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O'HARA WAIUKU PLAN CHANGE

STORMWATER MANAGEMENT PLAN– 45A, 92 & 130 CONSTABLE RD

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Project No.	32897	Approved for Issue	
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Status	Final	Signature	
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GARDON TRUST
O'HARA WAIUKU PLAN CHANGE – 45A, 92 AND 130 CONSTABLE ROAD

STORMWATER MANAGEMENT PLAN

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STORMWATER MANAGEMENT PLAN

1 INTRODUCTION

This Stormwater Management Plan (SMP) has been prepared on behalf of the Gardon Trust in support of a proposed Plan Change application to Auckland Council to change the zoning of the sites located at 45A, 92 and 130 Constable Road from 'Rural – Rural Mixed' zone to 'Residential – Mixed Housing Suburban' Zone. The sites have a combined total area of approximately 33ha.

This report identifies the anticipated stormwater effects of the plan change and subsequent development proposal and how effects will be managed to meet the Auckland Unitary Plan outcomes, and, for those assets to be vested to Council, the requirements under the regional network discharge consent (NDC). It complements the separate Engineering Report prepared by Fraser Thomas (March 2022) covering stormwater management in detail.

2 EXISTING SITE APPRAISAL

2.1 LOCATION AND GENERAL INFORMATION

The site is located on the northern side of Constable Road on the south-western side of the Waiuku township, abutting the current Rural Urban Boundary (RUB). It is surrounded by urban residential land to the east (Breaker Grove/Martyn Street area), rural land to the south and west, recreational land to the north-west and Waiuku College to the north-east. The site location and extent is shown in Figure 1 below.

The Plan Change site comprises three separate parcels of land, as listed in Table 1.

Table 1: Site Details

Registered Owner	Address	Legal Description	Title	Area (ha)	Zoning; Land Use
Pokorua Holdings Ltd	45A Constable Rd	SEC 1 SO 65397	NA85A/37	3.6434	Rural-Residential; Former pasture – currently subject to earthworks
Annette Therese Black, Donna Goettler, Gary Ian Goettler	92 Constable Rd	Pt Lot 4 Deeds Reg WHAU 29 DISTRICT	NA771/107	24.9033	Rural-Residential; Pasture
Terry Short	130 Constable Rd	Lot 3 DP 64198	NA26B/939	4.0448	Rural-Residential; Pasture
Total				32.5915	

Note: 45/45A Constable Road are shown as a single lot in Geomaps and other cadastral software. No 45 is zoned "residential-mixed housing suburban" while No 45A is zoned "rural-rural mixed". The 45/45A lot has a total area of 6.1477ha. The 45A portion is 3.64ha.

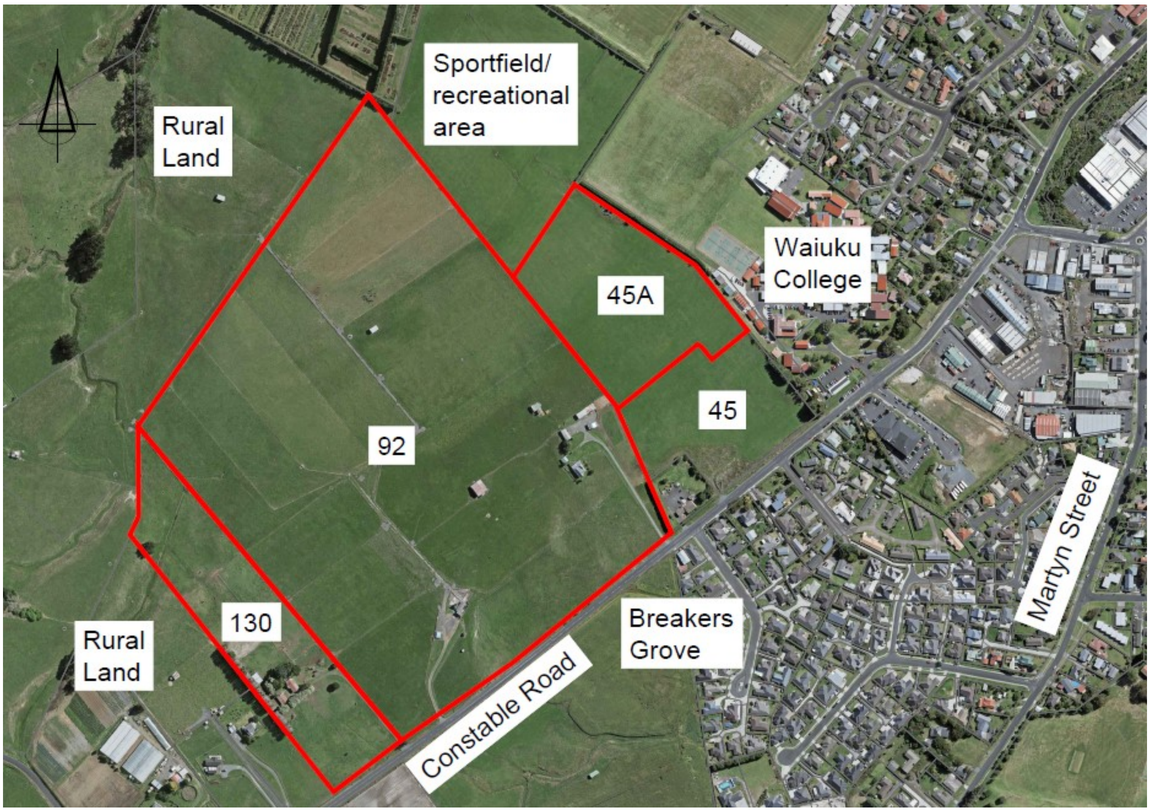


Figure 1: Site Location Plan

2.2 EXISTING LAND USE

The existing land use on each of the lots making up the Plan Change area is described separately in this section.

2.2.1 45/45A Constable Road

The No 45/45A site generally comprises gently undulating farm paddocks that have historically been used for grazing and growing maize.

Resource consent has been granted for the proposed residential subdivision of 45 Constable Road (SUB60237908) and for associated earthworks, including earthworks on No 45A (Ref: LUC60111076-A, LUC60271724-A). Bulk earthworks were undertaken on 45/45A Constable Road during the 2020/21 earthworks season. These earthworks include cut to fill across the entire property, with No 45A providing fill material for No 45 and No 45A also been used for stockpiling of unsuitable material and topsoil from the earthworks. It is understood that minor earthworks are still required on No 45A for final grading and establishing overland flowpaths.

2.2.2 92 Constable Road

The land is currently used as a dairy overflow for livestock grazing purposes and has been used for pastoral grazing purposes for the last 80 years. Two gravel accessways extend north-west from Constable Road, providing vehicular access to a decommissioned milk shed and paddocks (south-western accessway) and existing dwelling and associated farm buildings (south-eastern accessway).

An existing single-storey dwelling and a number of farm buildings are located adjacent to the north-eastern site boundary in the south-eastern corner of the site. Three additional farm buildings/sheds are located in the central part of the site. The central part of the site generally comprises gently undulating farm paddocks.

2.2.3 130 Constable Road

The property has historically been used for grazing horses and farming practices, which still applies today. A gravel accessway extends north-west from Constable Road, providing vehicular access to the property. An existing single-story dwelling and minor dwelling/garage are located in the western part of the site, while an existing shed is located to the north-west of the existing dwellings. Numerous, up to approximately 10 m tall trees, are located to the north-west and south-east of the existing dwellings and along the south-western site boundary, proximal to the existing dwellings. A horse arena is located approximately 50m north-west of the existing dwellings.

2.3 OVERLAYS

The site is not located within any stormwater related overlays, including Stormwater Management Area Flow (SMAF) or significant ecological areas (SEAs). It is located in an aquifer overlay area as discussed further in section 2.9 of this report.

2.4 TOPOGRAPHY

A ridge feature extends from 130 Constable Road to 45A Constable Road across the south-eastern part of the site. North-west of this ridge feature, the site is generally moderately undulating comprising a series of benches up to approximately 1.0 m in vertical height slopes. Low-lying areas within the site have arcuate features, benched and hummocky topography, indicative of localised, shallow-seated slope instability and soil creep features. The low-lying areas of the site generally coincide with overland flow paths and flood prone areas (from Council Geomaps) as shown in Figure 3.

The north-western site boundary generally abuts the crest of a north-west to south-east trending ridge that generally slopes down into 38 Harvey Road, Waiuku at an angle of approximately 8^{o} to the horizontal.

2.5 GEOTECHNICAL

A high level geotechnical assessment has been undertaken of the Plan Change area by Fraser Thomas, involving a desktop review of relevant geological maps, a visual appraisal and geotechnical assessment of the subject site to determine the subsoil conditions beneath the site and their implications for the proposed plan change.

The Institute of Geological and Nuclear Sciences map, scale 1:250,000, geological map 3, 2001, Geology of the Auckland Area and the Provisional Geological Map of New Zealand, scale 1:50,000, Pukekohe, Sheet R12 indicate that the site is in general underlain by Puketoka Formation alluvial soils of the Tauranga Group of Pliocene to Pleistocene Age and Awhitu Group sand dunes and associated facies of Pliocene age.

The subsurface conditions at the site were investigated by means of nine hand augered boreholes and associated dynamic cone (Scala) penetrometer (DCP) tests. The results of the visual appraisal and borehole investigation undertaken for the site, as reported herein, generally confirm that the site is underlain by Tauranga Group alluvial inorganic and organic soils and Awhitu Group sediments. However, a surficial veneer of reworked volcanic ash was encountered in the south half of the site. Surficial material, inferred to be recent alluvial sediments, was also encountered adjacent to overland flow paths.

Refer to the separate geotechnical investigation report for further details.

2.6 POTENTIAL SOIL CONTAMINATION

The FTL Preliminary Site Investigation (PSI) involved a desktop study, site walkover and reporting associated with potential land contamination issues on No 45A, 92 and 130. This found that the NESCS and the contaminated land provisions of the Auckland Unitary Plan: Operative in Part (AUP:OP) apply to both No 92 & 130, but not to 45A. These properties have essentially been used for livestock grazing purposes for the last 80 years. However, during this time, the following potential or actual HAIL activities have occurred on-site on No 92 and 130:

- Historical application of lead based paint and burning of unknown materials (potential I);
- Stock loading ramps and potential spray races (A8); and
- Asbestos products in a deteriorated state (E1) (92 Constable Road only).

The properties are considered suitable for proposed residential development. However, there are localised potential contamination issues at the subject sites that may present a risk to the health of site workers or residents from future residential developments. Hence, prior to subdivision or soil disturbance works, a Detailed Site Investigation will be required for both of these properties, which will determine the extent and severity of soil contamination (if any), the consent status of these areas under the NESCS and AUP:OP, and the need for any remedial works (if required).

2.7 EXISTING DRAINAGE FEATURES AND STORMWATER INFRASTRUCTURE

There is currently no stormwater network on the site. The network stops at 54 Constable Road. This can be seen in Figure 2.

Refer to section 2.8 for further information on existing stormwater drainage features.

The surrounding network discharges into the Waiuku River, which discharges into the Manukau Harbour.

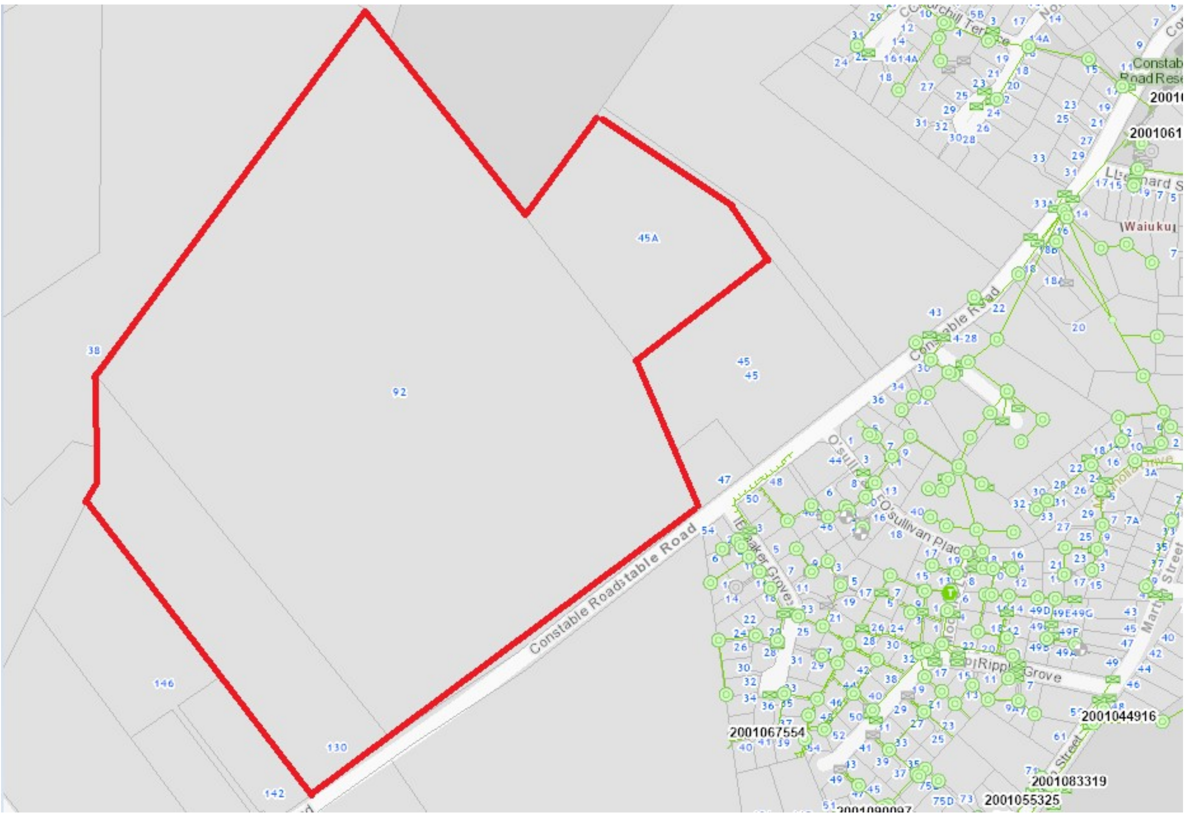


Figure 2: GIS Stormwater network surrounding site

2.8 MARINE RECEIVING ENVIRONMENT

All three catchments drain via different routes to the estuarine receiving environment, referred to as the Waiuku River or Channel, which is a branch of the Manukau Harbour.

Technical Report No 2 of the ARC-TA's Regional Urban Stormwater Strategy (SLG, 1997) identifies the Waiuku Catchment as largely lying within the Waitangi Stream catchment (No 436600) and the receiving environment as being the Waiuku River. The Waiuku River is described as a long, narrow, predominantly shallow waterway and is in fact an estuarial arm of the Manukau Harbour. It has a number of habitats within it, including sandbanks, spits, sandy shores, maritime marsh, and extensive mangrove marshes. Two sites, Pollok Spit, at the entrance to the Waiuku River, and Waipipi Creek, approximately 6 km down the river, are important conservation and bird roosting sites.

The River is home to diverse sandflat and mudflat communities. Common species include cockles, wedge shells, topshells, catseyes and welks. The upper estuarine mudflats support a less diverse community dominated by the mud snail, *Amphibola crenata* and the mud crab, *Helice crassa.* Juvenile species of flounder, snapper, mullet, kahawai use this area as a nursery and refuge.

Waiuku Estuary is an important fishing ground and recreational shellfish gathering occurs.

Further information on the marine environment is provided in Section 5.4 of the WICMP (FTL, August 2010). This includes relevant information extracted from the following reports:

- Tonkin & Taylor (2006) provided an overview of the physical characteristics of the Waiuku Estuary as a part of the development of a comprehensive Coastal Compartment Management Plan (CCMP) for the Waiuku estuary.
- Wildlands Consultants (2005) reviewed what was known about the ‘ecology’ of the Waiuku estuary as a contribution to the Waiuku Estuary CCMP focussing on the riparian margins and terrestrial vegetation around the estuary.

In summary:

- The upper estuarine arms of Waiuku Inlet below the WICMP area are typical of Manukau Harbour estuaries. They are typically muddy and are dominated by fringing mangroves. Mangroves are a recent addition to the flora of the estuary and have expanded for a number of reasons the principal one being the accumulation of fine sediments, compounded by the colonisation by mangroves.
- The fauna and flora of the upper Inlet intertidal areas is likely to be typical of similar habitat within the Manukau Harbour. Fish and bird will be typical of what is present in neighbouring estuaries.
- Assessment of sediment quality in the upper tidal creeks showed that metal concentrations in sediments were below the ANZECC (2000) ISQG-Low sediment quality guidance values. This would suggest that sediment quality is not likely to be a significant contributor to benthic infaunal community health.

2.9 FLOODING AND FLOW PATHS

2.9.1 Geomaps Data

The subject site is drained primarily by overland flow, other than some minor private drainage systems associated with existing buildings on 92 and 130 Constable Road.

The current Geomaps overland flowpath (OLFP), flood prone storage and floodplain imagery is shown in Figure 3. This information has been updated from that included in the Fraser Thomas Engineering report, which included Geomaps imagery based on 2013 LiDAR data, to show 2016 LiDAR data and corresponding updated OLFPs and flood prone areas, following a recent update of these GIS layers.

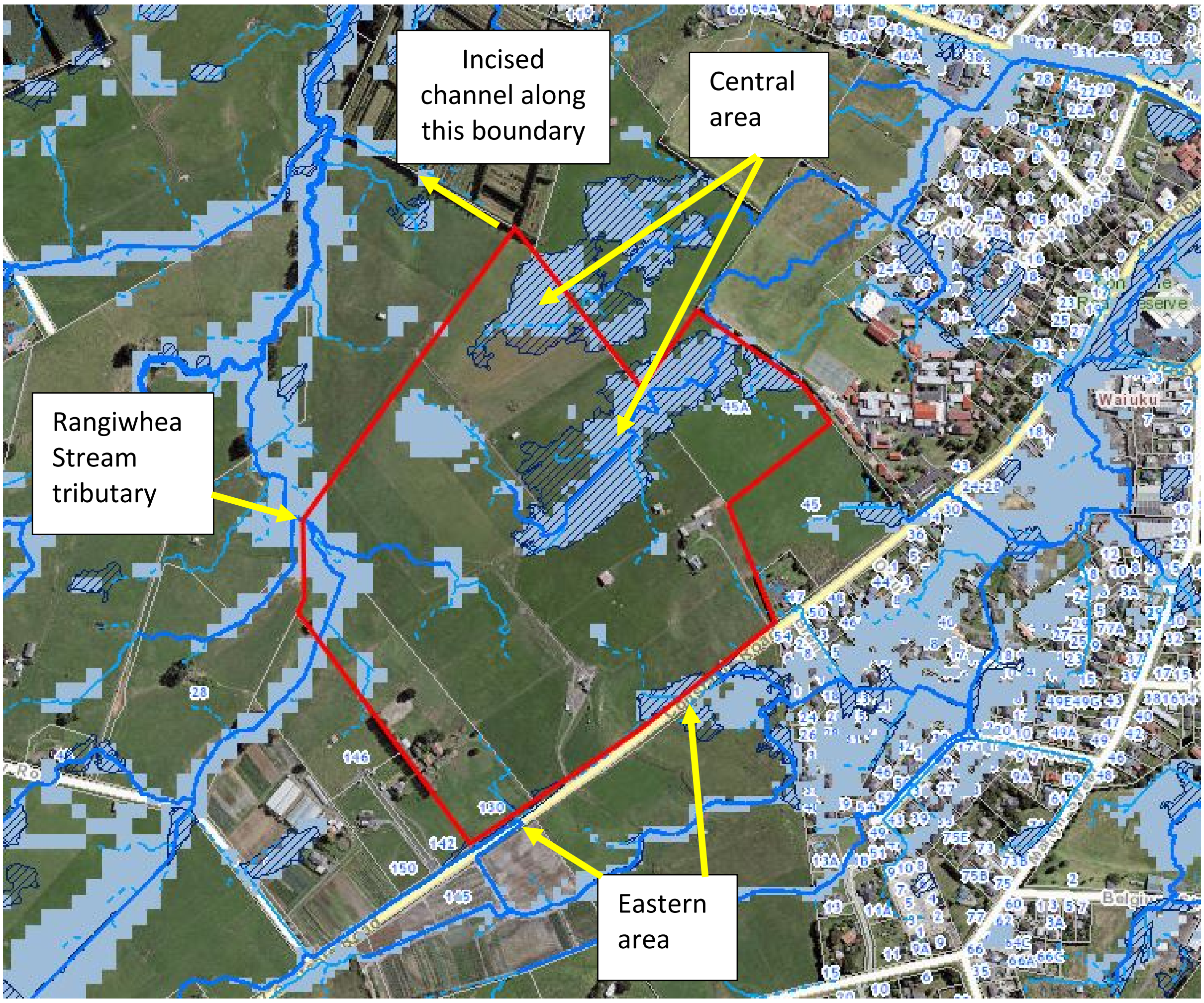


Figure 3: Auckland Council Geomaps OLFP and Floodplain Mapping (based on 2016 LiDAR)

The floodplain maps are from a 2009 Rapid Flood Hazard Assessment (RFHA) for the 100 year storm, existing development (as of 2009) and no climate change, which does not comply with current Council flood modelling requirements.

The Geomaps data shows that stormwater runoff from the site is split between three catchments.

The southern and western edge of the site (4.7ha catchment from Geomaps) drain to a tributary of the Rangiwhea Stream, which joins the main stream further to the north of the site, along with several other tributaries draining large rural catchment areas from the west. The floodplain within the site is associated primarily with flows along the Rangiwhea Stream tributary, rather than from the subject site. This stream travels northwards and flows between a number of residential properties off Lina Place and King Street, entering the Lina Place reserve, where it is piped under King Street by a hybrid 2.0m square/1.8m diameter culvert to the King Street Esplanade Reserve.

Site investigation of this area (refer separate geotechnical investigation report) found that the Rangiwhea Stream tributary runs along the northern side of No 130 and then through the north-western corner of No 92, before entering No 38 Harvey Road. The stream channel in this area comprises an approximately up to 2m deep incised watercourse. An up to 1.0 m deep, incised, north-west trending overland flowpath was noted within the north-western paddock on No 92. This originates from the central part of the No 92 paddock area, where it is understood that novaflo drains from the large Flats area discharge to.

The central portion of the site (majority of site) drains through the sportsfields to the north and then along King St to the estuary. Geomaps shows that this area is subject to a large flood prone area (also shown as floodplain), associated with a shallow depression straddling No 92 and No 45A. The OLFP catchment at the site boundary is 12.5ha (larger area than in Engineering report as LiDAR contours have been updated since then). Visual inspection of this area found no evidence of any channelised flow.

There is a secondary smaller flood prone/flood plain area in the northern most corner of the site (1.9ha catchment according to Geomaps). Site observations indicate that at least some of this catchment would flow overland along a steep, incised channel to the north-west to the Rangiwhea Stream as shown above.

The eastern portion of the site drains via three culverts under Constable Rd and across rural land and then through the Breaker Grove residential subdivision area, where it travels by a combination of piped reticulation and overland flow into the Tiware stream at the Constable Road reserve, immediately to the north of Leonard Street. Geomaps shows a small flood prone storage area and associated floodplain adjacent to Constable Road (3.8ha catchment), which appears to be associated with a localised depression caused by Constable Road being elevated relative to adjacent land and forming a dam at this location, blocking previously existing OLFPs. This is supported by site observations of this part of the site, which found that Constable Road has been formed on a fill embankment up to 2.0m in vertical height.

The existing site catchments are shown on drawing 32897/201.

2.9.2 Waiuku ICMP Stormwater Reticulation Network Modelling

Fraser Thomas was principal consultant for preparation of the Waiuku Integrated Catchment Management Plan (WICMP) for Franklin District Council during 2009-2012. Hydrologic and hydraulic modelling was undertaken of the Waiuku stormwater reticulation network as part of the WICMP by sub-consultant, Hydraulic Modelling Services (HMS), over the period 2008-2010. The modelling runs included a “2051 future growth scenario” under the Franklin District Growth Strategy (2007) (refer Figure 4) and a climate change adjustment to 2051 (9.3% increase in 1% AEP rainfall). The 2051 future growth scenario included No 45A and No 92 as future residential land but not No 130. Hence, this model does not include the entire area proposed for rezoning under this Private Plan change and does not comply with current Council flood modelling specifications in relation to modelling climate change to 2090.

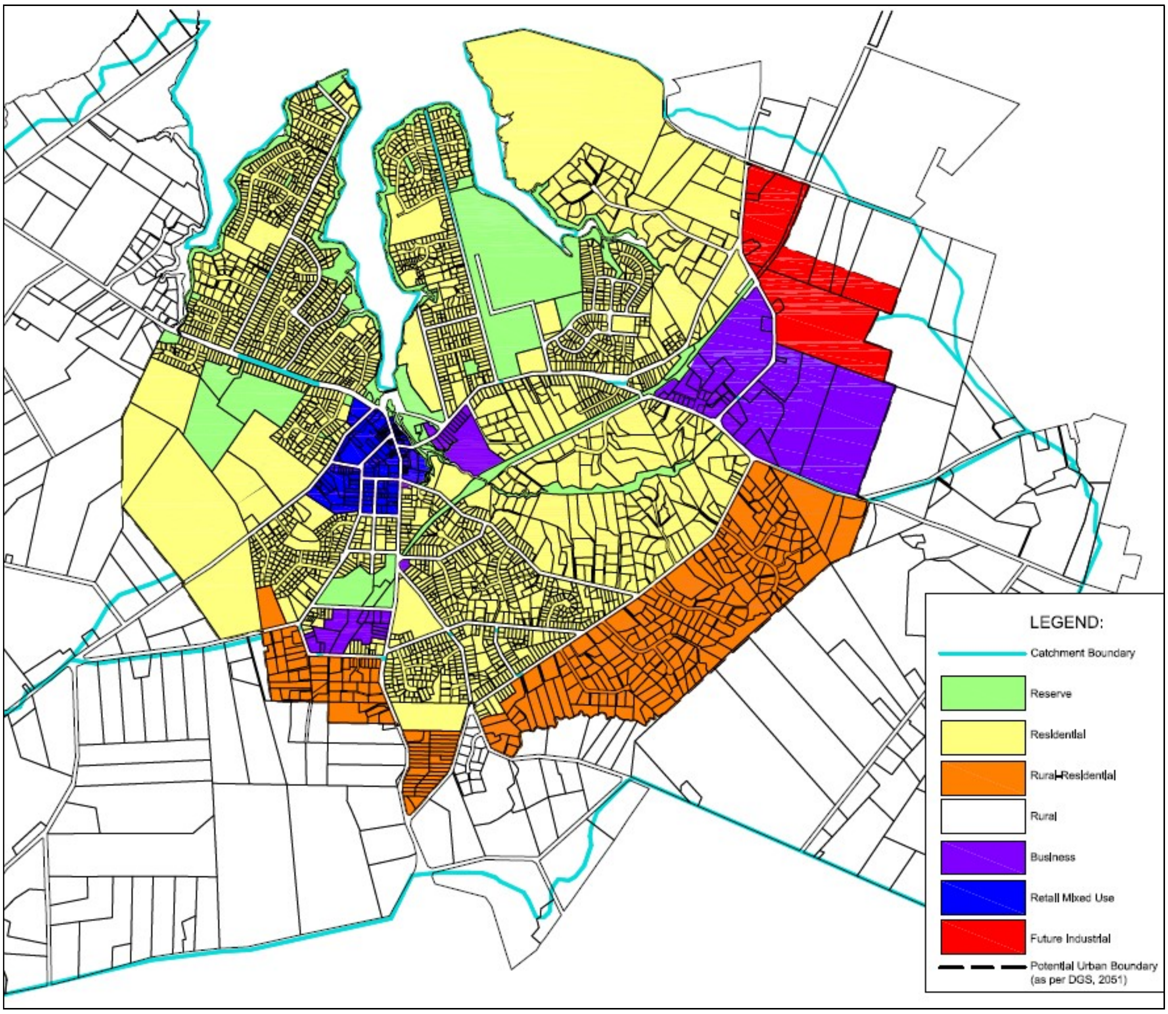


Figure 4: Franklin District Growth Strategy – Land Use and Zoning Map (2051)

In relation to the Plan Change area, HMS's modelling found:

- The existing stormwater system in the Breaker Grove/Martyn St area (i.e. residential block bounded by Breaker Grove to the south, Constable Road to the west, Leonard St to the north and Martyn St to the east) was found to be under stress. Most of the Martyn St primary line was operating under pressure in the 5 year event (20% AEP storm) for existing development, with flooding occurring in Martyn Street and throughout this block, while ponding will also occur on farmland immediately upstream of Breaker Grove.
- The existing stormwater system along King St was also shown to be significantly under capacity. However, this was found to be due to the model assuming that runoff from the majority of the large area shown as recreational reserve (existing sportsground) in this area drained towards King St and being captured by the stormwater reticulation through this area. FDC advised that their Parks section was separately investigating stormwater management measures for the Reserve area and that it was unlikely to impact on the King St residential area, meaning that the King St piped system is likely to have sufficient capacity. However, the outcome of this investigation is not known.
- Rangiwhea Stream - King St culvert: The HMS 2010 modelling results were superseded by subsequent modelling done by Stormwater Solutions Consulting Limited (SSCL) in 2012, as described in section 2.8.3 below.

Flooded manhole results for the 20% AEP storm and existing land use are shown in Figure 5.

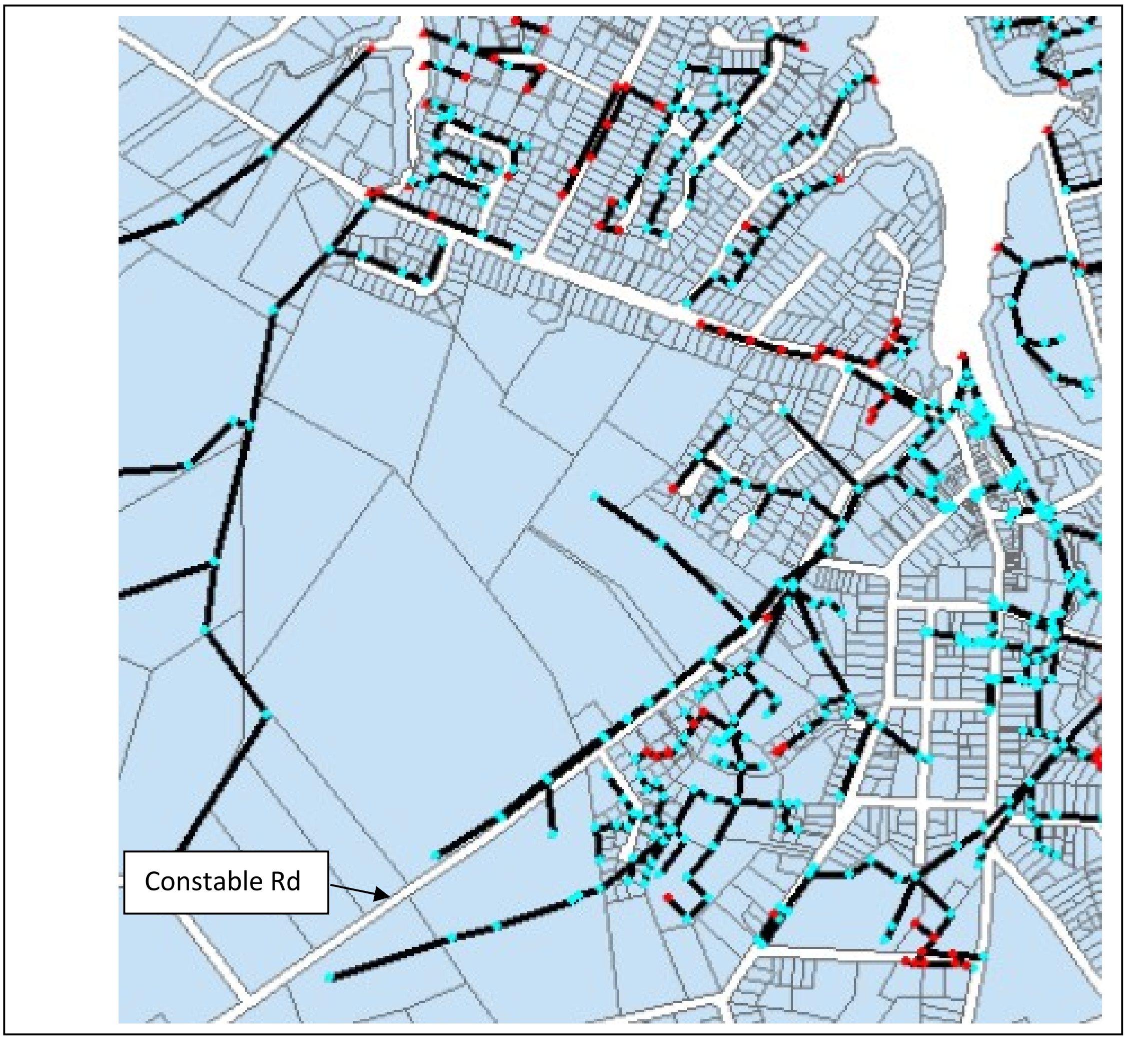


Figure 5: Flooded Manholes (20% AEP existing land use scenario (from HMS Waiuku ICMP – Modelling Report (June 2010); red = flooded manhole

FDC subsequently commissioned further work by Fraser Thomas to investigate a solution to the Breaker Grove/Martyn St block area to facilitate proposed future urban development of the upgradient catchment area as proposed under the Franklin District Growth Strategy (2007), including a new 30 lot subdivision at 45 Constable Road which was being designed by Harrison Grierson Limited (HGL) at that time. HGL had undertaken preliminary engineering design work for a piped stormwater system to serve this subdivision and also for a new stormwater piped system and associated OLFP along Constable Rd that will convey stormwater from the new subdivision to the discharge point to the downgradient open channel (Tiware Stream) immediately north of Leonard St. The new system along Constable Rd was proposed by HGL to avoid further straining the capacity of the existing stormwater system within the Breaker Grove/Martyn St area.

Implementation of the new primary line along Constable Road was found to prevent the existing situation in the Breaker Grove/Martyn St area from worsening, as shown in the modelling results in Figure 6. The proposed line was relatively deep and would operate under pressure but without surcharging for the 20%-1% AEP events, with some relatively minor overland flow also occurring along Constable Road in the future (2051) scenario. The estimated capital cost of this option in

2008 was **$1.44M**. It was also identified that constructability of the OLFP along Constable Road may be difficult due to possible lack of sufficient grade in localised areas. Additional scour/erosion protection measures may also be required at the Leonard St discharge point into the Tiware Stream.

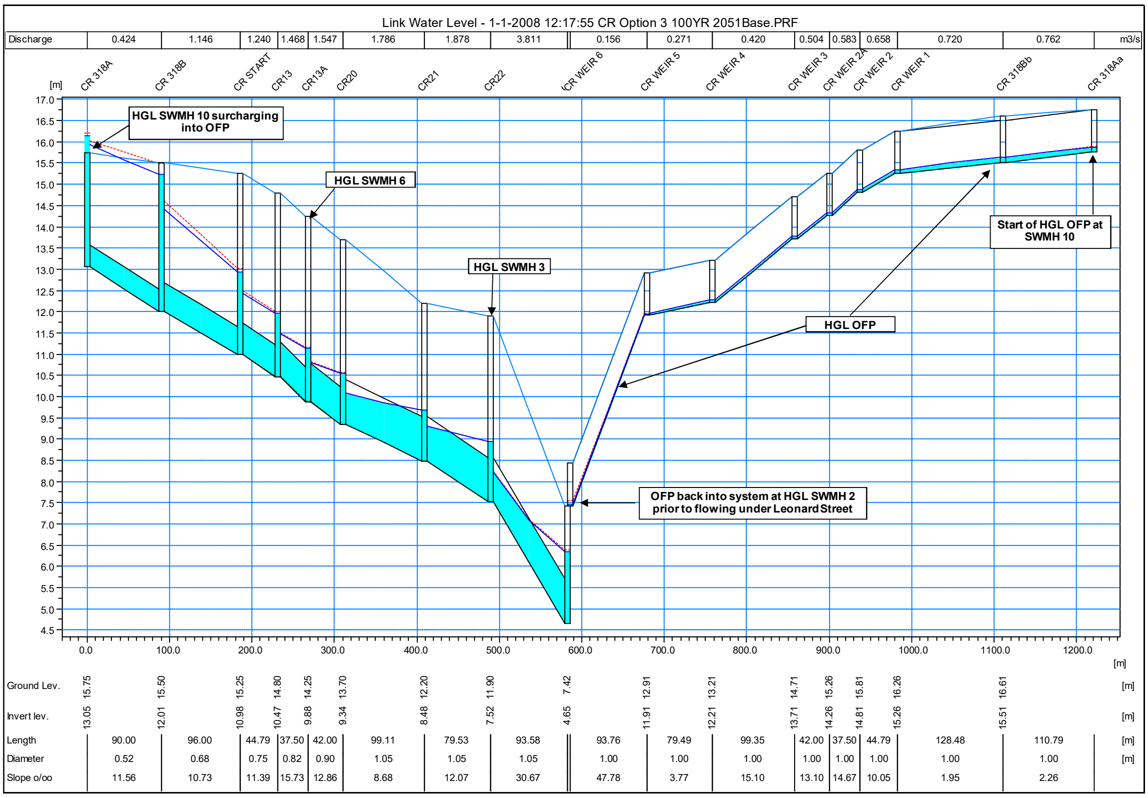


Figure 6: Constable Road – Option 3 (HGL Line and OLFP) 1% AEP 2051 Event – 2008 Model

Further design work in 2009 identified that larger pipe upgrades would be required to ensure strict compliance with FDC "service level" standards, including allowing for partial pipe blockages, while some road regrading would be required to achieve a continuous OLFP along Constable Road to Leonard St. With these changes, the estimated cost of the pipeline and associated works increased to **$2.42M (2009 prices).**

This new pipeline has not been constructed to date, primarily due to this portion of Franklin District becoming part of the Supercity.

2.9.3 Waiuku ICMP Floodplain Modelling

Supplementary work undertaken as part of the WICMP in 2012 included hydraulic modelling by sub-consultants, SSCL, on behalf of FTL of the Rangiwhea and Tiware Streams, using Lidar data and supplementary surveyed stream cross-section and culvert/bridge data. The model also focused on assessing the flood risk in areas proposed for future urban development at that time – namely 45A and 92 Constable Road. Hence, it provides a more useful assessment of the site's flood risk than the RFHA Assessment currently shown on Geomaps (although not strictly consistent with current Council flood modelling specifications).

Modelling was undertaken for the following scenarios summarised in Table 2.

Table 2: WICMP (2012) Flood Modelling Scenarios

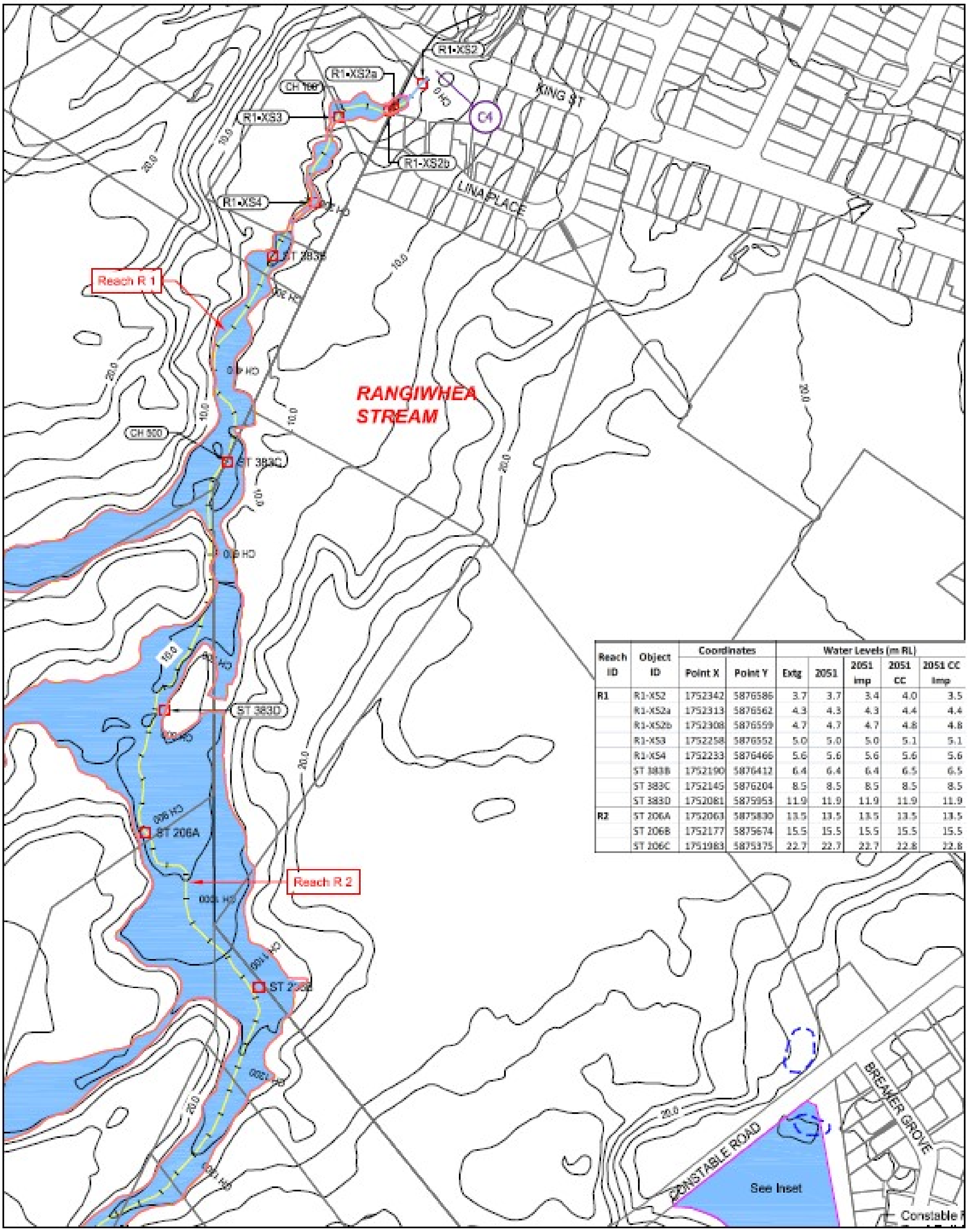
Scenario	Stormwater System	Catchment Land Use	Rainfall (AEP)
Sensitivity Testing	Existing	Existing	1%
1	Existing	Existing	1%
2	Existing	2051	1%
3	Upgraded	2051	1%
4	Existing	2051	1% with climate change
5	Upgraded	2051	1% with climate change

Notes:

- "Climate change" rainfall = 9.3% increase in 1% AEP rainfall depth, calculated as 8% increase in rainfall per degree of warming x 1.2°C projected mid-range temperature increase by 2051, as agreed with Nimal Gamage of Auckland Council.
- Sensitivity analysis assessed effects of different roughness coefficients on open channel flows over the expected range (Manning's n = 0.033 – 0.045).
- Catchment lag times were not revised, as agreed with Nimal Gamage of Auckland Council (email/telephone discussions of November 2011)

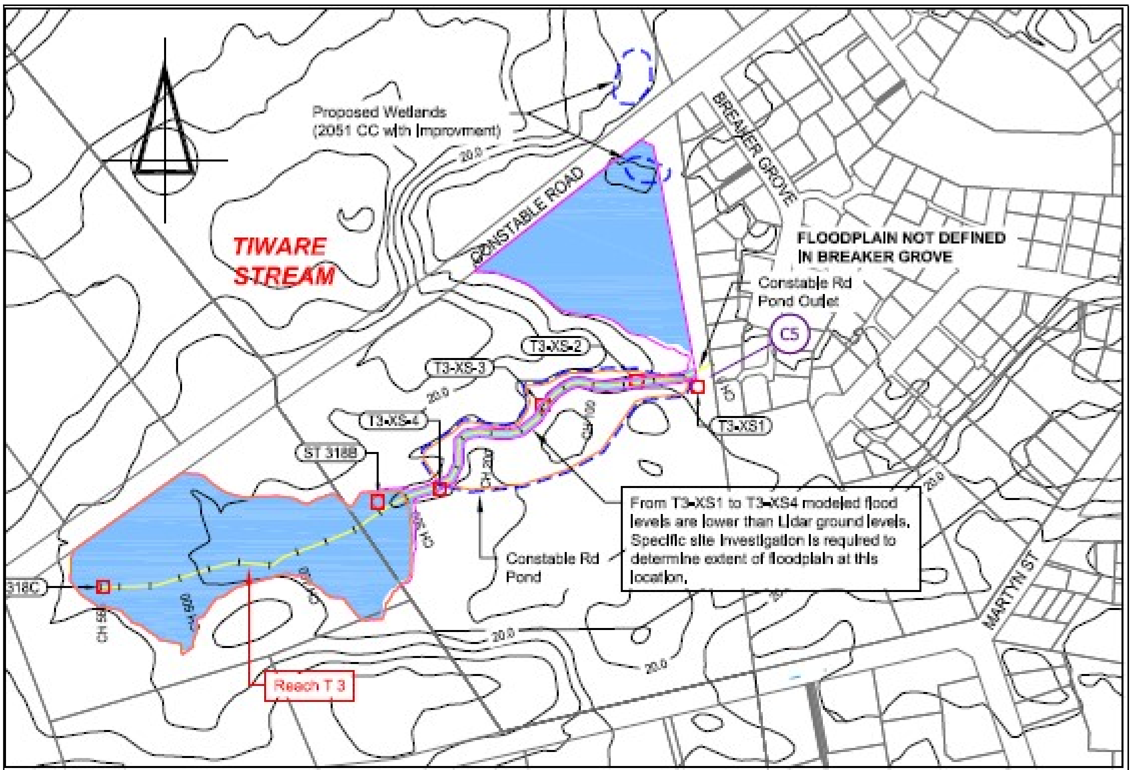
Key findings from the WICMP 2012 modelling are summarised below:

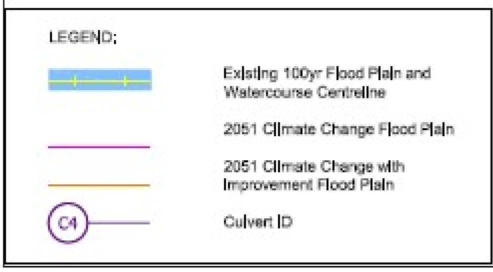
- The existing culvert on the Rangiwhea Stream under King St is an unusual hybrid culvert, comprising a box-pipe-box-pipe with step and kink in the line. The box section is 2m square, while the pipe section is 1800mm diameter. Modelling has shown that it does not require upgrading for existing and predicted future flows up to 2051. Refer Figure 7.
- The Breaker Grove subdivision is considered the area most at risk of flooding within the Waiuku urban area. The floodplain was only modelled for the proposed future growth area immediately to the west of Breaker Grove, due to a lack of adequate survey data in this area and project budgetary constraints. Modelled flood levels at the upstream node (T3-XS1) varied from 14.7-14.8m for the existing and future scenarios (2051 with and without climate change), reducing to 14.4m "with improvements" (scenarios 3 and 5: new 525-1050 diameter pipe along Constable Road and a large detention pond immediately west of Breaker Grove). In comparison, finished floor levels of 6 properties within Breaker Grove surveyed by Fraser Thomas for another project range from 14.22-14.75m. Comparison of these levels indicated that some houses within Breaker Grove may potentially be affected by overland flows from upstream, particularly during scenarios 1, 2 and 4. Refer Figure 8.



Reach ID	Object ID	Coordinates		Water Levels (m RL)				
		Point X	Point Y	Extg	2051	2051 imp	2051 CC	2051 CC imp
R1	R1-XS2	1752342	5876586	3.7	3.7	3.4	4.0	3.5
	R1-XS2a	1752313	5876562	4.3	4.3	4.3	4.4	4.4
	R1-XS2b	1752308	5876559	4.7	4.7	4.7	4.8	4.8
	R1-XS3	1752258	5876552	5.0	5.0	5.0	5.1	5.1
	R1-XS4	1752233	5876466	5.6	5.6	5.6	5.6	5.6
	ST 383B	1752190	5876412	6.4	6.4	6.4	6.5	6.5
	ST 383C	1752145	5876204	8.5	8.5	8.5	8.5	8.5
	ST 383D	1752081	5875953	11.9	11.9	11.9	11.9	11.9
R2	ST 206A	1752063	5875830	13.5	13.5	13.5	13.5	13.5
	ST 206B	1752177	5875674	15.5	15.5	15.5	15.5	15.5
	ST 206C	1751983	5875375	22.7	22.7	22.7	22.8	22.8

Figure 7: WICMP (2012) Floodplain Modelling Results – Rangiwhea Stream (See Figure 8 for legend)





Reach ID	Object ID	Coordinates		Water Levels (m RL)				
		Point X	Point Y	Extg	2051	2051 imp	2051 CC	2051 CC Imp
T3	T3-XS1	1752776	5875359	14.7	14.7	14.4	14.8	14.4
	T3-XS-2	1752726	5875364	15.0	15.1	n/a	15.1	n/a
	T3-XS-3	1752649	5875344	16.1	16.2	n/a	16.3	n/a
	CONSTABLE POND OUTLET	1752766	5875357	n/a	n/a	16.9	n/a	17.1
	CONSTABLE RD POND	1752566	5875276	n/a	n/a	16.9	n/a	17.2
	T3-XS-4	1752566	5875276	17.3	17.4	n/a	17.4	n/a
	ST 318B	1752516	5875265	18.6	18.6	18.6	18.6	18.6
	ST 318C	1752293	5875196	21.9	21.9	21.9	21.9	21.9

Figure 8: WICMP (2012) Floodplain Modelling Results – Tiware Stream

2.10 GROUNDWATER AQUIFERS

The Waiuku area overlies three sequences of significant groundwater reserves. These are broadly grouped as:

- Waitemata Group, consisting of interbedded sequences of mudstone and sandstone, some highly fractured; these are overlain by the:
- Kaawa aquifer, consisting of porous shell bed layers, sand and weakly-cemented, fractured sandstone; these, in turn, are overlain by the:
- Glenbrook volcanic aquifer, of basalt lava flows interspersed with scoria, lapilli and tuff deposits. The volcanic aquifer is generally covered by thick soil.

A detailed description of the respective aquifers and their hydrologic regimes is presented in the Auckland Regional Council report, Technical Publication (TP) 133 (2002).

The Kaawa aquifer and the volcanic aquifer are both heavily used and are subdivided, for administrative convenience, into a number of management areas. In the vicinity of Waiuku, the volcanic aquifer is represented by the Glenbrook volcanic management area and the Kaawa aquifer by the Waiuku Kaawa management area. The Waiuku public water supply wells draw from the

Kaawa aquifer (Waiuku Kaawa management area). Groundwater from both the volcanic and the Kaawa aquifers is considered to be of excellent quality.

Review of aquifer plans in the WICMP and on the Unitary Plan maps indicates that the subject site is located outside of both the Kaawa and Glenbrook volcanic aquifer management areas, but is underlain by a "quality sensitive aquifer management area" overlay (refer Figure 9).

Auckland Council's Water Allocation Team have advised that the subject site is underlain by the Waitemata aquifer. This consists of variably indurated, interbedded mudstones and sandstones of the Waitemata Group rocks. Although primary permeability is low, useful quantities of groundwater are obtained from fracture zones. Recharge is by vertical percolation from the surface and leakage from overlying strata, in particular the Kaawa aquifer - where the two overlap.

The Waitemata aquifer at Waiuku is not currently a High-Use Management Area at present and is not used by Franklin District for public supply. Use of the Waitemata aquifer around Waiuku is primarily outside of the footprint of the Glenbrook volcanic and Waiuku Kaawa aquifers (drawings 31671/3 and 4).

Figure 9: Quality Sensitive Aquifer Management Area Overlay

2.11 COASTAL INUNDATION

The site is located over 500m away from the coast. Therefore, coastal inundation will not be applicable to the site.

2.12 BIODIVERSITY

Golder Associates undertook an ecological assessment of the WICMP area as a sub-consultant to Fraser Thomas in 2008-2010. Their assessment covered:

- Terrestrial vegetation.
- Environmental quality – water and sediment.
- Habitat and ecology.
- Marine ecology (refer section 2.7).

This work is reported on in Section 5 of the WICMP and is summarised in the separate Ecological report by Boffa Miskell.

2.13 WATER SUPPLY

The existing water supply network for Waiuku extends along Constable Road from the township to 47 Constable Road. This water supply line comprises a 50mm dia PE line connected to a larger 150 diameter uPVC line by 43 Constable Road (Waiuku College). Refer Figure 10.

