P_{24})	mm	23.3333	34.50	70	100	120	140	160	180
c*			0.6924	0.7689	0.8710	0.9061	0.9205	0.9311	0.9391	0.9455
q* from ARC		Approx	0.135	0.142	0.150	0.153	0.154	0.155	0.155	0.156
Peak Flowrate	(q_p)	cumecs	0.0019	0.0030	0.0064	0.0093	0.0113	0.0132	0.0152	0.0171
Peak Flowrate	(q_p)	l/s	2	3	6	9	11	13	15	17
24 hour Runoff Depth	(Q_{24})	mm	19.09	29.99	65.17	95.07	115.03	135.00	154.98	174.96
24 hour Runoff Volume	(V_{24})	cu mtr	12	18	40	58	70	82	95	107

Existing Flows

			WQV $^1/_3$ 2yr	Ex. Det.	50% AEP 2yr ARI	20% AEP 5yr ARI	10% AEP 10yr ARI	5% AEP 20yr ARI	2% AEP 50yr ARI	1% AEP 100yr ARI
24 hour rainfall depth	(P_{24})	mm	23.3333	34.50	70	100	120	140	160	180
Peak Flowrate	(q_p)	cumecs	0.0264	0.0392	0.1240	0.2371	0.3203	0.4079	0.4990	0.5927
Peak Flowrate	(q_p)	l/s	26	39	124	237	320	408	499	593
24 hour Runoff Volume	(V_{24})	cu mtr	87	202	792	1478	2001	2564	3160	3783

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STORMWATER FLOWS - Site Catchment

Post Development Pervious

		CN	Area	Product
Hydrological Soil Group			Group B	
Grass		61	0.4000	24.4000
		totals	0.4000	24.4000
% Impervious			0.00%	
CN weighted			61.0000	
la weighted			5.0000	
Channelisation factor	(C)		0.6000	
Catchment Length	(l)		0.4120	km
Catchment Slope	(S_c)		0.0450	m/m
Runoff Factor			0.4388	
Time of Concentration	(t_c)		0.1866	hrs
Use	(t_c)		0.1866	hrs
Catchment Area			0.0040	km²
CN			61.0000	
Storage	(S)		162.3934	mm

11.2 min
11.2 min

Buckland Road Plan Change - NW Catchment

Table 3.3 - Curve numbers for typical Auckland conditions

Land use	Group A Soil (volcanic granular loam)	Group B Soil (alluvial)	Group C Soil (mudstone/sandstone)
Bush, humid-climate, not-grazed	30	55	70
Pasture, lightly grazed, good grass cover	39	61	74
Urban lawns	39	61	74
Crops, straight rows, minimal vegetative cover	72	81	88
Sealed roads, roofs	98	98	98

			WQV $^1/_3$ 2yr	Ex. Det.	50% AEP 2yr ARI	20% AEP 5yr ARI	10% AEP 10yr ARI	5% AEP 20yr ARI	2% AEP 50yr ARI	1% AEP 100yr ARI
24 hour rainfall depth	(P_{24})	mm	25.3333	34.50	76	111	136	163	187	210
c*			0.0451	0.0701	0.1689	0.2372	0.2795	0.3202	0.3527	0.3811
q* from ARC		Approx	0.031	0.031	0.053	0.072	0.081	0.089	0.095	0.100
Peak Flowrate	(q_p)	cumecs	0.0031	0.0042	0.0162	0.0318	0.0441	0.0582	0.0711	0.0839
Peak Flowrate	(q_p)	l/s	3	4	16	32	44	58	71	84
24 hour Runoff Depth	(Q_{24})	mm	2.26	4.54	21.60	41.86	58.49	77.92	96.18	114.39
24 hour Runoff Volume	(V_{24})	cu mtr	9	18	86	167	234	312	385	458