All three properties comprising the subject site are currently unserviced in relation to a reticulated water supply. No 45A has no buildings or other features on it, requiring a water demand, while No 92 and No 130 rely on roof rain water collection for their water supply, while No 92 also has a groundwater bore by the cowshed which is for stock use.

45A Constable Road is to be serviced by a previously consented 180mm diameter water main extension (Application #97218 dated 18/11/19) to the southern boundary abutting 45 Constable Road as shown on the Crang Civil Approved Engineering Plan (ENG60342237 dated 16/01/2020).

92 & 130 Constable Road are to be serviced via a new connection onto the previously consented 180mm diameter water main (Application #97218 dated 18/11/19) on the northern side of Constable Road in front of 45 Constable Road as shown on the Crang Civil Approved Engineering Plan (ENG60342237 dated 16/01/2020) and another connection onto the 280mm diameter water main on the southern side of King Street in front of 66 King Street.

The proposed water supply reticulation would involve a new extension from both existing lines at the connection locations mentioned above with a new ring main loop formed within the proposed plan change site. This ring main loop alignment represents the worst case for hydraulic assessment. The actual alignment is more likely to follow the roading and greenway layout within the site and will be determined at subdivision consent stage. Refer to FTL Drawing 32897/401 showing the proposed worst case water supply network extension layout which is reproduced below in Figure 10*:* for ease of reference.

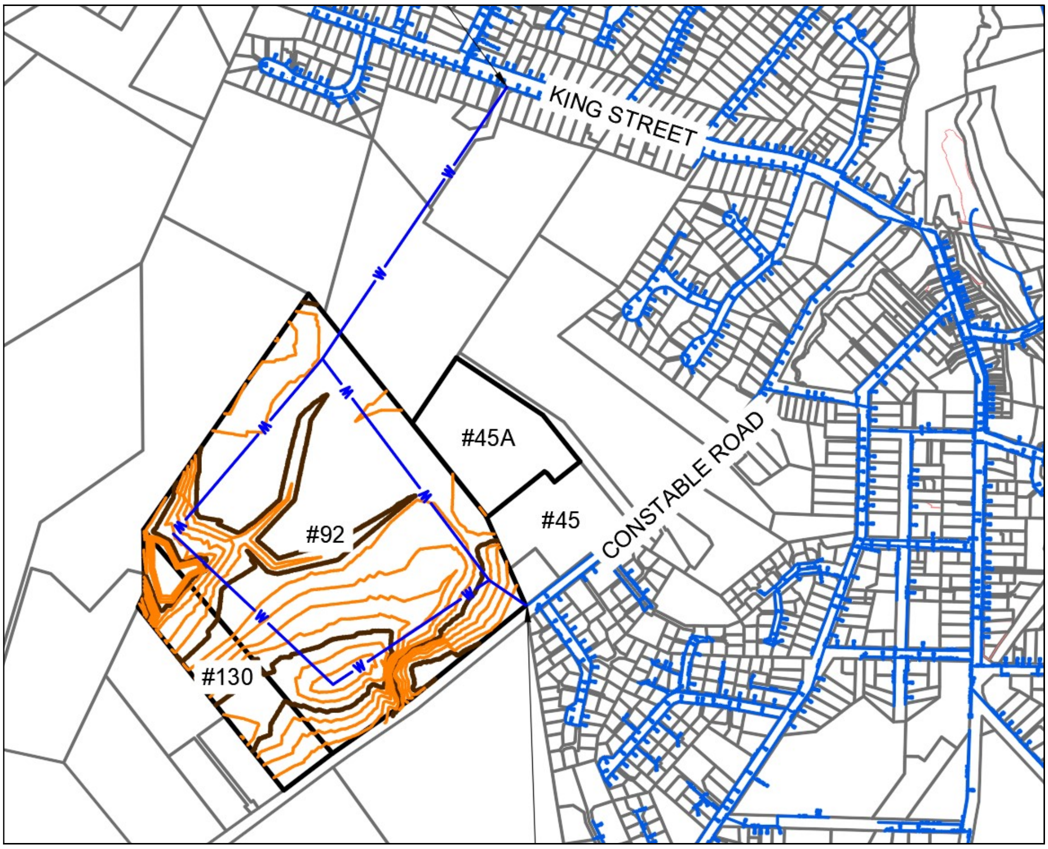


Figure 10: Proposed Indicative Water Supply Network Extension Layout (Worst Case Layout for Hydraulic Analysis Purposes)

2.14 WASTEWATER

The existing wastewater reticulation network for Waiuku extends along Constable Road from the township to 47 Constable Road.

All three properties comprising the subject site are currently unserviced in relation to wastewater reticulation. No 45A has no buildings or other features on it, that would produce wastewater, while No 92 and No 130 rely on on-site wastewater treatment and disposal systems.

A new wastewater line will be provided along Constable Road to service the Plan Change area, as describe further in the separate Engineering report. For this proposal, wastewater from the majority of the 92/130 Constable Rd development area can be conveyed by gravity to the new Constable Road line. Up to approximately 3.4ha of the development area may still need to be serviced by a relatively small wastewater pump station, located by the proposed wetland. It may be possible to reduce the size of the pump station catchment as part of further design work as there is potential to lower the upper portion of the new Constable Rd line by around 1.7m. An alternative wastewater servicing option is also presented in the separate Engineering report.

2.15 UTILITIES

There are existing power and telecommunication services in the berm of Constable Road provided by Counties Power and Chorus respectively. These will be extended to service the Plan Change area.

3 DEVELOPMENT SUMMARY AND PLANNING CONTEXT

3.1 REGULATORY AND DESIGN REQUIREMENTS

Regulatory and design requirements are summarised in the following table.

Table 3: Regulatory and Design Requirements

Requirement	Applicability
Unitary Plan – SMAF hydrology mitigation	N/A - the site is not within a SMAF zone.
High contaminating Generating Activity	N/A - there are no high contaminant generating activities on site.
Natural Hazards	N/A - there are no natural hazards.
Auckland Unitary Plan Precinct	N/A - the site is not within any unitary plan precincts.
Existing Catchment Management Plan	N/A - there is no existing catchment management plan for this site but the majority of the site is located within an area identified for future growth under the former Franklin District Growth Strategy, with stormwater management provisions for this area covered under the WICMP.
Auckland Council Regionwide Network Discharge Consent	Pathway for Greenfield Developments

As shown in the table above, stormwater management for the proposed development is governed by requirements under the Auckland Council Regionwide Network Discharge Consent.

The Auckland Council Regional Stormwater Network Discharge Consent (NDC) is a key tool for managing and integrating land uses, stormwater discharges and the region's natural water assets to mitigate impacts from climate change and flooding and allow multiple community and environmental outcomes to be realised. The NDC provides a pathway for "greenfield developments" such as this one to be included under it, subject to a Stormwater Management Plan (SMP) being prepared and approved by Council in accordance with Schedule 4 of the NDC, which addresses the requirements set out in Figure 11 relating to:

- Water Quality
- Stream Hydrology
- Flooding: 10% AEP property/pipe capacity
- Flooding: 1% AEP – building

These requirements are addressed in this report.

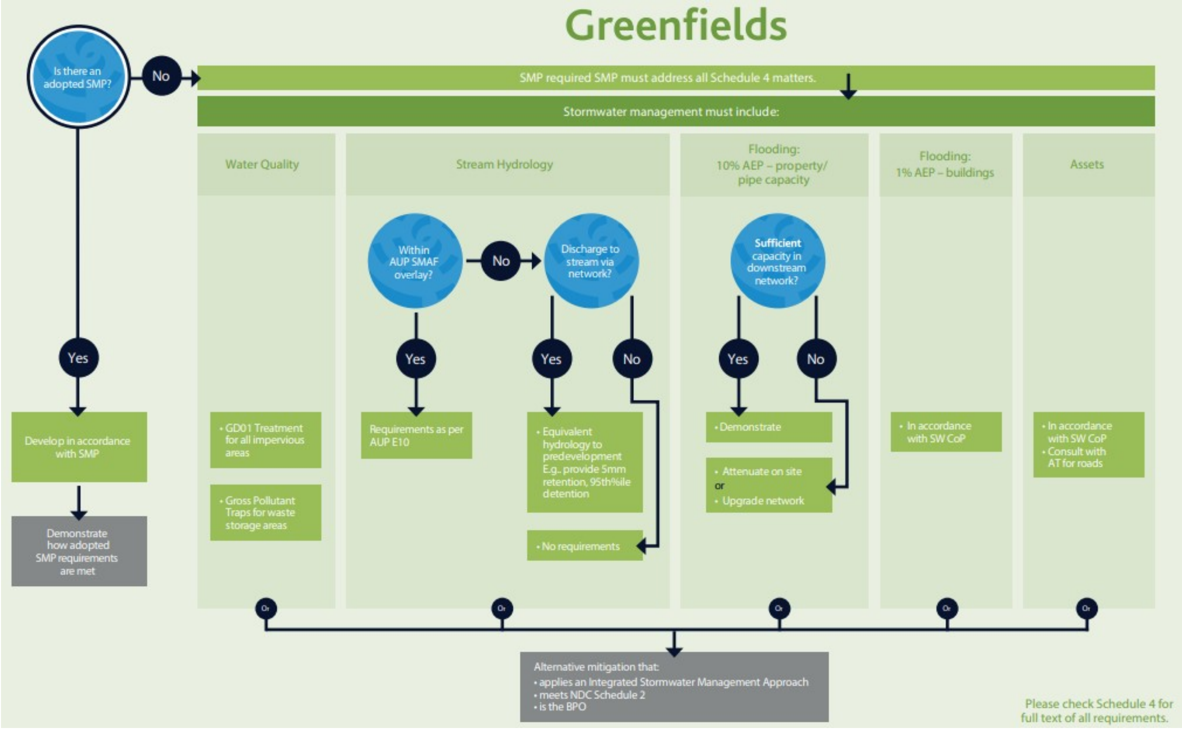


Figure 11: NDC Schedule 4 Requirements for Greenfields Sites

However, if this approach is not accepted by Council, the alternative approach would be to apply for a private stormwater discharge consent instead. Based on the site being rezoned urban, having an impervious area of approximately 19.2ha (Site area minus greenway area x 60% imperviousness), and discharging runoff to a tributary of the Rangiwhea Stream or to existing open channel drains, it is considered that the site would need a stormwater diversion and discharge consent under Section E8, Activity A10 of the AUP:OP as a **discretionary** activity. Similar stormwater management requirements would apply to this situation as for the NDC SMP approach. Hence, the design principles adopted here apply to both situations.

4 MANA WHENUA: TEA O MĀORI AND MATAURANGA

4.1 IDENTIFICATION AND INCORPORATION OF MANA WHENUA VALUES

Ngati Te Ata Waiohua have prepared a draft Cultural Values Assessment (CVA) Report for the proposed Plan Change at Constable Road, Waiuku (January 2021). Table 4 provides a summary of the main recommendations and aspirations from their report in relation to different issues, as well as a summary of how these issues have been responded to in the engineering design for the Plan Change area. Further specific comments are made in relation to stormwater in section 7.1 of this report.

Table 4: CVA Recommendations and Design Response

Item	Recommendation/Aspiration	Proposed Design Response
Heritage protection and recognition		
Physical landscapes	Identify and protect physical landscapes including but not limited to view shafts, hilltops, tuff rings, ridgelines,	Hilltops and ridgelines

Item	Recommendation/Aspiration	Proposed Design Response
	streams, floodplains, estuaries and coastlines.	are maintained. Riparian margin along Rangiwhea Stream. Any natural wetlands to be retained.
Whenua		
Urban development	Ensure in all development proposals that access is retained and improved to water bodies and cultural and/or spiritual sites.	Access to Rangiwhea Stream maintained and improved through greenways and proposed path along the stream
Soil and earthworks	Minimise earthworks and make maximum use of natural ground levels.	Proposed earthworks are minimal, equating to average 350mm soil depth across entire site
	Ensure sufficient erosion and sediment control measures are in place for earthworks.	Best practice erosion and sediment control practices to be followed, in accordance with GD05 (further details to be provided at subdivision consent)
	Riparian planting of appropriate, preferably indigenous, species must be promoted and increased to stabilise riverbanks and reduce erosion in the region.	Riparian planting proposed along Rangiwhea Stream and around proposed treatment/detention wetland.
Erosion and sediment controls	Strive to meet best practice such as GD05.	Best practice erosion and sediment control practices to be followed, in accordance with GD05 (further details to be provided at subdivision consent)
Wai		
Waterways	Future urban development should protect, rehabilitate and enhance waterways, especially where previous land use has degraded it. Preserve the physical integrity of receiving streams. Streams are well integrated with town centres with use of stream management plans and special policy requirements (green space, infrastructure, wider riparian margins). Development around streams/awa is limited to maintain access, preserve amenity, retain views and protect water	Rangiwhea Stream to be protected and enhanced, with this integrated into proposed development, including adjacent large wetland and connecting greenways.

Item	Recommendation/Aspiration	Proposed Design Response
	quality. Preserves and preferably enhances natural hydrologic functions of the site. Identifies and preserves sensitive areas that affect the hydrology, including streams and their buffers, floodplains, wetlands, steep slopes, high-permeability soils and areas of indigenous vegetation. Maintains recharge of aquifers with clean uncontaminated water. Effectively manages natural hazards. Considers beneficial re-use on-site of stormwater and wastewater. Considers water conservation. Provides for visual amenity consistent with the surrounding environment. Minimising stormwater impacts to the greatest extent practicable by reducing imperviousness, conserving natural resources and ecosystems, maintaining natural drainage courses, reducing use of pipes, and minimising clearing and grading. Providing runoff storage measures dispersed through the site's landscape with a variety of detention, retention, and runoff practices. Where they will be of benefit, encouraging the use of mechanisms such as rainwater harvesting, rain gardens, roof gardens, and onsite storage and retention. Where they will be of benefit, encouraging the use of stormwater treatment devices including on-site treatment systems, allowing for emergency storage and retention structures. For areas that have unavoidable impervious areas, attempt to break up these Impervious areas by installing infiltration devices, drainage swales, and providing retention areas. Minimise imperviousness by reducing the total area of paved surfaces Maintain existing topography and pre-development hydrological processes.	Streams and their buffer to be preserved. Treated stormwater runoff to be discharged to ground soakage where appropriate, particularly in peat and alluvial soil areas. Stormwater reuse and water conservation provided for through roof water harvesting. Integrated approach taken to stormwater management to minimise its impacts, including treatment train, retention, detention & reuse. Existing topography and drainage patterns largely retained.
Groundwater, recharge and water allocation	Ensure groundwater recharge to retain base flows within streams, and to keep aquifers recharged.	Groundwater recharge provided where appropriate.
Stormwater	‘Clean’ and ‘contaminated’ waters are not mixed i.e. no direct disposal of any waste into waterways, including wetlands. Highest level of stormwater treatment should be used before it is discharged into waterways. This includes, but is not limited to use of ‘treatment train’ approach; use of raingardens/swales and green roofs; all cesspits to be fitted	Only clean, treated stormwater will be discharged to waterways.

Item	Recommendation/Aspiration	Proposed Design Response
	with a 'stormwater 360 litter trap' or 'enviro-pod'; use of the new GD01 stormwater management devices guideline as an appropriate means to support the mitigation of stormwater issues.	
Wastewater	Land-based treatment of effluent is preferred. Exploration of natural processes rather than mechanical to treat wastewater, including vermiculture.	Wastewater will be conveyed to Watercare's reticulation network and treated at the Waiuku WWTP. Best practical option considering scale of plan change area.
Biodiversity	Promote the use of 'eco-sourced / whakapapa plants' that are indigenous plants and trees from within the Waiuku area. Establish new and enhance existing ecological corridors as a high priority. Implement programmes such as riparian planting and protect sensitive receiving environments and protect and enhance water quality	Eco-sourced plants to be used for all planting. Ecological corridor along Rangiwhea Stream enhanced. Riparian planting to be implemented.
Wetlands	Support the establishment of programmes to restore and expand wetland habitat, including restoring existing wetlands; removing and/or controlling plant and animal pests; using technology such as constructed wetlands where this is feasible; expanding the size of those wetlands where this is feasible; Maintain or enhance water levels. Establish or maintain 'buffer zones' of appropriate indigenous plant species Where appropriate land is available, and it is feasible, flood plains shall be restored to function as natural overflow areas along rivers and streams and to link more naturally with adjacent wetlands.	Any existing natural wetlands to be retained and enhanced where practical. New constructed wetland proposed for stormwater treatment and detention. Floodplain along Rangiwhea Stream maintained and adjacent low lying land utilised for proposed wetland. Multiple soft engineering solutions incorporated into development (e.g. rain gardens and swales).
Sustainability		
Sustainable Development	New development should have positive impacts on the environment e.g. enhance water quality, increase biodiversity connections, and remediate contaminated land. Significantly improve stormwater and wastewater management and treatment to acknowledge our cultural values. Support the use of LID (Low impact design) principles in all	Water quality will be enhanced. Any confirmed contaminated land will be appropriately remediated. Significantly improved stormwater

Item	Recommendation/Aspiration	Proposed Design Response
	new subdivisions and developments.	management, including use of LID.
Natural hazards	New land use and structures shall avoid creating actual or potential adverse effects, including an increase to the risk or magnitude of a natural hazard event. Encourage low-lying areas prone to flooding to be turned back into wetlands rather than using for urban development such as housing. 'Soft' engineering solution should be utilised over a 'hard' solution (e.g. the use of swales rather than concrete channels).	Downstream flooding hazard either reduced or similar to existing situation. Low lying area adjacent to Rangiwhea Stream to be used for constructed wetland. Extensive use of swales and rain gardens proposed.
Infrastructure	Actively explore alternative wastewater treatment and disposal options including removal of trade wastes, recycling of grey water, disposal to land (or other innovative methods) and not using water as a waste transport system. Support and encourage the use of water sensitive design in the provision of infrastructure.	Conventional wastewater reticulation system adopted. Water sensitive design adopted.

5 STAKEHOLDER ENGAGEMENT AND CONSULTATION

Stakeholder engagement is an important part of the design process. Many stakeholders were engaged regarding this project, to ensure that the needs of the community and those potentially affected by this development were met. This includes Iwi, with further details of this discussed in Section 4.

Table 5: Stakeholder Consultation Summary

Stakeholders	What is the Reason for their Interest?	What Engagement has been Completed?	Feedback and Response
Local Board - Franklin	The site is within that local board	A presentation was given to the full board on 8/12/20. There have also been other presentations and discussions in previous years.	
Ngati Te Ata Waiohua (refer Plan Change Appendix T for full list of all Iwi consulted	Mana whenua	CVA prepared and forms part of proposed plan change request.	Some CVA recommendations have been incorporated into Plan Change and Applicant committed to working with Iwi as they develop their land.
Plans and Places	This team has direct	Meeting was held with	The Plans and Places

Team (Auckland Council)	interest in the planning of Auckland suburbs	council to introduce the proposal on 4/03/21.	team provided Planning scope study finding, with an emphasis on infrastructure delivery and soils.
Healthy Waters	Healthy Waters will be vested stormwater assets as part of this development and manage the regionwide NDC	Online meeting held with Paula Vincent (Principal – Planning) and Nimal Gamage (Senior Engineer) of Healthy Waters on 17 December 2020. The proposed design approach was discussed and was generally supported by Healthy Waters.	Healthy Waters requested that a SMP (i.e. this report) meeting Schedule 4 NDC requirements be provided for review and provisional approval prior to notification.
Watercare	Watercare will be vested water supply and wastewater assets as part of this development.	Online meeting Watercare in March 2021. Ongoing consultation since then.	Initial water and wastewater assessments requested by Watercare completed. Waiting for Watercare's response to Council Clause 23 queries.
Waiuku College	Waiuku College lies next to the proposed development, so have a direct interest.	Ongoing discussion with the College for over a year.	College have provided written support for the project

6 PROPOSED DEVELOPMENT

6.1 GENERAL DEVELOPMENT INFORMATION

The proposed development comprises a multi-lot subdevelopment on a greenfield site.

45 and 45A Constable Road are being separately developed by their owner in two stages. Stage 1 (45 Constable Road) is fully consented, with all Council consents and approvals in place (SSUB60237908, LUC60111076-A, LUC60271724-A). Stage 2 (45A Constable Road) has an earthworks consent, with earthworks for both Stages 1 and 2 largely completed. Crang Civil are the consultant engineers for this project.

The development of 45 Constable Road provides for installation of a stormwater reticulation network that also caters for the development of 45A Constable Road. The plans have been approved by Healthy Waters (email from David Russell to Crang Civil, dated 24 July 2018). The approval includes for the upgrade of a 600dia section of pipe downstream along Constable Road and on the other side of Constable Road to 900 diameter to allow for the development of Stage 2. This pipe systems connects into the stormwater reticulation network serving the Breaker

Grove/Martyn St area and drains to the Tiware Stream. The approval does not cover overland flowpaths, which are yet to be resolved.

6.2 LOCATION AND AREA

The site is located on the Southern edge of the Waiuku township. Waiuku is a self-contained rural town which falls on the Southern Auckland Boundary. The urban extent of Waiuku and the residential rezoning of the sites referred to as the O'Hara Farm have been contemplated for over 20 years. However, the extent of urban residential zoning within the Auckland Unitary Plan Operative in Part ('**AUP**') remains unchanged from that contained in the Franklin District Plan 2000.

There are significant areas of vacant Light Industry zone land through the 'Fernleigh Structure Plan Area' and around Glenbrook, although that is not correspondingly reflected in the residential zoning and housing supply necessary to support this industrial growth with the provision of locally-based workers.

6.3 PURPOSE OF THE DEVELOPMENT

The purpose of this development is to provide for new housing within the Waiuku township. This is a growing part of Auckland as more people seek to find affordable housing.

At current population trajectories, Waiuku is not adequately providing for the housing growth required to support these employment areas nor the well-functioning future of the town. The current lack of sufficient development capacity impacts on housing prices within Waiuku and contributes towards increasing housing affordability issues for residents.

To address these issues, this development seeks to amend the GIS mapping layer of the AUP to rezone the site from Rural – Mixed Rural Zone to Residential - Mixed Housing Suburban Zone. This would make way for a new area of housing on the western side of the existing township.

6.4 SITE LAYOUT AND URBAN FORM

The zoning proposed for the development is Mixed Housing Suburban, which is consistent with the predominant zone for residential land in Waiuku.

Much of the town sits in a basin at the southern end of the Waiuku River, with slightly higher terraced landforms to the west, east and south. The site is located at the edge of the basin on the western terrace. The escarpment that forms the boundary between the basin and western terrace presents as somewhat of a loose 'gateway' in the landscape as you enter and leave the town from its south-western side. This point roughly correlates with the middle of the site at 92 Constable Road.

The indicative concept for development recognises the position of the land at the transition between town and countryside and seeks to emphasise the 'gateway' within the urban design response. The development concept also attempts to maximise connections, including to the existing recreation reserve at the northern boundary and to Waiuku College. Other features of the intended development are the extensive use of greenways to blend the development in to the rural landscape.

In a broader context, the development provides for a transformation in landscape character from pastoral farming to the houses, fences, and roads that accompany residential development. Moreover, the site occupies a rural 'wedge' in the side of the town that is close to the town centre and its development will tend to *complete* rather than *extend* the physical extent of the urban form.

6.4.1 Geotechnical

The FTL geotechnical assessment concluded that in general terms and within the limits of the high-level geotechnical assessment undertaken, the site is suitable for the proposed private plan change from Mixed Rural Zone to Mixed Housing Suburban Zone and associated future subdivisional development.

The report identified two main potential geotechnical hazards within the site:
- Slope instability,
- Settlement/Subsidence.

Three geotechnical risk zones were developed with regard to these hazards in relation to existing topography, as shown on the appended Fraser Thomas drawing 64932/1. The drawing provides a high-level classification of the land suitability to inform a Masterplan, with blue (Zone 1) being low risk, yellow (Zone 2) having moderate risk and red (Zone 3) high risk. The extent of the zones should not be taken as being definitive, but rather, is intended to be a guide to identify areas requiring more detailed geotechnical appraisal. The locations and extents of the hazard zones can be reappraised if further detailed specific geotechnical investigation and appraisal is undertaken.

Residential building development is not precluded from the moderate to high-risk zones but any proposed development within these zones would require a detailed geotechnical investigation and appraisal in support of the consent application, which may show that slope stabilisation or foundation improvement measures are required.

Given the low seismicity risk in the greater Auckland area and that the soils encountered in the boreholes comprise either cohesive silts and clays or dense to very dense sands, it is our opinion that liquefaction and/or lateral spreading does not pose a significant risk to the proposed development.

6.4.2 Zone 1 – Low Risk

This zone generally comprises flat to gently rolling topography that exhibits no signs of significant slope instability and is unlikely to be underlain by compressible organic and/or soft cohesive soils that would be subject to significant settlement under fill or building loads. This zone is considered likely to be suitable for NZS3604 type development, subject to expansive soil requirements and site-specific geotechnical investigation.

6.4.3 Zone 2 – Moderate Risk

This zone generally comprises gently to slightly sloping topography, with evidence of minor slope instability and/or likely underlain by highly compressible organic and/or soft cohesive soils. Development in this zone should be subject to site-specific geotechnical investigations and specific foundation or earthworks design where deemed necessary.

6.4.4 Zone 3 – High Risk

This zone comprises steeply sloping (greater than 1V:4H) topography or areas in close proximity to such slopes, and/or evidence of significant slope instability features. Development in this zone should be subject to geotechnical investigations and slope remediation and/or specific foundation design and/or earthworks where deemed necessary.

6.4.5 Zoning Changes as a Result of Proposed Earthworks

Post-earthworks, the extent of the Zone 2 and 3 areas will be reduced through regrading the majority of the steeper portions of the site (refer drawing 32897/104).

6.4.6 Roading and Greenways

Access roading will be provided generally in accordance with the roading alignments shown in the Common Ground Plan Change layout plans. These are based on four road types:

- Greenways: irregular sized reserves with park-like character, including footpaths and emergency/service vehicles. The proposed greenways provide several important functions, in relation to stormwater, amenity, connectivity and pedestrian/bicycle movements. Specific aspects relating to stormwater are covered in section 4 of this report.
- Living streets: links between greenways and local roads, providing park-like landscaping, with some vehicle access.
- Mews lane: 6-8m width vehicle access inside blocks, with minor landscaping.
- Local road: Typically 16-18m reserve width, with a 6m carriageway, footpaths and parking, with trees and landscaping.

Further details are provided in the separate Common Ground report supporting the Plan Change application.

6.5 EARTHWORKS

Preliminary earthworks design has been undertaken, taking into account the CVA recommendations/aspirations and to facilitate the stormwater design requirements (see section 4) to determine the associated earthworks cut/fill volumes and confirm that the stormwater design concept is feasible and practical from an earthworks perspective.

The proposed development plan showing final contours is shown on drawing 32897/101. The proposed earthworks cut and fill plan is shown on drawing 32897/102 and proposed site drainage long-sections are shown on drawing 32897/103.

Cut-fill earthworks are proposed over a total site area of 28.8ha involving 100,000m^3 of cut to fill, achieving a cut/fill balance, based on a 1.15 compaction factor for cut to fill. This represents an average 350mm earthworks depth across the entire site, demonstrating that relatively minor earthworks, are required, albeit over a large area, to achieve the required landform changes.

Stripped topsoil, based on an average topsoil depth of 0.3m from the geotechnical investigation borehole logs, is estimated to comprise 86,400m^3, of which some is likely to be surplus to respreading requirements. These volumes exceed permitted earthworks area and volume thresholds and will required consent under both the district and regional earthworks requirements of the Auckland Unitary Plan: Operative in Part (AUP:OP). These consents would be applied for at the resource consenting stage for land use/subdivision.

These earthworks represent preliminary bulk earthworks required primarily to provide for proposed roading and stormwater drainage. They do not allow for earthworks at the individual lot scale, required to form building platforms and parking and manoeuvring areas.

The earthworks operation and associated erosion/sediment controls will be designed, installed and operated in accordance with the Auckland Council GD05 “Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region” (June 2016/005) requirements and taking into account any more recent developments in best practice. Detailed earthworks plans and associated erosion/sediment control plans will be provided at the resource consent stage.

7 STORMWATER MANAGEMENT

7.1 PRINCIPLES

7.1.1 Compliance with NDC Requirements

To meet the requirements of the Auckland Region Stormwater Network Discharge Consent, stormwater from the proposed development will be managed in the following ways:

- Treatment of impervious areas including roofing (except where relatively inert roofing materials are used), paving and roading.
- Retention of 5mm of rainfall from all impervious areas.
- Detention of the difference in runoff volume from pre development to post development for a 95th percentile storm.
- No increases in peak flow for a 10% Annual Exceedance Probability (AEP) event from the site, or otherwise demonstrating sufficient downstream stormwater system capacity downstream of the site.
- No increases in downstream flooding for a 1% AEP event, for those areas where downstream flooding is currently a problem.

7.1.2 CVA Recommendations considered in Design

The recommendations within the Ngati Te Ata Waiohua Cultural Values Assessment (CVA) Draft Report from January 2021 were considered in the design of the proposed stormwater management system. Key recommendations relating to stormwater included:

- Future urban development should protect, rehabilitate and enhance waterways, especially where previous land use has degraded it.
- Preserve the physical integrity of receiving streams.
- Streams are well integrated with town centres with use of stream management plans and special policy requirements (green space, infrastructure, wider riparian margins).
- Decisions on use of reserves or similar provision in subdivision applications shall give priority to protecting the water body health regardless of the water body or subdivision size.

The CVA report suggests the following development principles to enhance the environment, including that the development:

- Preserve and preferably enhance the natural hydrologic functions of the site.
- Identify and preserve sensitive areas that affect the hydrology, including streams and their buffers, floodplains, wetlands, steep slopes, high-permeability soils and areas of indigenous vegetation.
- Maintain recharge of aquifers with clean uncontaminated water.
- Consider beneficial re-use on-site of stormwater and wastewater.
- Provide for visual amenity consistent with the surrounding environment.
- Minimise stormwater impacts to the greatest extent practicable by reducing imperviousness, conserving natural resources and ecosystems, maintaining natural drainage courses, reducing use of pipes, and minimising clearing and grading.
- Providing runoff storage measures dispersed through the site's landscape with a variety of detention, retention, and runoff practices.
- Where they will be of benefit, encouraging the use of mechanisms such as rainwater harvesting, rain gardens, roof gardens, and onsite storage and retention.
- Where they will be of benefit, encouraging the use of stormwater treatment devices including on-site treatment systems, allowing for emergency storage and retention structures.
- Such areas that have unavoidable impervious areas, attempt to break up these impervious areas by installing infiltration devices, drainage swales, and providing retention areas.
- Maintains existing topography and pre-development hydrological processes.

7.2 PROPOSED STORMWATER MANAGEMENT

7.2.1 General

During site development, a stormwater network will be installed to collect and convey the 10 year rainfall event. This network needs to discharge either to a downstream piped network, engineered open channel or watercourse. There are no existing public stormwater pipes, open channels or watercourses downstream of the discharge points from catchments F and G (a significant portion of the site) and hence piped flows from these areas need to be diverted to another location, or a new channel/pipe system installed through the downgradient land to connect into the existing downstream stormwater network closer to King St, subject to this system having sufficient capacity. Review of Geomaps stormwater pipe data indicates all downstream stormwater pipes in the King Street are relatively small diameter and hence it is unlikely this would be possible, unless the downstream pipe network was upgraded as well. This is supported by hydrologic/hydraulic modelling data from the WICMP (FTL, 2010 & 2012).

The alternative option of diverting piped flows from these areas to the Rangiwhea Stream is proposed instead. Preliminary work indicated the design objectives can be achieved, including in relation to not worsening downstream flooding, as the time of concentration from the redirected site catchments draining to the stream is significantly lower than the time of concentrations from the other larger rural catchments draining to the stream. Peak flows in the stream are controlled by these rural catchments, rather than the subject site, even with allowing for urban development of the subject site.

This alternative approach involves constructing a large wetland in the northwest corner of the site to retain and detain stormwater. A significant portion of the north-eastern area will be diverted to discharge to this wetland, as well as a proportion of the catchment areas discharging to Constable Road. Stormwater from both the proposed network and overland flow will be collected in a drain (swale or open watercourse) running along the proposed greenways, and discharging to the wetland. The wetland will provide an appropriate level of retention and detention, while storm runoff above a certain threshold will be allowed to bypass the wetland and flow directly to the Rangiwhea Stream to take advantage of the time of concentration differential.

Changing the discharge location of these internal catchments required careful evaluation to achieve this, particularly in relation to optimising the required storage, as this involved potentially large storage volumes, depending on the approach taken.

For catchments C, D and E, these all currently drain through three culverts under Constable Road and then by open channel drains into the Breaker Grove residential area. WICMP modelling from 2010 found that the stormwater reticulation network in this area is already under stress and that the area is prone to flooding, without allowing for any more residential development within the upgradient catchment. Earthworks have been designed to reduce the C, D and E catchment areas where practical and without compromising other aspects of the development, while on-site retention/detention and some supplementary communal detention will be used to ensure post-development flows do not exceed pre-development levels. This represents an approach compliant with stormwater NDC requirements. However, the Applicant has chosen to go beyond this and to upgrade the Constable Road stormwater network, providing a new connection to the site for these catchments.

A number of alternative stormwater management options and sub-options were investigated with a focus on catchments F and G. The options presented in this report represent the best practicable option, based on preliminary modelling and evaluation of these options.

7.2.2 Ground Conditions

The Land Use Capability and Soil Assessment completed by Natural Knowledge Ltd in September 2020 was reviewed. Their investigation involved general site observations, making twenty-five detailed soil borings and description of the soils using standard soil description methods. Their investigation found that two areas of the site contain peat, the mellow humic organic ake ake (shown in purple in Figure 12), and the peaty orthic gley whatakapa (shown in blue in Figure 12).

However, the FTL geotechnical investigation, which involved nine hand auger boreholes across the site, only found peat within the peaty orthic gley whatakapa soils.

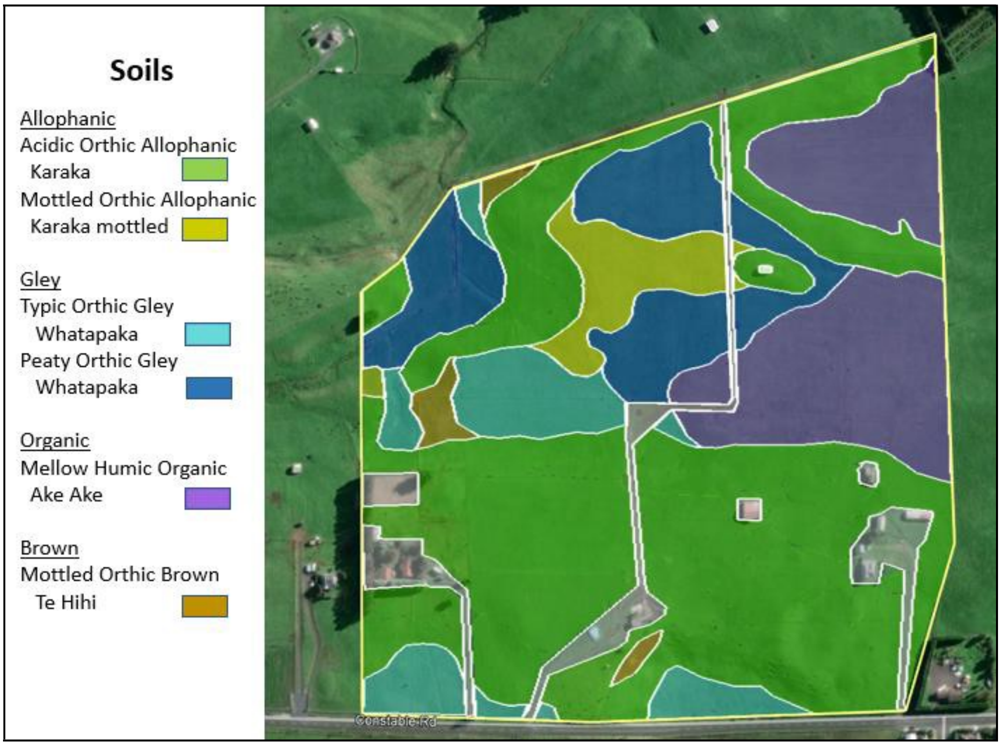


Figure 12: Soil Map Sourced from Natural Knowledge Ltd Land Use Capability and Soil Assessment

7.2.3 Ecological Assessment

The Boffa Miskell Ecological Values Assessment (refer separate report) involved a desktop study and site visits on 26 March and 7 May 2021 and in October 2021.

It found that no natural wetlands are present within the subject site, according to the National Policy Statement for Freshwater Management definition.

No visible natural flow paths were noted on the site by Boffa Miskell, other than some constructed drainage channels intersecting low-lying areas in the north-western corner of the site and discharging to the Rangiwhea Creek on neighbouring properties to the north-west. These drains appear to be regularly graded and maintained as they are largely free of silt and vegetation, containing only sparse, patchy growths of emergent aquatic species including willow weed, watercress and starwort. The drains had pools of standing water, but no flow was observed through them. The immediate aquatic receiving environment downstream of the site was found to be in poor condition, being largely unfenced, with no riparian cover other than close cropped pasture and subject to slumping and erosion scars in places.

The October 2021 site inspection confirmed the status of the drains in the north-western corner of the site to comprise an intermittent channel, feeding into a modified natural intermittent channel (straightened and deepened and an artificial drain, comprising the outlet from a sub-surface drain. These features are shown on Fraser Thomas drawing 32897/208.

7.3 METHODOLOGY

Catchment boundaries were assessed using Lidar 2016 level data. This data has an accuracy in this area of ±0.3m at 68% confidence, vertical ±0.1m at 68% confidence, supplemented by FTL topographical survey of specific drainage features:

- Culvert (2) diameters and invert levels along the Constable Rd frontage (third culvert found in October 2021 not surveyed).
- Multiple cross-sections through the middle of the site, to confirm catchment boundaries and gradients due to the flatness of this area.
- Multiple cross-sections along the Rangiwhea Stream in the north-western corner of the site to supplement other stream cross-section data already held by FTL.

Peak flows and volumes were determined for the pre-development and post-development scenarios for the subject site, utilising:

- Auckland Council TP108 and TP10 guidelines.
- Type B soils.
- Categorisation of land cover into two categories: impervious (CN=98) and pervious (CN=61).
- Adoption of future impervious area coverage of 60% for residential areas (consistent with maximum permitted impervious area for proposed zoning), 60% for roads and 0% for greenways. Living roads were assumed to be 60% impervious, balancing out the assumption of 0% imperviousness for greenways.
- Making changes to some catchments and runoff flow directions, as explained further below.
- Use of HEC-HMS modelling to compare pre-development and post-development flows. This included all sub-catchments downstream of the site to the King St culvert on the Rangiwhea Stream in order to check for possible adverse flooding effects along this entire length.

Consideration of four critical storm events in this assessment:

- The 2 year storm event (for stream erosion protection)
- The 10 year storm event (stormwater pipes are sized to this event)
- The 100 year storm event (current flooding issues)
- The 100 year storm event including climate change (future flooding issues)

7.4 EXISTING CATCHMENTS

The site currently is mostly grassed, and used primarily for stock grazing. The site is not served by a public stormwater network, as explained earlier. The existing stormwater drainage system and associated sub-catchments is shown on drawing 32897/201.

The south eastern portion of the site (sub-catchments C1, C2 and D1) slopes steeply toward Constable Road, draining to three small culverts under the road carriageway. These culverts discharge to surface drains leading toward Waiuku, where it is collected by the stormwater network in two locations upstream of an area of residential houses in the Breaker Grove/Martyn St area.

The north western portion of the site (sub-catchment B1) grades to the west to Rangiwhea Stream, where it combines with runoff from two rural sub-catchments (B2 and B3) and then flows north, combining with runoff from other rural areas (catchments A1-A5) and flows through the fringes of the Waiuku township and then under King Street via a culvert, where it is then discharged to the estuary.

Runoff from the north eastern portion of the site (sub-catchments F1, F2 and G1) discharges across the existing sport field and 45A Constable Road. Runoff from this area will flow overland toward Waiuku, and likely along the King Street Road carriageway until it discharges into the estuary by Tamakae Reserve.

For clarity, the stormwater catchment labels are based on the following:

- Catchments downstream of the north west corner of the site
- Catchments upstream of the north west corner of the site.
- Catchments discharging to the southernmost Constable Road culvert
- Catchments discharging to the northern Constable Road culvert
- Catchments discharging to the Constable Road drain which drains to the catchment D culvert
- Catchments discharging through 45A Constable Road to Council land
- Catchments discharging directly to Council land to the north of the site.

Existing catchment area data is summarised in Table 6.

Table 6: Catchment Area Breakdown (Ha)

Sub-catchment	Impervious	Pervious	Total
A1	0.0	6.5	6.5
A2	0.0	93.6	93.6
A3	0.0	86.9	86.9
A4	0.0	10.1	10.1
A5	0.0	16.2	16.2
A6	2.4	4.2	6.6
B1	0.0	8.6	8.6
B2	0.0	32.0	32.0
B3	0.0	7.5	7.5
C1	0.0	1.8	1.8
C2	0.0	0.6	0.6
D1	0.0	2.4	2.4
E1	0.0	2.0	2.0
F1	0.0	10.5	10.5
F2	0.0	2.9	2.9
G1	0.0	3.4	3.4

7.5 PROPOSED CATCHMENTS

The proposed stormwater catchments have been defined for and around the site as shown in FTL drawing 32897/202. The main changes from the existing situation are:

- Reduction in most of the catchments draining to Constable Road (sub-catchments C1, C2, D1 and E1), through minor earthworks to direct runoff from the northern sides of these catchments to the Rangiwhea Stream.
- Redirection of almost all runoff from the north-eastern portion of the site (catchments B1, F1 and G1) to the Rangiwhea Stream.
- Engineering design for 45A Constable Road (Catchment F1) is being undertaken by Crang Civil. The overland flowpath through this sub-catchment is shown on drawing 32897/202 and reflects the earthworks design provided to us by Crang Civil for this area. Overland flow discharges to the same location in the northern most corner of this sub-catchment as per the existing situation. Crang Civil have provided a separate engineering report for this area, with key points incorporated into this report.

Proposed catchment area data is summarised in Table 7.

Table 7: Catchment Area Breakdown (Ha)

Sub-catchment	Impervious	Pervious	Total
A1	0.0	6.5	6.5
A2	0.0	93.6	93.6
A3	0.0	86.9	86.9
A4	0.0	10.1	10.1
A5	0.0	16.2	16.2
A6	2.4	4.2	6.6
B1	4.3	4.4	8.7
B2	0.0	32.0	32.0
B3	0.0	7.5	7.5
C1	1.0	0.7	1.7
C2	0.4	0.3	0.7
D1	0.8	1.0	1.7
E1	0.4	0.8	1.2
F1	6.3	5.6	11.9
F2	1.8	1.2	2.9
G1	1.8	1.6	3.4

7.6 PROPOSED STORMWATER SYSTEM

FTL drawing 32897/203 shows the proposed stormwater management system outlined above, based on dividing the site into three distinct areas, while drawing 32897/204 demonstrates schematically the stormwater management approach in each area.

7.6.1 Area B

Two alternatives have been designed for area B: areas within peat, or outside of the peat extent.

Areas within the peat extent should have recharge pits installed for residential lots and rain gardens combined with recharge pits for the roading area to retain the first 15mm of rainfall and provide groundwater recharge.

Areas outside of the peat have also been designed to retain the first 15mm of rainfall. Residential roofing areas will drain to water storage tanks for household water reuse, and roading areas should have rain gardens or infiltration swales installed.

In stormwater events larger than 15mm, water will be captured and conveyed to the drains (swales or open watercourse) within the proposed greenways where further treatment of the runoff will occur along the length of drain prior to discharging into the wetland and then the Rangiwhea Stream.

The Rangiwhea Stream runs along the western side of the site. Below the site, it has some very large catchments connecting into it (catchment A2 = 93ha, catchment A3 = 87ha). These catchments have longer "times of concentration" than future discharges from the development area, the time of concentration being the time it takes for the peak flow to reach the catchment discharge point. As described briefly above, it is proposed that the stormwater system will discharge an appropriate proportion of its stormwater runoff more quickly than these external catchments. This will maintain peak flows at pre-development levels and reduce the amount of stormwater detention required. This approach is acceptable and good practice for sites located in the lower part of a catchment, releasing storm flows first before the upper catchment area peak flows come through. It represents a catchment specific design approach.

The wetland has therefore been designed to have a peak flow diversion around it, such that only the lower storm flows are captured within the wetland. Practically, this can be achieved by having an inlet chamber to the wetland, which allows low flows to enter it, with higher flows above a specified threshold (selected at 2.4 m^3/s for a 1% AEP storm) being directed over a weir and bypassing the wetland. Some treatment and detention storage will also be required for stormwater treatment and stream erosion protection objectives. Preliminary wetland sizing is provided in Table 8. Drawing 32897/203 shows the wetland extent. The wetland occupies an area of 6000m^2, effectively taking up the entire area available within the “greenway” shown in this part of the site, allowing for diversion of the existing intermittent stream that runs through this area around the wetland.

Table 8: Preliminary Wetland Sizing

Item	**Volume (m^3)**	**Water Depth (m)**
95th percentile storm	1,200	0.6
10% AEP storm	5,800	1.95
1% AEP storm	5,500	3
Total	12,500	3

HEC-HMS Model results are shown in Table 9 and Table 10 for the design storm events.

Table 9: Catchment Analysis – Storm Peak Flows (m^3/s)

Storm Event	**95th %ile AEP Storm**		**10% AEP Storm**		**1% AEP Storm**	
Node	Pre (m^3/s)	Post (m^3/s)	Pre (m^3/s)	Post (m^3/s)	Pre (m^3/s)	Post (m^3/s)
Wetland Inlet	N/A	0.24	N/A	3.1	N/A	5.2
Wetland Outlet	0.04	0.03	0.70	1.7	1.4	3.4
Rangiwhea 1 (upstream of site)	0.11	0.11	1.8	1.8	3.5	3.5
Rangiwhea 2	0.16	0.15	2.6	3.1	5.2	6.6
Rangiwhea 3	0.35	0.35	5.7	5.6	11.5	11.7
Rangiwhea 4	0.60	0.60	9.8	10.1	19.7	19.9
Rangiwhea 5	0.62	0.62	10.0	10.3	20.2	20.4
King Street Culvert	0.64	0.65	10.3	10.5	20.5	20.8
Point F#	0.05	~0	0.75	~0	1.5	~0
Point G#	0.02	~0	0.25	~0	0.5	~0

post-development flows not assessed but will be relatively low due to runoff diversion

Table 10: Catchment Analysis – Storm Volumes (1000m^3)

Storm Event	95th %ile AEP Storm		10% AEP Storm		1% AEP Storm	
Node	Pre (1000m^3)	Post (1000m^3)	Pre (1000m^3)	Post (1000m^3)	Pre (1000m^3)	Post (1000m^3)
Wetland Inlet	N/A	2.2	N/A	21.9	N/A	38.4
Wetland Outlet	0.35	2.1	5.3	21.9	10.5	38.4
Rangiwhea 1 (upstream of site)	1.3	1.3	19.6	19.6	38.8	38.8
Rangiwhea 2	2.0	3.7	29.5	46.1	58.3	86.3
Rangiwhea 3	6.1	7.8	91.2	108	180	208
Rangiwhea 4	10.3	12.1	155	171	306	334
Rangiwhea 5	10.8	12.5	161	177	318	345
King Street Culvert	11.6	13.4	167	183	328	356
Point F#	0.43	~0	6.4	~0	12.7	~0
Point G#	0.14	~0	2.1	~0	4.1	~0

post-development flows not assessed but will be relatively low due to runoff diversion

Table 9 shows that peak flows will almost have no change in a 95th percentile rainfall event at any node downstream. For this rainfall event, runoff volumes are increased, as the wetland will slowly discharge over 24 hours. In both a 10% and 1% AEP event, the peak flow directly out of the wetland will increase significantly, but once the first significant catchment (catchment A2) discharges to the stream (at node Rangiwhea 3), the post development peak flows are generally similar to or below pre development levels. The critical point analysed was the King Street culvert, which shows that peak flows are increased by only 1.5%, which will result in only a very minor rise in water level.

Table 10 shows that peak volumes are increased in all storm events. Given the scale of the upstream catchments, these volumes are increased by less than 10%, and will be spread out over a long duration.

Flows and volumes at points F and G are reduced to low values post-development as a result of the diversion of runoff from these catchments to the Rangiwhea Stream.

7.6.2 Area C

Catchments C1 and C2 currently drain into 225-300mm diameter culverts under Constable Road, through the neighbouring downstream property, and to a 525mm diameter stormwater pipe under the Breaker Grove subdivision. It is proposed to retain this discharge route for catchment C1, diverting at minimum catchment C2 into the upgraded stormwater pipe along Constable Road. Hence, post-development, catchment C is made up of catchment C1 only, and catchment C2 is part of Area D discussed further below (refer drawings 32897/201 and 202).

Within Area C, roof runoff is proposed to be retained in above ground tanks for reuse on each residential lot. The same tank will also be used for 95th percentile storm detention. Overall a 5m^3 tank was found to be a suitable fit, using 3m^3 for retention and 2m^3 for detention. Road runoff will drain to raingardens for treatment and retention. Larger storm flows will be detained in either a storage tank, wetland, or other detention device. The 225 and/or 300mm diameter culverts under

Constable Road may need to be upgraded, and this will need to be assessed at a later stage. The estimated detention requirement for Area C is summarised in Table 11.

Table 11: Area C Detention Storage Requirement

Item	Storage tank volume (m^3/per lot)	Storage tank volume total (m^3)	Detention Volume (m^3)
Retention Volume	3	72	0
95th percentile storm	2	48	135
10% AEP storm	0	0	20
1% AEP storm	0	0	0
Total	5	120	155

HEC-HMS Model results are shown in
Table *12* for the design storm events.

Table 12: Catchment Analysis – Area C

Storm Event	95th %ile AEP Storm		10% AEP Storm		1% AEP Storm	
	Pre	Post	Pre	Post	Pre	Post
Storm Peak Flows (m^3/s)	0.015	0.005	0.25	0.24	0.50	0.41
Storm Volumes (1000m^3)	0.1	0.25	1.5	1.7	2.9	3.0

Table 12 shows that the proposed stormwater management system will maintain or reduce peak flows for a 95th percentile, 10% AEP and 1% AEP storm flows.

7.6.3 Area D

Due to known stormwater issues in the Breaker Grove/O'Sullivan Place area, the Applicant has decided to go beyond a minimum compliance approach and to try to help alleviate the stormwater and flood hazard risks in the Breaker Grove/O'Sullivan Place area.

Rather than discharge Area D to the existing culvert under Constable Road, it is proposed to upgrade the stormwater network as shown on FTL Drawing 32897/205. A new connection will be made to the existing 900mm diameter pipe installed during the development at 45 Constable Road. The existing 600mm pipe after the 900mm pipe will be removed, and a new run of pipe will be made down the length of Constable Road to the existing 1600mm diameter pipe which discharges to a nearby gully.

Currently both 45 Constable Road and the College discharge their stormwater under Constable Road through a 600mm pipe, which leads to a 1200mm pipe. Under this proposal, both of these sources of stormwater and stormwater from 45A will be piped down Constable Road instead, discharging to the much larger 1600 diameter pipe. This reduces the catchment area and peak flows discharging into the Breaker Grove/O'Sullivan Place area, freeing up some capacity in the existing 1200mm pipe that drains this area, potentially allowing future upstream pipe network upgrades to the Breaker Grove subdivision to alleviate stormwater issues in this area.

As part of the design of the proposed stormwater network, the existing stormwater network was surveyed, starting from the first 1200mm pipe (Manhole ID MCC 69473) and ending at the discharge point of the 1600mm pipe into the gully (outlet ID MCC 9577). It was found that the network shown on Geomaps is incorrect, and skips a critical manhole along Constable Road.

The section of pipe between manhole MCC 69474 and this manhole has significantly less capacity than the pipe upstream (between manholes MCC 69473 and 69474). Our calculated capacity for this pipe is 4.6m^3/s, less than the 10% AEP storm flows. This results in surcharging of manhole 69473.

By diverting stormwater away from this manhole and into the proposed pipe, it is predicted that there will be significantly less overland flows. These manholes and manhole references can be found on FTL drawing 32897/205, as well as the surveyed and Geomaps stormwater system. These are replicated in Figure 13.

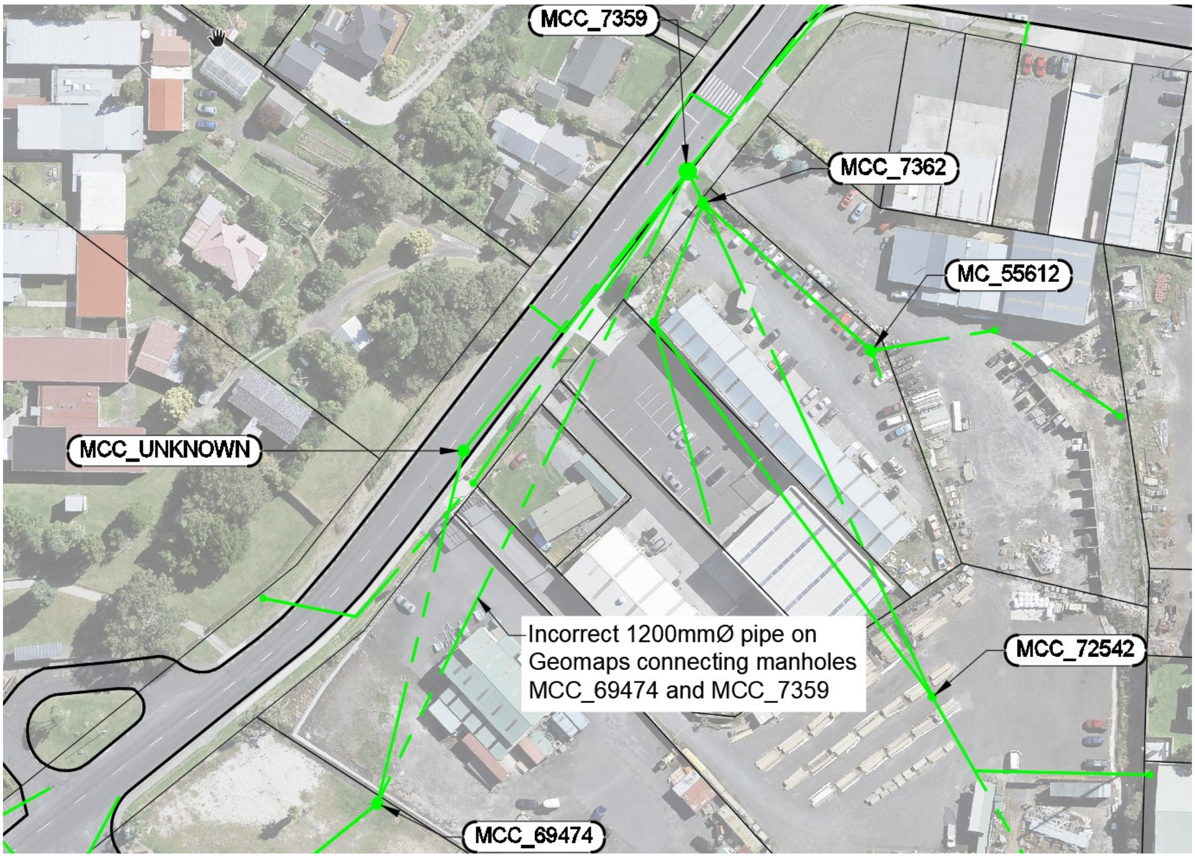


Figure 13: Manhole References and Surveyed/Geomaps Pipes

Similar to the development at 45 Constable Road, the new pipe system has been designed to accommodate the 1% AEP rainfall event, containing the 1% AEP flows for the proposed development (45A, 92 and 130), 45 Constable Road, and the college (with minor overflows up to approximately 50m^3 at 0.15m^3/s). The reason behind this is that the Applicant who has specific local knowledge of the area acknowledges that overland flowpaths are currently not adequately catered for, and does not want to increase the flood risk to neighbouring properties, while creating a continuous overland flowpath down Constable Road would require extensive road regrading. Overland flowpaths are likely to flood nearby neighbouring properties either in Breakers Grove or the more industrial area of Waiuku north-east of Breaker Grove. Therefore, this design goes beyond the requirements of the Stormwater NDC.

FTL have completed a 1D stormwater model in Autodesk software Storm and Sanitary Analysis (SSA) to confirm that the proposal will have a beneficial effect on the local Waiuku area, and to confirm that discharging stormwater into the 1600mm diameter pipe will not impact the capacity of any existing pipework. This is a high level analysis, with assumptions leaning on the conservative side. The design should be reviewed at during later stages to confirm that the design is not over-conservative. Key assumptions made were:

- No retention or detention for 45 and 45A Constable Road was allowed for.
- 47 Constable Road was assumed to be part of 45 Constable Road given that it is also being developed.
- No pipe blockage factors were allowed for.
- 4ha of the total 5ha college area were taken into account as flowing into the stormwater system with no allowance for detention or retention.
- The catchment upstream of Breaker Grove was assumed to flow directly into the 900mm pipe within the subdivision.

Key findings from the model are provided in Table 13. These results show that the proposal will reduce the likelihood of overland flow passing through the Breaker Grove subdivision area.

Table 13: Flood Model Results Showing Effects of Proposal

Item	Breakers Grove 900mm pipe (MCC_65148)		Existing 1200mm pipe (SWMH MCC_69473)		Existing 1600mm pipe (MCC_7359)	
	Pre	Post	Pre	Post	Pre	Post
10 year overflow (m^3/s)	0.23	0	0	0	-	-
100 year overflow (m^3/s)	2.44	1.74	3.32	1.40	-	-
10 year overflow (m^3)	252	0	0	0	-	-
100 year overflow (m^3)	7168	4448	3673	1183	-	-
10 year water level (m RL)	-	-	-	-	5.26	5.40
100 year water level (m RL)	-	-	-	-	5.27	6.14

Under the Stormwater Code of Practice when providing overland flowpaths, a blockage factor of 50% needs to be applied to pipes smaller than or equal to 1050mm diameter, and a 10% blockage factor for pipes greater than 1050mm diameter. It is proposed that a small detention area be constructed on the site, with a scruffy dome inlet into the pipe network to reduce the chance of blockage. Should blockage still occur, 1% AEP overland flows will occur over Constable Road in the direction of the existing flowpath direction.

The proposed 1% AEP flows from 92 and 130 Constable Road will be less than the existing case scenario, for two reasons: the proposed stormwater pipe will still take a significant amount of the rainfall runoff, and the catchments draining toward Constable Road have been significantly reduced.

Overland flows from 45 Constable Road have already been approved by Auckland Council. Overland flows from 45A are to be conveyed in the existing direction (i.e. away from Constable Road) and should be less than existing flows as the site will discharge most stormwater to the public network. It is also proposed to install several scruffy domes and super pits along the new stormwater network, which will lower the chance of pipe blockage. Hence, this approach is considered to comply with the Stormwater Code of Practice and will not increase flooding in a 1% AEP storm event, even when allowing for pipe blockage, going beyond a minimum compliance approach and reducing existing downstream overland flows and flooding.

To demonstrate this further, hydraulic modelling of the new Constable Road line has found:

- Some minor overflows from MH5 and MH6 (shown on FTL Drawing 32897/205) is anticipated only in a 1% AEP or larger storm. These flows are minor, and will be less than the current overland flows at these locations.
- At MH6, it is predicted that there will be 0.27m^3/s peak overflow, resulting in 142m^3 of discharge. This will enter the roadside drain along Constable Road and flow through the existing 225mm diameter culvert under the road towards Breaker Grove. The existing predicted peak flow at this location is 0.95m^3/s with a total storm volume of 5700m^3 flowing towards Breaker Grove. This is considered a significant improvement.
- Currently the stormwater network at 45 Constable Road is not designed to collect the 1% AEP event runoff. Hence, overland flow will occur out of this area. The proposed new scruffy domes or mega pits will collect these flows. In our modelling, MH5 on Constable Road is shown to overflow, indicating that there might be a small amount of overland flow that might not enter the pipe system. Overall, this is a significant improvement. Furthermore, the proposed detention storage can likely be sized to mitigate the overflow issues – this would be addressed at the next design stage.

Within Area D, roof runoff is proposed to be retained in above ground tanks for reuse on each residential lot. The same tank will also be used for 95th percentile storm detention. Overall a 5m^3 tank was found to be a suitable fit, using 4m^3 for retention and 1m^3 for detention. Road runoff will drain to raingardens for treatment and retention. Larger storm flows will be detained in a wetland within the green space near the existing culvert under Constable Road, or another suitable detention device. It is proposed that excess runoff from this area discharges to the second or third existing culverts (225 & 300dia) under Constable Road. These culverts are likely to have sufficient combined capacity, and this will be assessed at a later stage. The estimated detention required for Area D is summarised in Table 14.

Table 14: Area D Detention Storage Requirement

Item	Storage tank volume (m^3/per lot)	Storage tank volume total (m^3)	Detention Volume (m^3)
Retention Volume	3	240	0
95th percentile storm	2	60	200
10% AEP storm	0	0	100
1% AEP storm	0	0	0
Total	5	300	300

HEC-HMS Model results are shown in Table 15 for the design storm events.

Table 15: Catchment Analysis – Area D

Storm Event	95th %ile AEP Storm		1% AEP Storm	
	Pre	Post	Pre	Post
Storm Peak Flows (m^3/s)	0.03	0.02	0.96	0.89
Storm Volumes ($1000m^3$)	0.19	0.54	5.7	6.4

Table 15 shows that the 1% AEP storm volumes will be very similar post-development to pre development, and only small increases to storm volumes are anticipated for the 95th percentile and 10% AEP storm. This outcome is achieved due to the reduction in stormwater catchment area to each location, with a portion of each catchment being diverted to the wetland. All post development peak flows are less than pre development peak flows.

7.7 STORMWATER RETICULATION

Concept level drainage is shown on drawing 32897/203, showing the proposed stormwater sub-catchments (Areas B, C and D). Catchment B is the area draining to the wetland, where it is proposed that primary drainage (pipes) and overland flow from the catchment discharge to swales or streams within the greenways. The greenways will convey stormwater through the site safely away from houses to the wetland. Both catchments C and D will be drained with pipes which convey stormwater to either a small wetland or underground detention tank prior to discharging under Constable Road.

Stormwater drainage plans for 45A Constable Road are provided in the separate Crang Civil engineering report.

7.8 FLOODPLAIN MODELLING

A small section of stream between model nodes Rangiwhea 1 and Rangiwhea 2 will have increased peak flows, post development. The water levels have been modelled in 1D in HEC-RAS, using a Mannings roughness value of 0.049 for bed roughness, and 0.064 for the bank and floodplain roughness. This modelling was intended to determine the likely effect of the increased peak flows in regard to water level. The affected area is shown on FTL Drawing 32897/202, and the increases to peak flood depth summarised in Table 16. The area affected by increased peak flows is rural land, well below any nearby houses. The increase in flows is contained within the existing farm drain cross sections, and predicted to be 100mm or less.

Table 16: Peak Flow Effect on Water Level

Model Node	Peak flow Predevelopment (m^3/s)	Peak flow Post Development (m^3/s)	Peak water depth (m) Predevelopment	Peak water depth (m) Post development
Rangiwhea 2	5.2	6.6	1.13	1.13
Between Rangiwhea 1 and 2	5.2	6.6	0.91	0.96

Rangiwhea 3	11.5	11.7	0.75	0.80

7.9 STREAM DIVERSION

The wetland is proposed to be created in the gully area of the site where the existing farm drain/stream is located. The existing farm drain will be moved to pass around the outside of the proposed wetland, and re-established. The proposed diverted route is shown in FTL Drawing 32897/203. The design of the stream diversion will be completed at the resource consent stage.

7.10 COMPLIANCE WITH IWI RECOMMENDATIONS

The proposed stormwater system takes into account most Iwi recommendations, by including elements such as water reuse, recharge of aquifers, enhancing the natural hydraulic function of the site, incorporation of storage and treatment practices, provision of visual amenity, and enhancing waterways. Two recommendations that are not strictly followed are preserving the physical integrity of streams, and maintaining existing topography and hydrological processes.

It is proposed that a small section of farm drain is diverted to make room for the wetland. This will alter the existing stream. However, the proposed stream will be an enhancement of the current drain.

The proposal also makes a significant change to the existing hydrological catchments, diverting most of the site's stormwater to the wetland, and therefore Rangiwhea Stream. In our opinion, this will be an improvement on the current situation, as it will reduce stormwater passing through areas of Waiuku that currently do not have sufficient stormwater networks and which are prone to flooding.

7.11 ASSESSMENT AGAINST NDC SCHEDULE 4 REQUIREMENTS

The Network Discharge Consent Schedule 4 Connection Requirements for "Greenfields – future urban development" areas have been applied to and assessed for this site, in accordance with the headings in that Schedule.

7.11.1 Catchments/Areas

The site is not located within an area covered by an Adopted Stormwater Management Plan (SMP). Hence, this SMP has been provided addressing:

- Management approach/key elements
- Assessment of Effects
- Any Stormwater plan prepared as part of relevant structure plan

Management Approach/Key Elements

The proposed stormwater management approach defines the key elements in sufficient detail to support a Plan Change application. Areas of development are defined in this report, including the proposed roading and greenways networks and lot layout.

The stormwater management system comprises a treatment train approach involving:

- A range of measures located on private lots (e.g. detention tanks, soakage pits, etc.) which will remain in private ownership and be operated and maintained by individual landowners.
- A range of measures located within the road reserve and greenway areas comprising stormwater public reticulation, rain gardens, soakage pits, swales and a large constructed wetland, which will be vested in Council and operated and maintained by the. Assets located in the road corridor require approval of Auckland Transport and this will be sought further on in the development process.

Areas of on-site and communal (public) stormwater management are well defined and explained throughout the stormwater section of this report.

Significant site features and hydrology have been described in detail, including how relatively minor earthworks will be used to adjust some catchment areas and runoff flow patterns to take advantage of the runoff characteristics of the wider area, reducing runoff flows and volumes discharging to the Constable Road area and through the communal sportsfields, while directing more runoff towards the Rangiwhea Stream, albeit through a treatment train system so as avoid adverse effects on this stream in relation to peak flows, water quality and ecology.

All connection/vesting requirements specified in Schedule 4 have been met as described further below.

No Structure Plan applies to this area.

Assessment of Effects

The scale and significant of the effects of the proposal are relatively minor, due to the comprehensive, integrated stormwater management approach undertaken. Effects relating to peak flows and volumes have been quantitatively assessed already in earlier sections of this report, while the assessment of compliance with Iwi recommendations already addresses the majority of the issues required for an Assessment of Effects under Schedule 4 of the NDC. Hence, this section provides a summary of this earlier material, supplemented by additional information where relevant.

The stormwater related effects of development have been minimised through:

- Minor earthworks to redirect runoff away from existing areas with downstream stormwater issues (Constable Rd and King St) to the Rangiwhea Stream which has a significantly greater carrying capacity in relation to stormwater flows and volumes.
- Use of an extensive range of on-site and communal (public) stormwater devices to promote infiltration and groundwater recharge, provide adequate treatment of stormwater runoff and retain and detain stormwater to pre-development levels for the 95th percentile storm, 10 year and 100 year storm events, including an allowance for climate change.
- Utilisation of the proposed greenways for stormwater conveyance and treatment.

- Design of a new stormwater pipeline along Constable Road which goes beyond minimum compliance requirements and will alleviate existing stormwater issues in the Breaker Grove/O'Sullivan Place area.

Natural hydrology has been retained and/or restored as far as practicable through:

- The extensive use of retention, soakage and groundwater recharge measures to promote infiltration of runoff and reduce post-development stormwater runoff volumes.
- Utilisation of the proposed greenways as part of the stormwater conveyance and treatment network.
- Development of an extensive wetland to provide supplementary retention, treatment and detention of stormwater runoff discharged off-site into the Rangiwhea Stream.

The generation and discharge of contaminants (including gross stormwater pollutants and stormwater flows at source will be minimised through:

- The proposed use of relatively inert roofing.
- The use of first flush diverters or similar on household rainwater tanks inflows.
- The use of gross pollutant traps at or prior to the inlets to stormwater devices such as soakage pits, rain gardens, swales and the large wetland (e.g. submerged sumps/catchpits, Enviropods, forebays, etc.
- Retention/detention of stormwater runoff, including roofwater capture for household reuse.

Temperature related effects will be minimised through appropriate planting along any swales and open channels within the greenways and within the wetland.

Freshwater systems will be enhanced including swales and open channels along the greenways, the wetland and within the riparian margins of the Rangiwhea Stream within the site, through extensive planting of appropriate species.

The locations of engineered structures in streams will be minimised.

The site is not located within any Significant Ecological Areas.

7.11.2 Water Quality

The site is located in close proximity to a tributary of the Rangiwhea Stream and is also underlain by a quality sensitive aquifer.

All impervious areas will be treated by a water quality device designed in accordance with GD01/TP10 for the relevant contaminants, other than household roofing, which will be relatively inert. These devices have been described throughout the stormwater section of this report.

They represent an Integrated Stormwater Management Approach, meet the NDC Objectives and Outcomes in Schedule 2; and represent the BPO for this site, taking into account existing topography, soils, geology and hydrology.

7.11.3 Stream Hydrology

The majority of stormwater runoff will be discharged to the Rangiwhea Stream via a public stormwater network located outside of any SMAF areas. The stormwater management system for the site has been designed to achieve equivalent hydrology (infiltration, runoff volume, peak flow) to pre-development (grassed state) levels, in accordance with AUP:OP requirements.

Again, this represents an Integrated Stormwater Management Approach, meets the NDC Objectives and Outcomes in Schedule 2; and represents the BPO for this site, in relation to promoting infiltration, runoff volume reduction and peak flow attenuation to pre-development levels, taking into account the characteristics of the site and adjacent area.

This is achieved through providing:

- Retention (volume reduction) of a minimum of 5mm runoff depth is provided for all impervious areas; and
- Detention (temporary storage) with a draindown period of 24 hours for the difference between the pre-development (grassed state) and post-development runoff volumes from the 95th percentile, 24 hour rainfall event minus the retention volume for all impervious areas.

7.11.4 Flooding

Downstream Pipe System Capacity – 10% AEP Event

The proposed development ensures there is no adverse effect on the pipe network downstream of the connection point(s) by attenuating and reducing stormwater flows and volume on-site such that there is no increase in peak flow in a 10% AEP event from the site compared to that prior to the new development. This applies to the three discharge points from the site. Furthermore, the proposed stormwater system design will help mitigate existing stormwater pipe system capacity issues in the Breaker Grove/O'Sullivan Place area. An Operation and Maintenance Plan will be provided prior to the commissioning of any stormwater management devices on-site, either at the resource consent application stage, or post-consent as a condition of consent.

Buildings – 1% AEP event

All buildings will be developed in accordance with the Auckland Council Stormwater Code of Practice and in accordance with the final adopted SMP for the development. All new buildings will be located outside of overland flowpaths and floodplains areas, as defined in the AUP:OP and will be designed with appropriate finished floor levels, determined in accordance with Building Code and the Stormwater Code of Practice requirements.

Furthermore, the proposed stormwater system design will help mitigate existing stormwater overland flow and flooding issues in the Breaker Grove/O'Sullivan Place area.

7.12 ASSET OWNERSHIP

All new assets that are intended to become part of the public stormwater network are to be designed and constructed to be durable and perform to the required level of service for the life of the asset, in accordance with the Stormwater Bylaw, Stormwater Code of Practice, and subject to reasonable asset maintenance. This will be confirmed at the Resource Consent, Engineering Plan Approval and Building Consent application stages. A Safety in Design register will be prepared as part of the design process to ensure that safety issues associated with construction and operation of new assets are adequately addressed.

Approval for stormwater management assets in the road corridor from Auckland Transport will be obtained prior to vesting.

Approval for stormwater management assets in the greenways from Auckland Council Community Facilities will be obtained prior to vesting.

7.13 ONGOING MAINTENANCE REQUIREMENTS

All stormwater devices will need to be adequately managed and maintained in order to be effective. A preliminary Operation and Maintenance Plan (O&M Plan) is set out in Appendix C. Maintenance requirements shall be undertaken by a suitably qualified company/individual specifically for this purpose.

A more complete O&M Plan will be prepared at the resource consent stage, if required.

7.14 IMPLEMENTATION OF STORMWATER NETWORK

Stormwater will be managed for the proposed development in accordance with the preliminary staging and timing of key infrastructure provision summarised in the table below for clarity.

Table 17: Summary of What Devices are built in Each stage of Development

Stage	Internal	External
0	Wetland	None
1A, 1B1, 1C1	Pipe reticulation Public SW treatment	Constable Rd SW pipe
1B2	Central greenway/swale Pipe reticulation Public SW treatment	None
1C2	Pipe reticulation Public SW treatment	None
2	Northern greenway/swale Pipe reticulation Public SW treatment	None

The development will be undertaken in stages, based on the preliminary staging plan attached to this response as drawing 32897/105, and explained in the following:

1. The Plan Change site comprises three different lots under separate ownership, with each owner planning to develop their property separately but in accordance with the overall Plan Change layout. The Staging Plan allows for the first stage to include land belonging to each owner to facilitate this.
2. Development of the site does depend on some internal infrastructure being constructed or upgraded for specific areas, with this being taken into account in sub-staging.
3. All earthworks are proposed to be undertaken in one stage. The rationale for this is that the earthworks achieve a cut:fill balance and are relatively minor in terms of volume, comprising 100,000m^3 of cut to fill, representing an average depth of 350mm across the site area of 28.8ha. Doing them in one stage will minimise double handling of material while also creating the landform required to facilitate stormwater management via the greenways and wetland. The site would be split into earthworks catchments of a maximum of 5ha each in accordance with GD05 requirements, with each draining to a Sediment Retention Pond (SRP) or alternative GD05 compliant device.
4. The wetland area is referred to as Stage 0. It will initially be used as a SRP and then converted to a wetland prior to receiving discharges from any impervious areas within its contributing catchments - Areas 1B2, 1C2 and 2.
5. Stage 1 involves approximately 72% of the site, split into three areas covering each of the Plan Change owner landholdings – i.e. Stages 1A, 1B and 1C. The Stage 1 boundary is based on a proposed ridge line, so that the site is essentially being split along stormwater catchments, as these are more controlling in relation to development constraints than water or wastewater. It is anticipated that Stage 1A (#45A) will be ready to be developed first. The new stormwater line along Constable Rd is needed for the development of the hatched parts of Stage 1 (Areas 1A, 1B1, 1C1). The new wastewater line along Constable Rd is needed for the development of all of Area 1, noting there is a small portion of Areas 1B and 1C that won't be able to be serviced until a wastewater pump station is installed. The Stage 1 split also allows for early construction of the alternative access/dropoff zone to Waiuku College.
6. Stage 2 comprises development of the balance of the site on the northern side. A small wastewater pump station is needed to service part of this stage.
7. The likely staging sequence, subject to further planning and design work, is tabulated below:

Table 18: Likely Stormwater Infrastructure Staging

Sequence	Stages served	Essential Infrastructure Prerequisites	Comments
0	1B2, 1C2, 2 (stormwater only)	Wetland	Sediment Retention Ponds (SRPs) will be converted into wetland, with planting undertaken as early as practical based on planting seasons. This will allow maximum time for wetland plants to become established prior to the construction of impervious areas.

Sequence	Stages served	Essential Infrastructure Prerequisites	Comments
1	1A, 1B1, 1C1	New Constable Road stormwater and wastewater lines; new water supply ring main and booster pumps (TBC)	New wastewater reticulation line required along Constable Rd for all development; new stormwater line would be installed at same time for cost efficiencies
2	Part 1B2, 1C2 and 2	New wastewater pump station and associated rising main	

7.15 DEPENDENCIES

The Stormwater management Plan is dependent on the staging plan outlined in section 7.11. The order for implementation is important as some devices need to be built before others to ensure stormwater is effectively managed over the lots. In particular, the Constable Rd pipeline needs to be built before Stages 1A, 1B1 and 1C1 can be certified.

7.16 DEPARTURES FROM REGULATORY OR DESIGN CODES

The proposed stormwater management system has been designed in line with all regulatory and design code requirements.

The one exception is sizing of the stormwater pipe for Constable Road. This pipe is to collect all stormwater from the development and link to the existing network. It has been sized for a 1% AEP storm event, instead of a 10% AEP storm event. This has been done to alleviate existing overland flow/flooding problems downstream of the site along the existing overland flowpath from this area in the Breaker Grove residential area, as no other alternative OLFP is viable, without major redesign of Constable Road to facilitate overland flow down the road instead.

8 CONCLUSIONS AND RECOMMENDATIONS

The proposed stormwater management measures satisfy the requirements for “greenfield developments” set out under the regional Stormwater Network Discharge Consent, in relation to the essential components of this SMP, addressing water quality, stream hydrology, flooding: 10% AEP property/pipe capacity and flooding: 1% AEP – buildings, as well as the requirements for a private stormwater discharge consent under Section E8, Activity A10 of the AUP:OP as a **discretionary** activity.

The proposed stormwater management measures have been assessed against recommendations from the Cultural Values Assessment and the NDC Schedule 4 requirements and show strong alignment with both documents.

To meet these requirements, stormwater from the proposed development will be managed in the following ways:

- Treatment of impervious areas including roofing (except where relatively inert roofing materials are used), paving and roading.
- Retention of 5mm of rainfall from all impervious areas.
- Detention of the difference in runoff volume from pre development to post development for a 95th percentile storm.
- No increases in peak flow for a 10% Annual Exceedance Probability (AEP) event from the site.
- No increases in downstream flooding for a 1% AEP event, for those areas where downstream flooding is currently a problem.

Key features of this approach are minor recontouring of the site so as to redirect runoff from stormwater problem areas (i.e. Breaker Grove/Martyn St area) through a large constructed treatment/retention/detention wetland to the Rangiwhea Stream, which has significant flow and volume capacity. whilst a new 825-1200mm diameter stormwater pipeline will also be provided along Constable Road. The latter goes beyond the minimum compliance requirements of the Regional Stormwater Network Discharge Consent, further alleviating existing stormwater and flooding problems in the Breaker Grove/O'Sullivan Place area.

9 DISCLAIMER

The professional opinion expressed herein has been prepared solely for, and is furnished to our client, Gardon Trust and for the information of Council, on the express condition that it will only be used for the purpose for which it is intended.

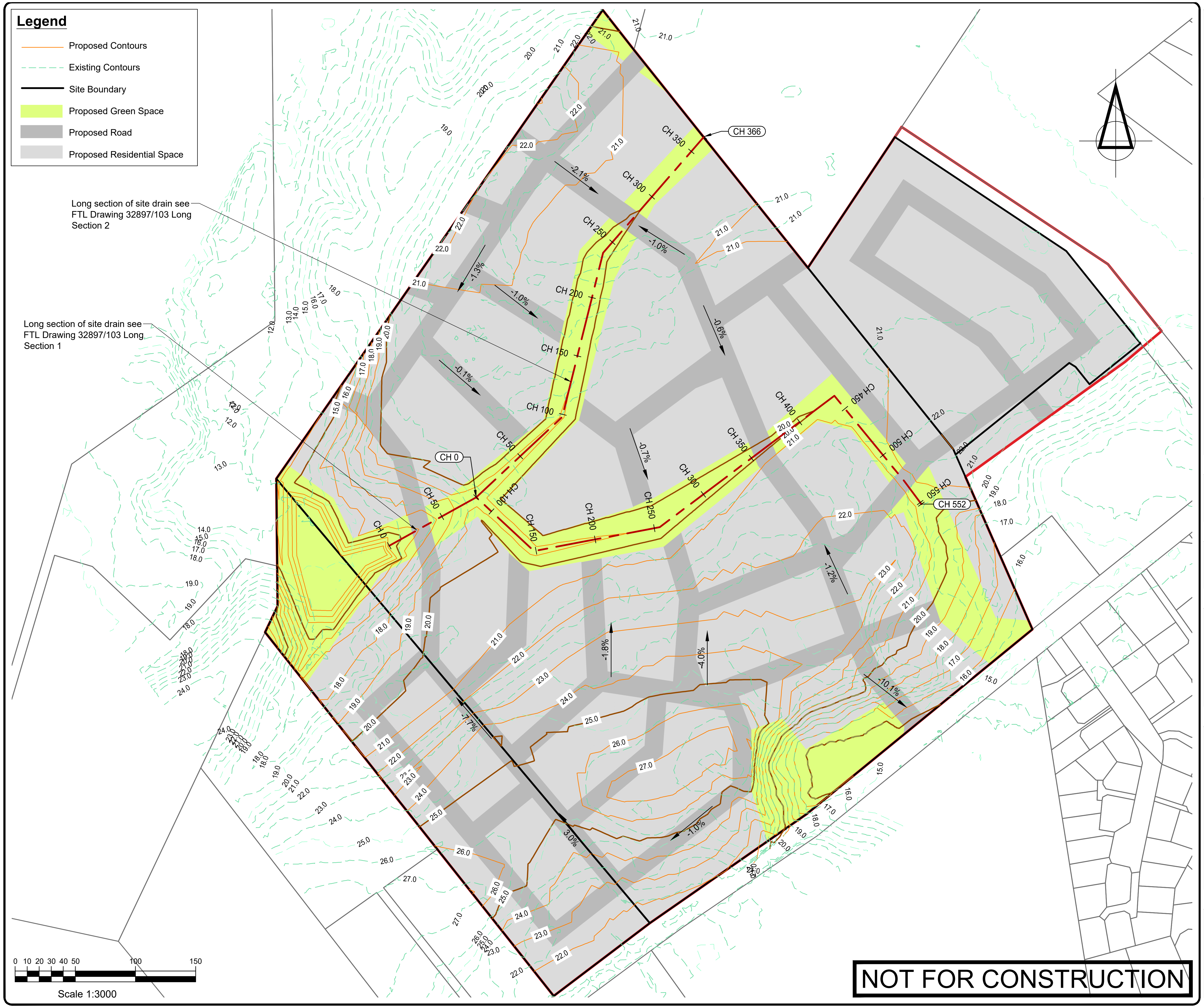
No liability is accepted by this firm or by any Principal, or Director, or any servant or agent of this firm, in respect of its use by any other person, and any other person who relies upon any matter contained in this report does so entirely at its own risk. This disclaimer shall apply notwithstanding that this report may be made available to any person by any person in connection with any application for permission or approval, or pursuant to any requirement of law.

We do not assume any liability for misrepresentation or items not visible, accessible or present at the subject site during the time of the site inspection; or for the validity or accuracy of any information provided by our client or third parties that have been utilised in the preparation of this report.

The conclusions and recommendations expressed herein should be read in conjunction with the remainder of this report and should not be referred to out of context with the remainder of this report.

J:\32 series\32897 Gardon Trust Waiuku PPC\Report\32897 SW Mgmt report 211105md.doc

Figures and Drawings



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SURVEYED			SF	
DESIGNED	TB	17/02/21	18/02/21	
DRAWN	TB	17/02/21		
CHECKED	SF	18/02/21		

REVISION	CHANGES	CHECKED	DATE
A	MINOR CHANGES	SF	15/06/21

NOTES

CLIENT

GARDON TRUST

PROJECT

O'HARA WAIUKU PLAN CHANGE
45A, 92 & 130 CONSTABLE ROAD
WAIUKU

TITLE

PROPOSED DEVELOPMENT PLAN

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STATUS

PLAN CHANGE

Construction works shall commence only on receipt of and in accordance with the Council or Council organisation stamped approved drawings, unless otherwise indicated.

SCALE 1:3000 (A3)

DRAWING No 32897/101

REVISION A

Legend

- Proposed Cut
- Proposed Fill

Notes:

Total Cut: 100,000m^3
Total Fill: 100,000m^3 (based on 1.15 compaction factor)
Net: 0m^3

Total topsoil strip: 86,400 m^3 (based on 0.3m average depth)

Total cut area: 133,964m^2
Total fill area: 154,030m^2
Total earthworks area: 287,994m^2

0 10 20 30 40 50 100 150

Scale 1:3000

NOT FOR CONSTRUCTION

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			APPROVED	DATE
SURVEYED			SF	
DESIGNED	TB	17/02/21	18/02/21	
DRAWN	TB	17/02/21		
CHECKED	SF	18/02/21		

REVISION	CHANGES	CHECKED	DATE
A	EARTHWORKS AMMENDED	SF	15/06/21

NOTES

1. Earthworks for 45A are covered under existing consents LUC60111076-A and LUC60271724-A and are not shown in this plan.

CLIENT

GARDON TRUST

PROJECT

O'HARA WAIUKU PLAN CHANGE
45A, 92 & 130 CONSTABLE ROAD
WAIUKU

TITLE

PROPOSED EARTHWORKS
CUT AND FILL PLAN

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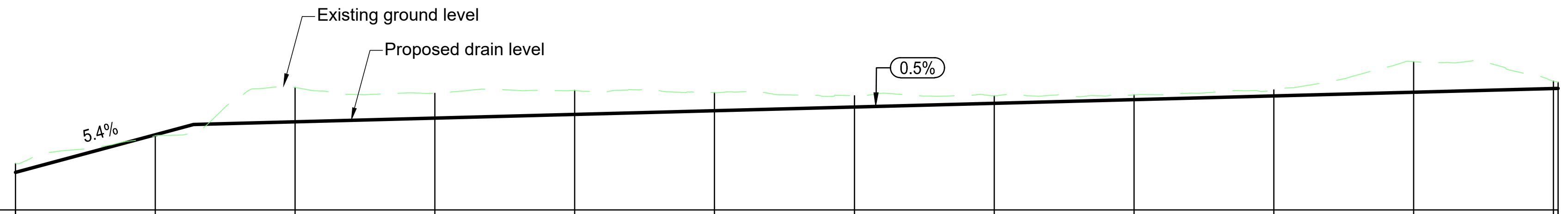
SCALE 1:3000 (A3)

DRAWING No 32897/102

REVISION A



DATUM: 12.00

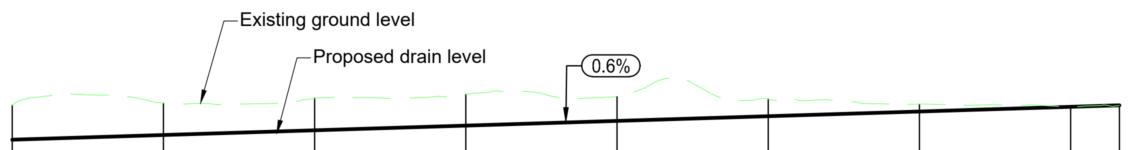
CUT/FILL DEPTHS	-0.63	0.07	-2.48	-1.79	-1.73	-1.30	-0.82	-0.54	-0.34	-0.43	-2.19	-0.53	
DESIGN LEVELS	14.70	17.39	18.32	18.59	18.86	19.12	19.39	19.65	19.92	20.19	20.45	20.72	
EXISTING LEVELS	15.33	17.32	20.80	20.37	20.59	20.42	20.21	20.19	20.26	20.62	22.64	21.25	
CHAINAGE	0	50	100	150	200	250	300	350	400	450	500	550	561

VERTICAL GEOMETRY	63.66 5.4%	488.02 0.5%

HORIZ. GEOMETRY	82.70m 60°54'02"	65.53m 132°57'58"	106.42m 79°14'02"	181.54m 53°02'46"	91.70m 140°40'47"	23.79m 143°22'45"

Drain Long Section 1

Scale 1:2500 Horiz, 1:500 Vert



DATUM: 16.00

CUT/FILL DEPTHS	-2.27	-2.12	-2.13	-2.08	-1.60	-1.14	-0.49	-0.02	0.00
DESIGN LEVELS	18.23	18.54	18.85	19.16	19.47	19.78	20.09	20.40	20.51
EXISTING LEVELS	20.50	20.66	20.98	21.24	21.07	20.93	20.59	20.43	20.51
CHAINAGE	0	50	100	150	200	250	300	350	366

VERTICAL GEOMETRY	366.15 0.6%

HORIZ. GEOMETRY	97.70m 46°57'40"	140.53m 14°00'20"	127.91m 40°59'11"

Drain Long Section 2

Scale 1:2500 Horiz, 1:500 Vert

0 10 20 30 40 50 100
Scale 1:2500

0 2 5 10 25
Scale 1:500

NOT FOR CONSTRUCTION

SURVEYED		
DESIGNED	TB	17/02/21
DRAWN	TB	17/02/21
CHECKED	SF	18/02/21

APPROVED: SF — DATE: 18/02/21

REVISION	CHANGES	CHECKED	DATE
A	EARTHWORKS AMMENDED	SF	15/06/21

NOTES

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GARDON TRUST

PROJECT
O'HARA WAIUKU PLAN CHANGE
45A, 92 & 130 CONSTABLE ROAD
WAIUKU

TITLE
PROPOSED SITE DRAINAGE
LONG SECTIONS

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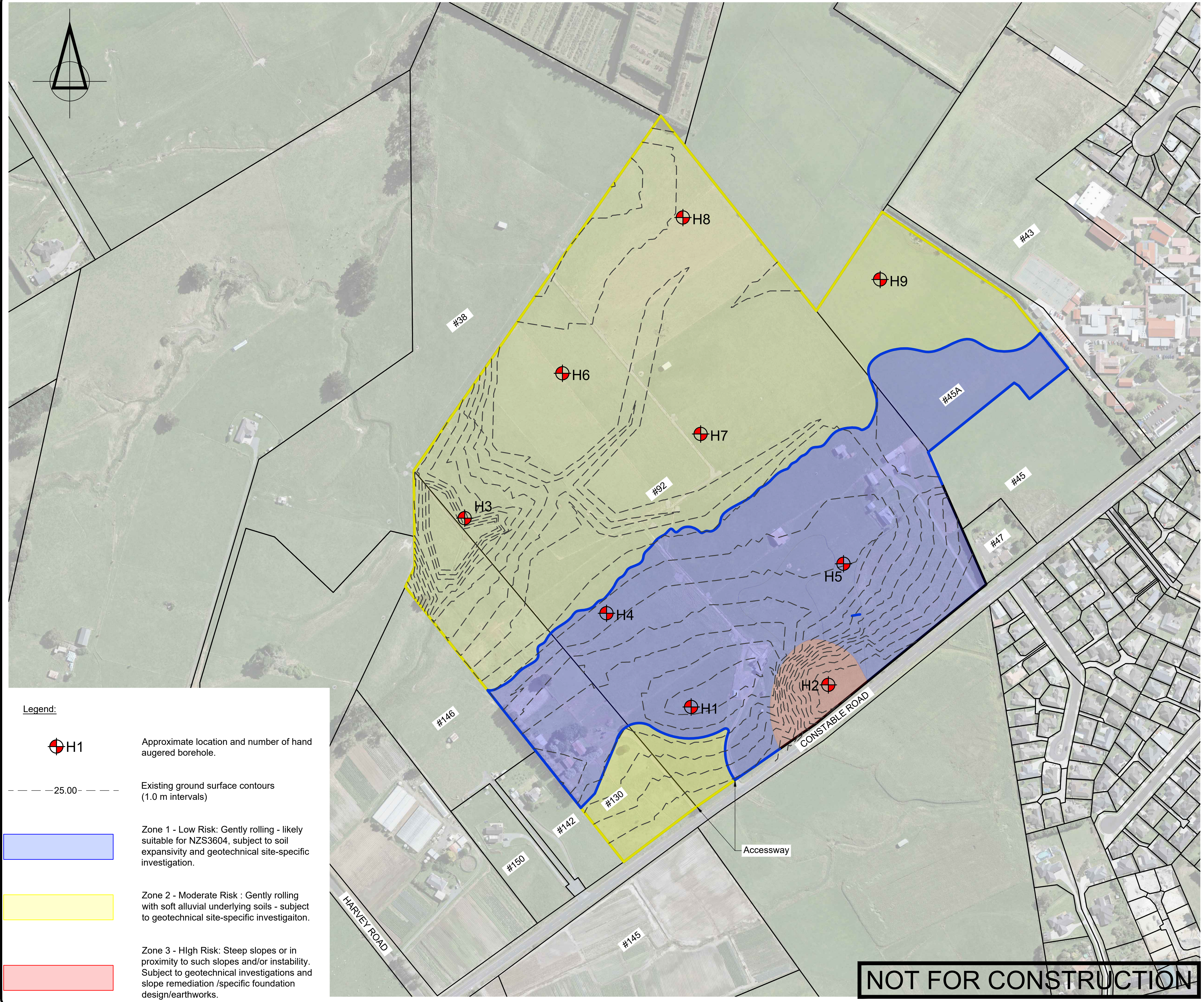
SCALE AS SHOWN (A3)

DRAWING No 32897/103 — REVISION A



Legend:

H1	Approximate location and number of hand augered borehole.
— — —25.00— — —	Existing ground surface contours (1.0 m intervals)
(blue)	Zone 1 - Low Risk: Gently rolling - likely suitable for NZS3604, subject to soil expansivity and geotechnical site-specific investigation.
(yellow)	Zone 2 - Moderate Risk : Gently rolling with soft alluvial underlying soils - subject to geotechnical site-specific investigaiton.
(red)	Zone 3 - HIgh Risk: Steep slopes or in proximity to such slopes and/or instability. Subject to geotechnical investigations and slope remediation /specific foundation design/earthworks.

			APPROVED	DATE
SURVEYED			SF	
DESIGNED	TB	17/02/21	18/02/21	
DRAWN	TB	17/02/21		
CHECKED	SF	18/02/21		

REVISION	CHANGES	CHECKED	DATE
A	RISK ZONES AMMENDED	SF	15/06/21

NOTES

1. The land contours shown on this plan are based on 2017 LiDAR data.
2. Refer to Fraser Thomas Ltd. Report No. 64932, dated March 2021 for full description of Risk Zones.
3. Risk zones based on Fraser Thomas Ltd. finished ground contours. Zones for the existing ground contours can be found in the Fraser Thomas Ltd. Report No. 64932, dated March 2021. If finished ground contours are significantly different from those shown on this drawing then risk zones may change.

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PROJECT

O'HARA WAIUKU PLAN CHANGE
45A, 92 & 130 CONSTABLE ROAD
WAIUKU

TITLE

GEOTECHNICAL RISK ZONES FOR PROPOSED GROUND LEVELS

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PLAN CHANGE

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SCALE 1:4000 (A3)

DRAWING No 32897/104

REVISION A

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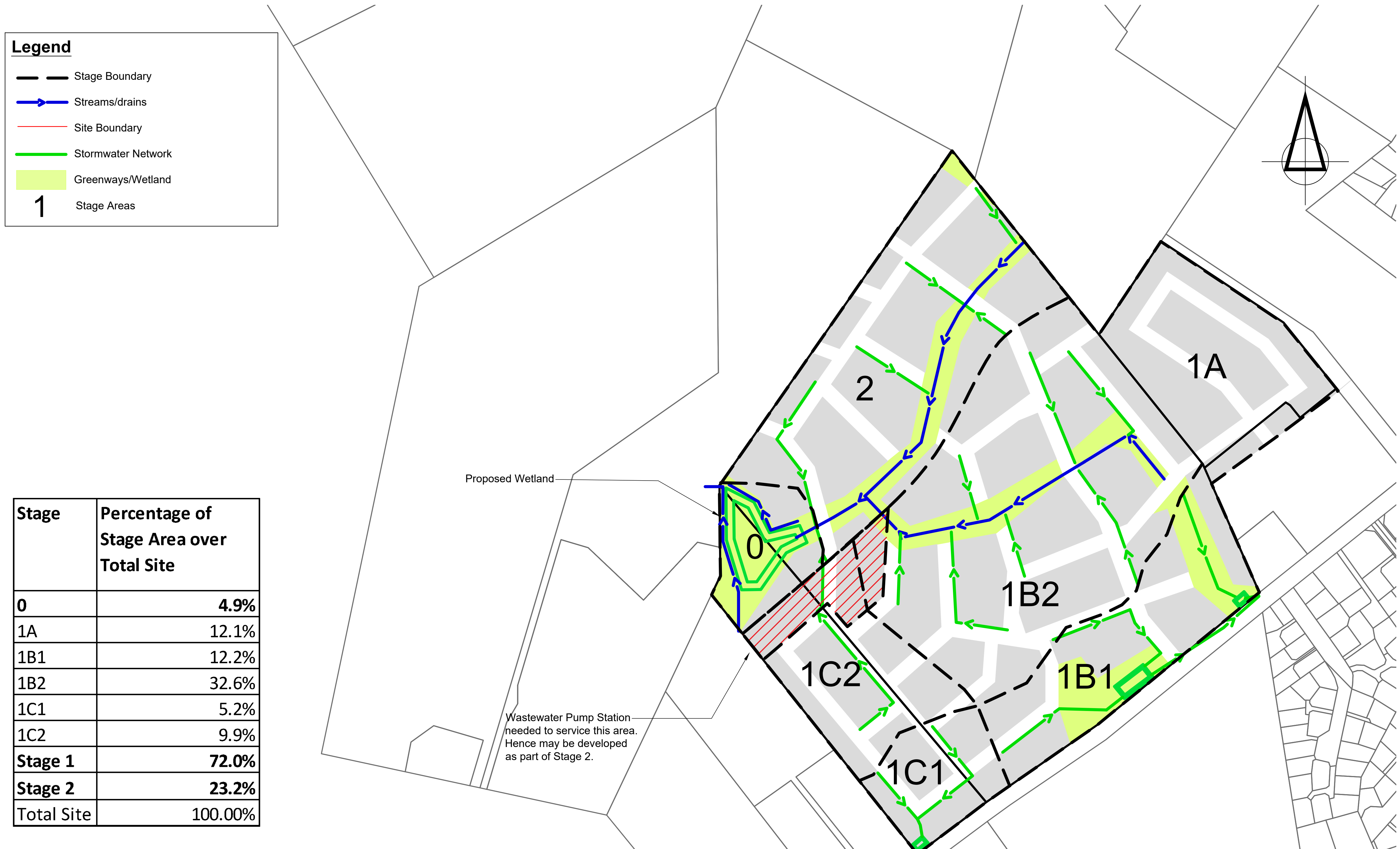

Stage	Percentage of Stage Area over Total Site
0	**4.9%**
1A	12.1%
1B1	12.2%
1B2	32.6%
1C1	5.2%
1C2	9.9%
Stage 1	**72.0%**
Stage 2	**23.2%**
Total Site	100.00%

Phase	Stages served	Essential Infrastructure Prerequisites	Comments
0	1B2, 1C2, 2 (stormwater only)	Wetland	Post-earthworks, wetland to be planted as early as practical based on planting seasons, allowing maximum time for wetland plants to become established prior to the construction of impervious areas.
1	1A, 1B1, 1C1	New Constable Road stormwater and wastewater lines; new water supply ring main and booster pumps	New wastewater reticulation line required along Constable Rd for all development; new stormwater line would be installed at same time for cost efficiencies
2	Part 1B2, 1C2 and 2	New wastewater pump station and associated rising main	Booster

NOT FOR CONSTRUCTION

SURVEYED			APPROVED	DATE
DESIGNED				
DRAWN	MD	3/11/21		
CHECKED				

REVISION	CHANGES	CHECKED	DATE

NOTES

CLIENT
GARDON TRUST

PROJECT
O'HARA WAIUKU PLAN CHANGE
45A, 92 & 130 CONSTABLE ROAD
WAIUKU

TITLE
PRELIMINARY STAGING PLAN

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PLAN CHANGE
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SCALE 1:5000 (A3)

DRAWING No 32897/105
REVISION

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DESIGNED	TB	17/02/21	SF	18/02/21
DRAWN	TB	17/02/21		
CHECKED	SF	18/02/21		

REVISION	CHANGES	CHECKED	DATE
A	MINOR CHANGES	SF	15/06/21
B	ADDITIONAL CULVERT ADDED	SF	17/11/21

NOTES

CLIENT

GARDON TRUST

PROJECT

O'HARA WAIUKU PLAN CHANGE
45A, 92 & 130 CONSTABLE ROAD
WAIUKU

TITLE

EXISTING STORMWATER
CATCHMENT PLAN

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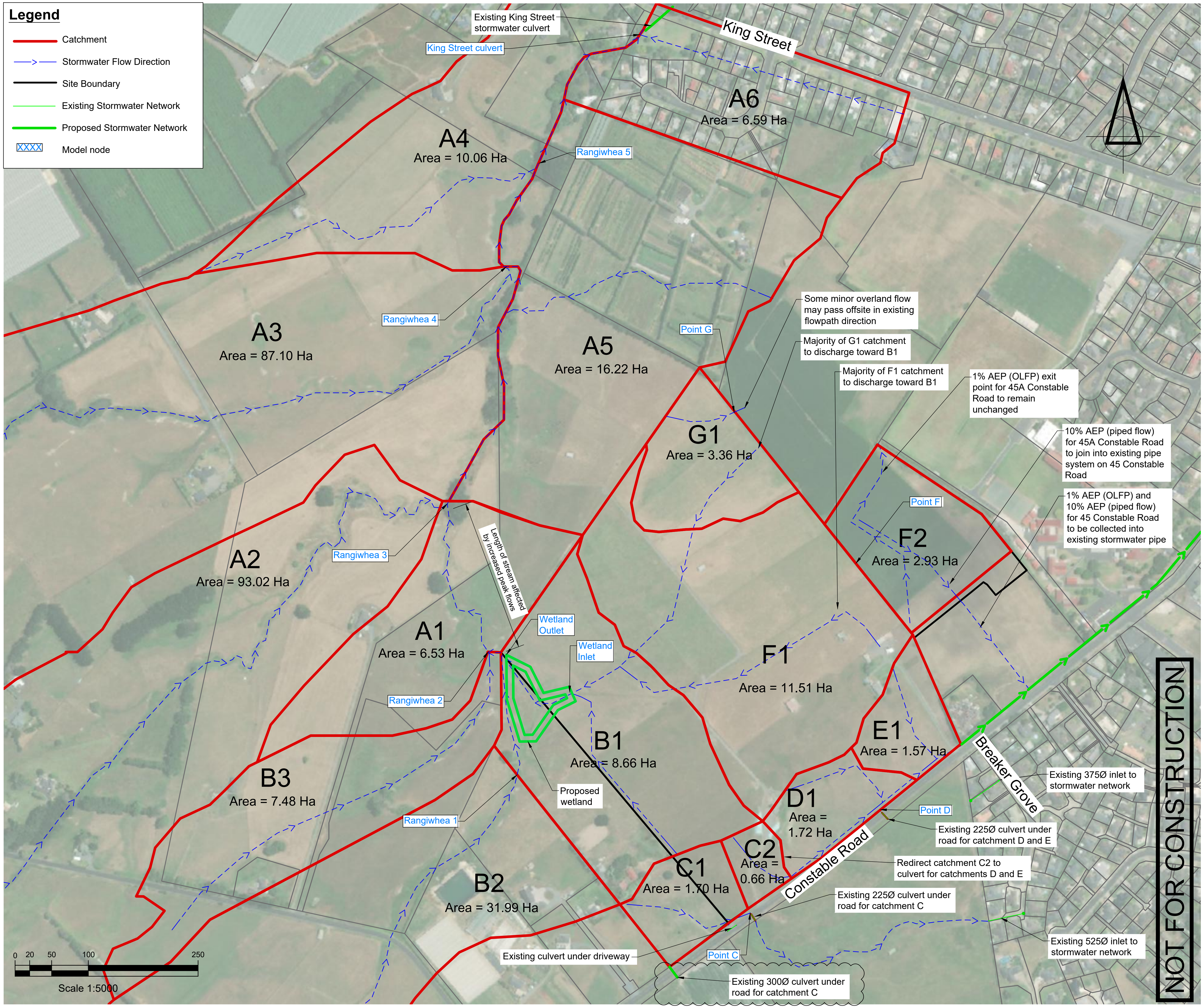
PLAN CHANGE

Construction works shall commence only on receipt of and in accordance with the Council or Council organisation stamped approved drawings, unless otherwise indicated.