STORMWATER FLOWS - Site Catchment

Post Development Impervious

		CN	Area	Product
Hydrological Soil Group			Group_B_Impervious	
Building		98	1.8555	181.8390
Roads		98	1.8555	181.8390
		totals	3.7110	363.6780
% Impervious			100.00%	
CN weighted			98.0000	
la weighted			0.0000	
Channelisation factor	(C)		0.6000	
Catchment Length	(l)		0.4120	km
Catchment Slope	(S_c)		0.0450	m/m
Runoff Factor			0.9608	
Time of Concentration	(t_c)		0.1213	hrs
Use	(t_c)		0.1667	hrs
Catchment Area			0.0371	km²
CN			98.0000	
Storage	(S)		5.1837	mm

7.3 min
10.0 min

			WQV $^1/_3$ 2yr	Ex. Det.	50% AEP 2yr ARI	20% AEP 5yr ARI	10% AEP 10yr ARI	5% AEP 20yr ARI	2% AEP 50yr ARI	1% AEP 100yr ARI
24 hour rainfall depth	(P_{24})	mm	25.3333	34.50	76	111	136	163	187	210
c*			0.7096	0.7689	0.8800	0.9146	0.9292	0.9402	0.9475	0.9530
q* from ARC		Approx	0.145	0.150	0.160	0.163	0.164	0.165	0.165	0.166
Peak Flowrate	(q_p)	cumecs	0.1362	0.1926	0.4511	0.6701	0.8267	0.9960	1.1464	1.2906
Peak Flowrate	(q_p)	l/s	136	193	451	670	827	996	1146	1291
24 hour Runoff Depth	(Q_{24})	mm	21.03	29.99	71.15	106.05	131.01	157.98	181.96	204.94
24 hour Runoff Volume	(V_{24})	cu mtr	780	1113	2640	3935	4862	5862	6752	7605

Post Development Flows

			WQV $^1/_3$ 2yr	Ex. Det.	50% AEP 2yr ARI	20% AEP 5yr ARI	10% AEP 10yr ARI	5% AEP 20yr ARI	2% AEP 50yr ARI	1% AEP 100yr ARI
24 hour rainfall depth	(P_{24})	mm	25.3333	34.50	76	111	136	163	187	210
Peak Flowrate	(q_p)	cumecs	0.1393	0.1969	0.4673	0.7019	0.8709	1.0541	1.2175	1.3745
Peak Flowrate	(q_p)	l/s	139	197	467	702	871	1054	1218	1375
24 hour Runoff Volume	(V_{24})	cu mtr	789	1131	2727	4103	5096	6174	7137	8063

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STORMWATER FLOWS - Site Catchment

Existing Pervious Area

Hydrological Soil Group			Group B	
		CN	Area	Product
Grassed		61	3.7045	225.9745
		totals	3.7045	225.9745
% Impervious			0.00%	
CN weighted			61.0000	
I_a weighted			5.0000	
Channelisation factor	(C)		1.0000	
Catchment Length	(l)		0.4070	km
Catchment Slope	(S_c)		0.0430	m/m
Runoff Factor			0.4388	
Time of Concentration	(t_c)		0.3127	hrs
Use	(t_c)		0.3127	hrs
Catchment Area			0.0370	km^2
CN			61.0000	
Storage	(S)		162.3934	mm

18.8 min
18.8 min

Buckland Road Plan Change - SE Catchment

Table 3.3 - Curve numbers for typical Auckland conditions

Land use	Group A Soil (volcanic granular loam)	Group B Soil (alluvial)	Group C Soil (mudstone/sandstone)
Bush, humid-climate, not-grazed	30	55	70
Pasture, lightly grazed, good grass cover	39	61	74
Urban lawns	39	61	74
Crops, straight rows, minimal vegetative cover	72	81	88
Sealed roads, roofs	98	98	98