SCALE 1:5000 (A3)

DRAWING No 32897/201

REVISION B



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SURVEYED			SF	
DESIGNED	TB	17/02/21		
DRAWN	TB	17/02/21	18/02/21	
CHECKED	SF	18/02/21		

REVISION	CHANGES	CHECKED	DATE
A	CATCHMENTS AMMENDED	SF	15/06/21
B	ADDITIONAL CULVERT ADDED	SF	17/11/21

NOTES

CLIENT
GARDON TRUST

PROJECT
O'HARA WAIUKU PLAN CHANGE
45A, 92 & 130 CONSTABLE ROAD
WAIUKU

TITLE
PROPOSED STORMWATER
CATCHMENT PLAN

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STATUS
PLAN CHANGE
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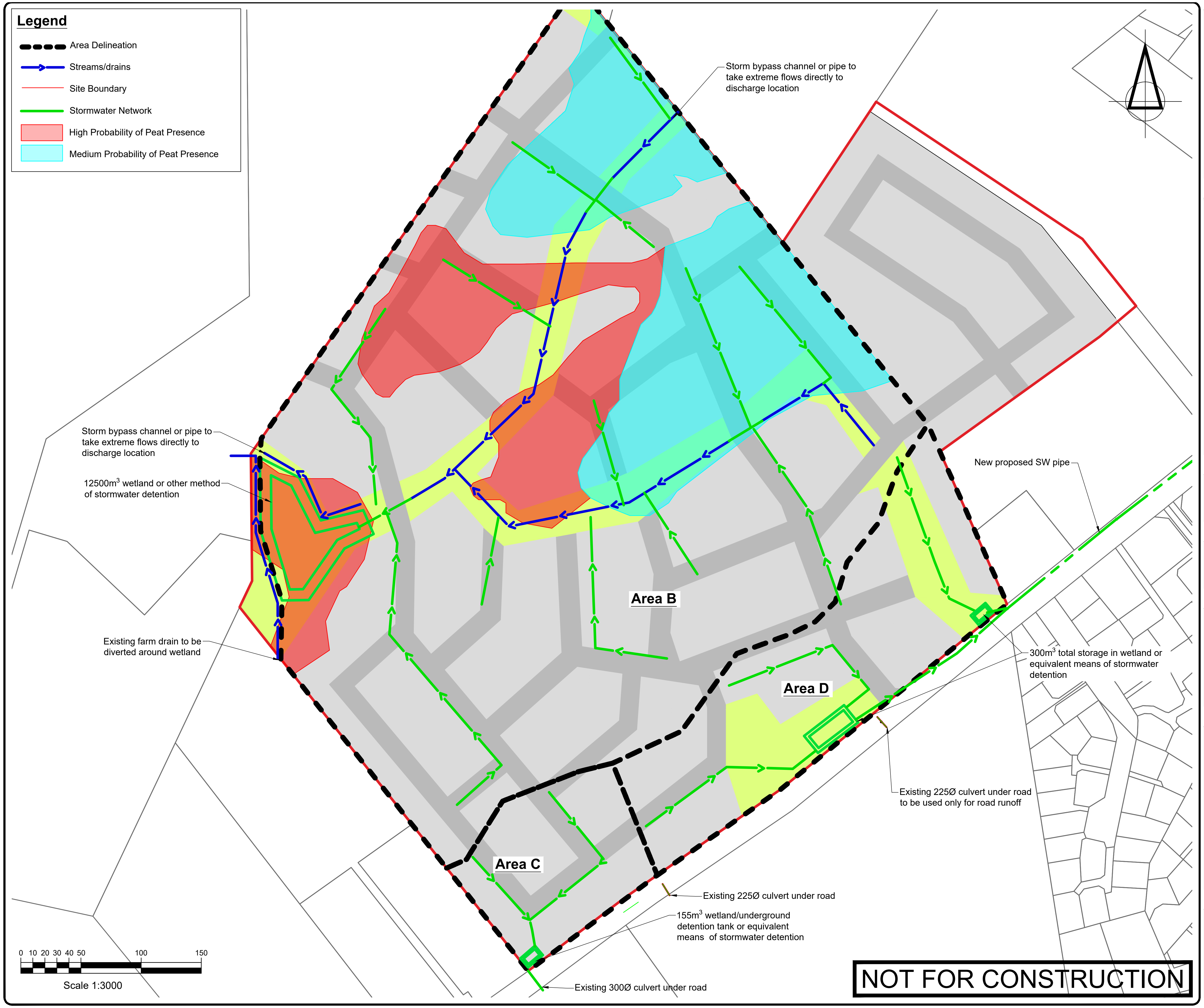
SCALE 1:5000 (A3)

DRAWING No 32897/202
REVISION B



SURVEYED			APPROVED	DATE
DESIGNED	TB	17/02/21	SF	18/02/21
DRAWN	TB	17/02/21		
CHECKED	SF	18/02/21		

REVISION	CHANGES	CHECKED	DATE
A	CONSTABLE ROAD PIPE ADDED	SF	15/06/21
B	ADDITIONAL CULVERT ADDED	SF	17/11/21

NOTES

1. Peat presence based on the Land Use Capability and Soil Assessment completed by Natural Knowledge Ltd in September 2020

CLIENT

GARDON TRUST

PROJECT

O'HARA WAIUKU PLAN CHANGE
45A, 92 & 130 CONSTABLE ROAD
WAIUKU

TITLE

PROPOSED STORMWATER MANAGEMENT

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SCALE 1:3000 (A3)

DRAWING No 32897/203

REVISION B

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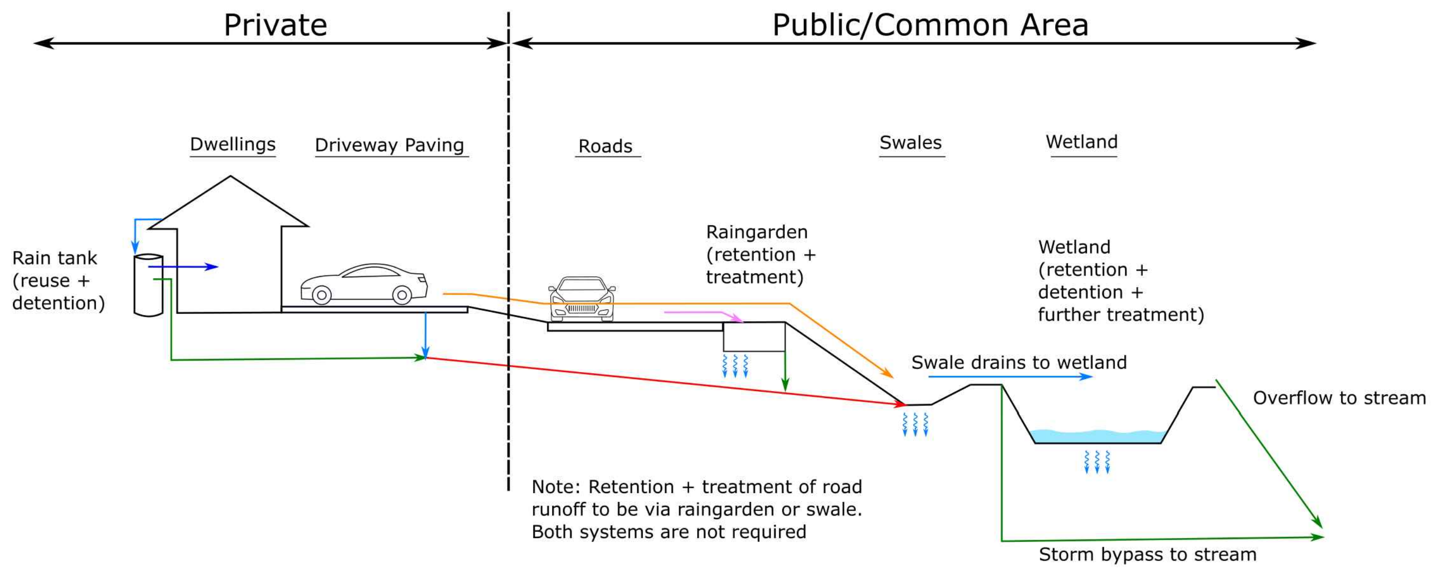
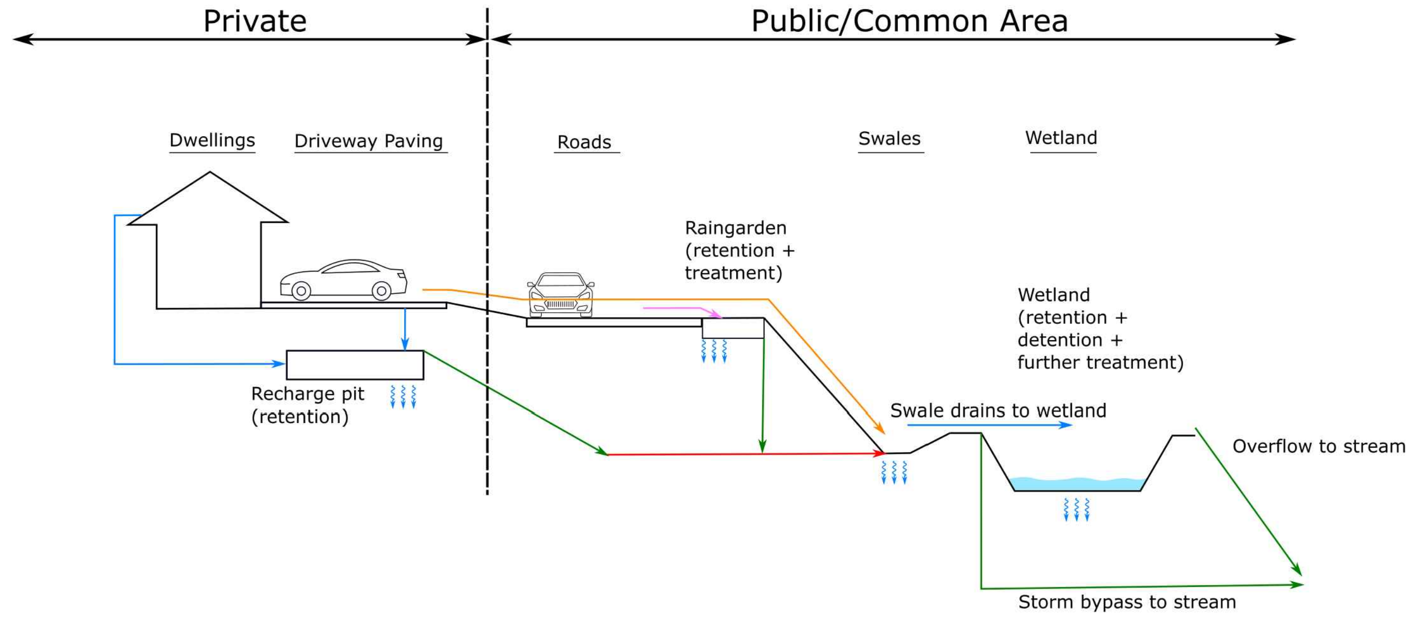


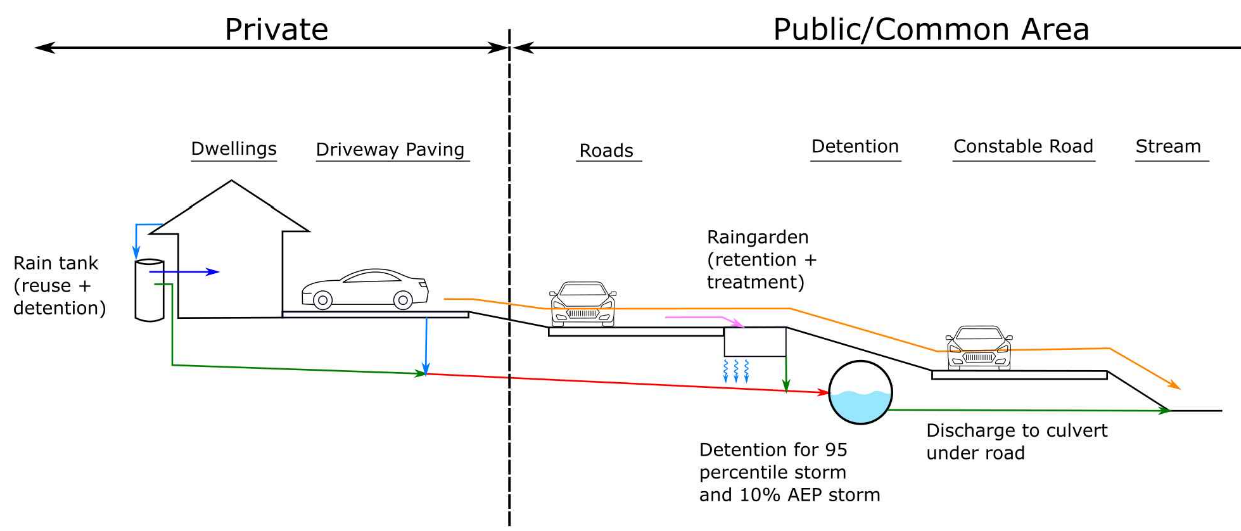
Area B - Outside Peat Extent



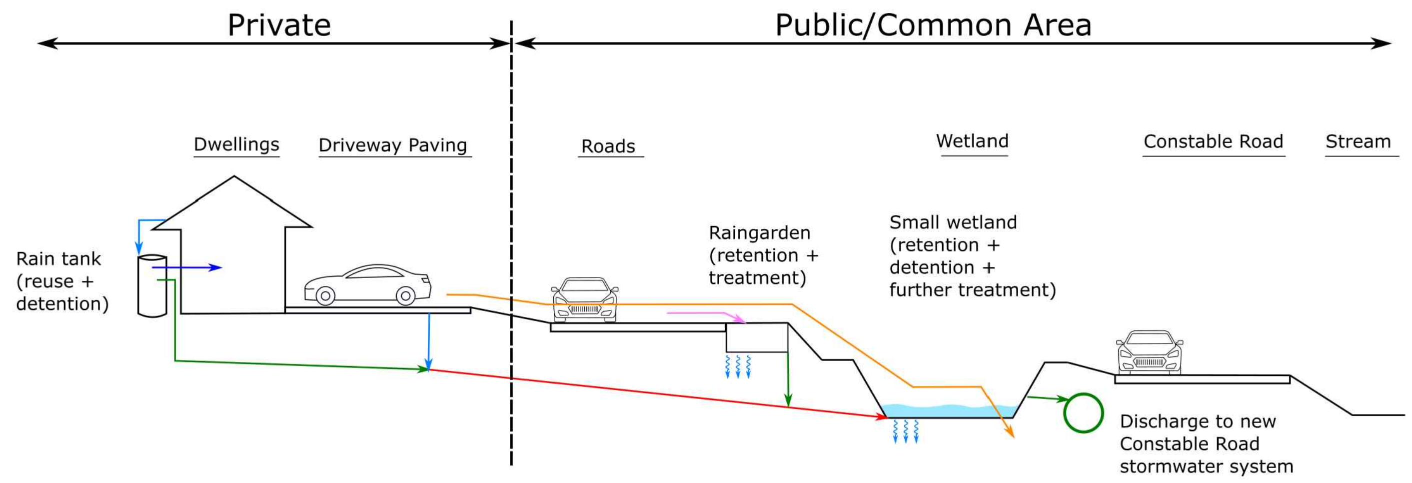
Area B - Within Peat Extent

Legend

- Clean water flow
- Road runoff
- Water overflow
- Pipe system
- Overland flowpath
- Water reuse
- Soakage



Area C



Area D

NOT FOR CONSTRUCTION

P:\32 series\32897 Brookdale Waiuku PPC\03 Drawings\32897-204.dwg, 204, 22/06/2021 4:14:54 pm

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CLIENT: GARDON TRUST

PROJECT: O'HARA WAIUKU PLAN CHANGE 45A, 92 & 130 CONSTABLE ROAD WAIUKU

TITLE: PROPOSED STORMWATER MANAGEMENT STRATEGY SCHEMATIC

SURVEYED		
DESIGNED	TB	17/02/21
DRAWN	TB	17/02/21
CHECKED	SF	18/02/21
APPROVED	SF	18/02/21

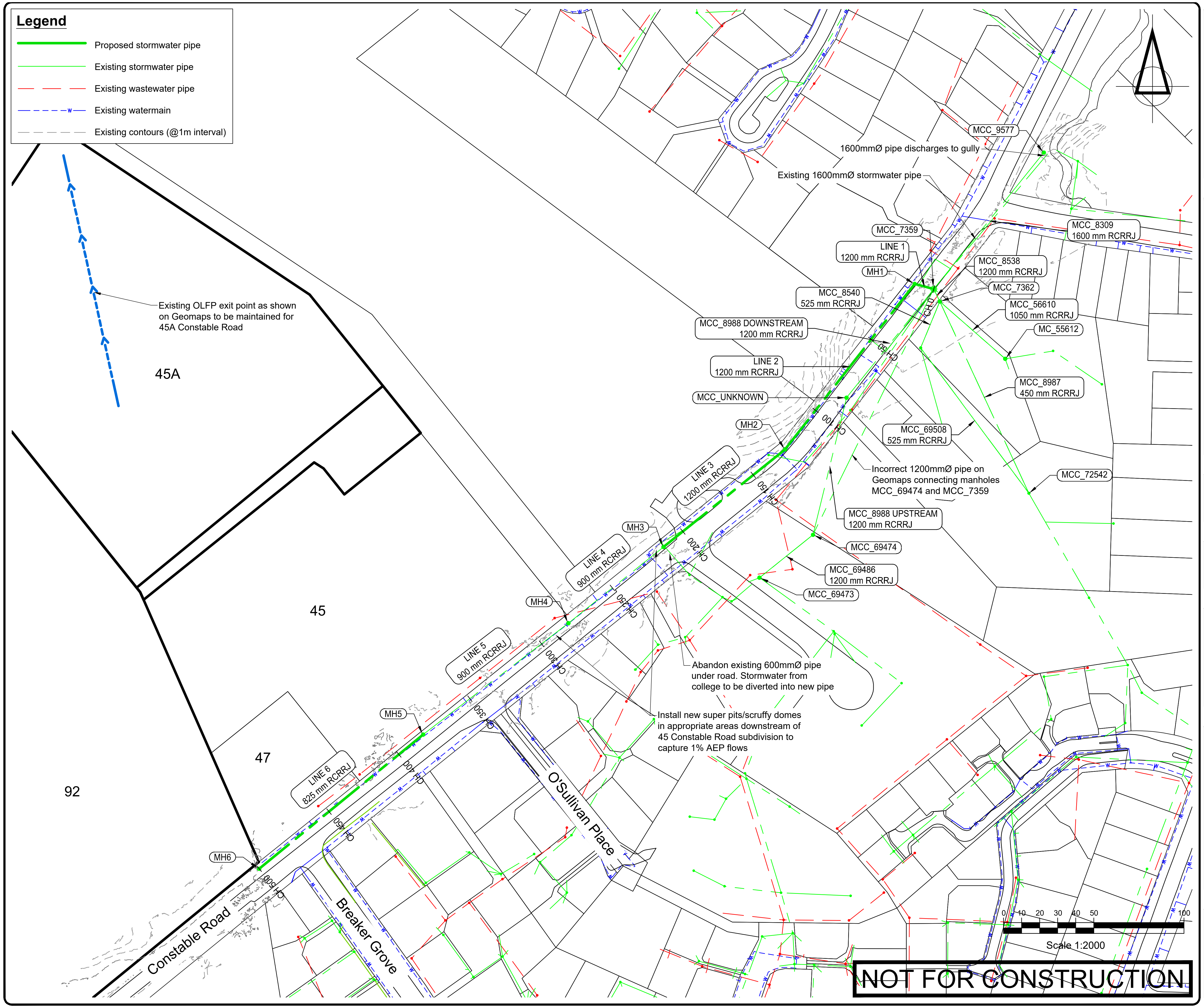
REVISION	DESCRIPTION	CHECKED	DATE
A	CONSTABLE ROAD PIPE ADDED	SF	15/06/21

STATUS: PLAN CHANGE

Construction works shall commence only on receipt of and in accordance with the Council or Council organisation stamped approved drawings

SCALE: NTS (A3)

DRAWING No: 32897/204 REVISION: A



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SURVEYED			APPROVED	DATE
DESIGNED	TB	10/06/21	SF	10/06/21
DRAWN	TB	10/06/21		
CHECKED	SF	10/06/21		

REVISION	CHANGES	CHECKED	DATE
A	SURVEYED PIPES ADDED	SF	25/06/21
B	ASBUILT PIPES ADDED	SF	07/07/21

NOTES

CLIENT

GARDON TRUST

PROJECT

O'HARA WAIUKU PLAN CHANGE
45A, 92 & 130 CONSTABLE ROAD
WAIUKU

TITLE

PROPOSED CONSTABLE ROAD
STORMWATER UPGRADE PLAN

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PLAN CHANGE

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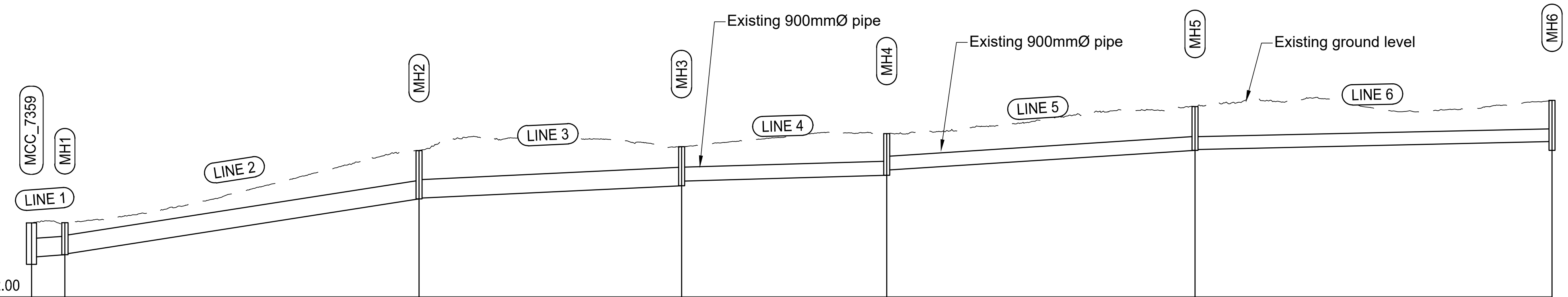
SCALE 1:2000 (A3)

DRAWING No 32897/205

REVISION B

Legend

- Proposed stormwater pipe
- Existing stormwater pipe
- Existing wastewater pipe
- Existing watermain



DATUM: 2.00

LID LEVEL	6.86	6.87		11.61		11.88		12.73		14.51		14.92
INVERT LEVEL	4.61 / 4.77	4.82		8.44 / 8.49		9.30 / 9.61		10.00 / 10.33		11.63 / 11.69		12.21
DEPTH TO INVERT	2.72	2.10		3.17		2.57		2.73		2.88		3.29
PIPE SIZE & GRADIENT	1200 mm RCRRJ @ 1.45%		1200 mm RCRRJ @ 3.11%		1200 mm RCRRJ @ 0.95%		900 mm RCRRJ @ 0.58%		900 mm RCRRJ @ 1.28%		825 mm RCRRJ @ 0.45%	
LENGTH	0.00	10.98	116.42 m	127.41	86.35 m	213.76	67.45 m	281.21	101.39 m	382.60	117.38 m	499.98

10.98 m

Proposed Constable Road Stormwater Upgrade Long Section

Scale: 1:2000, 1:400 (H,V)

0 5 10 20
Scale 1:400

0 10 20 30 40 50 100
Scale 1:2000

NOT FOR CONSTRUCTION

SURVEYED			APPROVED	DATE
DESIGNED	TB	10/06/21	SF	
DRAWN	TB	10/06/21	10/06/21	
CHECKED	SF	10/06/21		

REVISION	CHANGES	CHECKED	DATE
A	ASBUILT PIPES ADDED	SF	07/07/21

NOTES

CLIENT
GARDON TRUST

PROJECT
O'HARA WAIUKU PLAN CHANGE
45A, 92 & 130 CONSTABLE ROAD
WAIUKU

TITLE
PROPOSED CONSTABLE ROAD STORMWATER UPGRADE LONG SECTION

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PLAN CHANGE
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SCALE AS SHOWN (A3)

DRAWING No 32897/206
REVISION A

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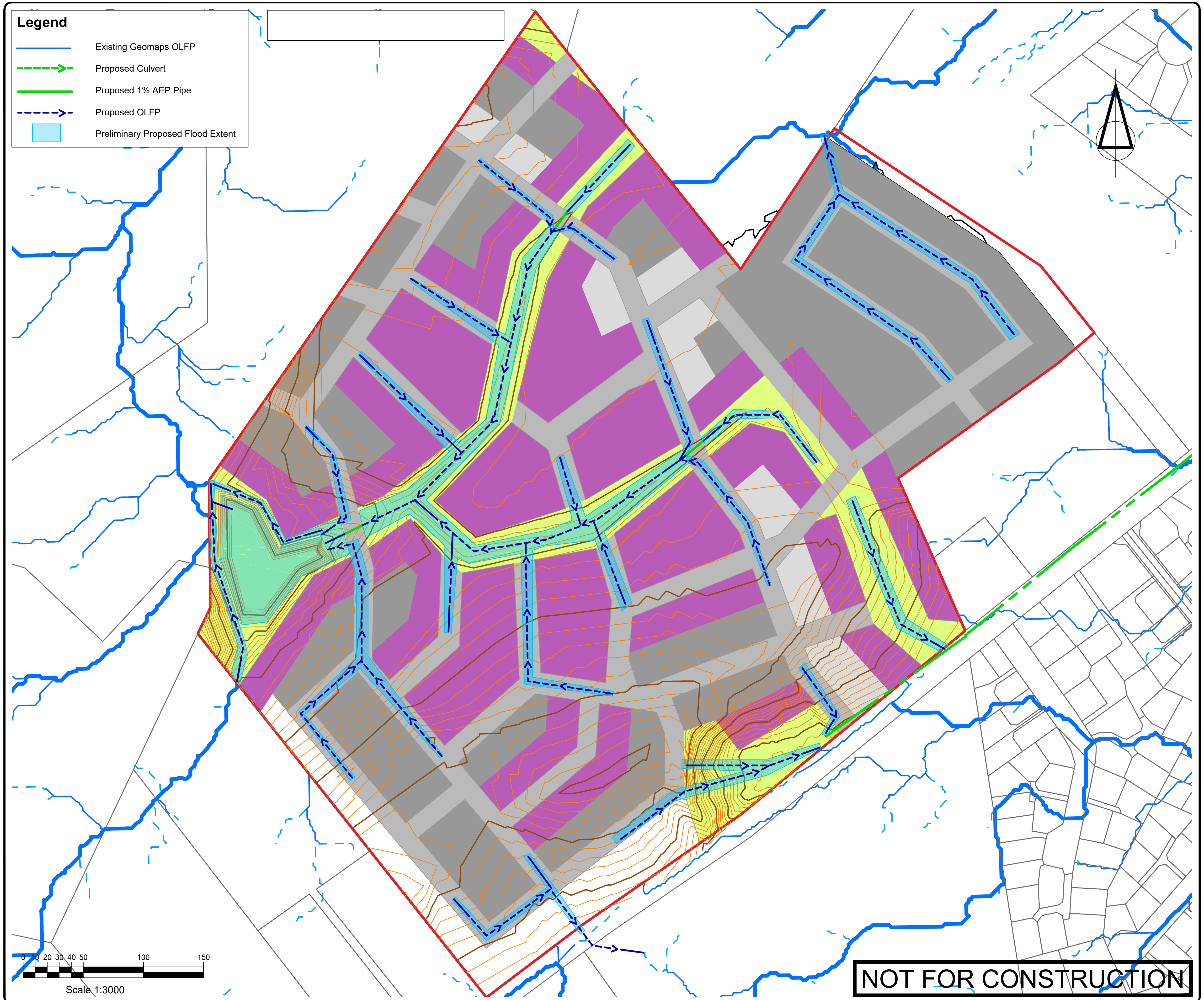

P:\32 series\32897 Brookdale Waiuku PPC\03 Drawings\32897-207.dwg, 207, 17/11/2021 4:02:48 pm

			APPROVED	DATE
SURVEYED			SF	
DESIGNED	TB	05/11/21	05/11/21	
DRAWN	TB	05/11/21		
CHECKED	SF	05/11/21		

REVISION	CHANGES	CHECKED	DATE

NOTES

CLIENT

GARDON TRUST

PROJECT

O'HARA WAIUKU PLAN CHANGE
45A, 92 & 130 CONSTABLE ROAD
WAIUKU

TITLE

PROPOSED OVERLAND
FLOWPATHS AND FLOOD
EXTENT

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STATUS

PLAN CHANGE

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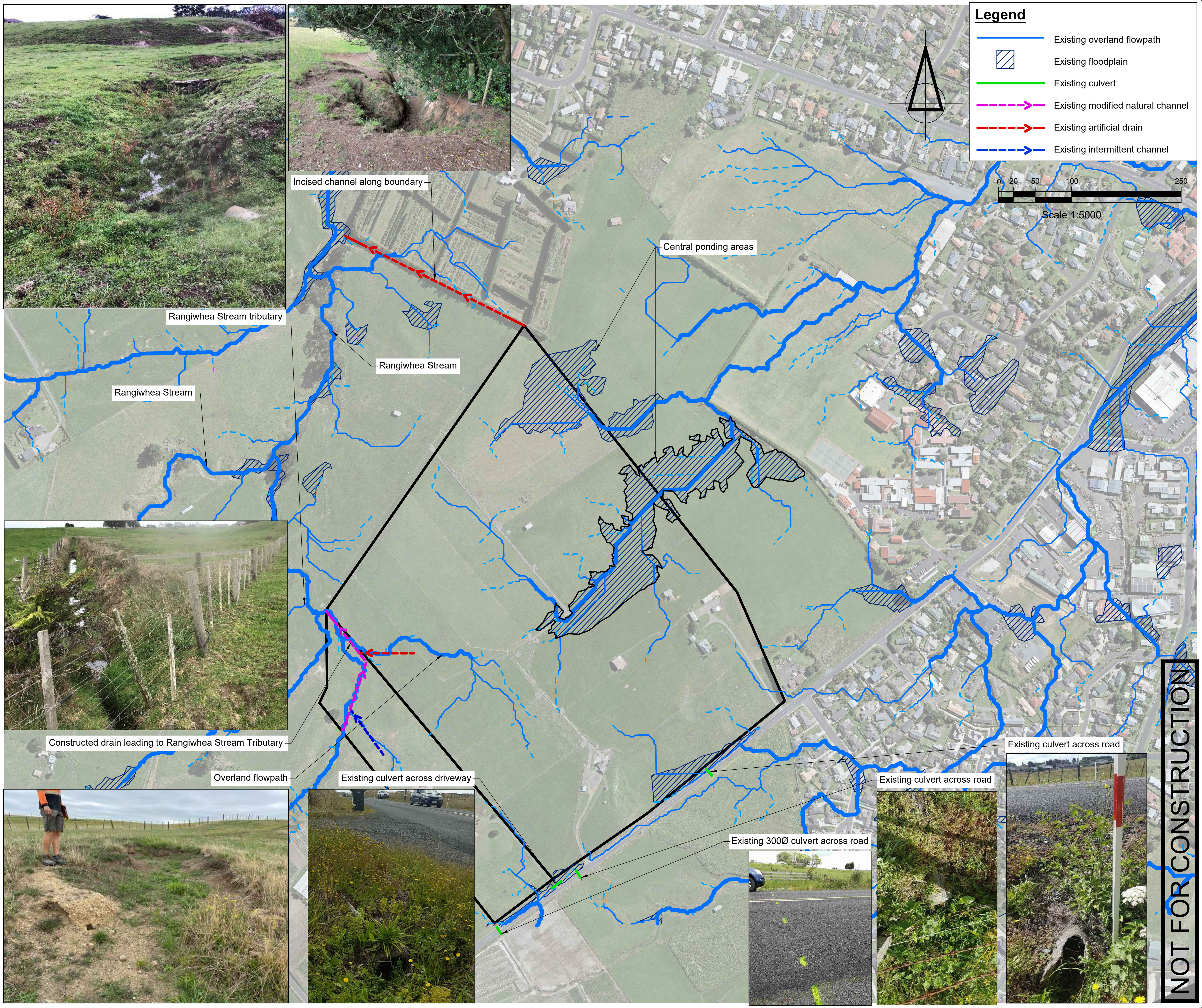
SCALE 1:3000 (A3)

DRAWING No 32897/207

REVISION -



SURVEYED		
DESIGNED		
DRAWN	TB	05/11/21
CHECKED	SF	05/11/21

APPROVED: SF DATE: 05/11/21

REVISION	CHANGES	CHECKED	DATE

NOTES

CLIENT

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PROJECT

O'HARA WAIUKU PLAN CHANGE
45A, 92 & 130 CONSTABLE ROAD
WAIUKU

TITLE

EXISTING DRAINAGE FEATURES PLAN

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STATUS

PLAN CHANGE

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SCALE 1:5000 (A3)

DRAWING No 32897/208 REVISION -

P:\32 series\32897 Brookdale Waiuku PPC\03 Drawings\32897-208.dwg, 208, 18/11/2021 4:20:00 pm

Appendix A

Stormwater Calculations

Stormwater Appendices

Appendix A1

Stormwater Catchments and Modelling Set-Up Sheets

Predevelopment Catchment Areas

Catchment	Total area (ha)	Has imp area	Proposed greenway (ha)	Pervious area (ha)	Impermeable (ha)	Total area check (ha)
A1	6.5262	FALSE	0	6.5262	0	6.5262
A2	93.602	FALSE	0	93.602	0	93.602
A3	86.9	FALSE	0	86.9	0	86.9
A4	10.0606	FALSE	0	10.0606	0	10.0606
A5	16.2215	FALSE	0	16.2215	0	16.2215
A6	6.5885	TRUE	1.8885	4.2385	2.35	6.5885
B1	8.6246	FALSE	1.5535	8.6246	0	8.6246
B2	31.9943	FALSE	0	31.9943	0	31.9943
B3	7.4836	FALSE	0	7.4836	0	7.4836
C1	1.8067	FALSE	0	1.8067	0	1.8067
C2	0.5823	FALSE	0	0.5823	0	0.5823
D1	2.3608	FALSE	0.4393	2.3608	0	2.3608
E1	1.9636	FALSE	0.5017	1.9636	0	1.9636
F1	10.4695	FALSE	1.4032	10.4695	0	10.4695
F2	2.9252	FALSE	0	2.9252	0	2.9252
G1	3.3622	FALSE	0.4278	3.3622	0	3.3622

Assumed impermeability

60%	within proposed site
50%	out of site

Sample predevelopment worksheet has been attached. Others can be provided on request.

Project	92 Constable Road		By	MED	Date	11/01/2021
Job No	32897		Checked		Date	

SW Flow - OLFP

Note - MHS 60% Impervious

1. Runoff Curve Number (CN) and Initial Abstraction (I_a)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN	Pre-dev area (ha)	Post-dev area (ha)	CN x pre-dev area	CN x post-dev area
Group B	Vegetated area	61			0.00	0.00
Group B	Pasture/grassed/vegetated areas	61	6.526	6.526	398.10	398.10
Group B	Residential roofs/paving	98			0.00	0.00
Group B	Roads/access ways	85			0.00	0.00
		Total	6.526	6.526	398	398
	CN (weighted) = total product/total area =				61.0	61.0
	CN (pervious) = pervious product/pervious area =				61	61.0
	I_a (weighted) = 5 x pervious area/total area =				5.00	5.00

2. Time of Concentration

		Pre	Post	
Channelisation factor	C =	1.0	1	(from TP 108 Table 4.2)
Catchment length	L =	461.53	461.53	m (along drainage path)
Catchment length	L =	0.46153	0.46153	km (along drainage path)
Catchment slope	S_c =	0.034	0.034	m/m
Runoff factor, (CN/200-CN) =		**0.439**	**0.439**	
t_c =	$0.14xCxL^{0.66x}(CN/(200-CN))^{-0.55}xS_c^{-0.30}$ =	0.37	0.37	hrs
SCS Lag for HEC-HMS, $t_p = 2/3\ t_c$ =		0.24	0.24	hrs

3. Graphical Peak Flow Rate

			Pre	Post	
Catchment Area	A =		0.0653	0.0653	km^2 (from 1 above)
Runoff Curve Number	CN =		61.000	61.000	(from 1 above)
Initial Abstraction	I_a =		5.000	5.000	mm (from 1 above)
Time of Concentration	t_c=		0.37	0.37	hrs (calculated)
Storage	S=	((1000/CN)-10)x25.4	162.4	162.4	mm

A. Pre-development

ARI (yr event)	Units	2	1/3 of 2yr	5	10	50	100	34.5
24 hour rainfall depth P_{24}	mm	**33**	**11**	**99**	**115**		**180**	**34.5**
Runoff Index, $c^* = (P_{24} - 2 \times I_a)/(P_{24} - 2 \times I_a + 2 \times S)$		**0.066**	**0.051**	**0.215**	**0.244**	**-0.032**	**0.344**	**0.070**
Specific Peak Flow Rate q* (from Fig 5.1)	$m^3/s/(km^2.mm)$	**0.016**	**0.013**	**0.049**	**0.055**	**#REF!**	**0.073**	**0.017**
Peak Flow Rate $q_p = q^* \times A \times P24$	m^3/s	**0.035**	**0.009**	**0.318**	**0.412**	**#REF!**	**0.862**	**0.039**
Runoff Depth	Perv (mm)	**4.12**	**0.21**	**34.46**	**44.42**	**0.16**	**90.77**	**4.54**
$Q_{24} = (P_{24} - I_a)^2/((P_{24} - I_a) + S)$	Imperv (mm)	**28.52**	**7.48**	**94.07**	**110.04**	**0.00**	**174.96**	**29.99**
Runoff Volume	Perv (m^3)	**268.7**	**14.0**	**2249.1**	**2899.0**	**10.4**	**5923.8**	**296.0**
$V_{24} = 1000 \times Q_{24} \times A$	Imper (m^3)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
	Total (m^3)	**268.7**	**14.0**	**2249.1**	**2899.0**	**10.4**	**5923.8**	**296.0**

Data	Area (km^2)	CN	I_a (mm)	S (mm)
Perv	0.065262	61.0	5.0	162.4
Imperv	0.000000	98	0.0	5.2

B. Post-development

ARI (yr event)	Units	95%ile	1/3 of 2yr	5	10	50	100	34.5
24 hour rainfall depth P_{24}	mm	**33.0**	**11.0**	**110.2**	**130.2**	**0.0**	**210.2**	**34.5**
Runoff Index, $c^* = (P_{24} - 2 \times I_a)/(P_{24} - 2 \times I_a + 2 \times S)$		**0.066**	**0.003**	**0.236**	**0.270**	**-0.032**	**0.381**	**0.070**
Specific Peak Flow Rate q* (from Fig 5.1)	$m^3/s/(km^2.mm)$	**0.016**	**#REF!**	**0.053**	**0.060**	**#REF!**	**0.080**	**0.017**
Peak Flow Rate $q_p = q^* \times A \times P24$	m^3/s	**0.035**	**#REF!**	**0.383**	**0.509**	**#REF!**	**1.098**	**0.039**
Runoff Depth	Perv (mm)	**4.12**	**0.21**	**41.35**	**54.49**	**0.16**	**114.58**	**4.54**
$Q_{24} = (P_{24} - I_a)^2/((P_{24} - I_a) + S)$	Imperv (mm)	**28.52**	**7.48**	**105.24**	**125.19**	**0.00**	**205.18**	**29.99**
Runoff Volume	Perv (m^3)	**268.7**	**14.0**	**2698.5**	**3556.2**	**10.4**	**7477.7**	**296.0**
$V_{24} = 1000 \times Q_{24} \times A$	Imper (m^3)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
	Total (m^3)	**268.7**	**14.0**	**2698.5**	**3556.2**	**10.4**	**7477.7**	**296.0**

Data	Area (km^2)	CN	I_a (mm)	S (mm)
Perv	0.065262	61.0	5.0	162.4
Imperv	0.000000	98	0.0	5.2

D. Summary

Peak Flows

ARI (yr event)	Units	2	1/3 of 2yr	5	10	50	100	34.5
q_p (pre-dev)	m^3/s	0.035	0.009	0.318	0.412	#REF!	0.86191	0.039
q_p (post-dev)	m^3/s	0.035	#REF!	0.383	0.509	#REF!	1.09763	0.039
Increase in q_p (post to pre)	m^3/s	0.000	#REF!	0.065	0.097	#REF!	0.236	0.000
Increase in q_p (post to pre)	%	0.00	#REF!	20.39	23.54	#REF!	27.35	0.00

Notes:

1. Increase in q_p = (q_p (post) - q_p (pre)) / q_p (pre) x 100%

Runoff Volumes

ARI (yr event)	Units	2	1/3 of 2yr	5	10	50	100	34.5
Runoff volume (pre-dev)	m^3	269	14	2249	2899	10	5924	296
Runoff volume (post-dev)	m^3	269	14	2699	3556	10	7478	296
Increase in Vol (post to pre)	m^3	0	0	449	657	0	1554	0
Increase in Vol (post to pre)	%	0.00	0.00	19.98	22.67	0.00	26.23	0.00

Post Development Catchment Areas

Catchment	Total area (ha)	Has imp area	Proposed greenway (ha)	Pervious area (ha)	Impermeable (ha)	Total area check (ha)
A1	6.5262	FALSE	0	6.5262	0	6.5262
A2	93.602	FALSE	0	93.602	0	93.602
A3	86.9	FALSE	0	86.9	0	86.9
A4	10.0606	FALSE	0	10.0606	0	10.0606
A5	16.2215	FALSE	0	16.2215	0	16.2215
A6	6.5885	TRUE	1.8885	4.2385	2.35	6.5885
B1	8.66	TRUE	1.5535	4.3961	4.2639	8.66
B2	31.9943	FALSE	0	31.9943	0	31.9943
B3	7.4836	FALSE	0	7.4836	0	7.4836
C1	1.7	TRUE	0	0.68	1.02	1.7
C2	0.66	TRUE	0	0.264	0.396	0.66
D1	1.72	TRUE	0.4393	0.95158	0.76842	1.72
E1	1.57	TRUE	0.5017	0.92902	0.64098	1.57
F1	11.86	TRUE	1.4032	5.58592	6.27408	11.86
F2	2.9252	TRUE	0	1.17008	1.75512	2.9252
G1	3.3622	TRUE	0.4278	1.60156	1.76064	3.3622

Assumed impermeability

60%	within proposed site
50%	out of site

Post development worksheets can be provided on request

Detention Sizing

Assumed that 4 m3 tanks will be installed.
2 m3 will be used for on site retention. See note 1
2 m3 will be used for 95th %ile storm detention

Diameter 2.5 m
Height 1 m

							Orifice catch c =		0.01 m		Orifice catch d=		0.01 m	
Height	Volume Type 1	Volume type 2	Catch C vol	Catch D vol	Catch C 1000 vo	Catch D 1000 vol	Head (m)	H/D	Flow per ta	Total flow	Head (m)	H/D	Flow per ta	Total flow
0	0.0	0.0	0.00	0	0.0000000	0.0000000				0.0000				0
0.1	0.0	0.0	0.00	0	0.0000000	0.0000000				0.0000				0
0.2	0.0	0.0	0.00	0	0.0000000	0.0000000				0.0000				0
0.3	0.0	0.0	0.00	0	0.0000000	0.0000000				0.0000				0
0.4	0.0	0.0	0.00	0	0.0000000	0.0000000				0.0000				0
0.5	0.0	0.0	0.00	0	0.0000000	0.0000000	0	0	0	0	0	0	0	0
0.6	0.0	0.0	0.00	0	0.0000000	0.0000000	0	0.000	0.000	0	0	0.000	0.000	0
0.7	0.5	0.0	11.78	0	0.0117810	0.0000000	0.1	10.000	0.000	0.001596	0	0.000	0.000	0
0.8	1.0	0.0	23.56	0	0.0235619	0.0000000	0.2	20.000	0.000	0.002286	0	0.000	0.000	0
0.9	1.5	0.5	35.34	29	0.0353429	0.0294524	0.3	30.000	0.000	0.002812	0.1	10.000	0.000	0.003989
1	2.0	1.0	47.12	59	0.0471239	0.0589049	0.4	40.000	0.00014	0.003254	0.2	20.000	0.000	0.005716
1.15	2.7	1.7	64.80	103	0.0647953	0.1030835	0.55	55.000	0.00016	0.003822	0.35	35.000	0.000	0.007602

Additional storage requirement - catchment C

Depth	Volume	Volume 1000m3	
0	0	0.000	
0.75	135	0.135	95th%ile
0.9	155	0.155	10yr
1	160	0.160	
2	170	0.170	
3	180	0.180	

Orifice catch c =		0.05 m	Orifice catch c =		0.6 m	Total flow
Head (m)	H/D	Flow per tank	Head (m)	H/D	Flow per tank	
0	0	0	0	0	0	0
0.75	15.000	0.005	0	0.000	0.000	0.004592
0.9	18.000	0.005	0.15	0.250	0.301	0.305815
1	20.000	0.005	0.25	0.417	0.388	0.393618
2	40.000	0.008	1.25	2.083	0.868	0.875829
3	60.000	1.000	2.25	3.750	0.000	1

Additional storage requirement - catchment D

Depth	Volume	Volume 1000m3	
0	0	0.000	
0.75	200	0.200	95th%ile
0.9	205	0.205	
1.1	300	0.300	10yr
2	301	0.301	
3	302	0.302	

Orifice catch d =		0.08 m	Orifice catch c =		0.6 m	Total flow
Head (m)	H/D	Flow per tank	Head (m)	H/D	Flow per tank	
0	0	0	0	0	0	0
0.75	9.375	0.012	0	0.000	0.000	0.011633
0.9	11.250	0.013	0.15	0.250	0.301	0.313574
1.1	13.750	0.014	0.35	0.583	0.459	0.473649
2	25.000	0.019	1.25	2.083	0.868	0.887579
3	37.500	1.000	2.25	3.750	0.000	3

Wetland Outlet Control

	Pond levels
Invert	11
95th%	11.6
10yr	13.4
100yr	14

Orifice calcs

		Flow (m3/s)
Head (m)	H/D	Orifice
0	0	0
0.08	1.600	0.00126476
0.1	2.000	0.00147692
0.15	3.000	0.0019067
0.2	4.000	0.00225604
0.26	5.200	0.00261434
0.3	6.000	0.00282809
0.37	7.400	0.00316765
0.5	10.000	0.00371684
0.6	12.000	0.00408942
0.7	14.000	0.00443077

Outlet dia = 0.05 m

Pipe outlet calcs

Invert Upstream	Invert Downstream	Pipe Length (m)	Pipe Grad (%)	Dia (mm)	Velocity (m/s)	Q_c (L/s)
11.6001	10	11	14.55%	300	5.30	374.6
13.4	10	11	30.91%	300	7.73	546.4
14	10	11	36.36%	300	8.39	593.1
15	10	11	45.45%	300	9.38	663
		1.5	0.6			

Combined Outfall curve

10	0
11	0
11.08	0.001265
11.1	0.001477
11.15	0.001907
11.2	0.002256
11.26	0.002614
11.3	0.002828
11.37	0.003168
11.5	0.003717
11.6	0.004089
11.6001	0.3746
13.4	0.5464
14	0.5931
15	0.663

Project	Waiuku
Job No	32897

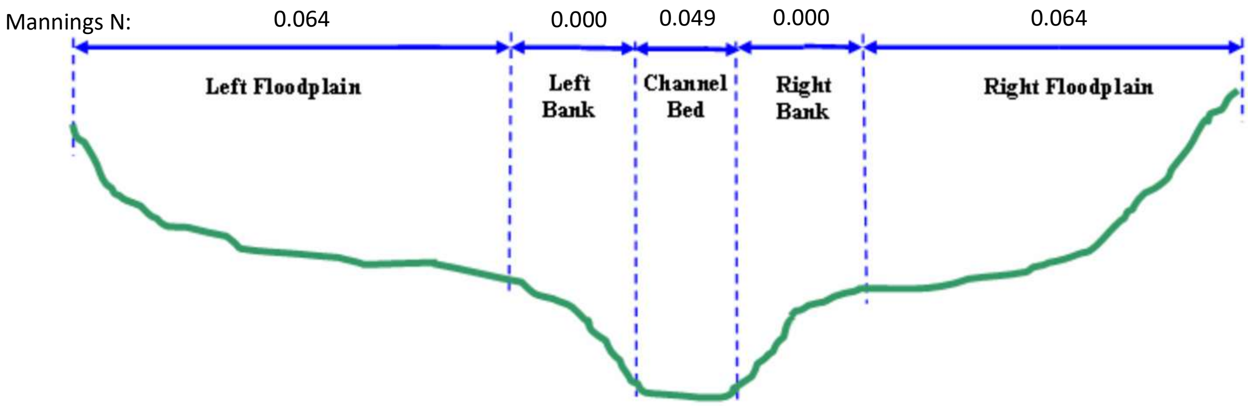
By	TB	Date	17/02/2021
Checked		Date	

Mannings Roughness Values

Correction factor for meandering:

Straight channel:	0.3
Meandering	0.45
Sever Meandering	0.6
Chosen value:	0.3

N Values	Bed	Bank	Floodplain
Material substrate	0.02		0.02
Vegetation	0.03		0.045
Irregularities	0.01		0.0017
Sum	0.037	0.000	0.049
Total	0.049	0.000	0.064



Note: Calculation methodology as per Auckland Council Stormwater Flood Modelling Specification 2011

Appendix A2

HEC-HMS catchment and wetland modelling results

HEC-HMS MODEL RESULTS

Predevelopment model overview

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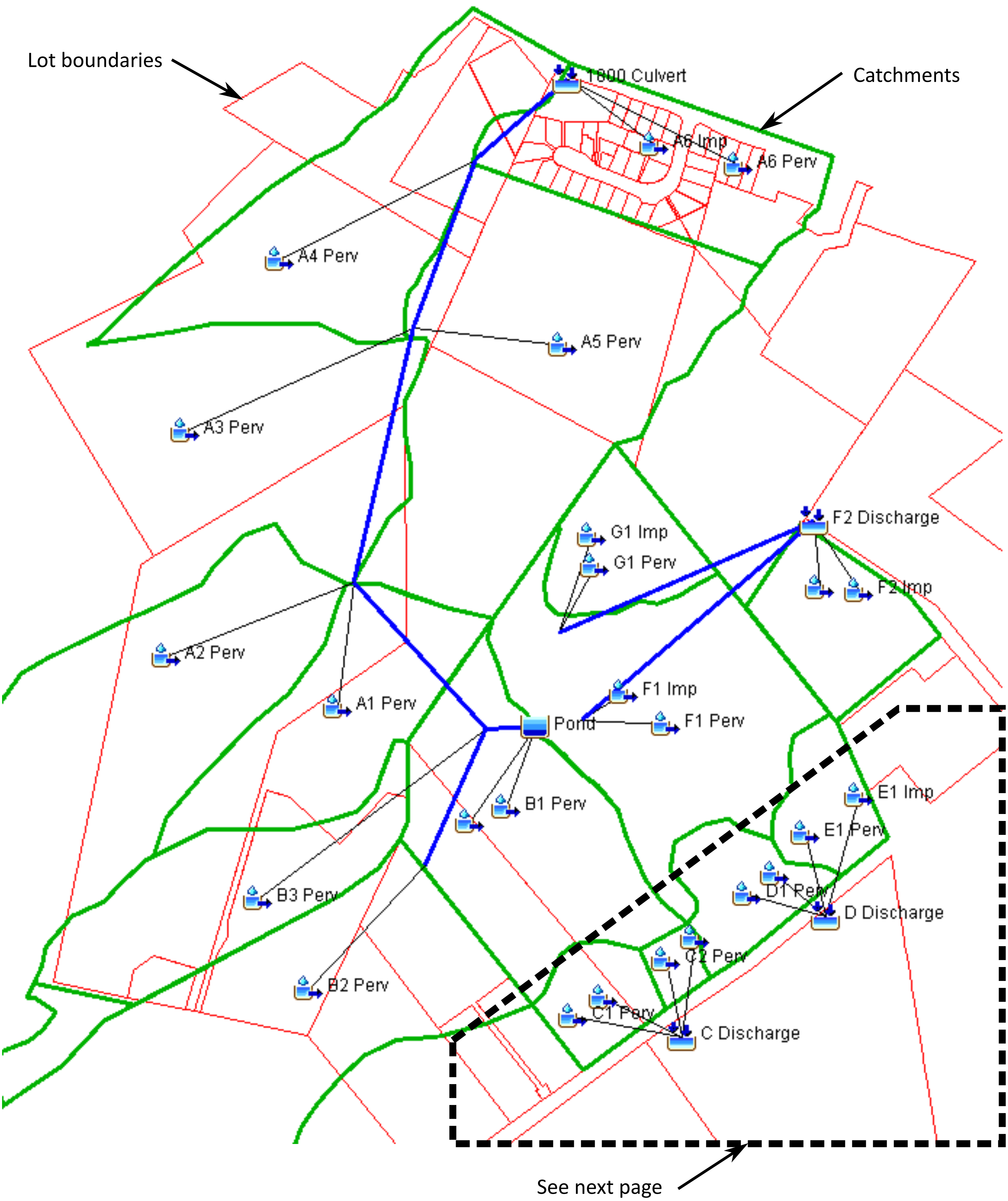
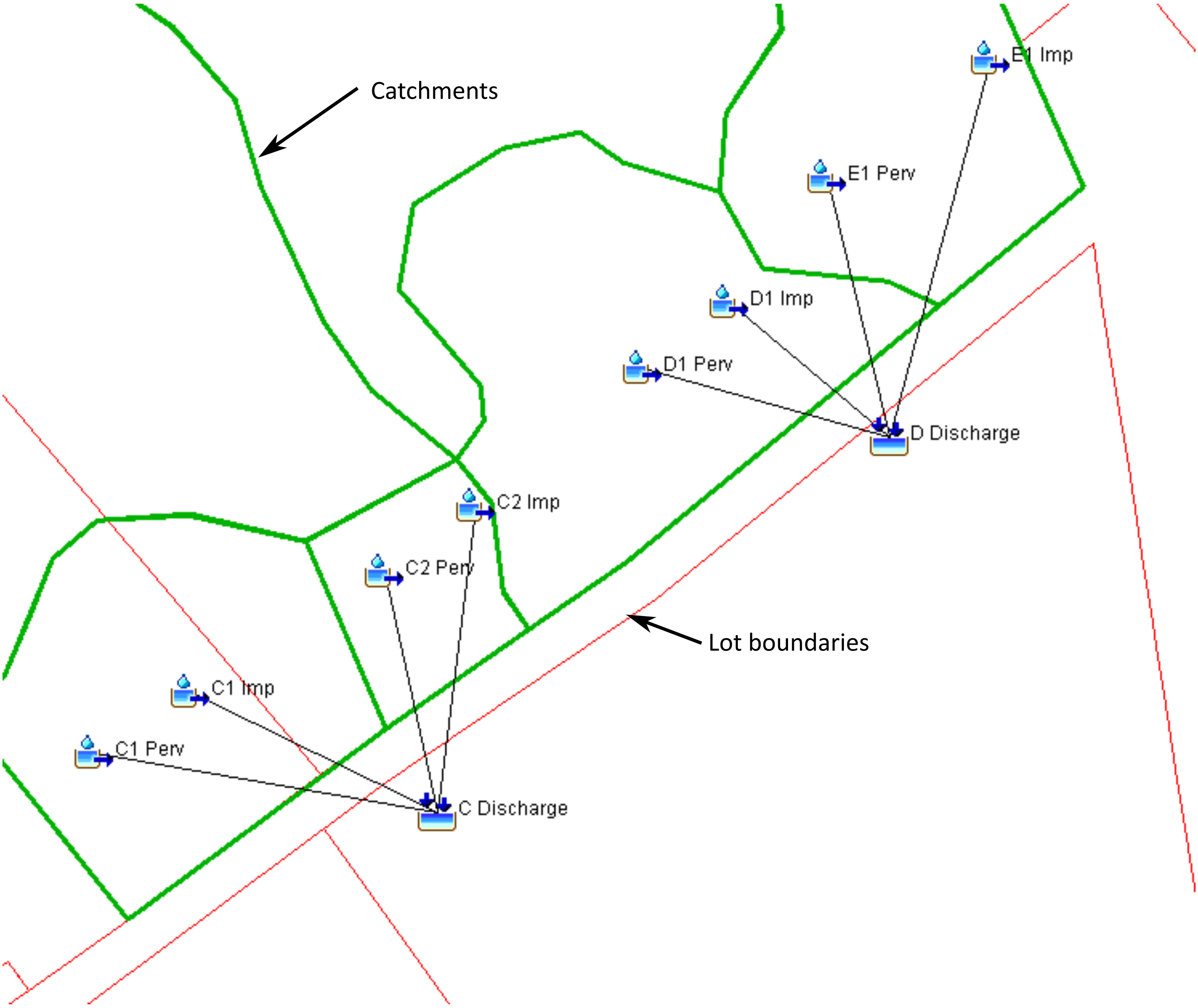
Main model



Catchments C, D and E



HEC-HMS MODEL RESULTS

Post development model overview

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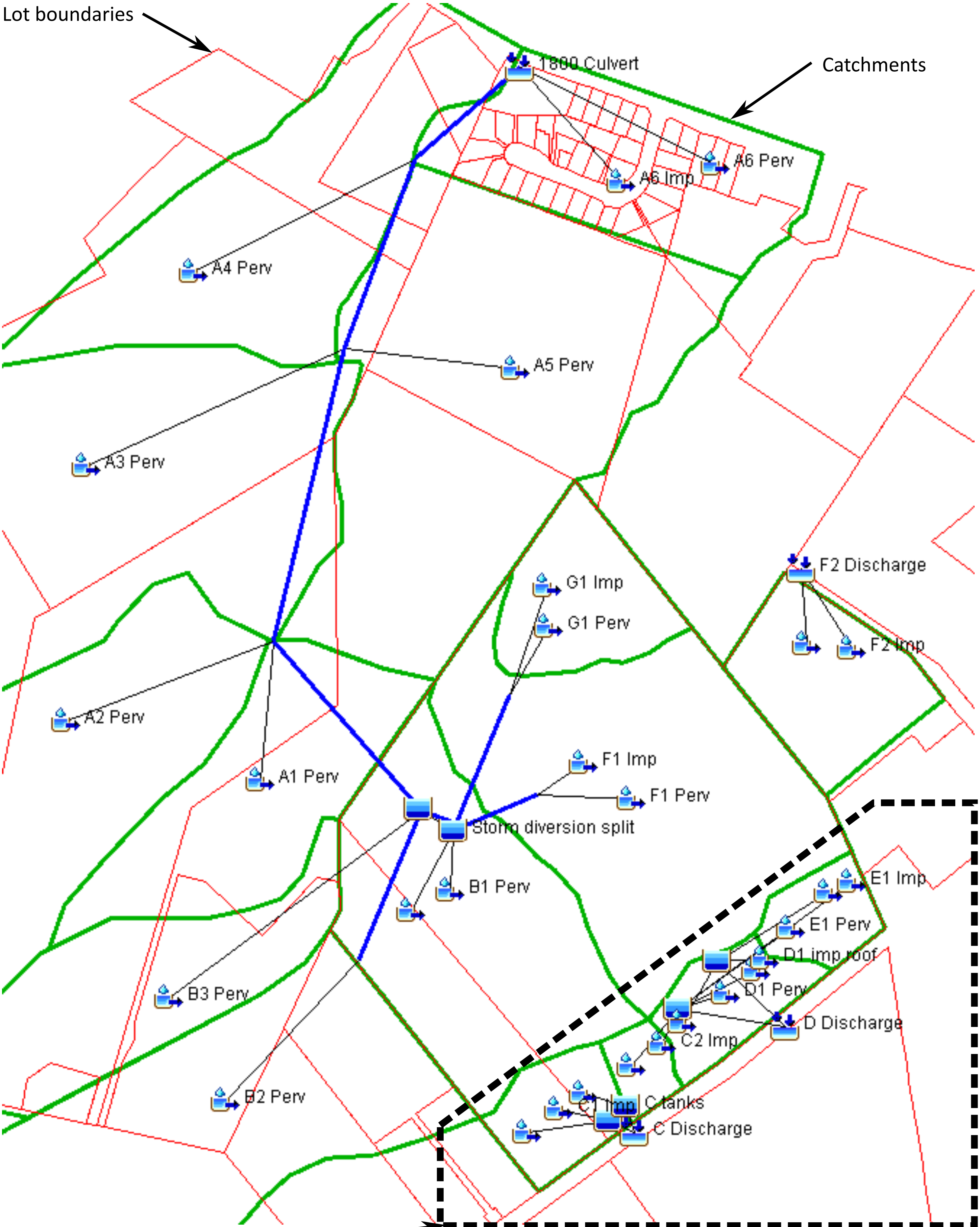
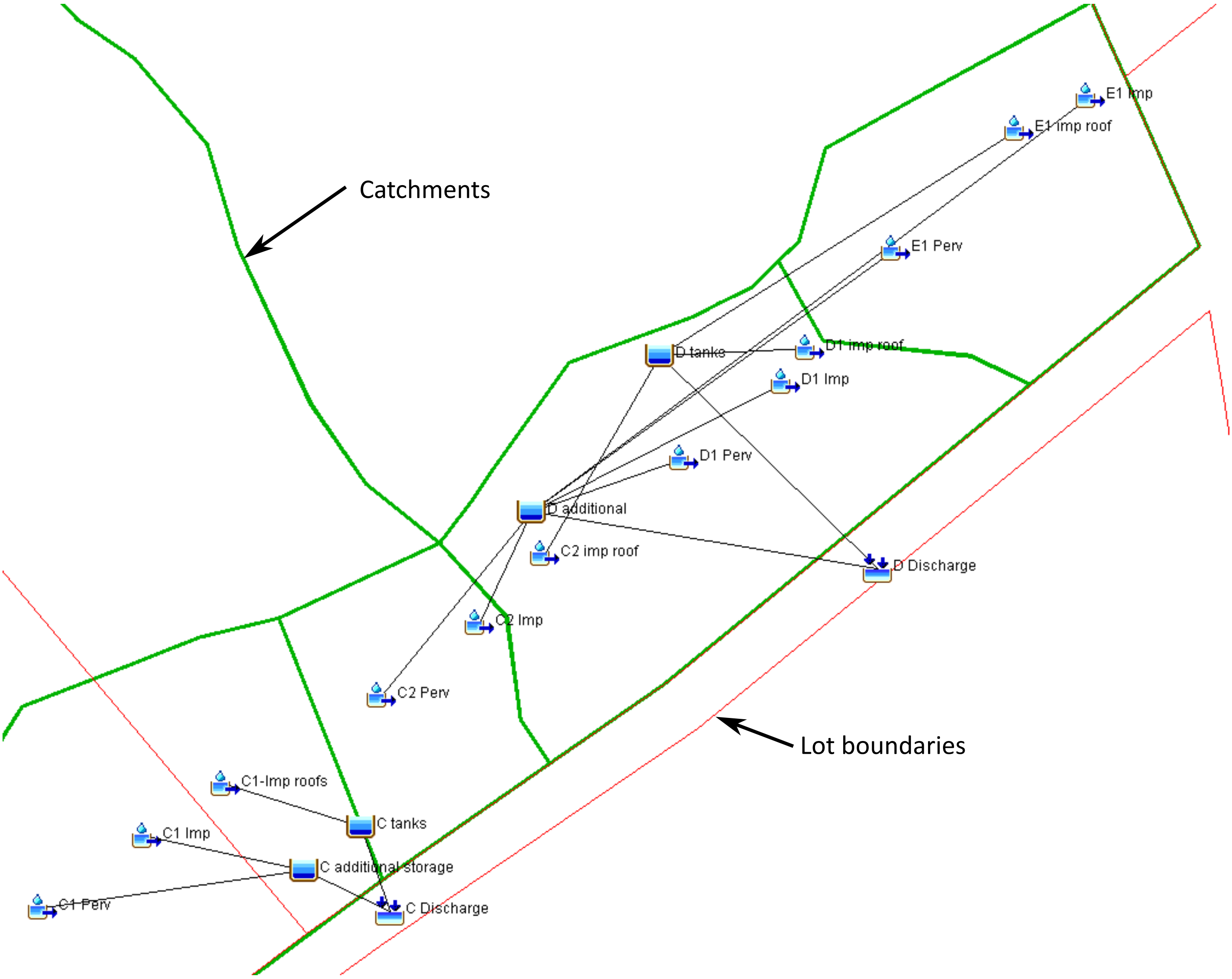
Main model



See next page

Catchments C, D and E



Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
B2 Perv	0.31994	0.105	01Jan2000, 12:50	1.313
R1	0.31994	0.105	01Jan2000, 12:50	1.313
B1 Perv	0.086246	0.042	01Jan2000, 12:20	0.354
B1 Imp	0.00001	0.000	01Jan2000, 12:10	0.000
Pond	0.0	0.000	01Jan2000, 00:00	0.000
Pond outfall	0.086256	0.042	01Jan2000, 12:20	0.354
B3 Perv	0.074836	0.030	01Jan2000, 12:30	0.307
A2 Perv	0.938024	0.224	01Jan2000, 13:30	3.865
R2	0.481032	0.153	01Jan2000, 12:40	1.974
A1 Perv	0.06526	0.031	01Jan2000, 12:20	0.268
R3	1.484316	0.347	01Jan2000, 13:10	6.106
A3 Perv	0.8710	0.223	01Jan2000, 13:20	3.573
A5 Perv	0.1622	0.080	01Jan2000, 12:20	0.665
R4	2.517516	0.595	01Jan2000, 13:10	10.345
A4 Perv	0.1006	0.048	01Jan2000, 12:20	0.413
R5	2.618116	0.611	01Jan2000, 13:10	10.758
A6 Perv	0.04239	0.022	01Jan2000, 12:20	0.174
A6 Imp	0.0235	0.091	01Jan2000, 12:20	0.669
1800 Culvert	2.684006	0.641	01Jan2000, 13:10	11.601
G1 Imp	0.01761	0.008	01Jan2000, 12:20	0.072
G1 Perv	0.01602	0.007	01Jan2000, 12:20	0.066
F1 Imp	0.0544	0.023	01Jan2000, 12:30	0.223
F1 Perv	0.05030	0.022	01Jan2000, 12:30	0.206
F1 lag	0.10470	0.045	01Jan2000, 12:30	0.430
G1 lag	0.03363	0.015	01Jan2000, 12:30	0.138
F2 Imp	0.01755	0.011	01Jan2000, 12:10	0.072
F2 Perv	0.0117	0.006	01Jan2000, 12:20	0.048
F2 Discharge	0.16758	0.070	01Jan2000, 12:30	0.688
D1 Perv	0.02738	0.017	01Jan2000, 12:10	0.112
E1 Perv	0.01963	0.011	01Jan2000, 12:10	0.081
D1 Imp	0.00001	0.000	01Jan2000, 12:10	0.000
E1 Imp	0.000001	0.000	01Jan2000, 12:10	0.000
D Discharge	0.047021	0.028	01Jan2000, 12:10	0.193
C1 Perv	0.01807	0.011	01Jan2000, 12:10	0.074
C2 Perv	0.00582	0.004	01Jan2000, 12:10	0.024
C1 Imp	0.00001	0.000	01Jan2000, 12:10	0.000
C2 Imp	0.000001	0.000	01Jan2000, 12:10	0.000
C Discharge	0.023901	0.015	01Jan2000, 12:10	0.098

HEC-HMS MODEL RESULTS

Pre development 10% AEP Rainfall: Global Summary

Fraser Thomas

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Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
B2 Perv	0.31994	1.752	01Jan2000, 12:40	19.640
R1	0.31994	1.731	01Jan2000, 12:50	19.640
B1 Perv	0.086246	0.697	01Jan2000, 12:20	5.294
B1 Imp	0.00001	0.000	01Jan2000, 12:10	0.001
Pond	0.0	0.000	01Jan2000, 00:00	0.000
Pond outfall	0.086256	0.698	01Jan2000, 12:20	5.296
B3 Perv	0.074836	0.505	01Jan2000, 12:30	4.594
A2 Perv	0.938024	3.677	01Jan2000, 13:20	57.721
R2	0.481032	2.564	01Jan2000, 12:40	29.530
A1 Perv	0.06526	0.528	01Jan2000, 12:20	4.006
R3	1.484316	5.687	01Jan2000, 13:00	91.257
A3 Perv	0.8710	3.690	01Jan2000, 13:10	53.468
A5 Perv	0.1622	1.332	01Jan2000, 12:20	9.957
R4	2.517516	9.799	01Jan2000, 13:10	154.681
A4 Perv	0.1006	0.814	01Jan2000, 12:20	6.175
R5	2.618116	10.055	01Jan2000, 13:10	160.857
A6 Perv	0.04239	0.359	01Jan2000, 12:20	2.602
A6 Imp	0.0235	0.408	01Jan2000, 12:20	3.176
1800 Culvert	2.684006	10.258	01Jan2000, 13:10	166.635
G1 Imp	0.01761	0.130	01Jan2000, 12:20	1.081
G1 Perv	0.01602	0.119	01Jan2000, 12:20	0.983
F1 Imp	0.0544	0.387	01Jan2000, 12:20	3.339
F1 Perv	0.05030	0.358	01Jan2000, 12:20	3.088
F1 lag	0.10470	0.737	01Jan2000, 12:30	6.427
G1 lag	0.03363	0.241	01Jan2000, 12:20	2.064
F2 Imp	0.01755	0.180	01Jan2000, 12:10	1.077
F2 Perv	0.0117	0.096	01Jan2000, 12:20	0.718
F2 Discharge	0.16758	1.189	01Jan2000, 12:20	10.287
D1 Perv	0.02738	0.281	01Jan2000, 12:10	1.681
E1 Perv	0.01963	0.194	01Jan2000, 12:10	1.205
D1 Imp	0.00001	0.000	01Jan2000, 12:10	0.001
E1 Imp	0.000001	0.000	01Jan2000, 12:10	0.000
D Discharge	0.047021	0.475	01Jan2000, 12:10	2.887
C1 Perv	0.01807	0.186	01Jan2000, 12:10	1.109
C2 Perv	0.00582	0.060	01Jan2000, 12:10	0.357
C1 Imp	0.00001	0.000	01Jan2000, 12:10	0.001
C2 Imp	0.000001	0.000	01Jan2000, 12:10	0.000
C Discharge	0.023901	0.246	01Jan2000, 12:10	1.468

HEC-HMS MODEL RESULTS

Pre development 1% AEP Rainfall: Global Summary

Fraser Thomas

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Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
B2 Perv	0.31994	3.539	01Jan2000, 12:40	38.801
R1	0.31994	3.476	01Jan2000, 12:50	38.801
B1 Perv	0.086246	1.405	01Jan2000, 12:20	10.459
B1 Imp	0.00001	0.000	01Jan2000, 12:10	0.002
Pond	0.0	0.000	01Jan2000, 00:00	0.000
Pond outfall	0.086256	1.405	01Jan2000, 12:20	10.462
B3 Perv	0.074836	1.016	01Jan2000, 12:30	9.076
A2 Perv	0.938024	7.398	01Jan2000, 13:20	113.973
R2	0.481032	5.161	01Jan2000, 12:40	58.338
A1 Perv	0.06526	1.063	01Jan2000, 12:20	7.914
R3	1.484316	11.461	01Jan2000, 13:00	180.225
A3 Perv	0.8710	7.428	01Jan2000, 13:10	105.630
A5 Perv	0.1622	2.679	01Jan2000, 12:20	19.671
R4	2.517516	19.655	01Jan2000, 13:10	305.526
A4 Perv	0.1006	1.638	01Jan2000, 12:20	12.200
R5	2.618116	20.169	01Jan2000, 13:10	317.726
A6 Perv	0.04239	0.720	01Jan2000, 12:20	5.141
A6 Imp	0.0235	0.638	01Jan2000, 12:20	5.016
1800 Culvert	2.684006	20.521	01Jan2000, 13:10	327.883
G1 Imp	0.01761	0.264	01Jan2000, 12:20	2.136
G1 Perv	0.01602	0.240	01Jan2000, 12:20	1.943
F1 Imp	0.0544	0.784	01Jan2000, 12:20	6.597
F1 Perv	0.05030	0.725	01Jan2000, 12:20	6.100
F1 lag	0.10470	1.477	01Jan2000, 12:30	12.697
G1 lag	0.03363	0.488	01Jan2000, 12:20	4.078
F2 Imp	0.01755	0.363	01Jan2000, 12:10	2.128
F2 Perv	0.0117	0.193	01Jan2000, 12:20	1.419
F2 Discharge	0.16758	2.403	01Jan2000, 12:20	20.323
D1 Perv	0.02738	0.566	01Jan2000, 12:10	3.320
E1 Perv	0.01963	0.391	01Jan2000, 12:10	2.381
D1 Imp	0.00001	0.000	01Jan2000, 12:10	0.002
E1 Imp	0.000001	0.000	01Jan2000, 12:10	0.000
D Discharge	0.047021	0.957	01Jan2000, 12:10	5.703
C1 Perv	0.01807	0.374	01Jan2000, 12:10	2.191
C2 Perv	0.00582	0.120	01Jan2000, 12:10	0.706
C1 Imp	0.00001	0.000	01Jan2000, 12:10	0.002
C2 Imp	0.000001	0.000	01Jan2000, 12:10	0.000
C Discharge	0.023901	0.495	01Jan2000, 12:10	2.900

HEC-HMS MODEL RESULTS

Predevelopment Node "Pond Outfall" Discharge

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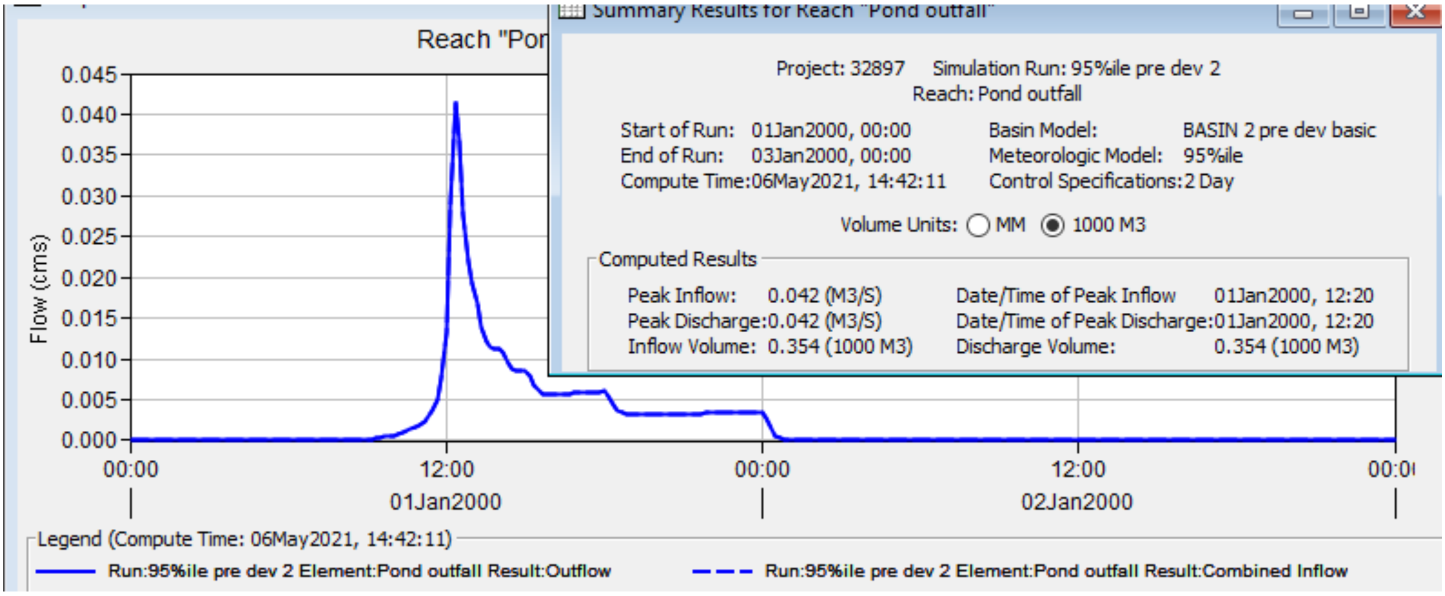
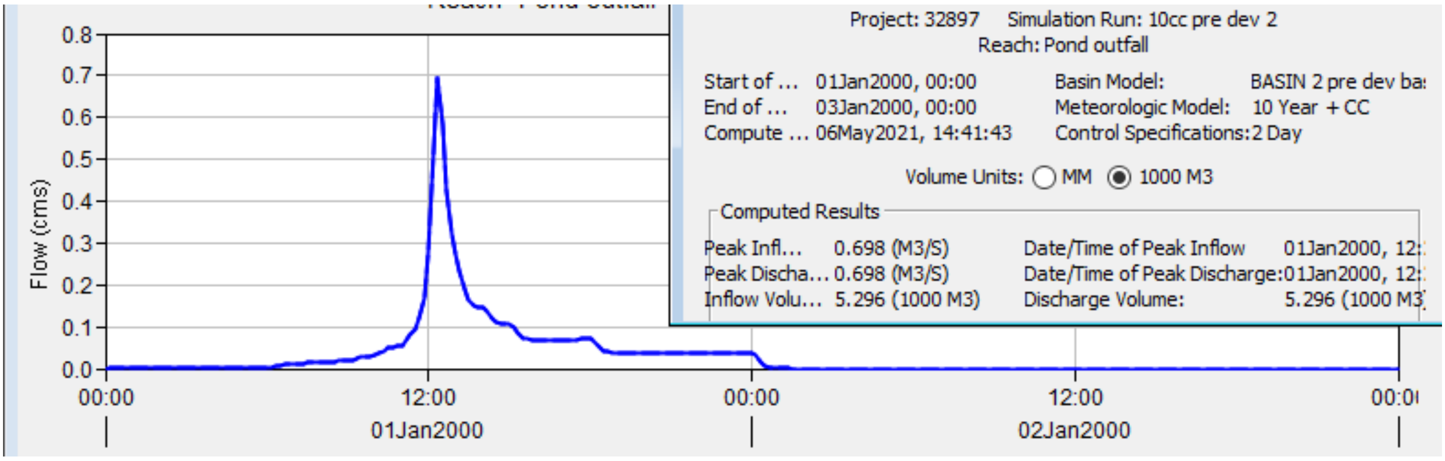
95th Percentile Storm



10% AEP Storm



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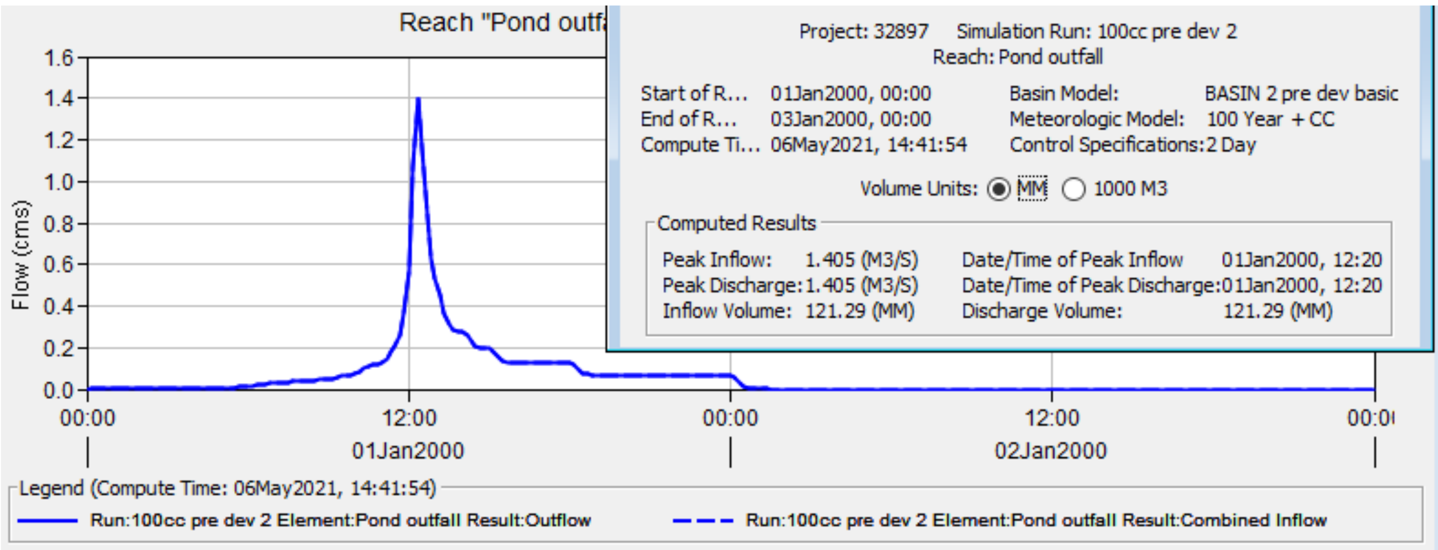

HEC-HMS MODEL RESULTS

Predevelopment Node "Rangiwhea 1" Discharge

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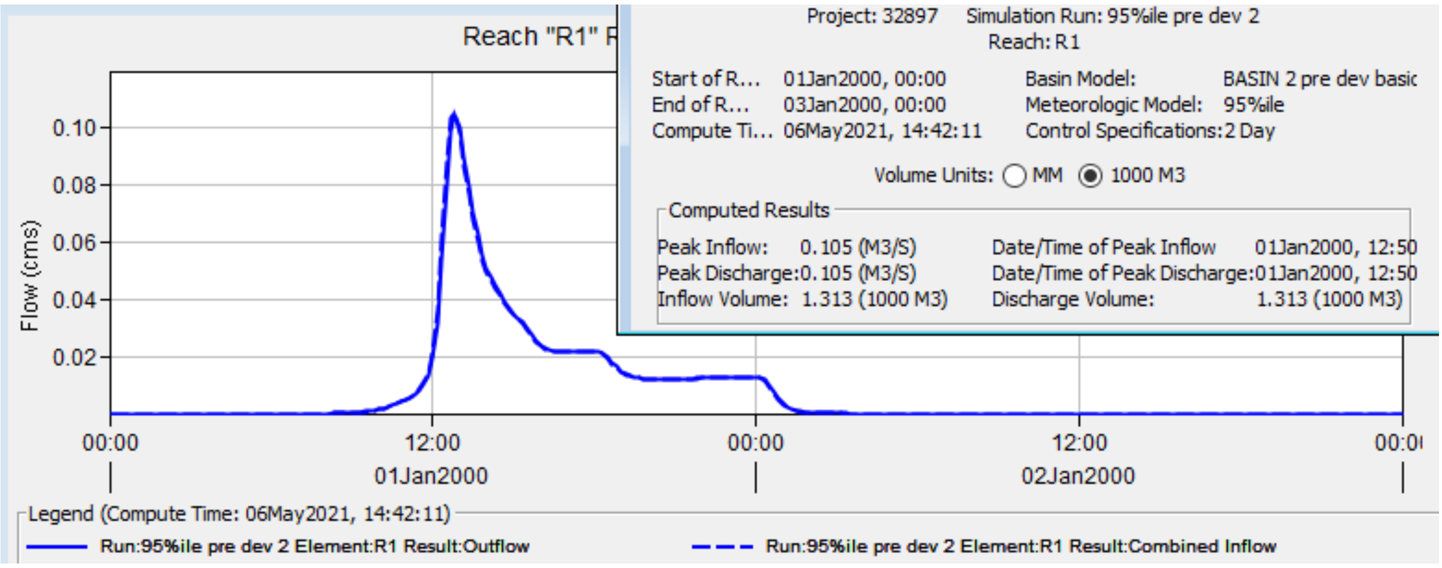
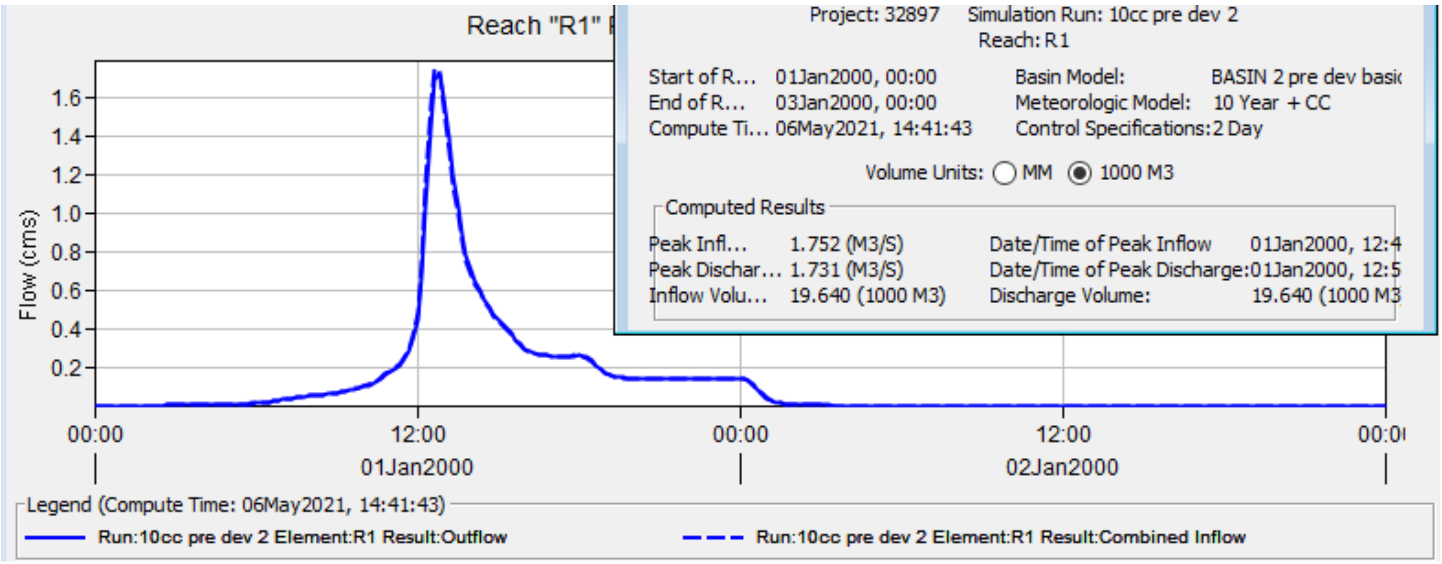
95th Percentile Storm



10% AEP Storm



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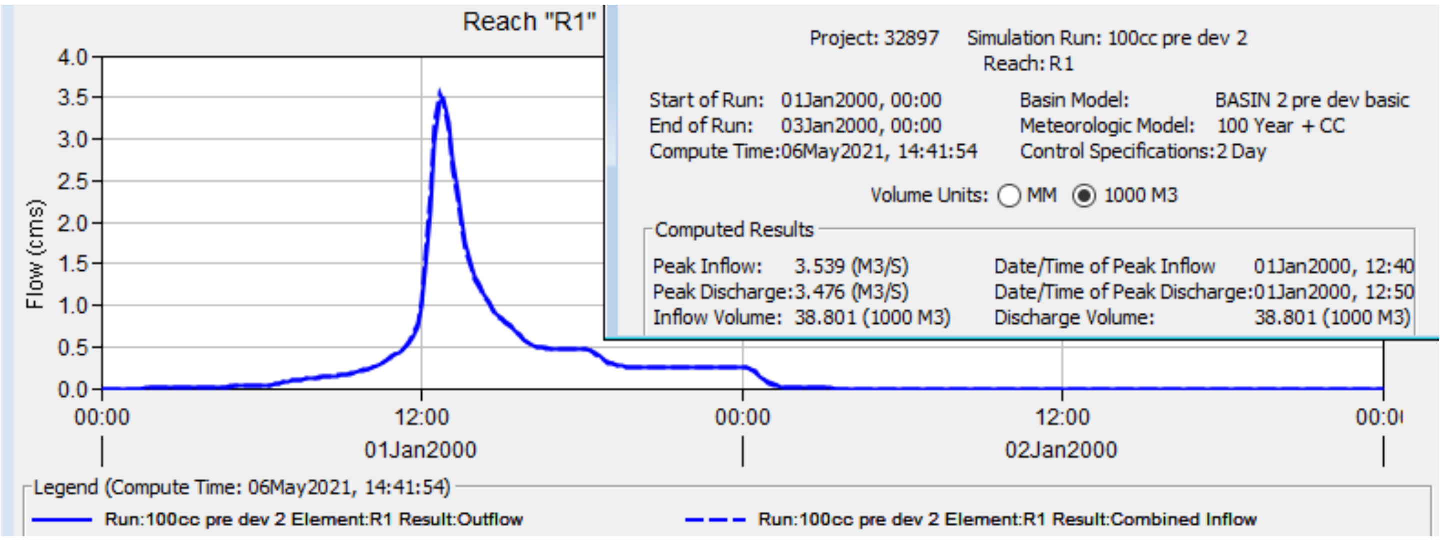

HEC-HMS MODEL RESULTS

Predevelopment Node "Rangiwhea 2" Discharge

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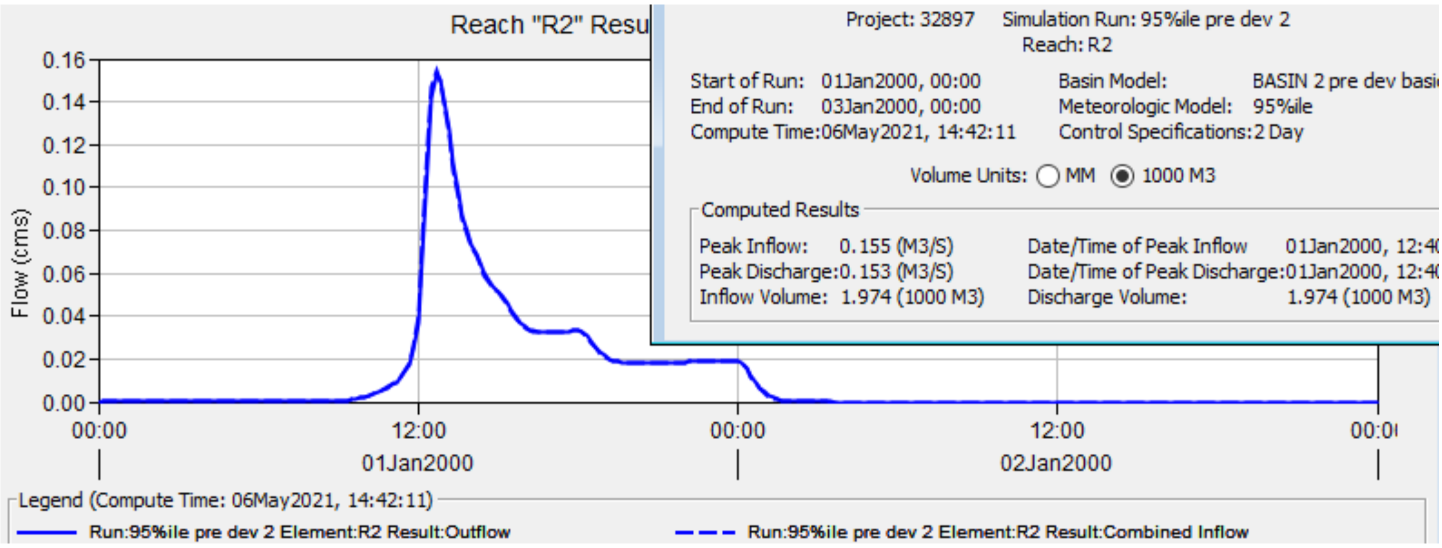
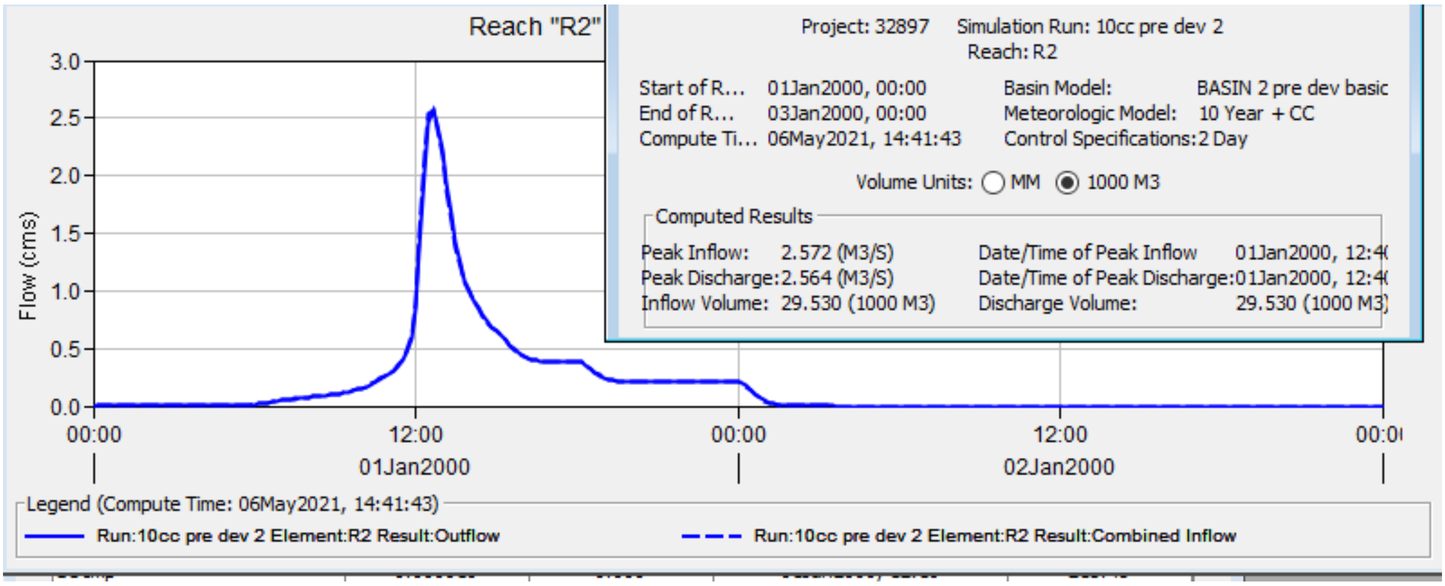
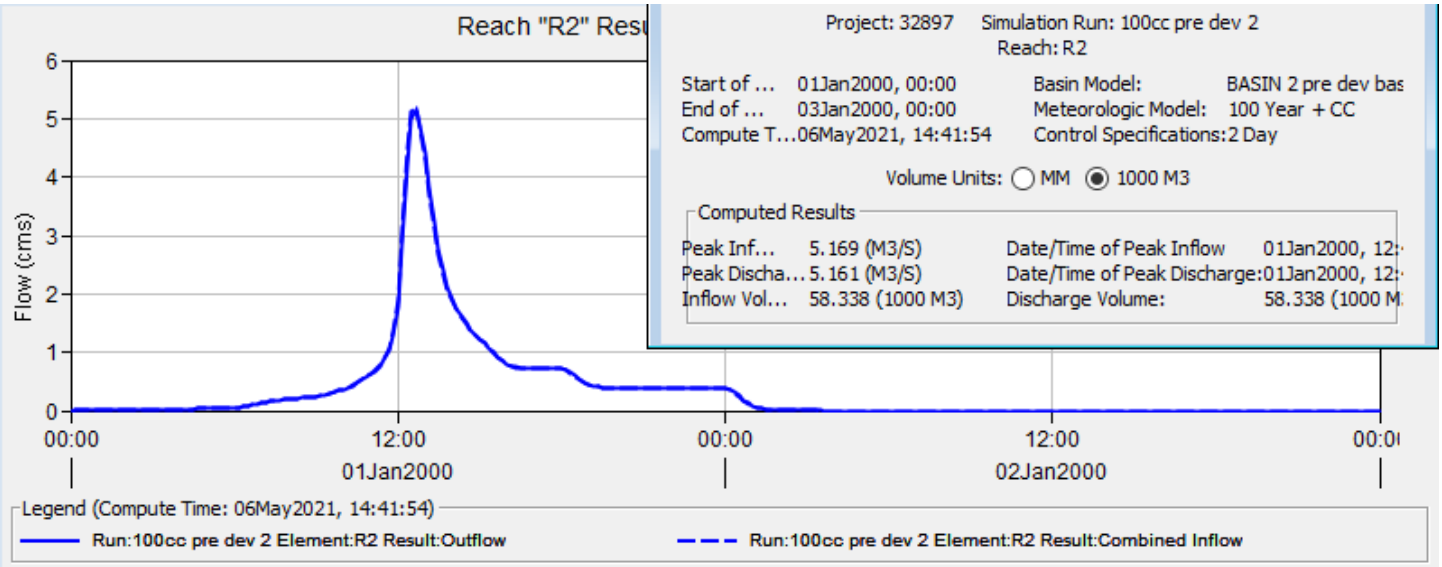
95th Percentile Storm



10% AEP Storm



1% AEP Storm



HEC-HMS MODEL RESULTS

Predevelopment Node "Rangiwhea 3" Discharge

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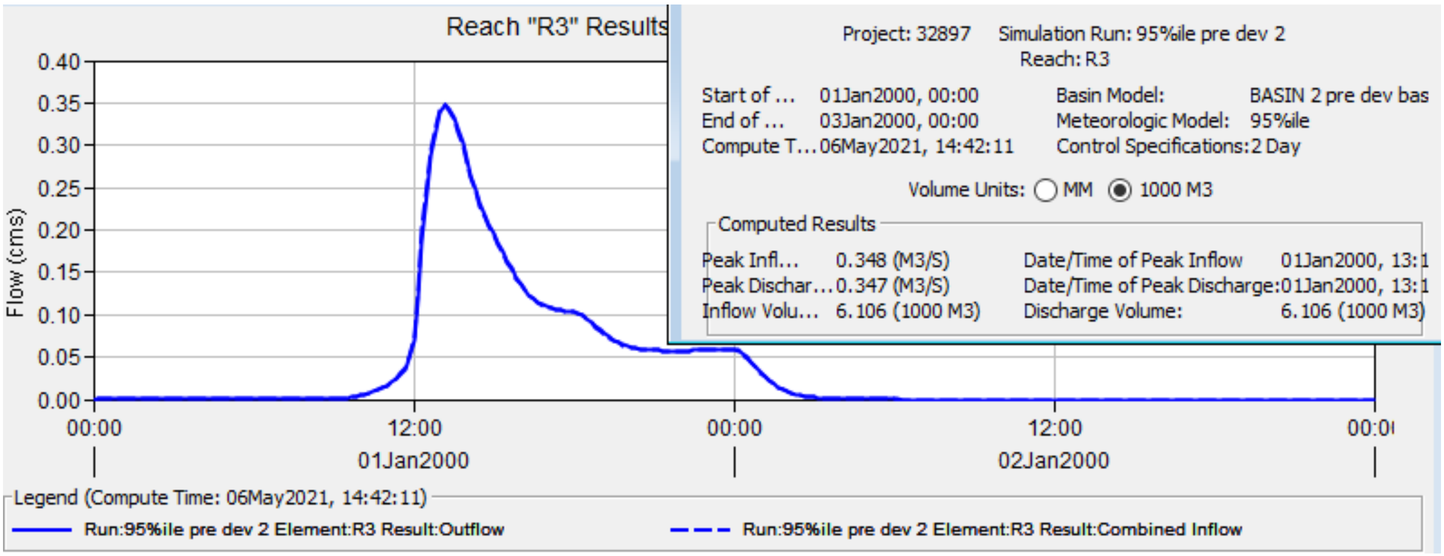
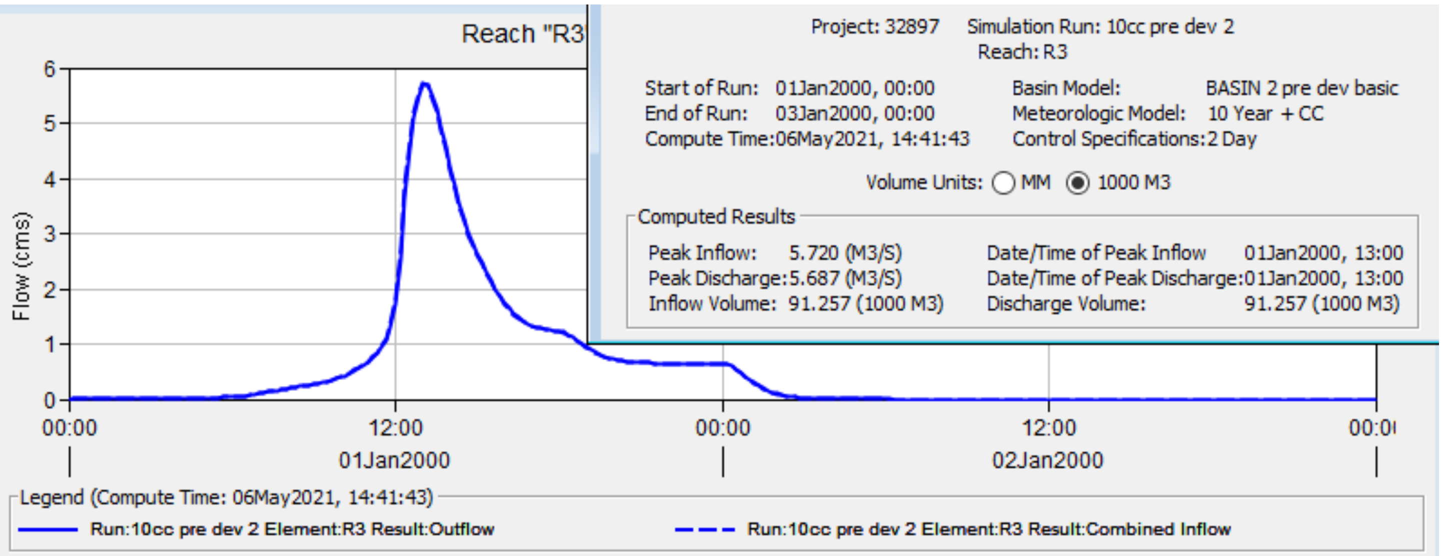
95th Percentile Storm



10% AEP Storm



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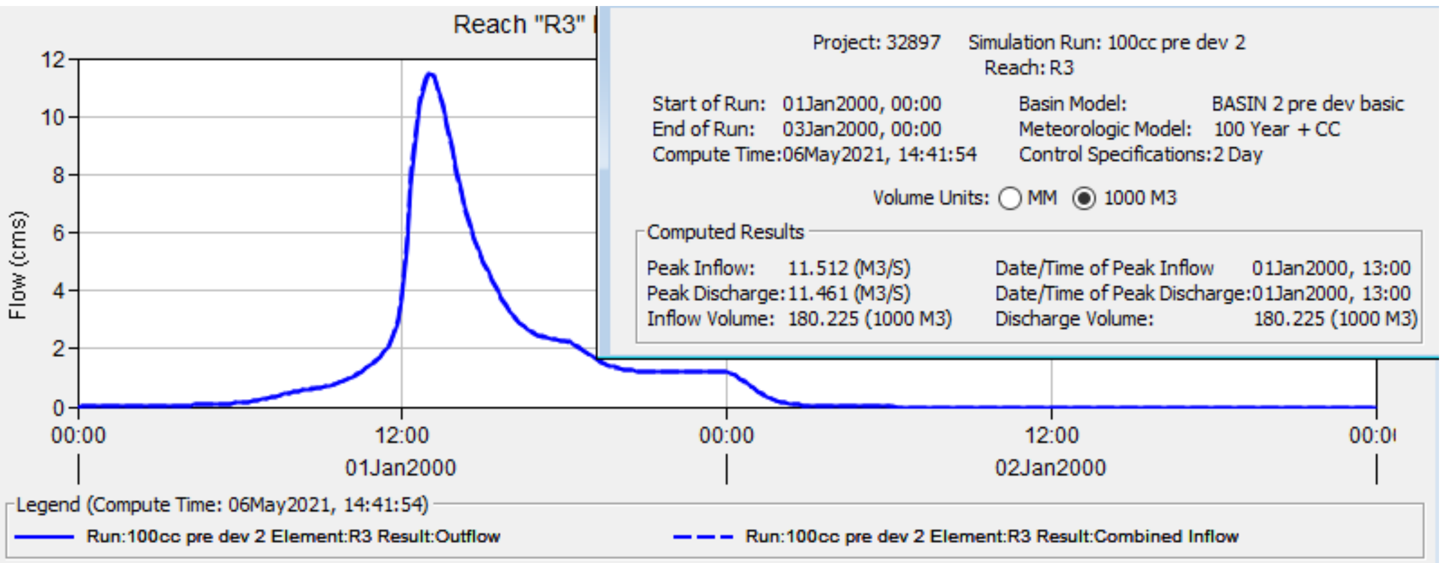
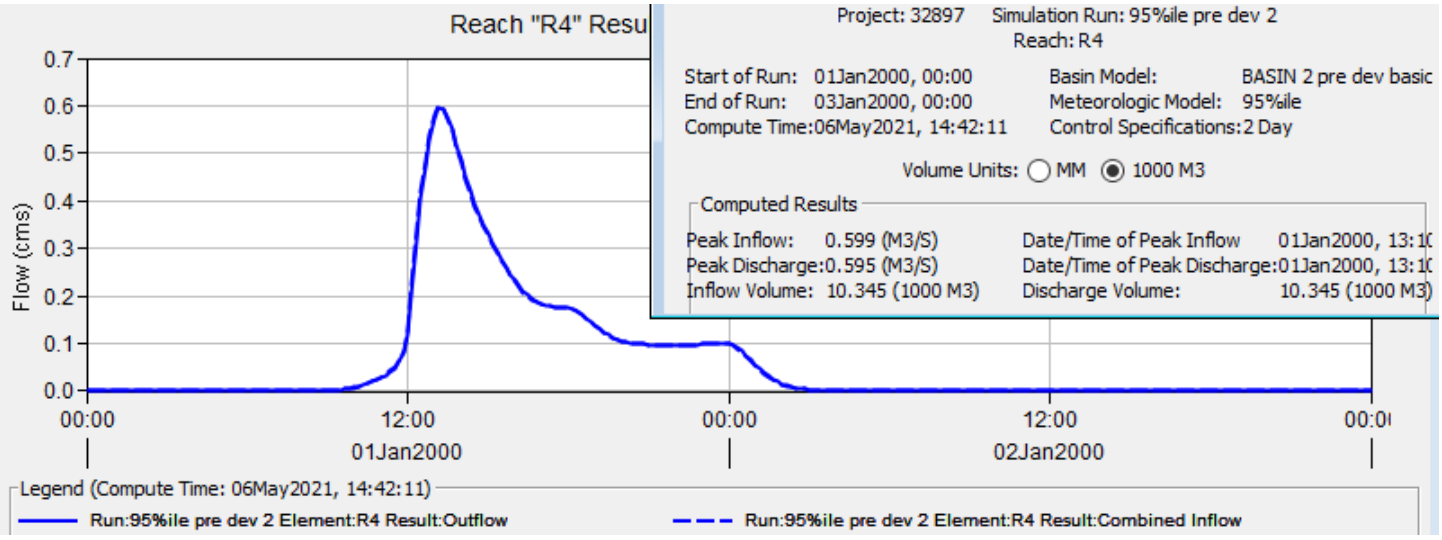