			WQV $^1/_3$ 2yr	Ex. Det.	50% AEP 2yr ARI	20% AEP 5yr ARI	10% AEP 10yr ARI	5% AEP 20yr ARI	2% AEP 50yr ARI	1% AEP 100yr ARI
24 hour rainfall depth	(P_{24})	mm	23.3333	34.50	70	100	120	140	160	180
c*			0.0394	0.0701	0.1559	0.2170	0.2530	0.2858	0.3159	0.3436
q* from ARC		Approx	0.026	0.026	0.041	0.056	0.063	0.069	0.075	0.079
Peak Flowrate	(q_p)	cumecs	0.0223	0.0330	0.1073	0.2079	0.2821	0.3603	0.4417	0.5255
Peak Flowrate	(q_p)	l/s	22	33	107	208	282	360	442	525
24 hour Runoff Depth	(Q_{24})	mm	1.86	4.54	18.58	35.06	47.68	61.28	75.69	90.77
24 hour Runoff Volume	(V_{24})	cu mtr	69	168	688	1299	1766	2270	2804	3363

STORMWATER FLOWS - Site Catchment

Existing Impervious

Hydrological Soil Group			Group_B_Impervious	
		CN	Area	Product
Building		98	0.0565	5.5370
		totals	0.0565	5.5370
% Impervious			100.00%	
CN weighted			98.0000	
I_a weighted			0.0000	
Channelisation factor	(C)		1.0000	
Catchment Length	(l)		0.4070	km
Catchment Slope	(S_c)		0.0430	m/m
Runoff Factor			0.9608	
Time of Concentration	(t_c)		0.2032	hrs
Use	(t_c)		0.2032	hrs
Catchment Area			0.0006	km^2
CN			98.0000	
Storage	(S)		5.1837	mm

12.2 min
12.2 min

			WQV $^1/_3$ 2yr	Ex. Det.	50% AEP 2yr ARI	20% AEP 5yr ARI	10% AEP 10yr ARI	5% AEP 20yr ARI	2% AEP 50yr ARI	1% AEP 100yr ARI
24 hour rainfall depth	(P_{24})	mm	23.3333	34.50	70	100	120	140	160	180
c*			0.6924	0.7689	0.8710	0.9061	0.9205	0.9311	0.9391	0.9455
q* from ARC		Approx	0.135	0.142	0.150	0.153	0.154	0.154	0.155	0.155
Peak Flowrate	(q_p)	cumecs	0.0018	0.0028	0.0059	0.0086	0.0104	0.0122	0.0140	0.0158
Peak Flowrate	(q_p)	l/s	2	3	6	9	10	12	14	16
24 hour Runoff Depth	(Q_{24})	mm	19.09	29.99	65.17	95.07	115.03	135.00	154.98	174.96
24 hour Runoff Volume	(V_{24})	cu mtr	11	17	37	54	65	76	88	99

Existing Flows

			WQV $^1/_3$ 2yr	Ex. Det.	50% AEP 2yr ARI	20% AEP 5yr ARI	10% AEP 10yr ARI	5% AEP 20yr ARI	2% AEP 50yr ARI	1% AEP 100yr ARI
24 hour rainfall depth	(P_{24})	mm	23.3333	34.50	70	100	120	140	160	180
Peak Flowrate	(q_p)	cumecs	0.0241	0.0358	0.1132	0.2165	0.2925	0.3726	0.4557	0.5413
Peak Flowrate	(q_p)	l/s	24	36	113	217	293	373	456	541
24 hour Runoff Volume	(V_{24})	cu mtr	80	185	725	1353	1831	2346	2892	3461

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STORMWATER FLOWS - Site Catchment

Post Development Pervious

Buckland Road Plan Change - SE Catchment

Hydrological Soil Group		Group B	
	CN	Area	Product
Grass	61	0.3760	22.9360
totals		0.3760	22.9360
% Impervious		0.00%	
CN weighted		61.0000	
la weighted		5.0000	
Channelisation factor	(C)	0.6000	
Catchment Length	(l)	0.4070	km
Catchment Slope	(S_c)	0.0430	m/m
Runoff Factor		0.4388	
Time of Concentration	(t_c)	0.1876	hrs
Use	(t_c)	0.1876	hrs
Catchment Area		0.0038	km²
CN		61.0000	
Storage	(S)	162.3934	mm