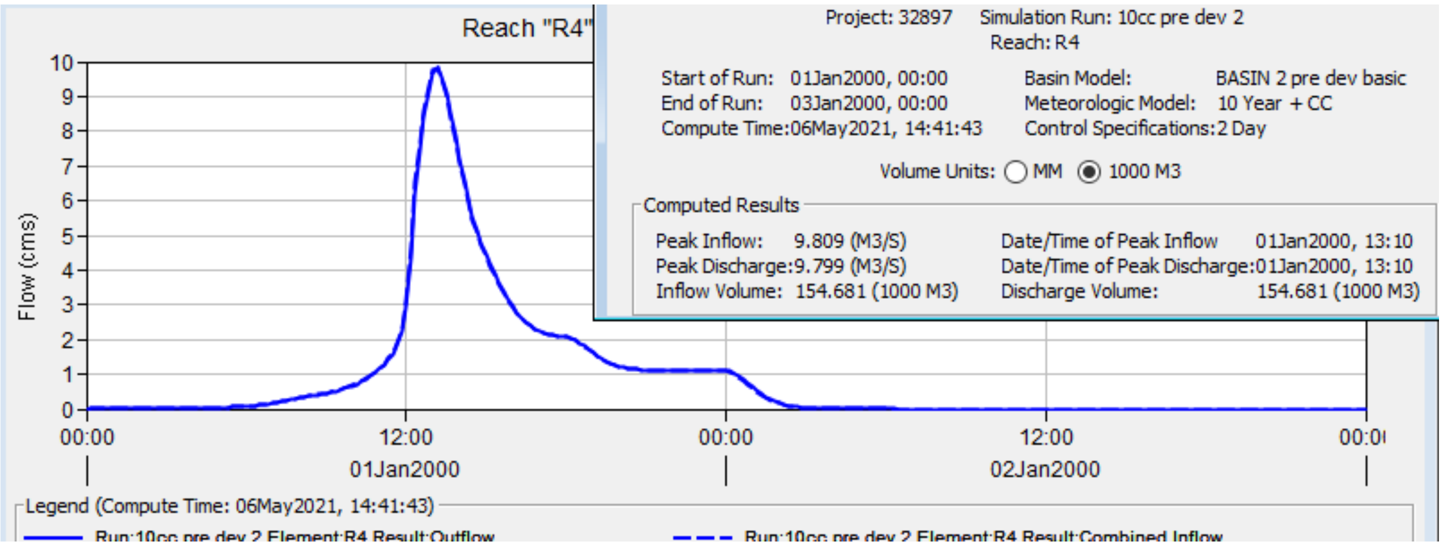
HEC-HMS MODEL RESULTS

Predevelopment Node "Rangiwhea 4" Discharge

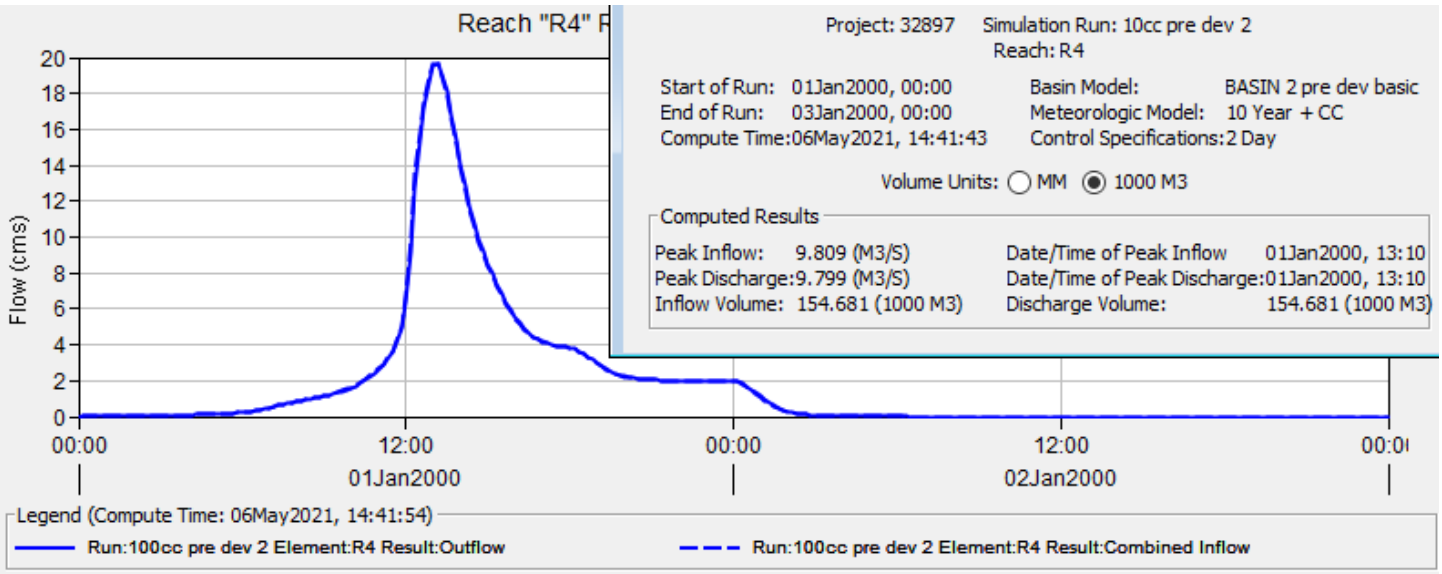
95th Percentile Storm



10% AEP Storm



1% AEP Storm



HEC-HMS MODEL RESULTS

Predevelopment Node "Rangiwhea 5" Discharge

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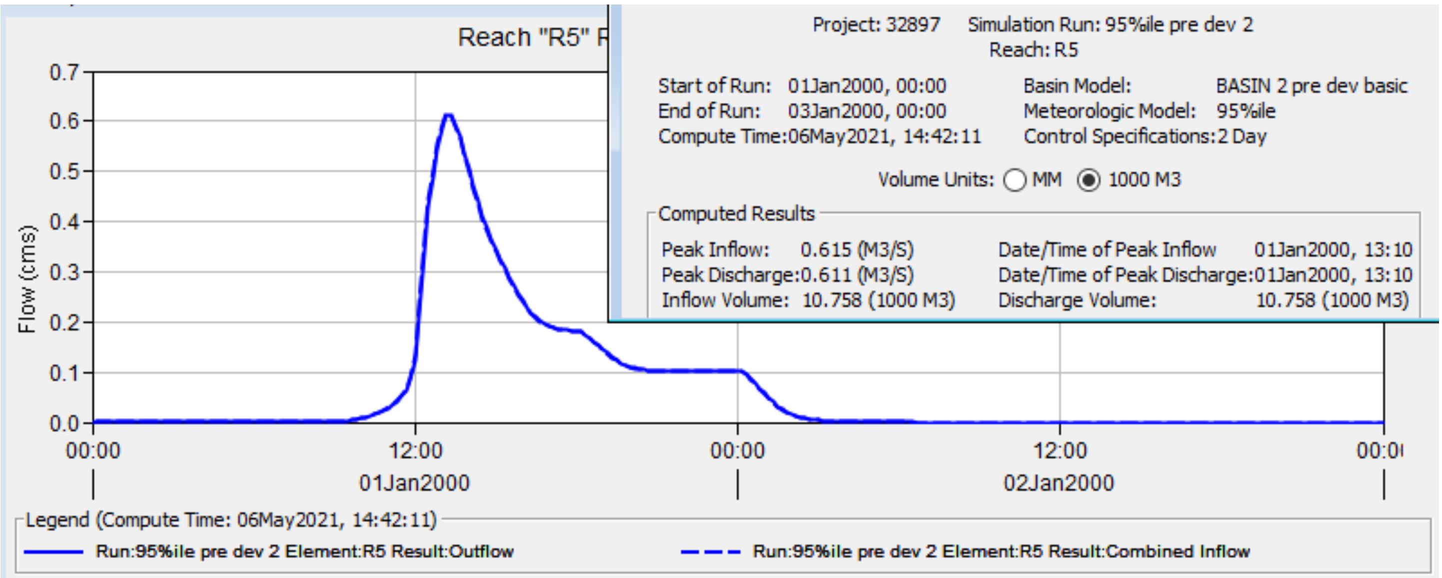
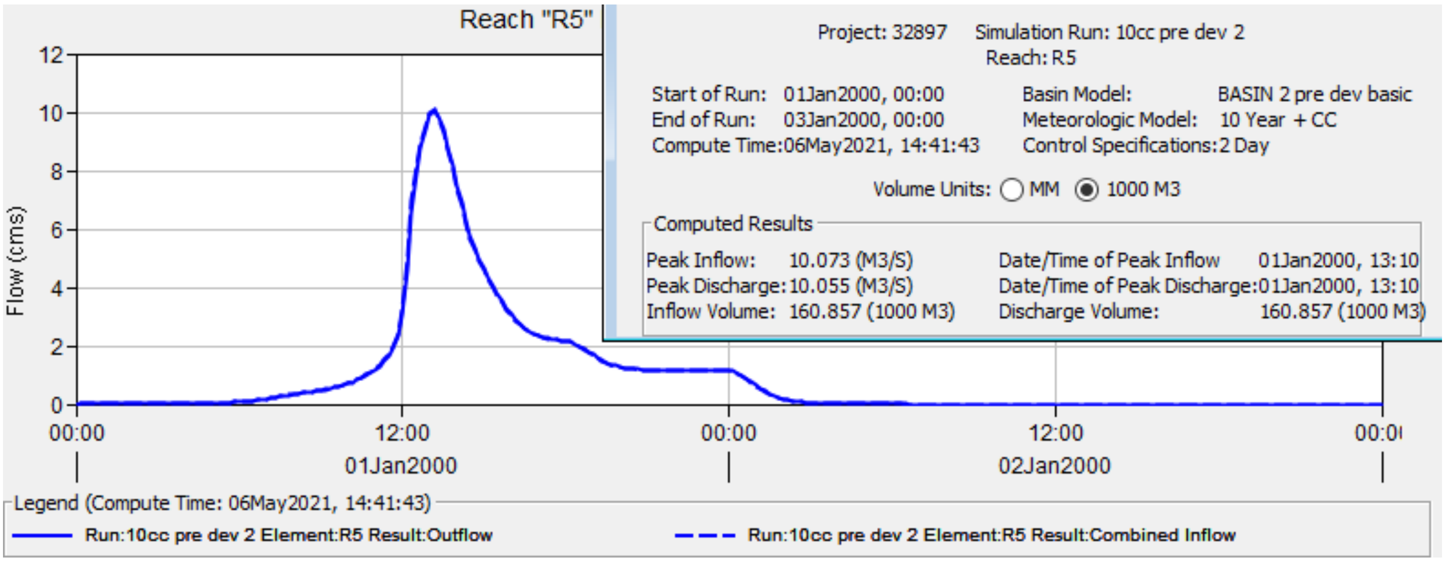
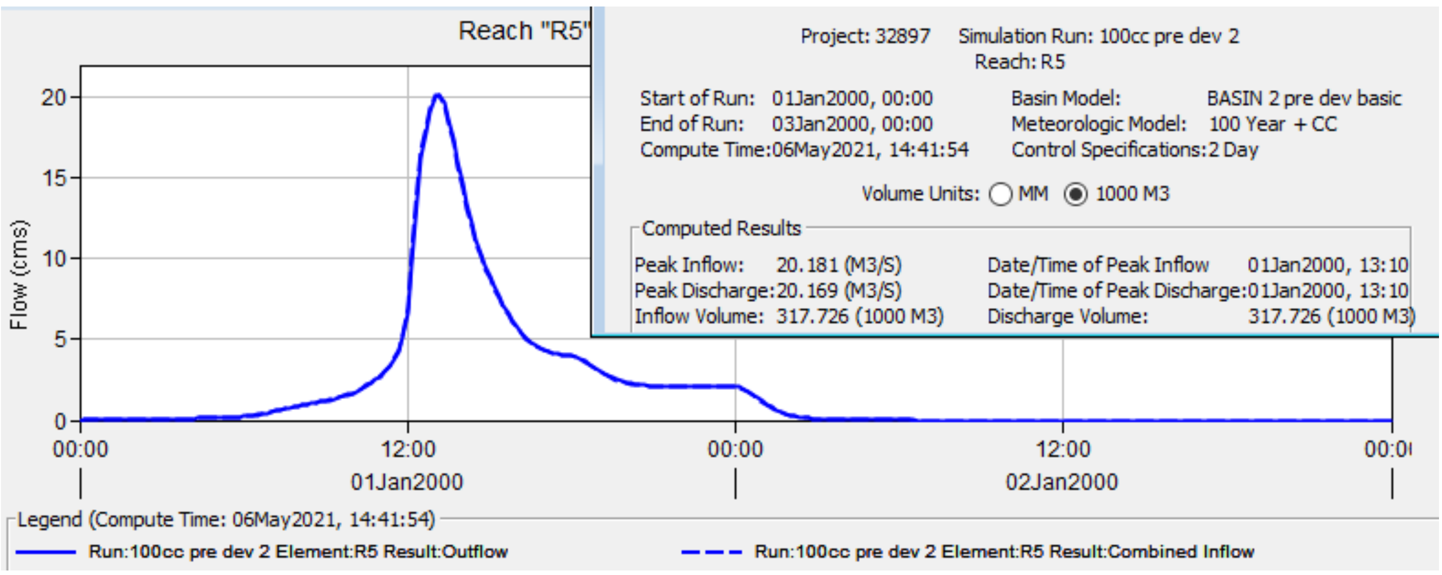
95th Percentile Storm



10% AEP Storm



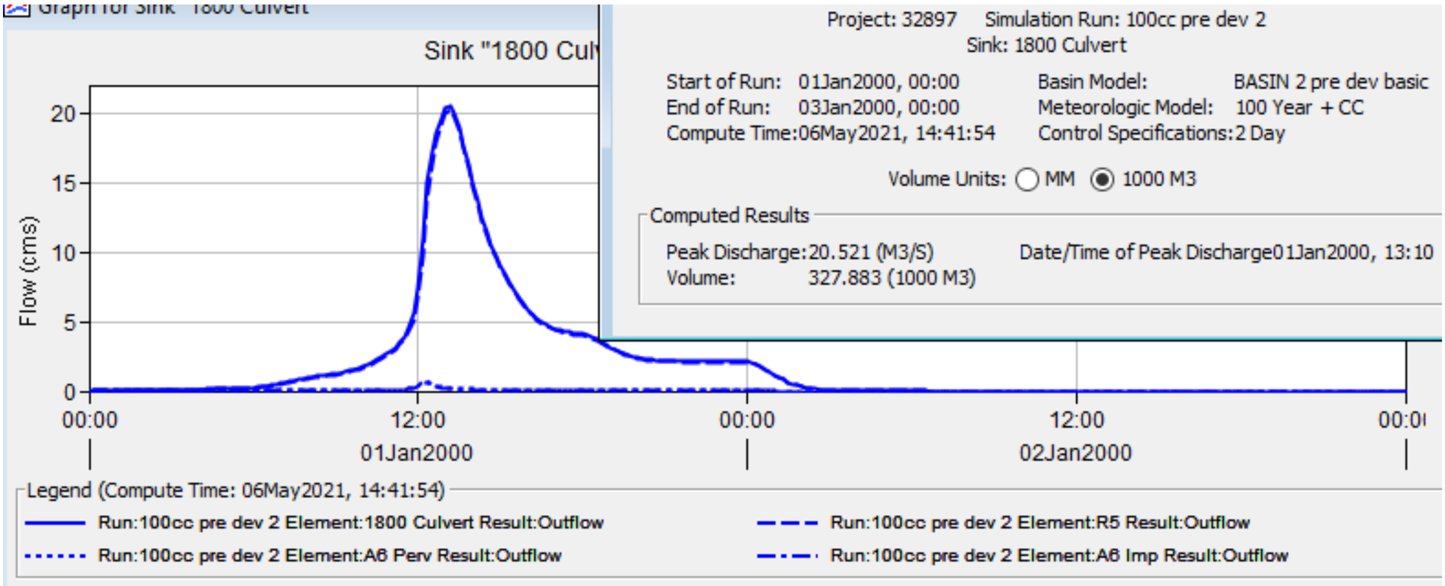
1% AEP Storm



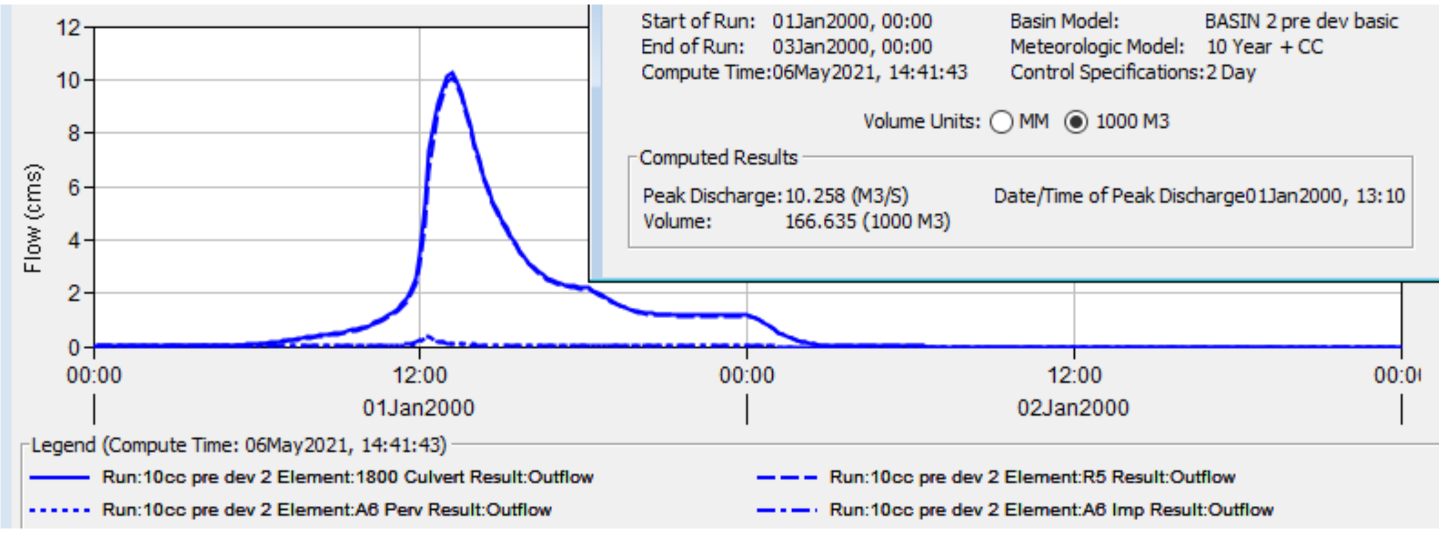
HEC-HMS MODEL RESULTS

Predevelopment Node "King Street Culvert" Discharge

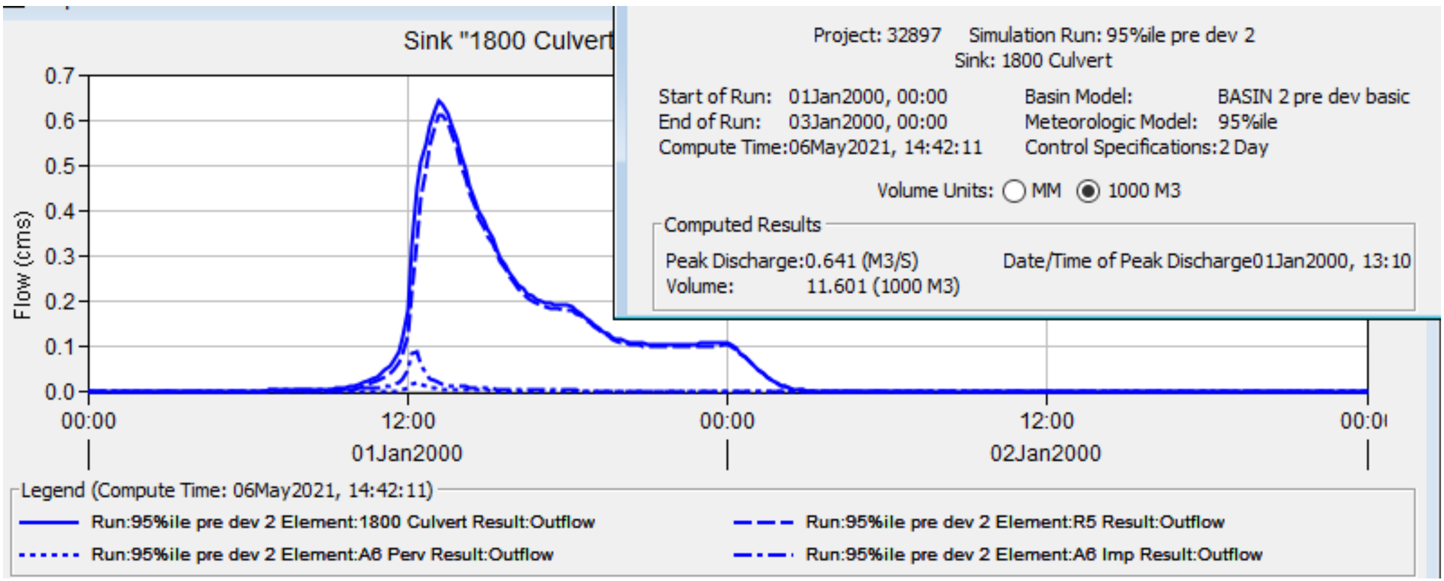
95th Percentile Storm



10% AEP Storm



1% AEP Storm



HEC-HMS MODEL RESULTS

Predevelopment Node "C" Discharge

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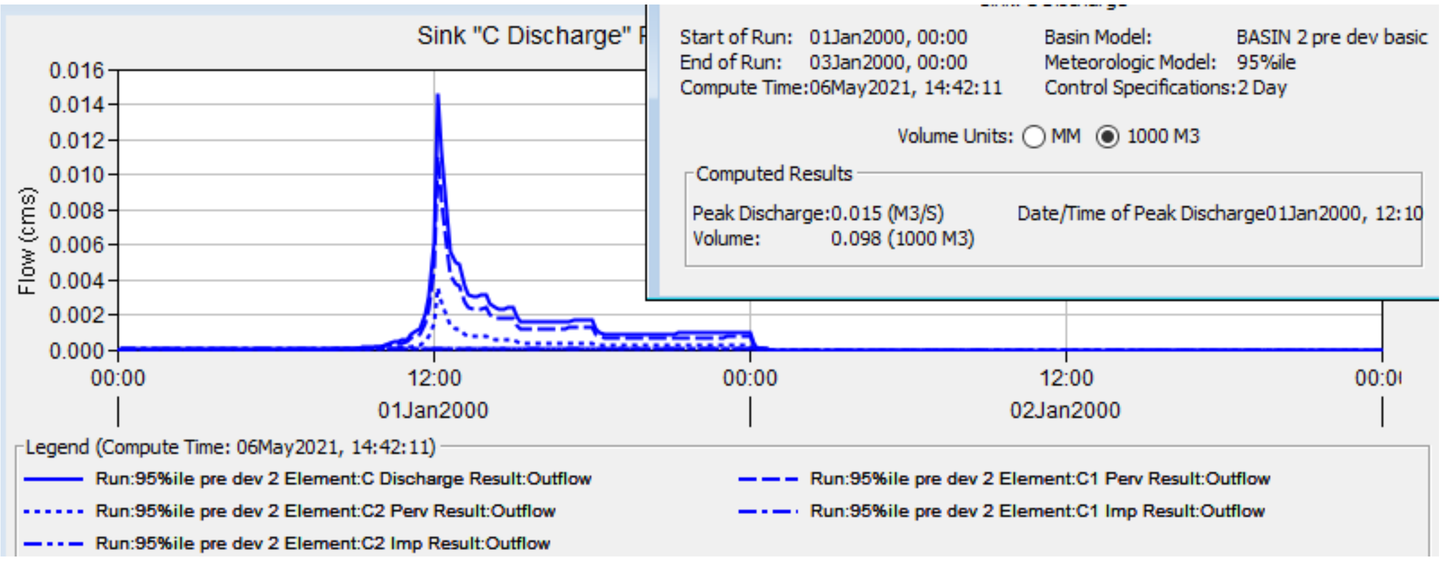
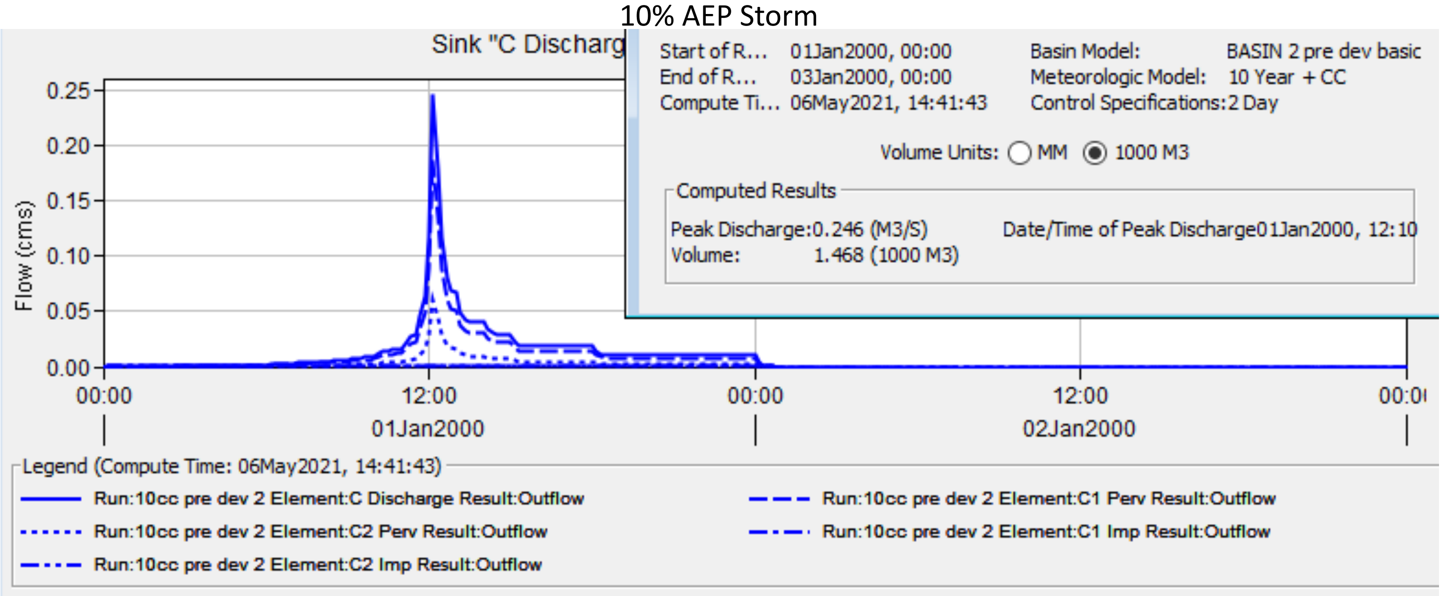
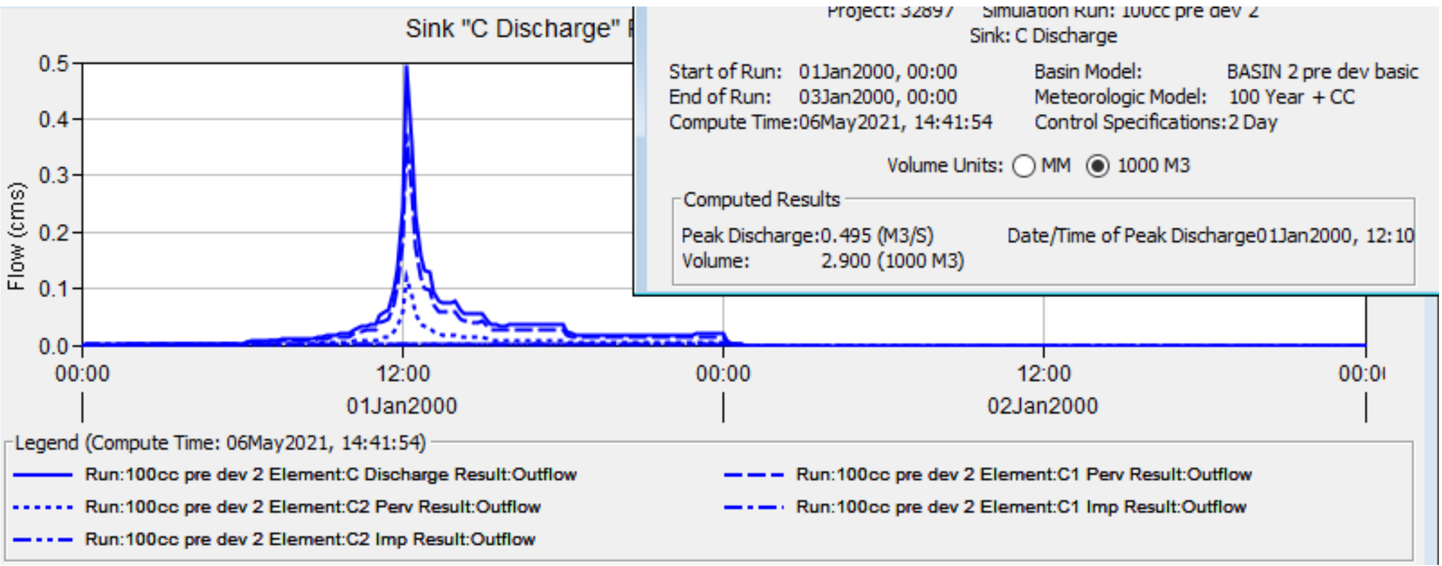
95th Percentile Storm



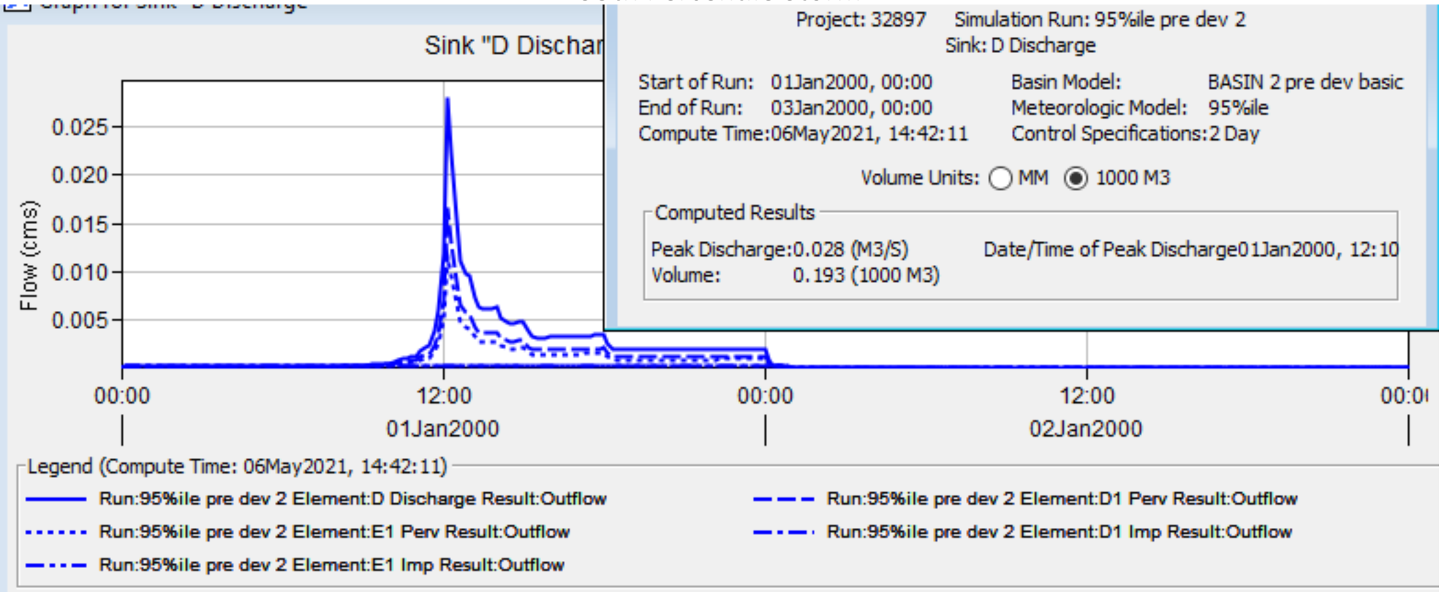
10% AEP Storm



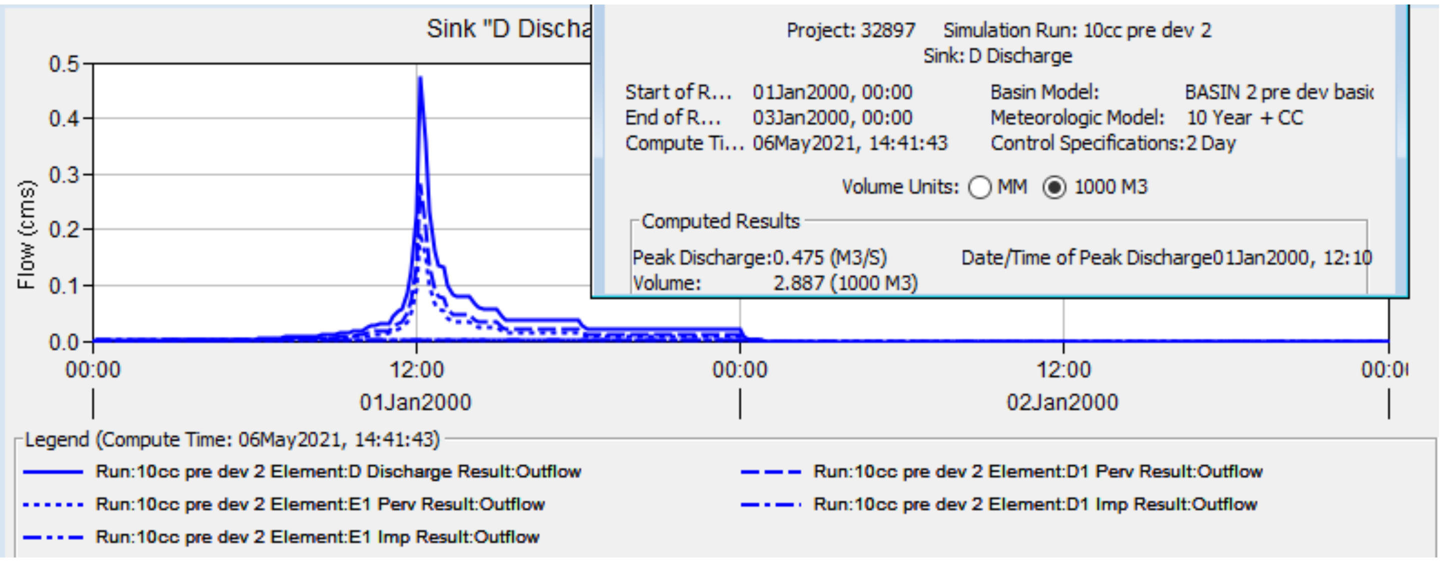
1% AEP Storm



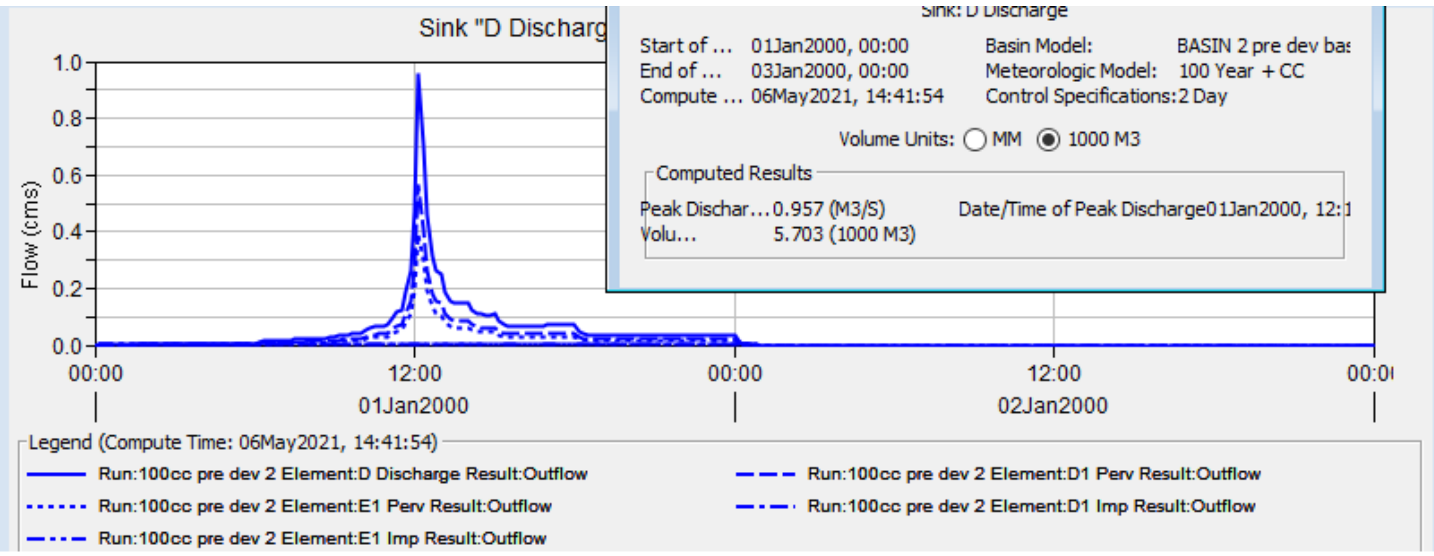
95th Percentile Storm



10% AEP Storm



1% AEP Storm



HEC-HMS MODEL RESULTS

Predevelopment Node "F" Discharge

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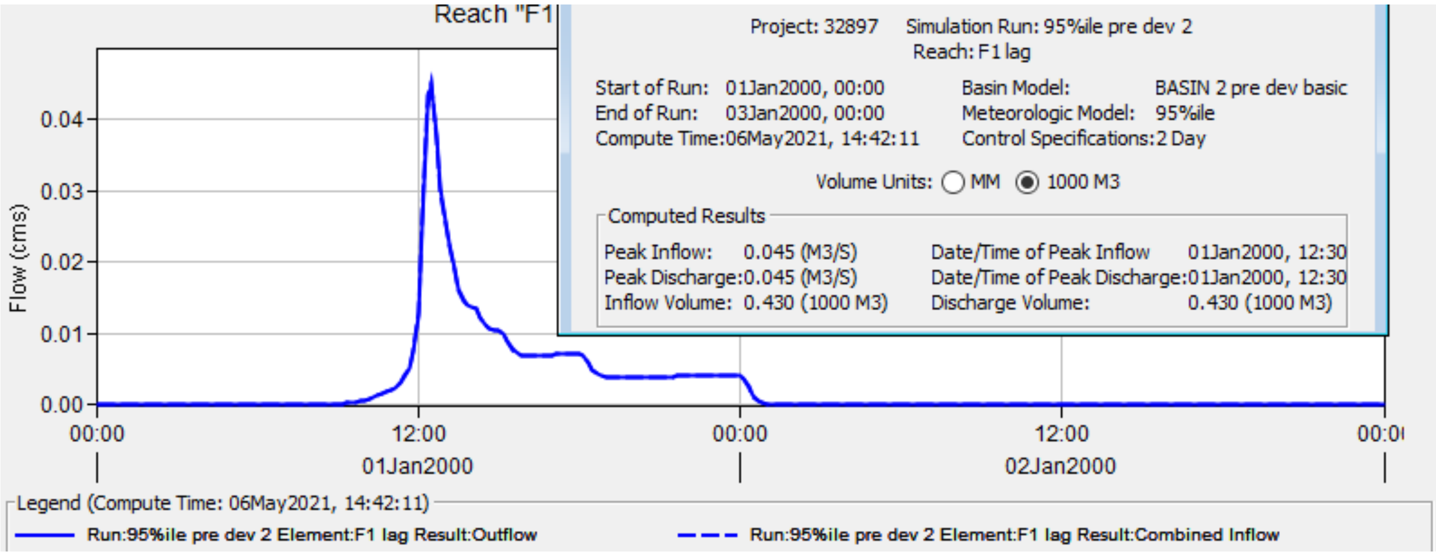
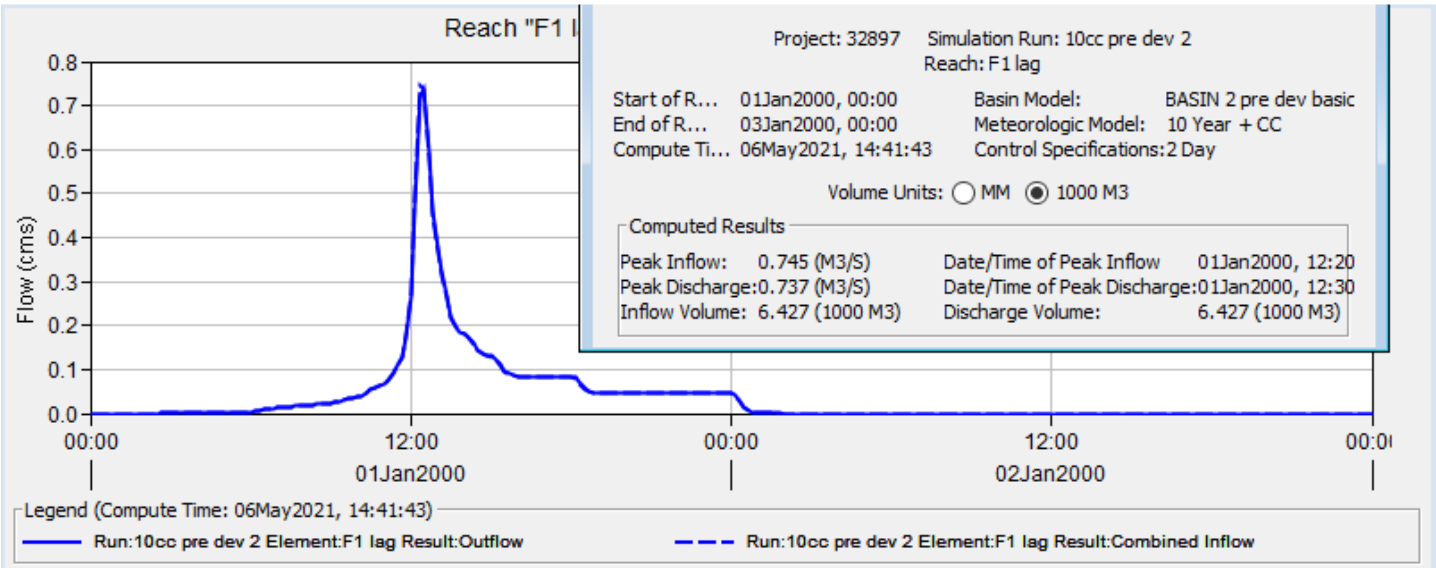
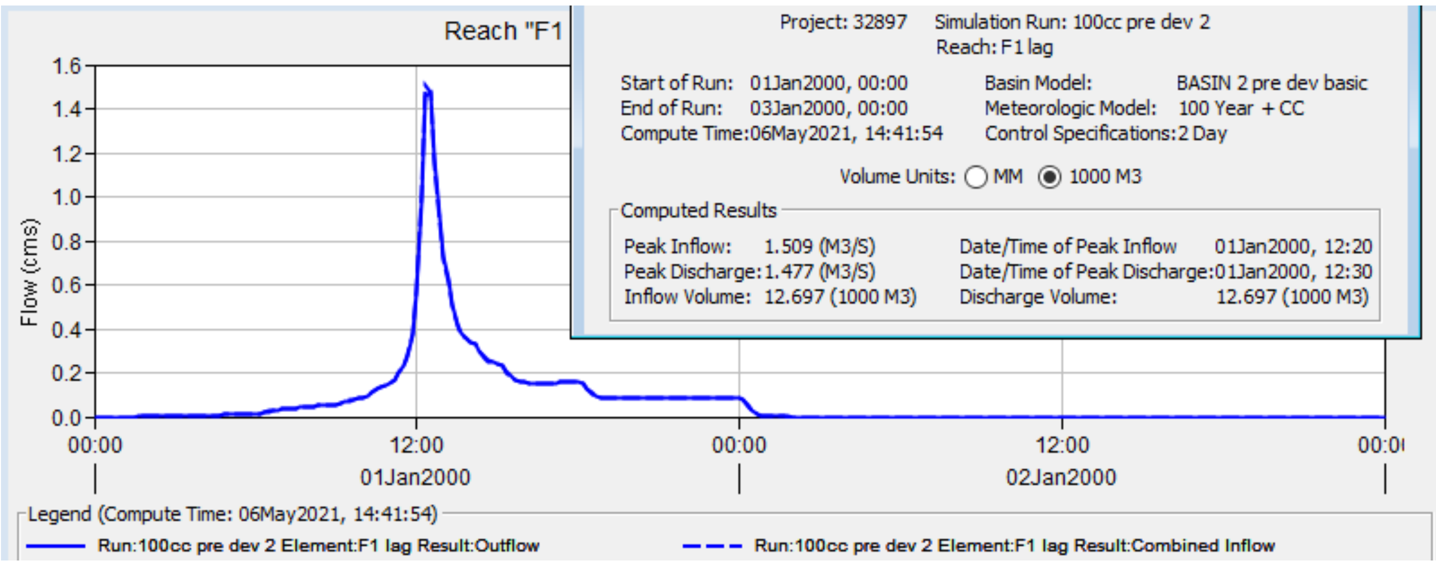
95th Percentile Storm



10% AEP Storm



1% AEP Storm



HEC-HMS MODEL RESULTS

Predevelopment Node "G" Discharge

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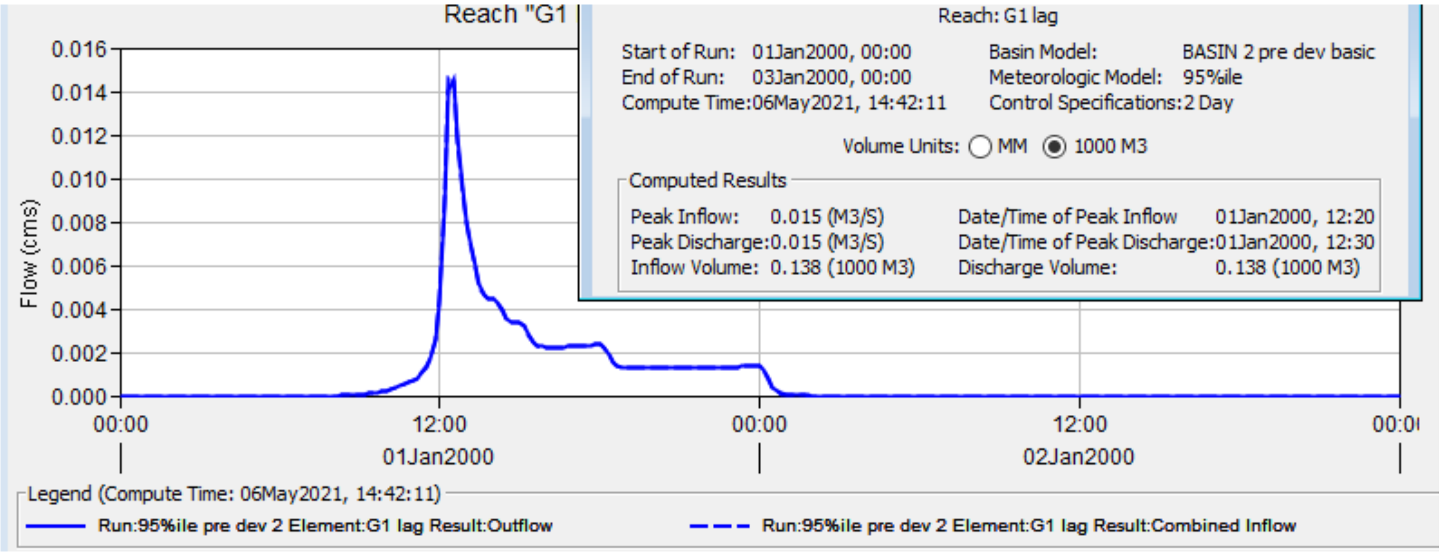
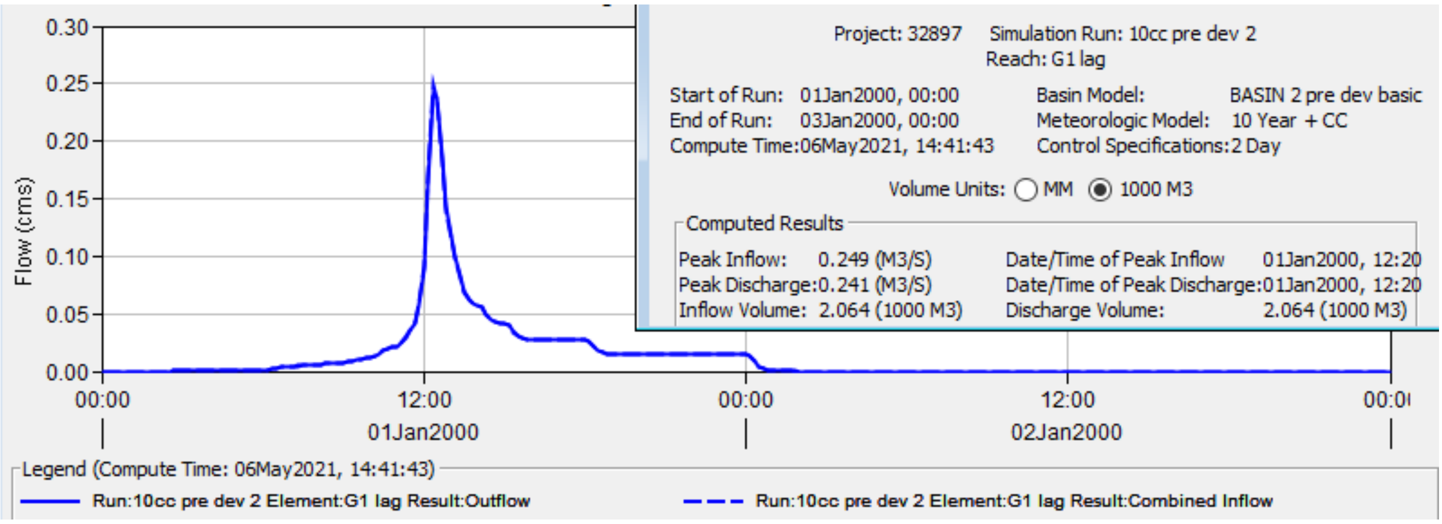
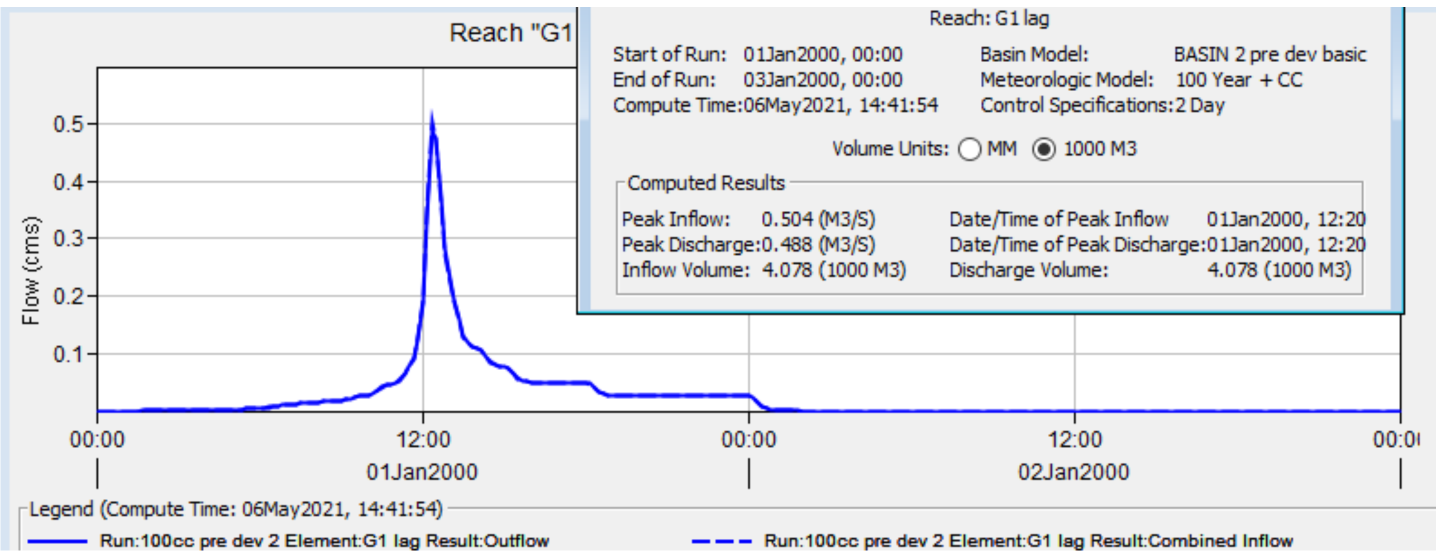
95th Percentile Storm



10% AEP Storm



1% AEP Storm



HEC-HMS MODEL RESULTS

Post development 95%ile Rainfall Event: Global Summary

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Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
R1	0.31994	0.105	01Jan2000, 12:50	1.313
F1 Imp	0.0627	0.096	01Jan2000, 12:20	0.873
F1 Perv	0.05585	0.024	01Jan2000, 12:30	0.229
F1 lag	0.11855	0.119	01Jan2000, 12:20	1.102
B1 Perv	0.04396	0.023	01Jan2000, 12:20	0.180
B1 Imp	0.042639	0.067	01Jan2000, 12:20	0.594
G1 Imp	0.01761	0.028	01Jan2000, 12:20	0.245
G1 Perv	0.01602	0.007	01Jan2000, 12:20	0.066
G1 lag	0.03363	0.035	01Jan2000, 12:20	0.311
Storm diversion split	0.238779	0.230	01Jan2000, 12:30	2.187
Wetland	0.238779	0.033	01Jan2000, 18:10	2.119
Pond outfall	0.238779	0.033	01Jan2000, 18:10	2.119
Storm outfall	0.0	0.000	01Jan2000, 00:00	0.000
B3 Perv	0.074836	0.030	01Jan2000, 12:30	0.307
A2 Perv	0.938024	0.224	01Jan2000, 13:30	3.865
R2	0.633555	0.147	01Jan2000, 12:50	3.739
A1 Perv	0.06526	0.031	01Jan2000, 12:20	0.268
R3	1.636839	0.352	01Jan2000, 13:20	7.871
A3 Perv	0.8710	0.223	01Jan2000, 13:20	3.573
A5 Perv	0.1622	0.080	01Jan2000, 12:20	0.665
R4	2.670039	0.601	01Jan2000, 13:20	12.110
A4 Perv	0.1006	0.048	01Jan2000, 12:20	0.413
R5	2.770639	0.617	01Jan2000, 13:20	12.522
A6 Perv	0.04239	0.022	01Jan2000, 12:20	0.174
A6 Imp	0.0235	0.091	01Jan2000, 12:20	0.669
1800 Culvert	2.836529	0.645	01Jan2000, 13:10	13.365
F2 Imp	0.01755	0.084	01Jan2000, 12:10	0.500
F2 Perv	0.0117	0.006	01Jan2000, 12:20	0.048
D1 Perv	0.00952	0.006	01Jan2000, 12:10	0.039
E1 Perv	0.0093	0.005	01Jan2000, 12:10	0.038
D1 imp roof	0.00230	0.011	01Jan2000, 12:10	0.065
E1 imp roof	0.0019	0.009	01Jan2000, 12:10	0.054
C2 imp roof	0.001188	0.006	01Jan2000, 12:10	0.034
D tanks	0.005388	0.005	01Jan2000, 13:00	0.156
D1 Imp	0.00538	0.024	01Jan2000, 12:10	0.127
E1 Imp	0.0045	0.020	01Jan2000, 12:10	0.106
C2 Imp	0.002772	0.013	01Jan2000, 12:10	0.065
C2 Perv	0.00264	0.002	01Jan2000, 12:10	0.011
D additional	0.039500	0.016	01Jan2000, 13:30	0.542
D Discharge	0.039500	0.016	01Jan2000, 13:30	0.542
F2 Discharge	0.02925	0.088	01Jan2000, 12:10	0.548
C1 Imp	0.00714	0.032	01Jan2000, 12:10	0.168
C1 Perv	0.0068	0.004	01Jan2000, 12:10	0.028
C1-Imp roofs	0.00306	0.015	01Jan2000, 12:10	0.087
C tanks	0.00306	0.003	01Jan2000, 13:10	0.088
C additional storage	0.01700	0.005	01Jan2000, 16:00	0.279
C Discharge	0.01700	0.005	01Jan2000, 16:00	0.279

HEC-HMS MODEL RESULTS

Post development 10% AEP Rainfall Event: Global Summary

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Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
B2 Perv	0.31994	1.732	01Jan2000, 12:40	19.640
R1	0.31994	1.728	01Jan2000, 12:50	19.640
F1 Imp	0.0627	1.162	01Jan2000, 12:10	7.535
F1 Perv	0.05585	0.397	01Jan2000, 12:20	3.428
F1 lag	0.11855	1.451	01Jan2000, 12:20	10.963
B1 Perv	0.04396	0.372	01Jan2000, 12:20	2.699
B1 Imp	0.042639	0.916	01Jan2000, 12:10	5.124
G1 Imp	0.01761	0.378	01Jan2000, 12:10	2.116
G1 Perv	0.01602	0.119	01Jan2000, 12:20	0.983
G1 lag	0.03363	0.459	01Jan2000, 12:10	3.100
Storm diversion split	0.238779	2.037	01Jan2000, 12:20	20.828
Wetland	0.238779	0.547	01Jan2000, 13:50	20.736
Pond outfall	0.238779	0.547	01Jan2000, 13:50	20.736
Storm outfall	0.0	0.842	01Jan2000, 12:20	1.140
B3 Perv	0.074836	0.505	01Jan2000, 12:30	4.594
A2 Perv	0.938024	3.677	01Jan2000, 13:20	57.721
R2	0.633555	3.005	01Jan2000, 12:30	46.110
A1 Perv	0.06526	0.528	01Jan2000, 12:20	4.006
R3	1.636839	5.950	01Jan2000, 13:10	107.837
A3 Perv	0.8710	3.690	01Jan2000, 13:10	53.468
A5 Perv	0.1622	1.332	01Jan2000, 12:20	9.957
R4	2.670039	10.052	01Jan2000, 13:10	171.262
A4 Perv	0.1006	0.814	01Jan2000, 12:20	6.175
R5	2.770639	10.312	01Jan2000, 13:10	177.437
A6 Perv	0.04239	0.359	01Jan2000, 12:20	2.602
A6 Imp	0.0235	0.408	01Jan2000, 12:20	3.176
1800 Culvert	2.836529	10.514	01Jan2000, 13:10	183.215
F2 Imp	0.01755	0.378	01Jan2000, 12:10	2.372
F2 Perv	0.0117	0.096	01Jan2000, 12:20	0.718
D1 Perv	0.00952	0.098	01Jan2000, 12:10	0.584
E1 Perv	0.0093	0.092	01Jan2000, 12:10	0.571
D1 imp roof	0.00230	0.050	01Jan2000, 12:10	0.311
E1 imp roof	0.0019	0.041	01Jan2000, 12:10	0.257
C2 imp roof	0.001188	0.026	01Jan2000, 12:10	0.161
D tanks	0.005388	0.098	01Jan2000, 12:20	0.728
D1 Imp	0.00538	0.116	01Jan2000, 12:10	0.700
E1 Imp	0.0045	0.097	01Jan2000, 12:10	0.586
C2 Imp	0.002772	0.060	01Jan2000, 12:10	0.361
C2 Perv	0.00264	0.027	01Jan2000, 12:10	0.162
D additional	0.039500	0.473	01Jan2000, 12:20	3.666
D Discharge	0.039500	0.473	01Jan2000, 12:20	3.666
F2 Discharge	0.02925	0.452	01Jan2000, 12:10	3.090
C1 Imp	0.00714	0.154	01Jan2000, 12:10	0.929
C1 Perv	0.0068	0.070	01Jan2000, 12:10	0.417
C1-Imp roofs	0.00306	0.066	01Jan2000, 12:10	0.414
C tanks	0.00306	0.056	01Jan2000, 12:20	0.416
C additional storage	0.01700	0.243	01Jan2000, 12:20	1.754
C Discharge	0.01700	0.243	01Jan2000, 12:20	1.754

HEC-HMS MODEL RESULTS

Post development 1% AEP Rainfall Event: Global Summary

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Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
R1	0.31994	3.470	01Jan2000, 12:40	38.801
F1 Imp	0.0627	1.822	01Jan2000, 12:10	12.443
F1 Perv	0.05585	0.805	01Jan2000, 12:20	6.773
F1 lag	0.11855	2.456	01Jan2000, 12:20	19.216
B1 Perv	0.04396	0.746	01Jan2000, 12:20	5.331
B1 Imp	0.042639	1.436	01Jan2000, 12:10	8.462
G1 Imp	0.01761	0.593	01Jan2000, 12:10	3.495
G1 Perv	0.01602	0.240	01Jan2000, 12:20	1.943
G1 lag	0.03363	0.759	01Jan2000, 12:10	5.438
Storm diversion split	0.238779	2.394	01Jan2000, 12:20	33.707
Wetland	0.238779	0.591	01Jan2000, 15:10	33.723
Pond outfall	0.238779	0.591	01Jan2000, 15:10	33.723
Storm outfall	0.0	2.471	01Jan2000, 12:20	4.795
B3 Perv	0.074836	1.016	01Jan2000, 12:30	9.076
A2 Perv	0.938024	7.398	01Jan2000, 13:20	113.973
R2	0.633555	6.528	01Jan2000, 12:30	86.394
A1 Perv	0.06526	1.063	01Jan2000, 12:20	7.914
R3	1.636839	11.694	01Jan2000, 13:00	208.281
A3 Perv	0.8710	7.428	01Jan2000, 13:10	105.630
A5 Perv	0.1622	2.679	01Jan2000, 12:20	19.671
R4	2.670039	19.810	01Jan2000, 13:10	333.582
A4 Perv	0.1006	1.638	01Jan2000, 12:20	12.200
R5	2.770639	20.375	01Jan2000, 13:00	345.782
A6 Perv	0.04239	0.720	01Jan2000, 12:20	5.141
A6 Imp	0.0235	0.638	01Jan2000, 12:20	5.016
1800 Culvert	2.836529	20.802	01Jan2000, 13:00	355.939
F2 Imp	0.01755	0.591	01Jan2000, 12:10	3.746
F2 Perv	0.0117	0.193	01Jan2000, 12:20	1.419
D1 Perv	0.00952	0.197	01Jan2000, 12:10	1.155
E1 Perv	0.0093	0.185	01Jan2000, 12:10	1.128
D1 imp roof	0.00230	0.078	01Jan2000, 12:10	0.491
E1 imp roof	0.0019	0.064	01Jan2000, 12:10	0.406
C2 imp roof	0.001188	0.040	01Jan2000, 12:10	0.254
D tanks	0.005388	0.154	01Jan2000, 12:20	1.152
D1 Imp	0.00538	0.181	01Jan2000, 12:10	1.121
E1 Imp	0.0045	0.152	01Jan2000, 12:10	0.938
C2 Imp	0.002772	0.093	01Jan2000, 12:10	0.578
C2 Perv	0.00264	0.055	01Jan2000, 12:10	0.320
D additional	0.039500	0.885	01Jan2000, 12:20	6.396
D Discharge	0.039500	0.885	01Jan2000, 12:20	6.396
F2 Discharge	0.02925	0.741	01Jan2000, 12:10	5.165
C1 Imp	0.00714	0.241	01Jan2000, 12:10	1.488
C1 Perv	0.0068	0.141	01Jan2000, 12:10	0.825
C1-Imp roofs	0.00306	0.103	01Jan2000, 12:10	0.653
C tanks	0.00306	0.087	01Jan2000, 12:20	0.655
C additional storage	0.01700	0.406	01Jan2000, 12:20	2.959
C Discharge	0.01700	0.406	01Jan2000, 12:20	2.959

HEC-HMS MODEL RESULTS

Post development Node "Pond Inlet" Discharge - 95%ile Storm

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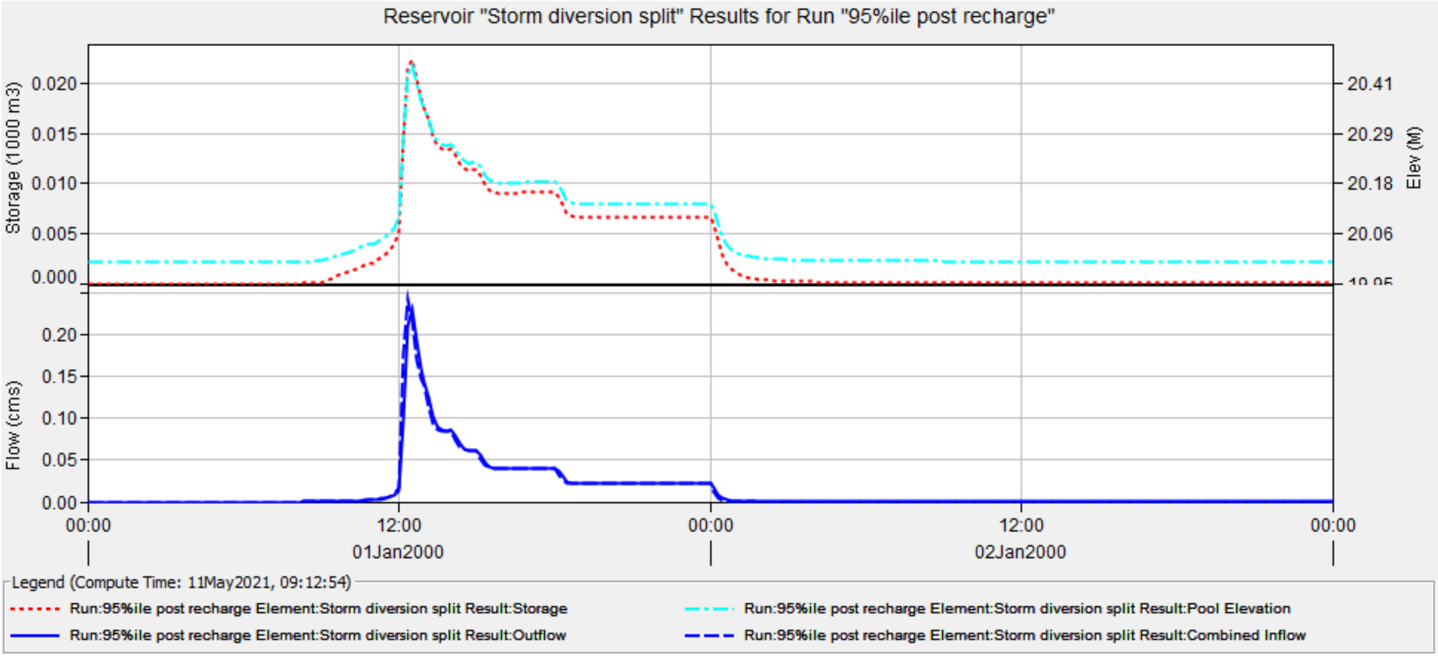
Pond Inlet Flows and Outflow to Wetland Storage



Pond Inlet Flow Summary

Project: 32897 Simulation Run: 95%ile post recharge
Reservoir: Storm diversion split

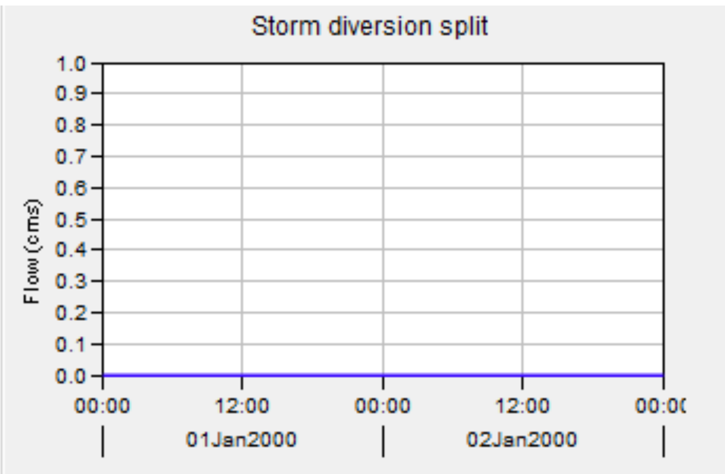
Start of Run:	01Jan2000, 00:00	Basin Model:	BASIN 2 post dev recahrge
End of Run:	03Jan2000, 00:00	Meteorologic Model:	95%ile
Compute Time:	11May2021, 09:12:54	Control Specifications:	2 Day

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Inflow:	0.244 (M3/S)	Date/Time of Peak Inflow:	01Jan2000, 12:30
Peak Discharge:	0.230 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:30
Inflow Volume:	2.187 (1000 M3)	Peak Storage:	0.023 (1000 M3)
Discharge Volume:	2.187 (1000 M3)	Peak Elevation:	20.450 (M)

Discharge to Diversion Around Wetland



HEC-HMS MODEL RESULTS

Post development Node "Pond Inlet" Discharge - 10% AEP Storm

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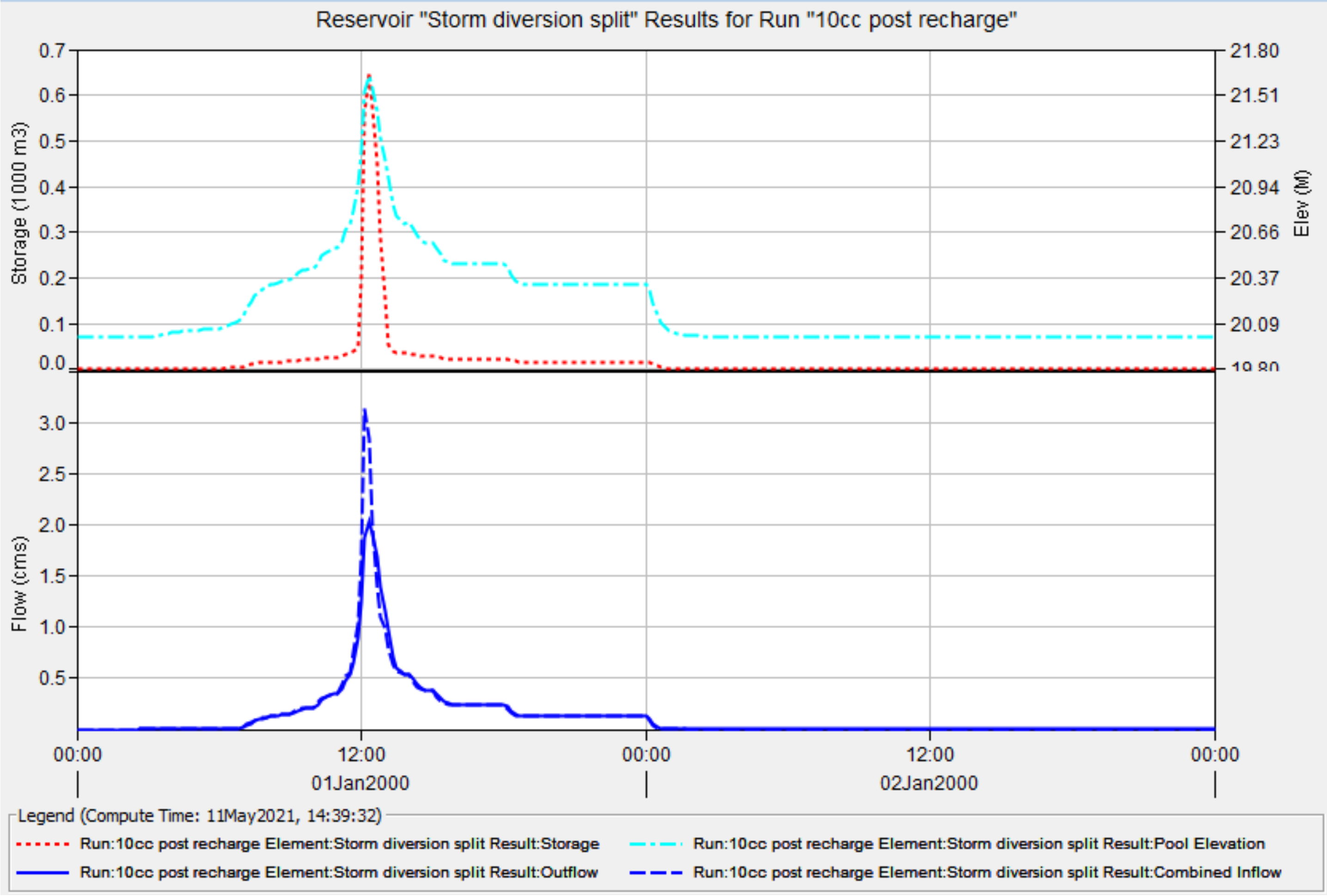
Pond Inlet Flows and Outflow to Wetland Storage



Pond Inlet Flow Summary

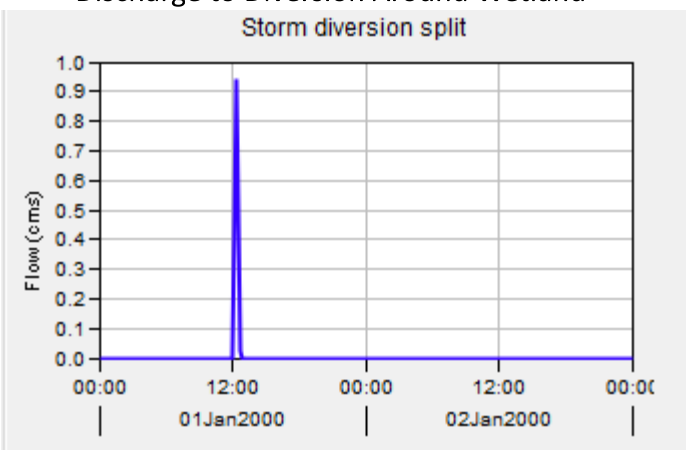
Start of Run:	01Jan2000, 00:00	Basin Model:	BASIN 2 post dev recahrge
End of Run:	03Jan2000, 00:00	Meteorologic Model:	10 Year + CC
Compute Time:	11May2021, 14:39:32	Control Specifications:	2 Day

Volume Units: ◉ MM ○ 1000 M3

Computed Results

Peak Inflow:	3.127 (M3/S)	Date/Time of Peak Inflow:	01Jan2000, 12:20
Peak Discharge:	2.037 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:20
Inflow Volume:	91.65 (MM)	Peak Storage:	0.650 (1000 M3)
Discharge Volume:	87.23 (MM)	Peak Elevation:	21.631 (M)

Discharge to Diversion Around Wetland



HEC-HMS MODEL RESULTS

Post development Node "Pond Inlet" Discharge - 1% AEP Storm

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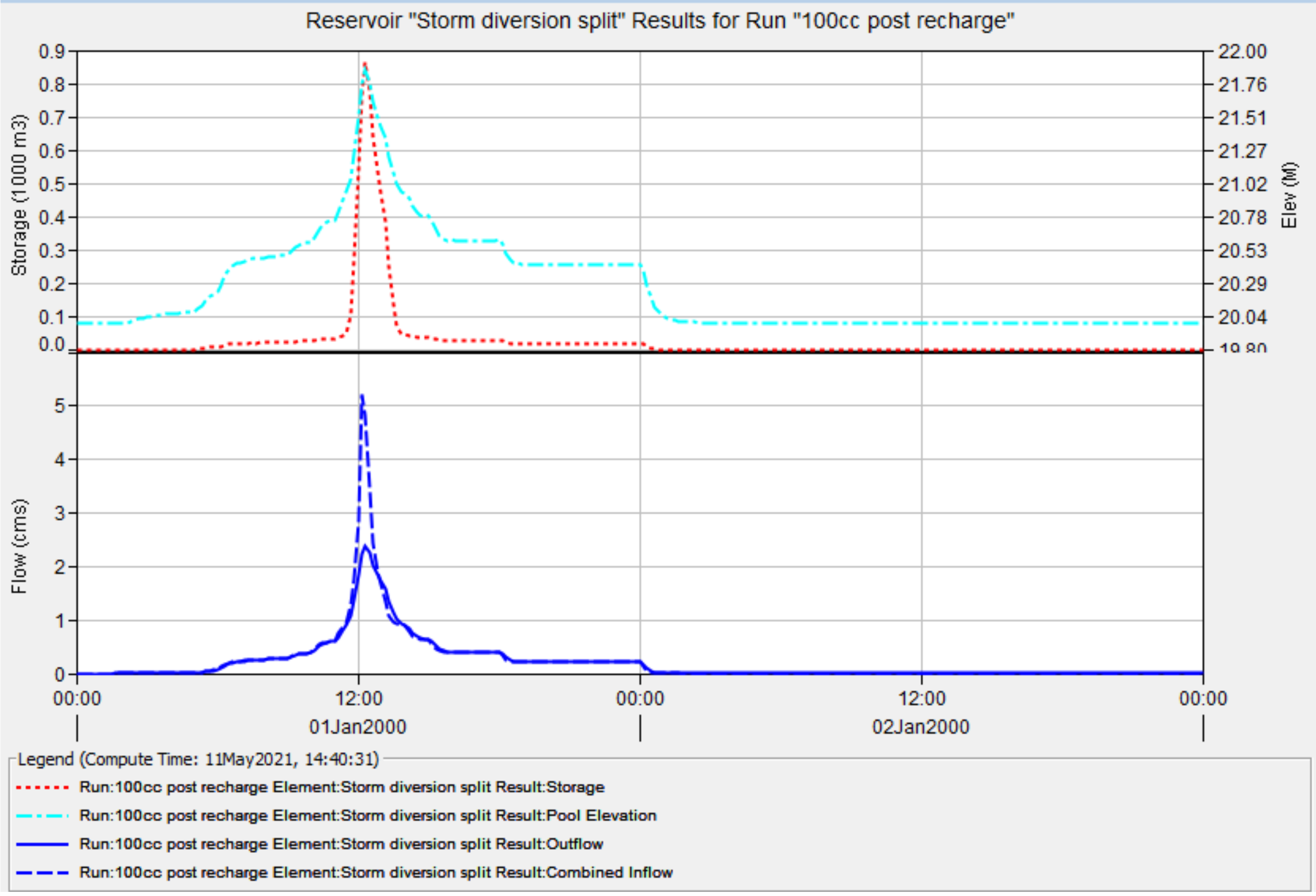
Pond Inlet Flows and Outflow to Wetland Storage



Pond Inlet Flow Summary

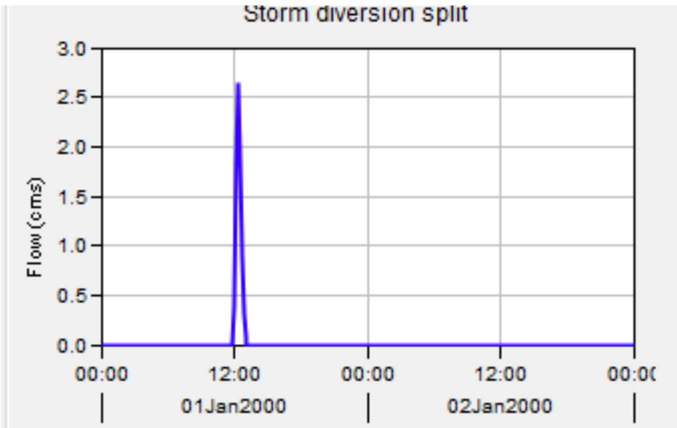
Start of Run:	01Jan2000, 00:00	Basin Model:	BASIN 2 post dev recahrge
End of Run:	03Jan2000, 00:00	Meteorologic Model:	100 Year + CC
Compute Time:	11May2021, 14:40:31	Control Specifications:	2 Day

Volume Units: ○ MM ◉ 1000 M3

Computed Results

Peak Inflow:	5.226 (M3/S)	Date/Time of Peak Inflow:	01Jan2000, 12:20
Peak Discharge:	2.394 (M3/S)	Date/Time of Peak Discharge:	01Jan2000, 12:20
Inflow Volume:	38.447 (1000 M3)	Peak Storage:	0.866 (1000 M3)
Discharge Volume:	33.707 (1000 M3)	Peak Elevation:	21.859 (M)

Discharge to Diversion Around Wetland



HEC-HMS MODEL RESULTS

Post development Node "Pond Outlet" Discharge

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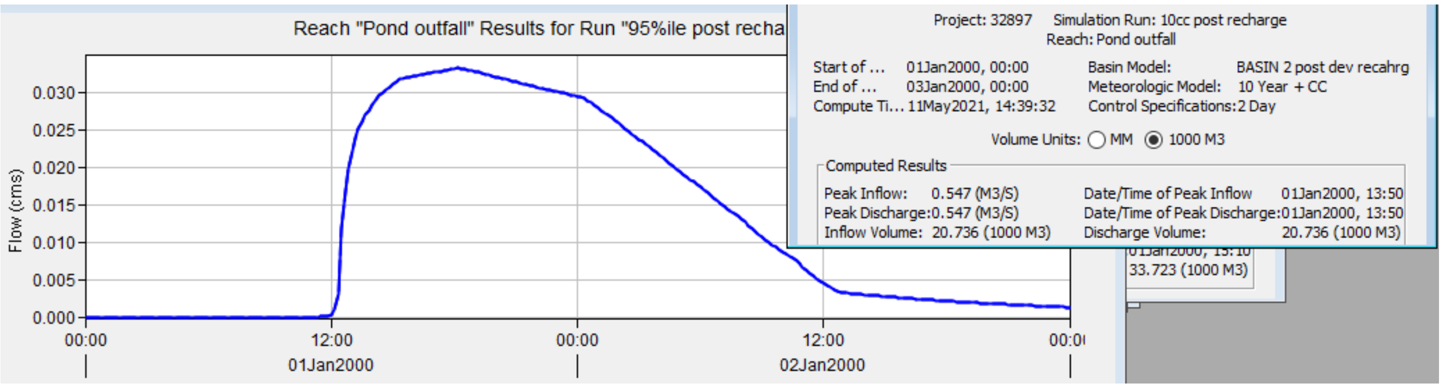
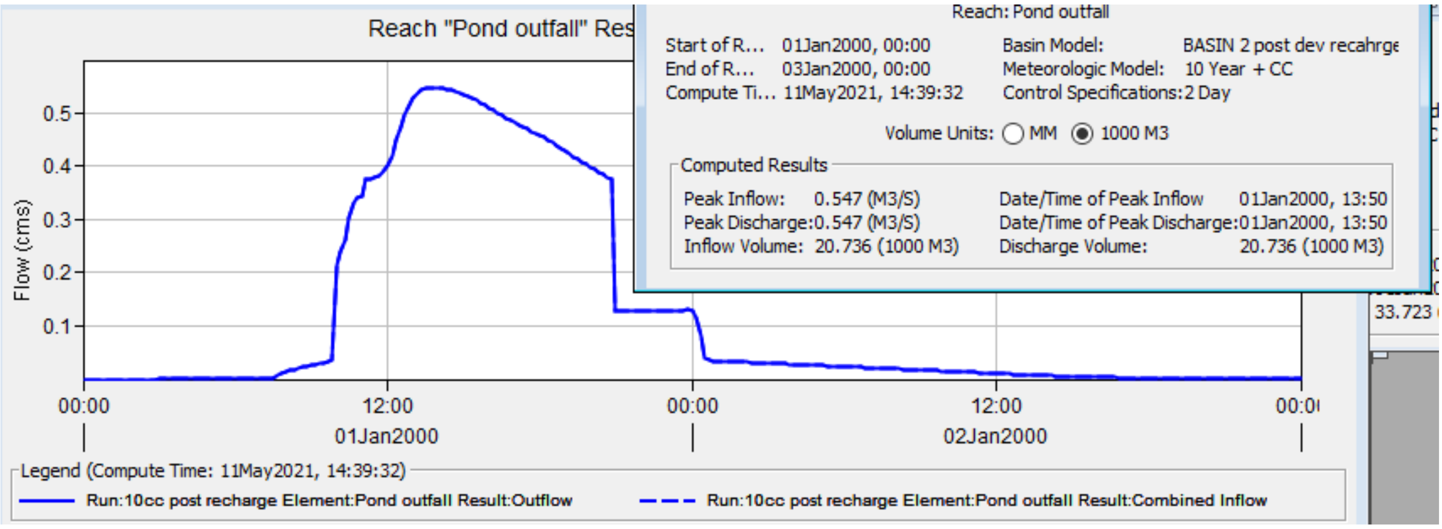
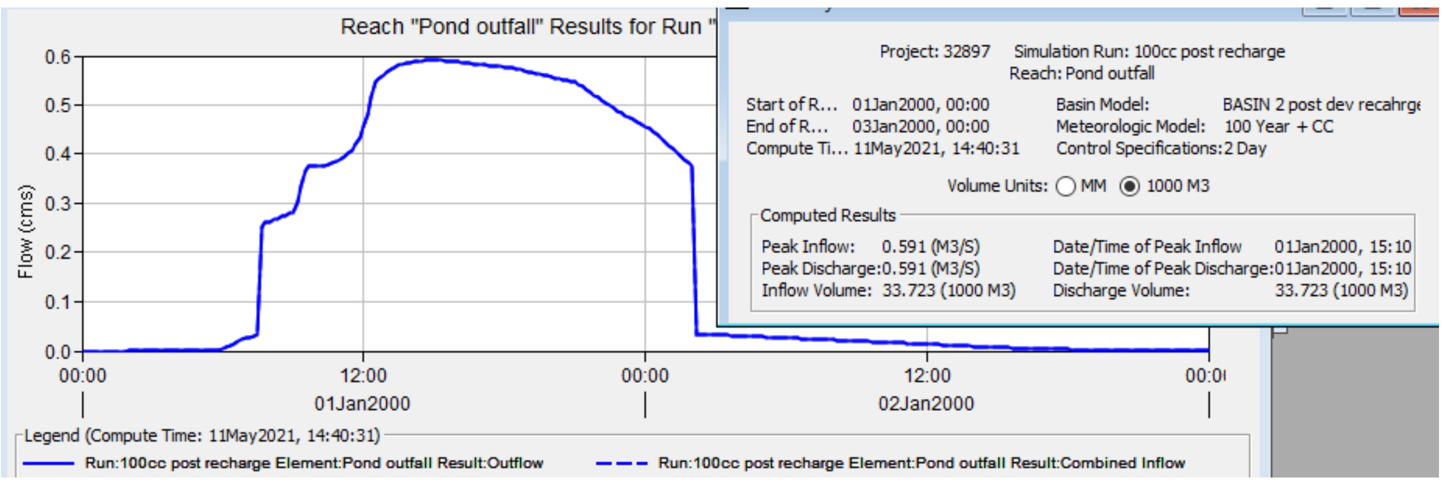
95th Percentile Storm



10% AEP Storm



1% AEP Storm



HEC-HMS MODEL RESULTS

Post development Wetland Results

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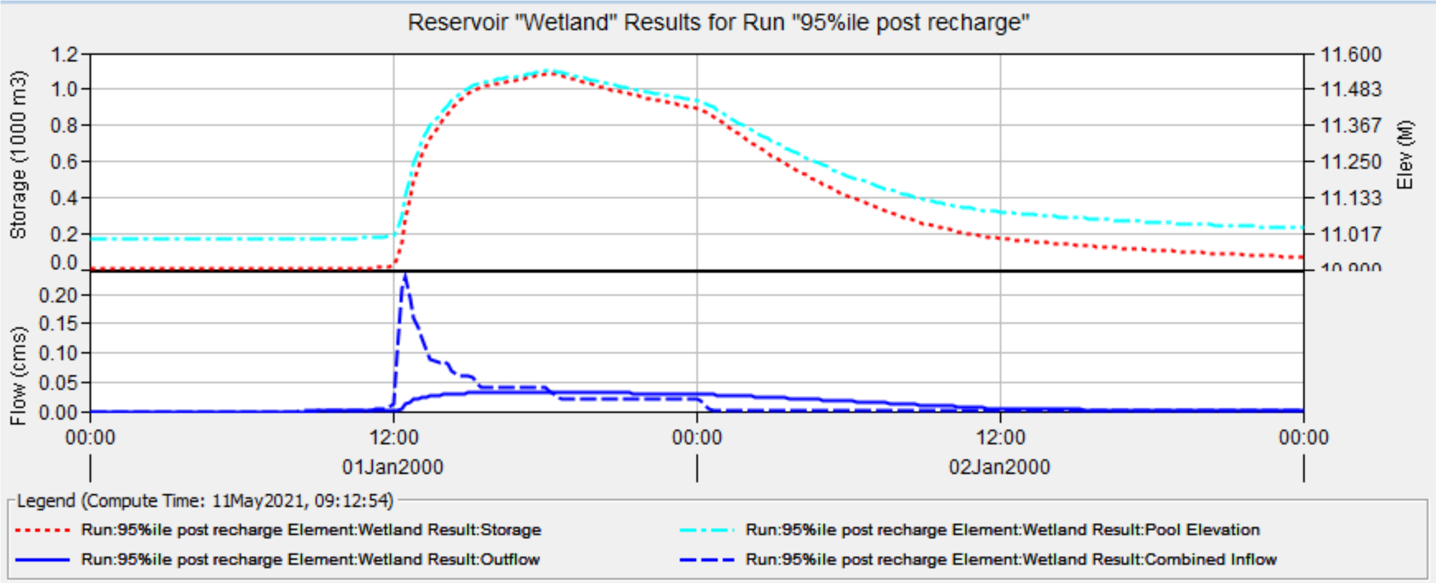
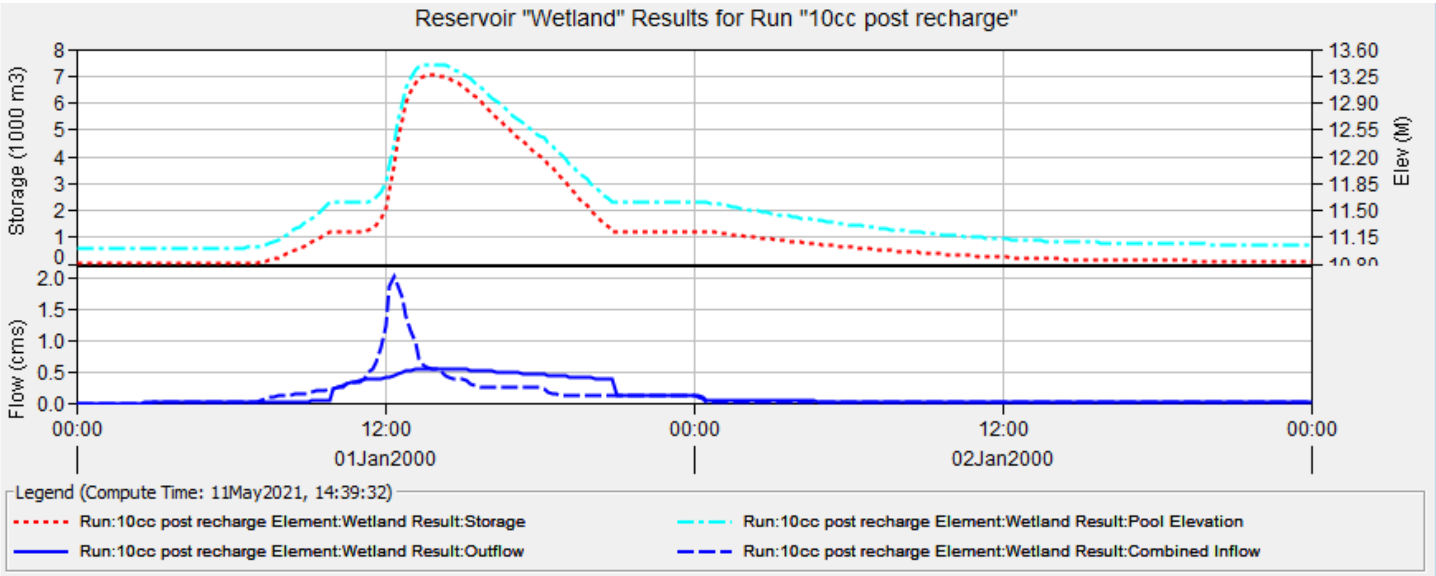
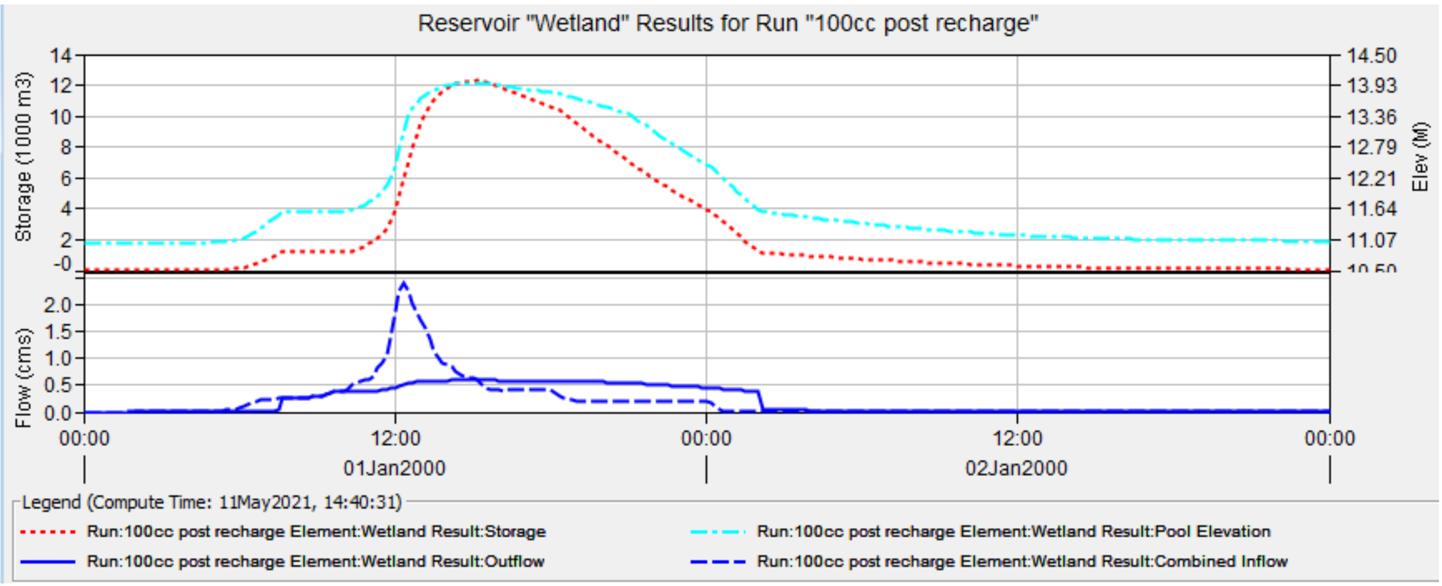
95th Percentile Storm



10% AEP Storm



1% AEP Storm



HEC-HMS MODEL RESULTS

Post development Node "Rangiwhea 1" Discharge

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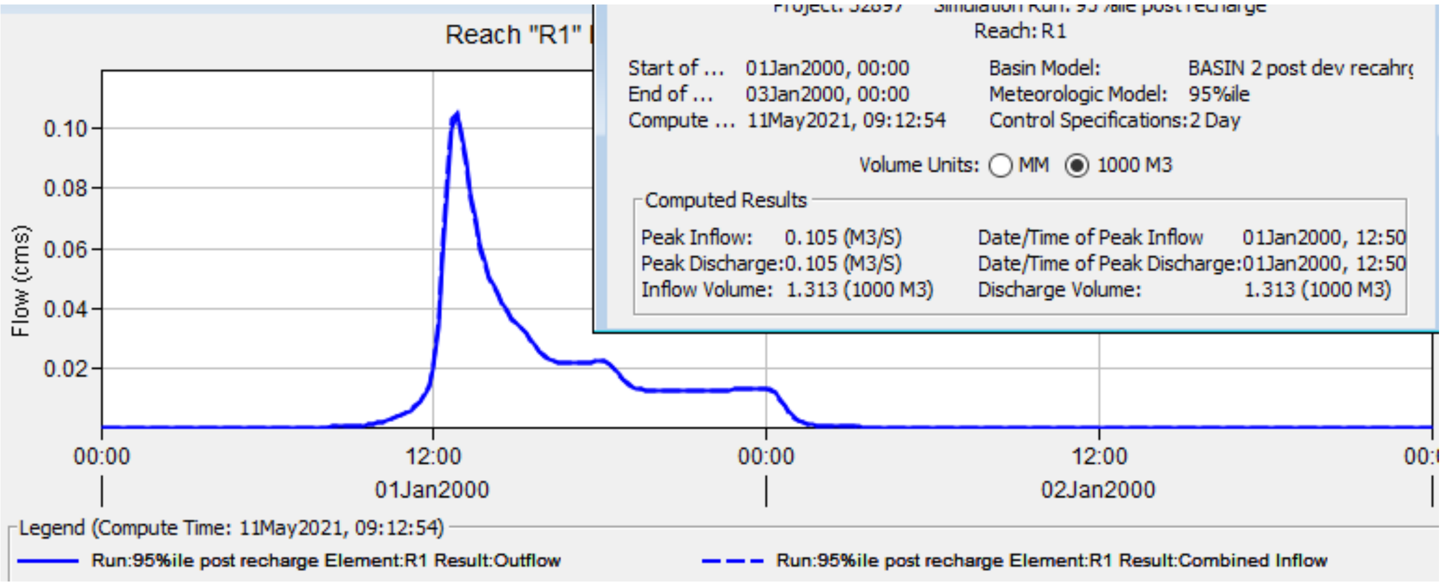
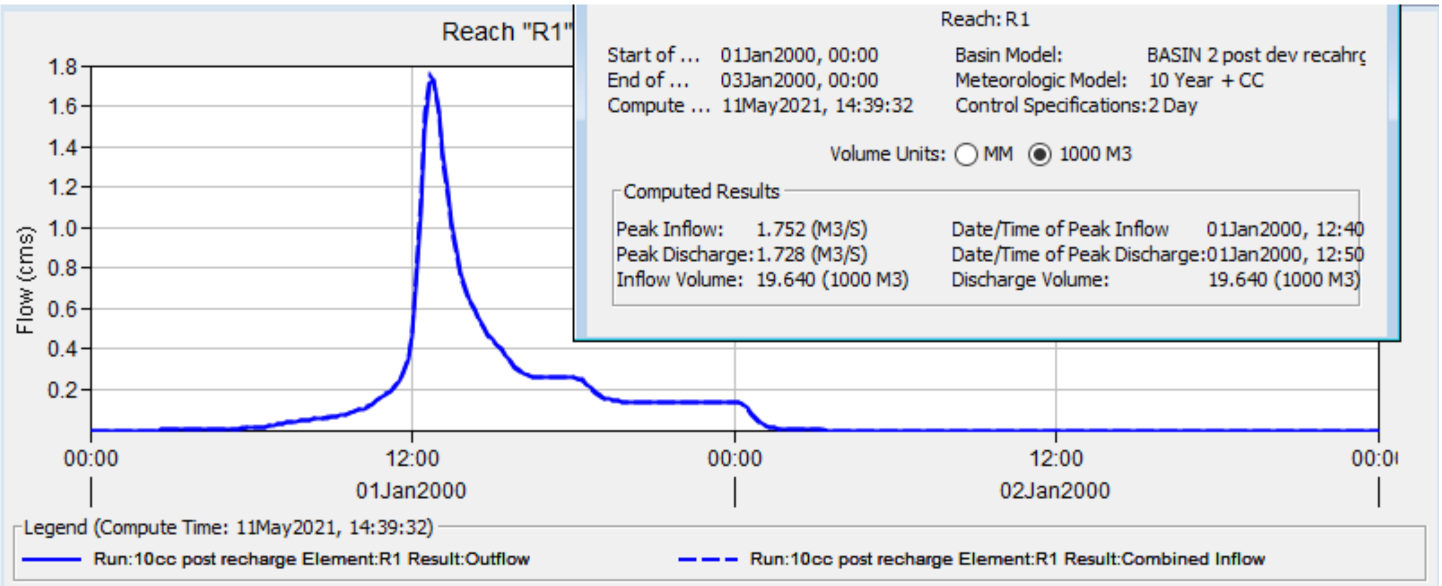
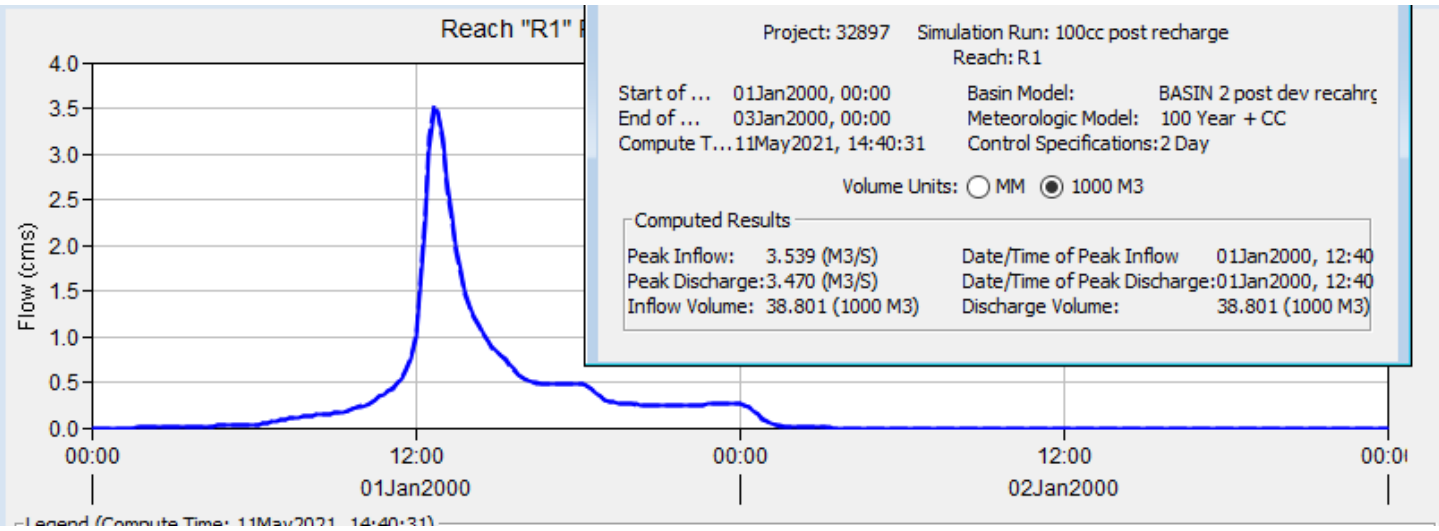
95th Percentile Storm