11.3 min
11.3 min

Table 3.3 - Curve numbers for typical Auckland conditions

Land use	Group A Soil (volcanic granular loam)	Group B Soil (alluvial)	Group C Soil (mudstone/sandstone)
Bush, humid-climate, not-grazed	30	55	70
Pasture, lightly grazed, good grass cover	39	61	74
Urban lawns	39	61	74
Crops, straight rows, minimal vegetative cover	72	81	88
Sealed roads, roofs	98	98	98

			WQV $^1/_3$ 2yr	Ex. Det.	50% AEP 2yr ARI	20% AEP 5yr ARI	10% AEP 10yr ARI	5% AEP 20yr ARI	2% AEP 50yr ARI	1% AEP 100yr ARI
24 hour rainfall depth	(P_{24})	mm	25.3333	34.50	76	111	136	163	187	210
c*			0.0451	0.0701	0.1689	0.2372	0.2795	0.3202	0.3527	0.3811
q* from ARC		Approx	0.031	0.031	0.053	0.071	0.081	0.089	0.095	0.100
Peak Flowrate	(q_p)	cumecs	0.0029	0.0040	0.0152	0.0298	0.0414	0.0546	0.0668	0.0787
Peak Flowrate	(q_p)	l/s	3	4	15	30	41	55	67	79
24 hour Runoff Depth	(Q_{24})	mm	2.26	4.54	21.60	41.86	58.49	77.92	96.18	114.39
24 hour Runoff Volume	(V_{24})	cu mtr	9	17	81	157	220	293	362	430

STORMWATER FLOWS - Site Catchment

Post Development Impervious

Hydrological Soil Group		Group_B_Impervious	
	CN	Area	Product
Building	98	1.6925	165.8650
Roads	98	1.6925	165.8650
totals		3.3850	331.7300
% Impervious		100.00%	
CN weighted		98.0000	
la weighted		0.0000	
Channelisation factor	(C)	0.6000	
Catchment Length	(l)	0.4070	km
Catchment Slope	(S_c)	0.0430	m/m
Runoff Factor		0.9608	
Time of Concentration	(t_c)	0.1219	hrs
Use	(t_c)	0.1667	hrs
Catchment Area		0.0339	km²
CN		98.0000	
Storage	(S)	5.1837	mm

7.3 min
10.0 min

			WQV $^1/_3$ 2yr	Ex. Det.	50% AEP 2yr ARI	20% AEP 5yr ARI	10% AEP 10yr ARI	5% AEP 20yr ARI	2% AEP 50yr ARI	1% AEP 100yr ARI
24 hour rainfall depth	(P_{24})	mm	25.3333	34.50	76	111	136	163	187	210
c*			0.7096	0.7689	0.8800	0.9146	0.9292	0.9402	0.9475	0.9530
q* from ARC		Approx	0.145	0.150	0.160	0.163	0.164	0.165	0.165	0.166
Peak Flowrate	(q_p)	cumecs	0.1242	0.1757	0.4115	0.6113	0.7541	0.9085	1.0457	1.1772
Peak Flowrate	(q_p)	l/s	124	176	411	611	754	908	1046	1177
24 hour Runoff Depth	(Q_{24})	mm	21.03	29.99	71.15	106.05	131.01	157.98	181.96	204.94
24 hour Runoff Volume	(V_{24})	cu mtr	712	1015	2408	3590	4435	5347	6159	6937

Post Development Flows

			WQV $^1/_3$ 2yr	Ex. Det.	50% AEP 2yr ARI	20% AEP 5yr ARI	10% AEP 10yr ARI	5% AEP 20yr ARI	2% AEP 50yr ARI	1% AEP 100yr ARI
24 hour rainfall depth	(P_{24})	mm	25.3333	34.50	76	111	136	163	187	210
Peak Flowrate	(q_p)	cumecs	0.1272	0.1797	0.4266	0.6411	0.7955	0.9631	1.1125	1.2560
Peak Flowrate	(q_p)	l/s	127	180	427	641	796	963	1112	1256
24 hour Runoff Volume	(V_{24})	cu mtr	720	1032	2490	3747	4655	5640	6521	7367