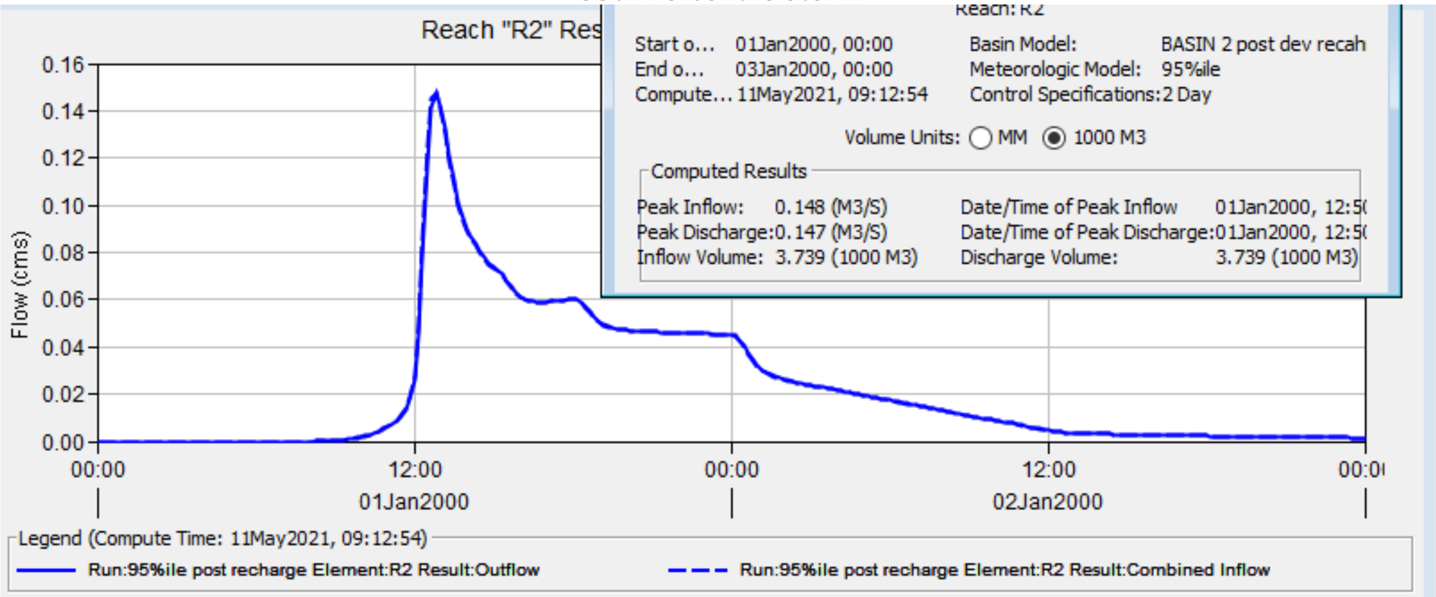
10% AEP Storm



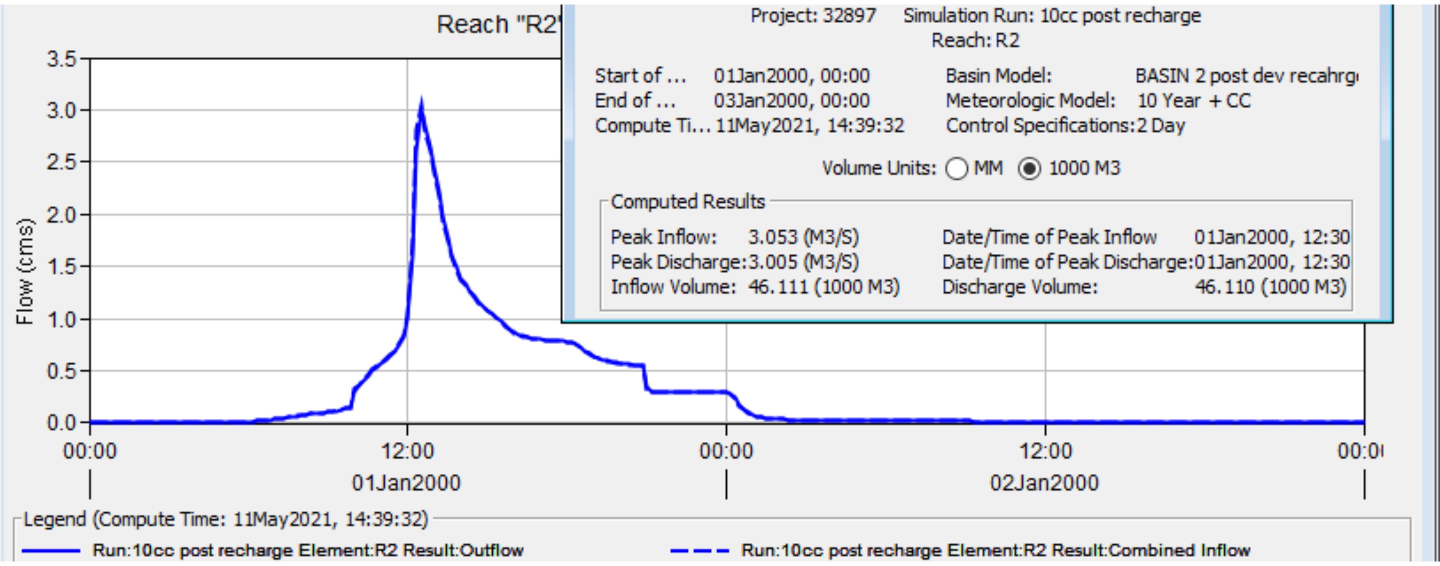
1% AEP Storm



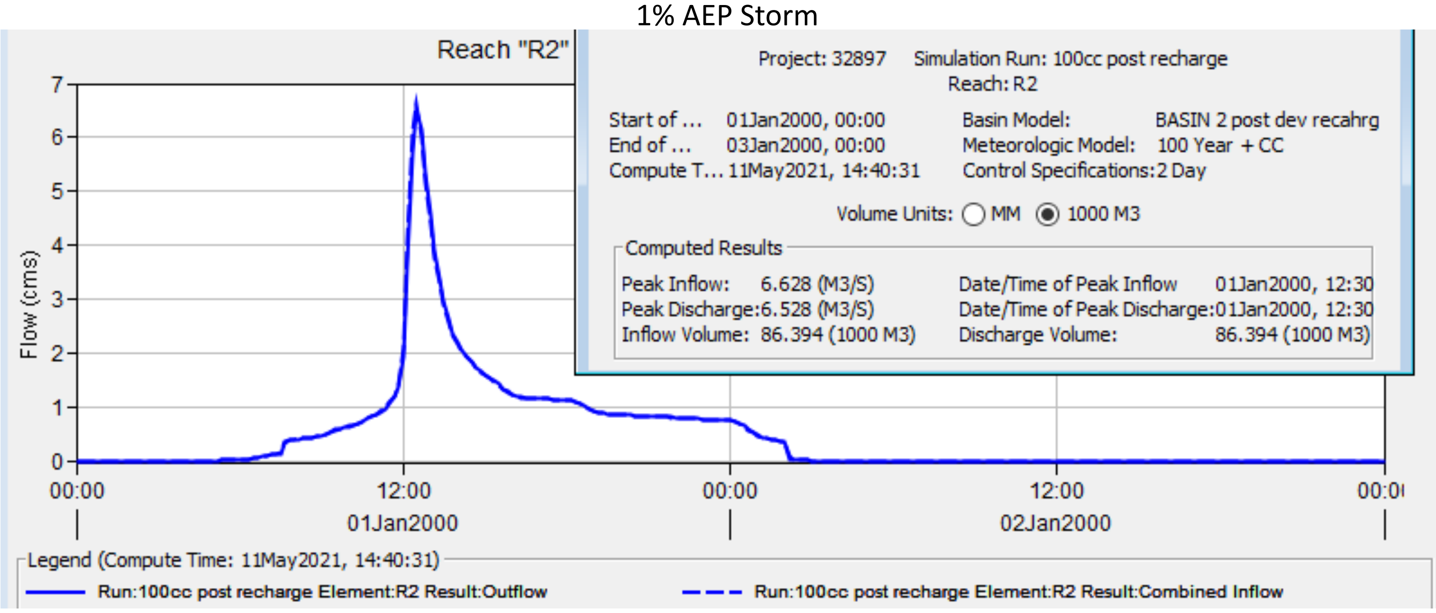
95th Percentile Storm



10% AEP Storm



1% AEP Storm



Post development Node "Rangiwhea 3" Discharge

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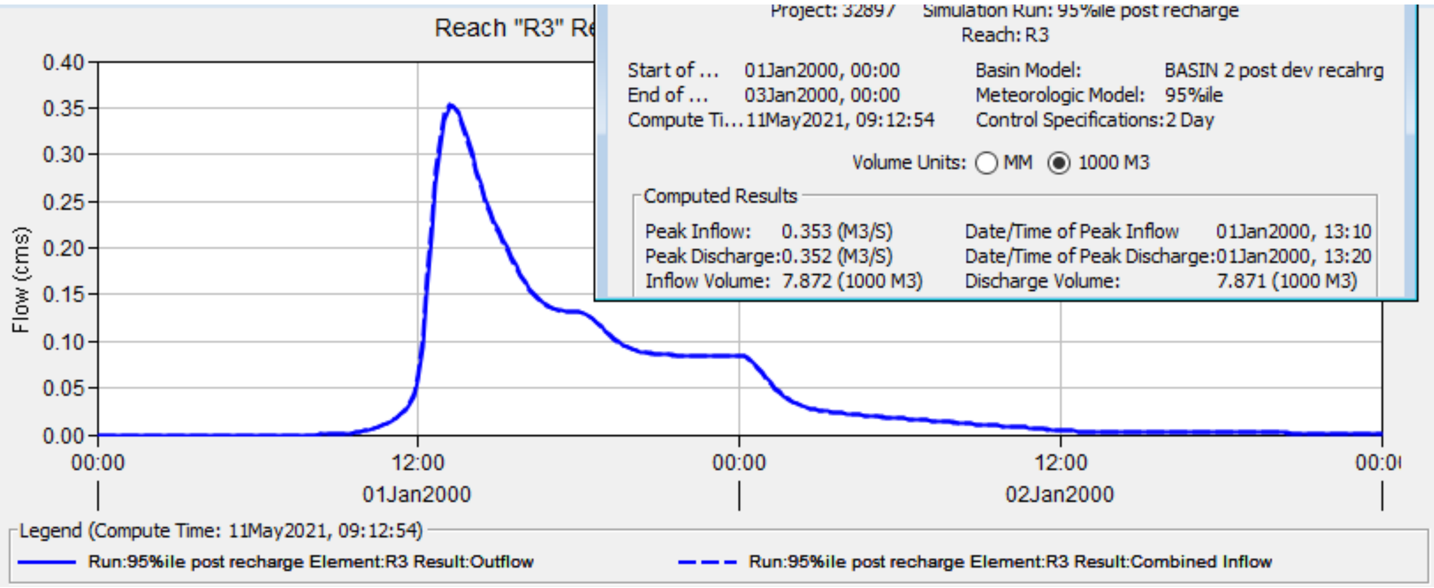
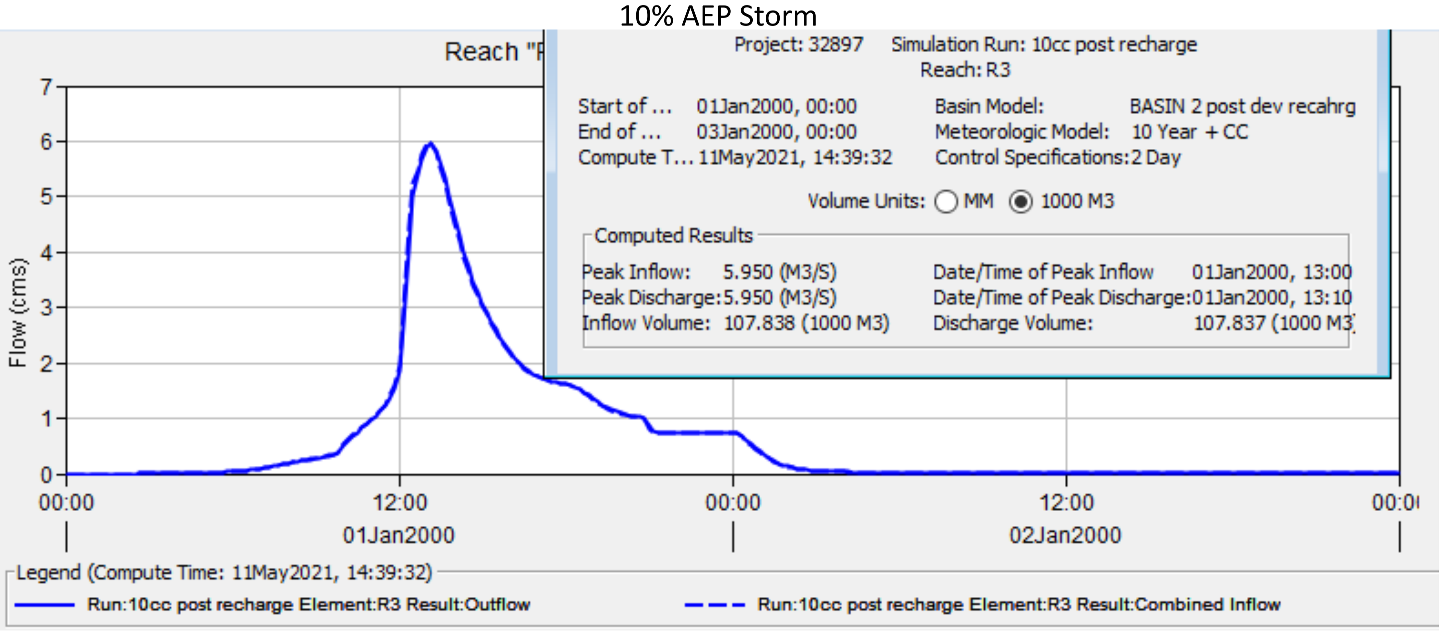
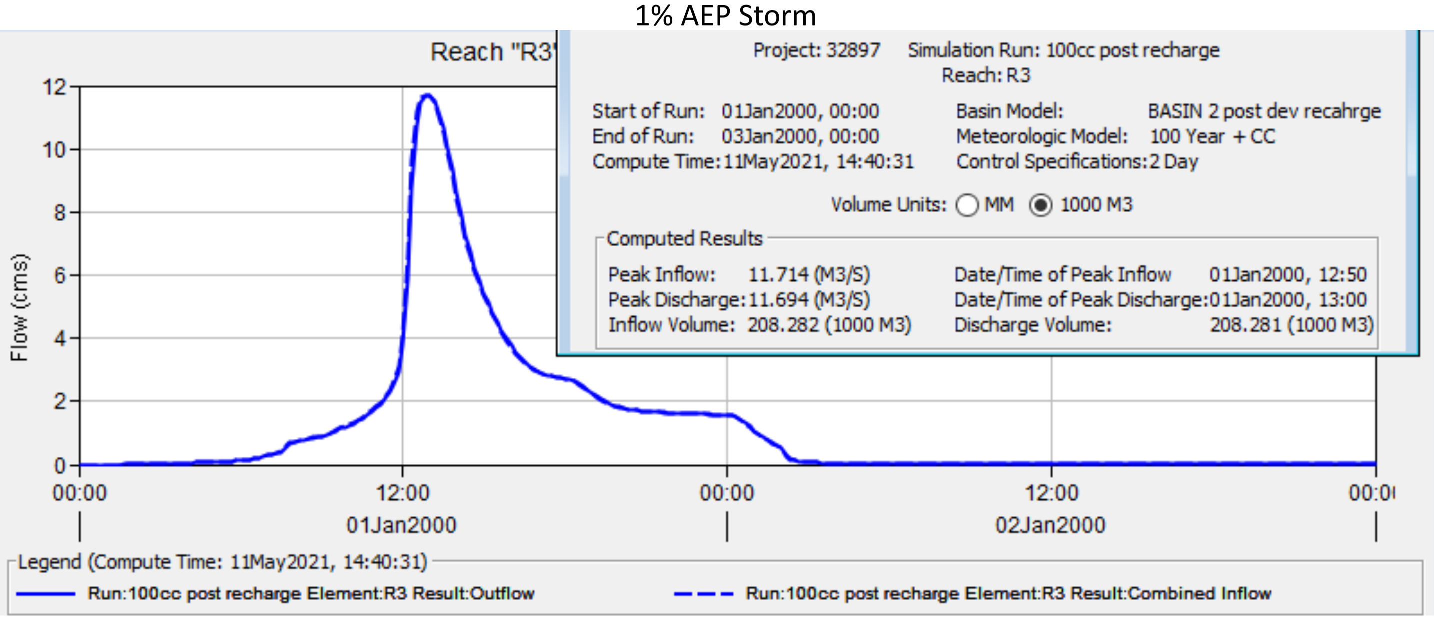
95th Percentile Storm



10% AEP Storm



1% AEP Storm



HEC-HMS MODEL RESULTS

Post development Node "Rangiwhea 4" Discharge

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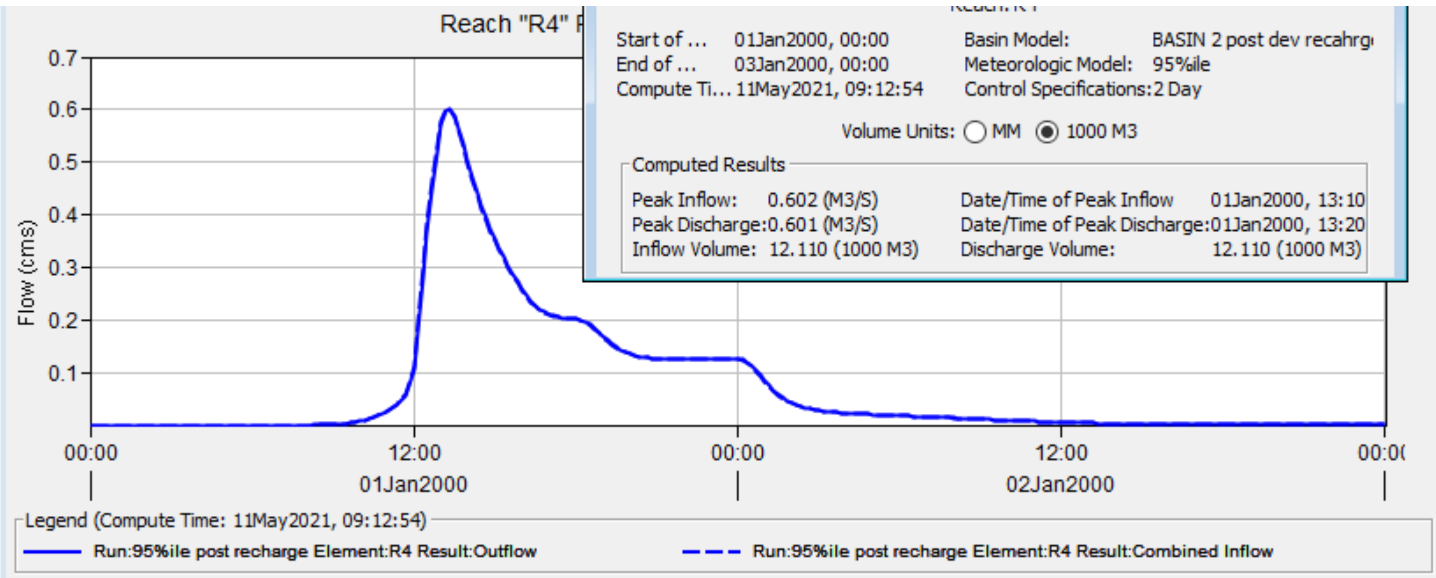
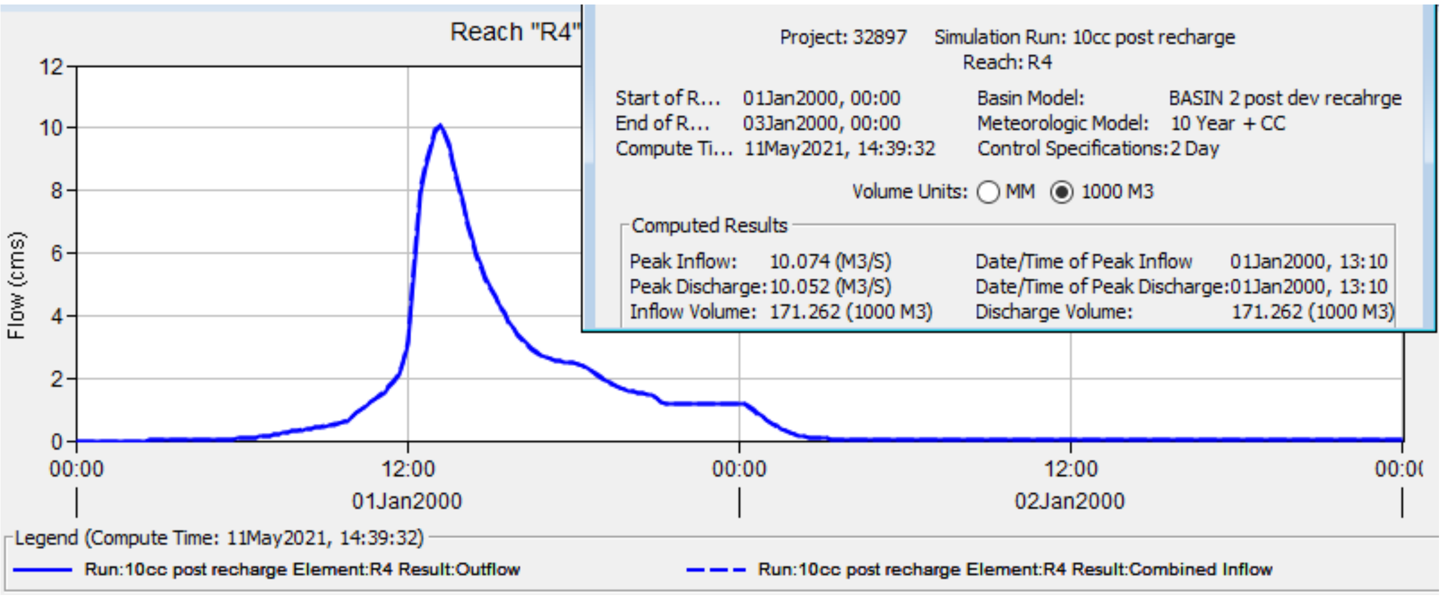
95th Percentile Storm



10% AEP Storm



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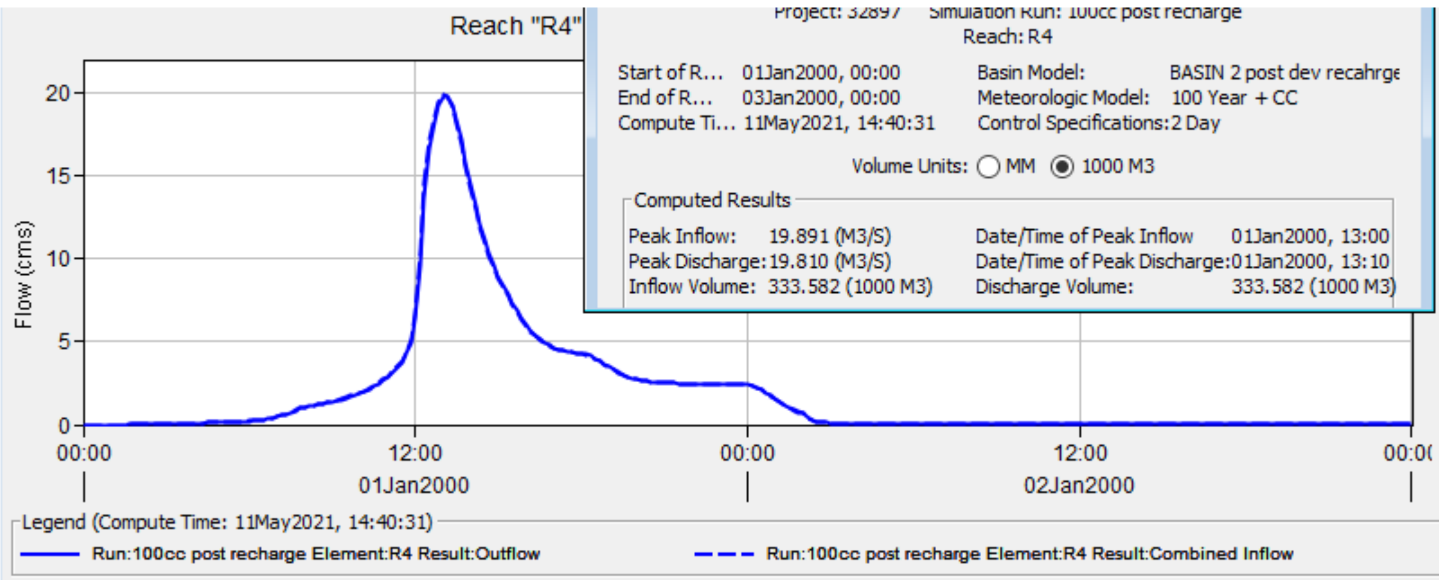
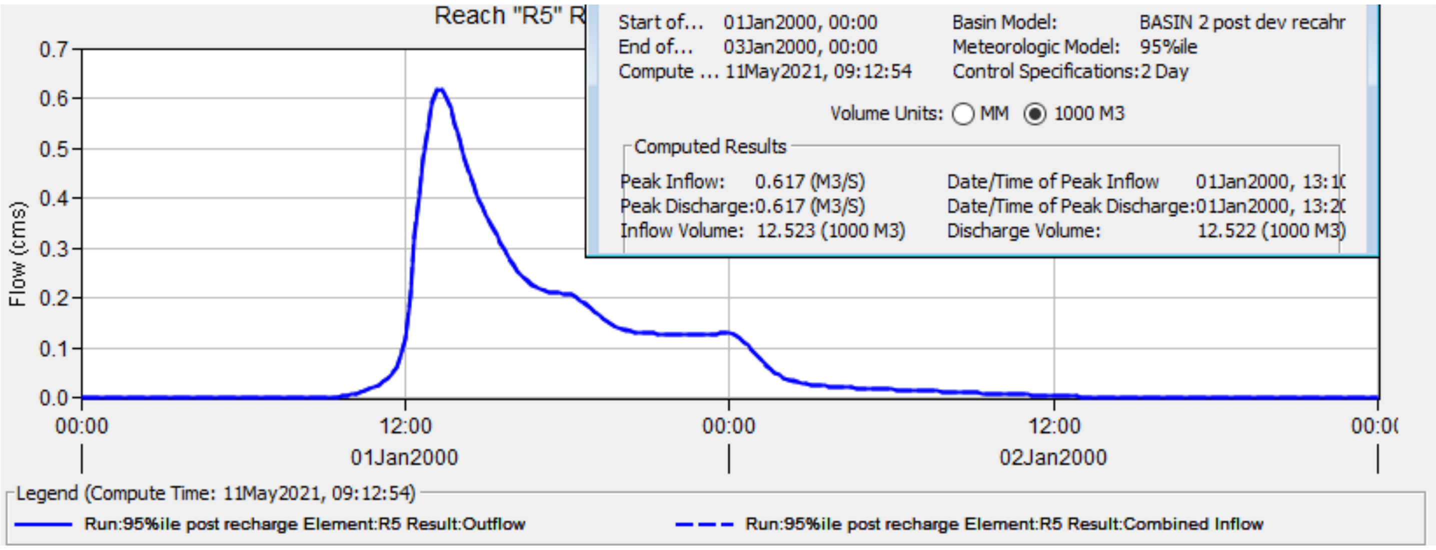


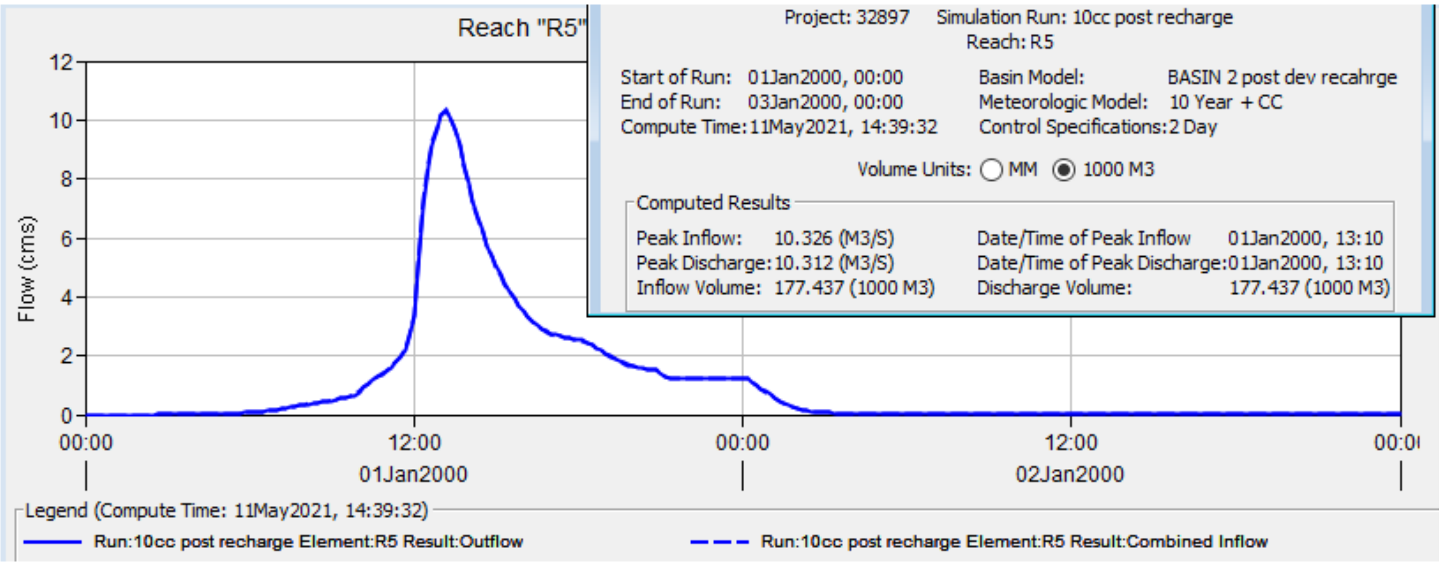
HEC-HMS MODEL RESULTS

Post development Node "Rangiwhea 5" Discharge

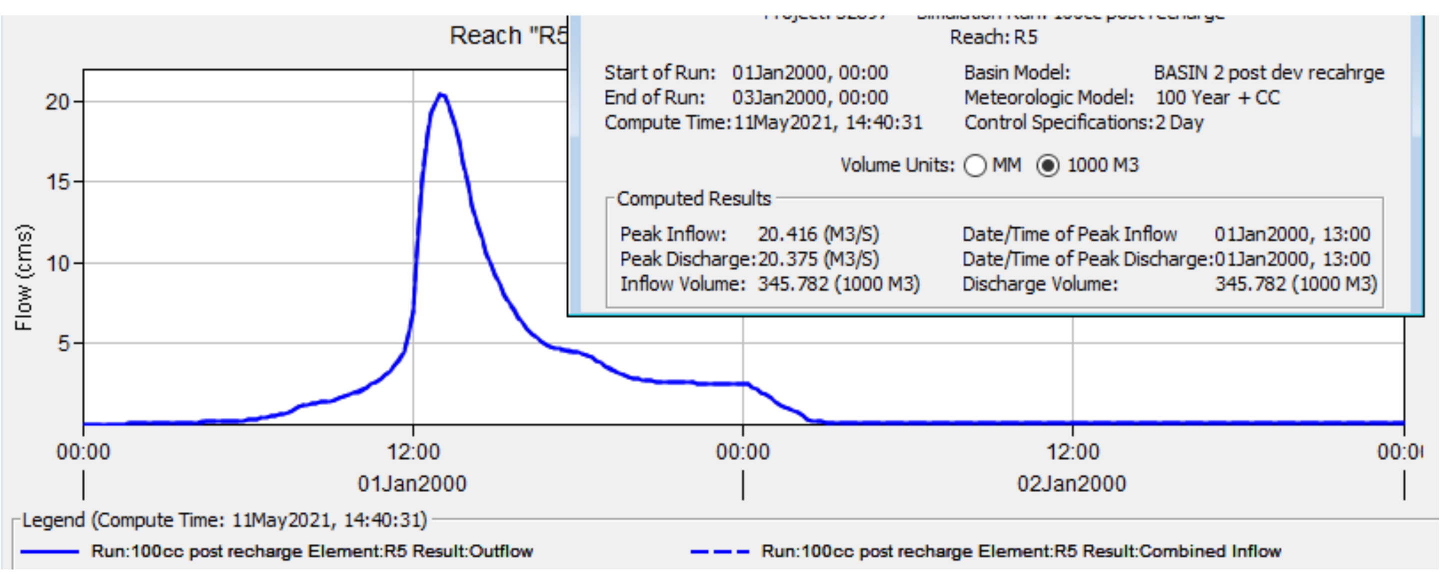
95th Percentile Storm



10% AEP Storm



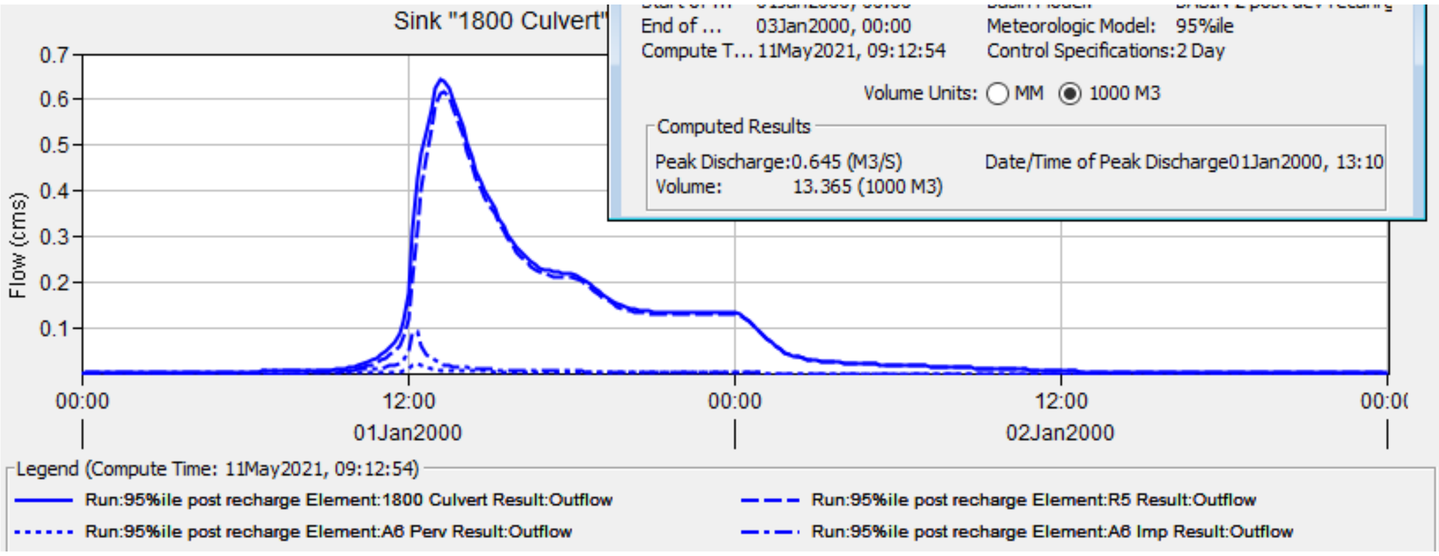
1% AEP Storm



HEC-HMS MODEL RESULTS

Post development Node "King Street Culvert" Discharge

95th Percentile Storm



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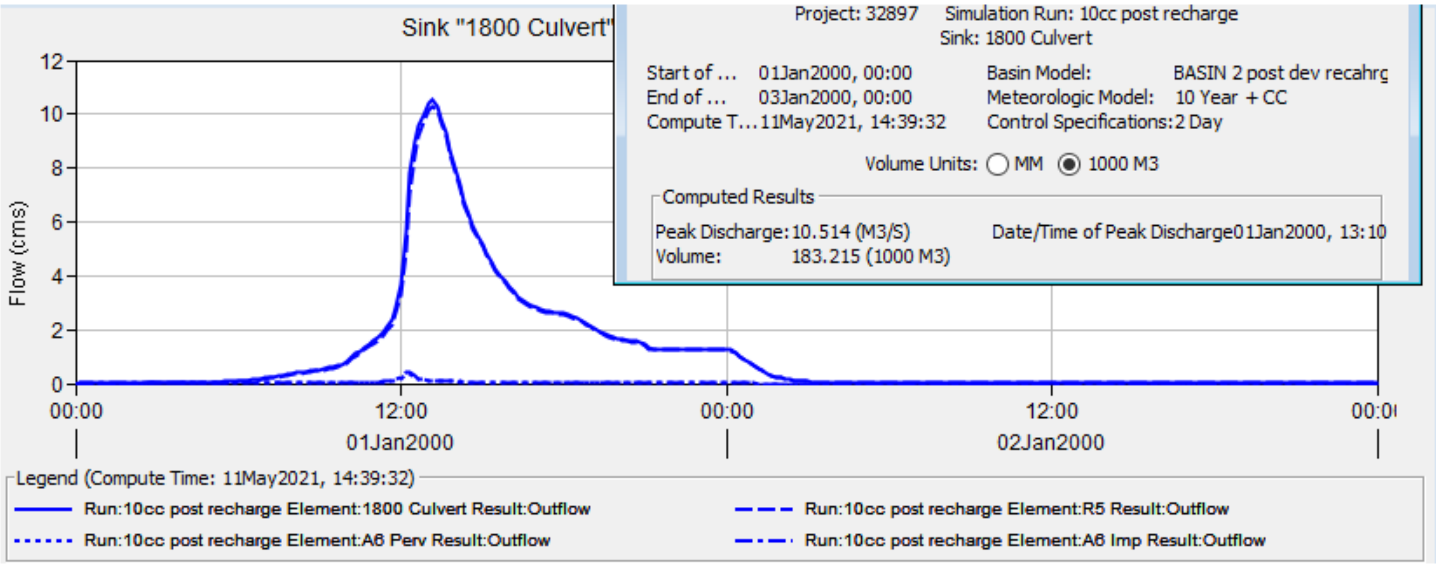

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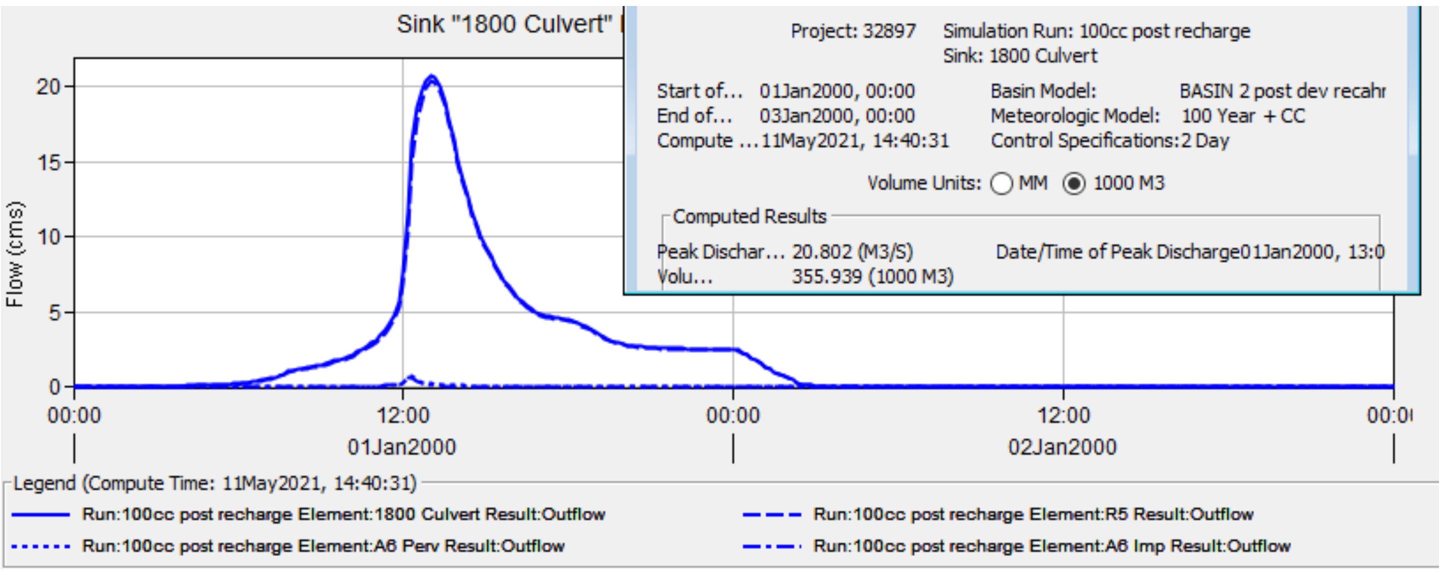

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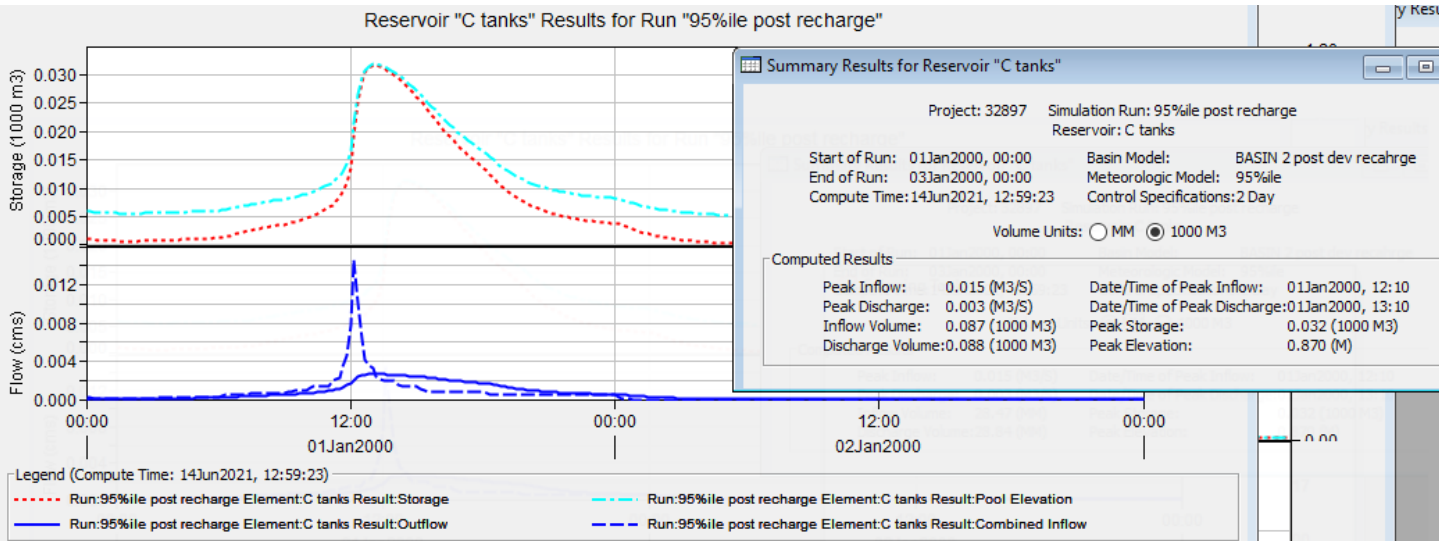

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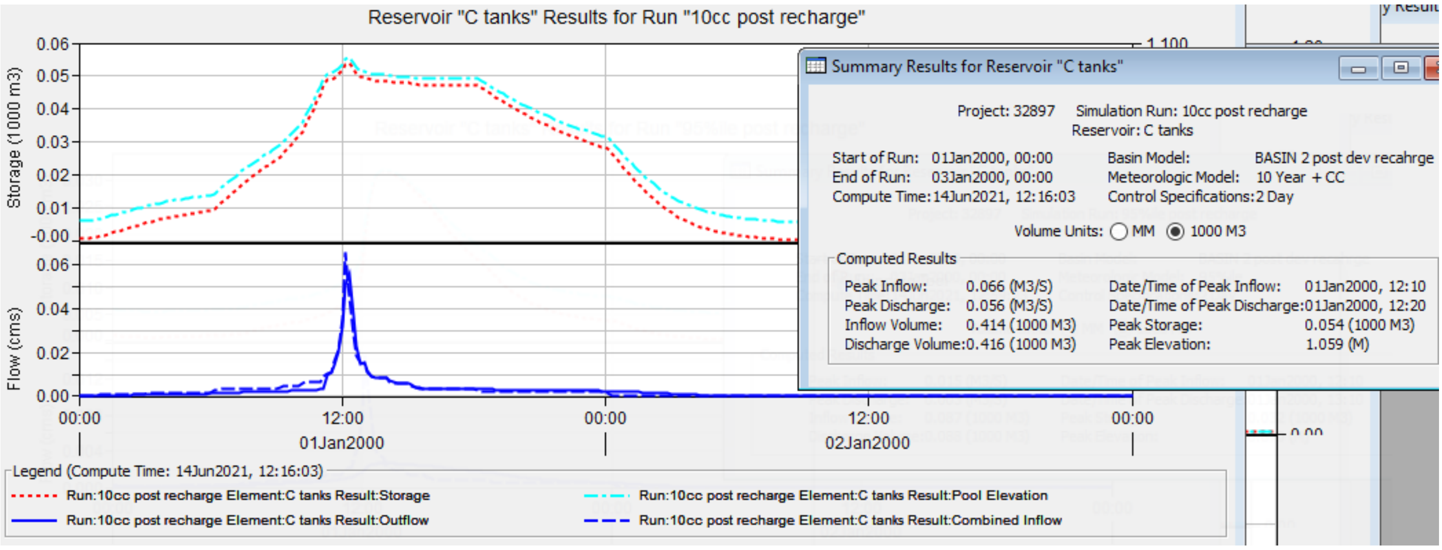
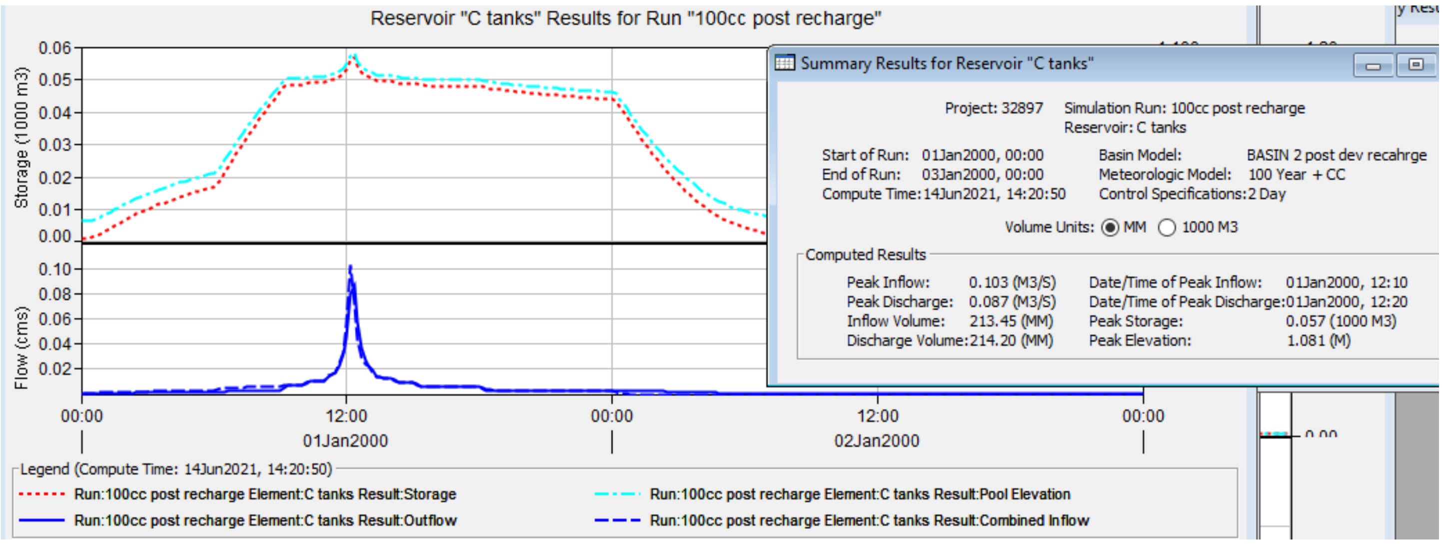


1% AEP Storm



HEC-HMS MODEL RESULTS

Post development Catchment C Detention Storage

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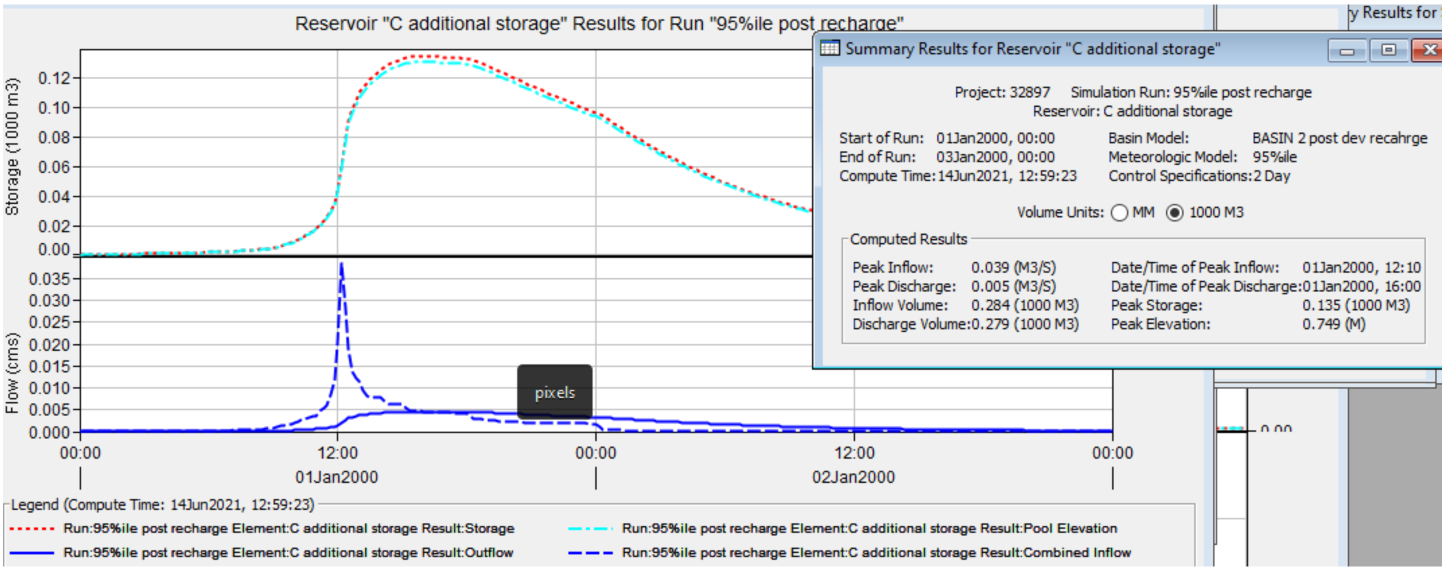
95th Percentile Storm



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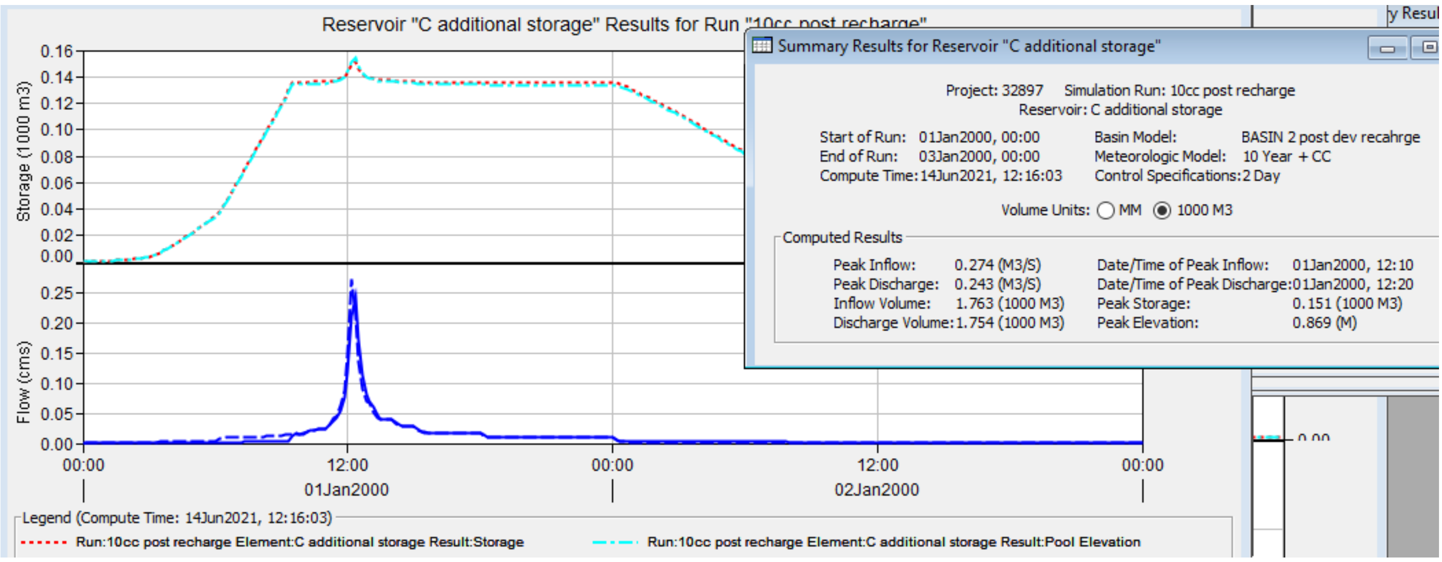

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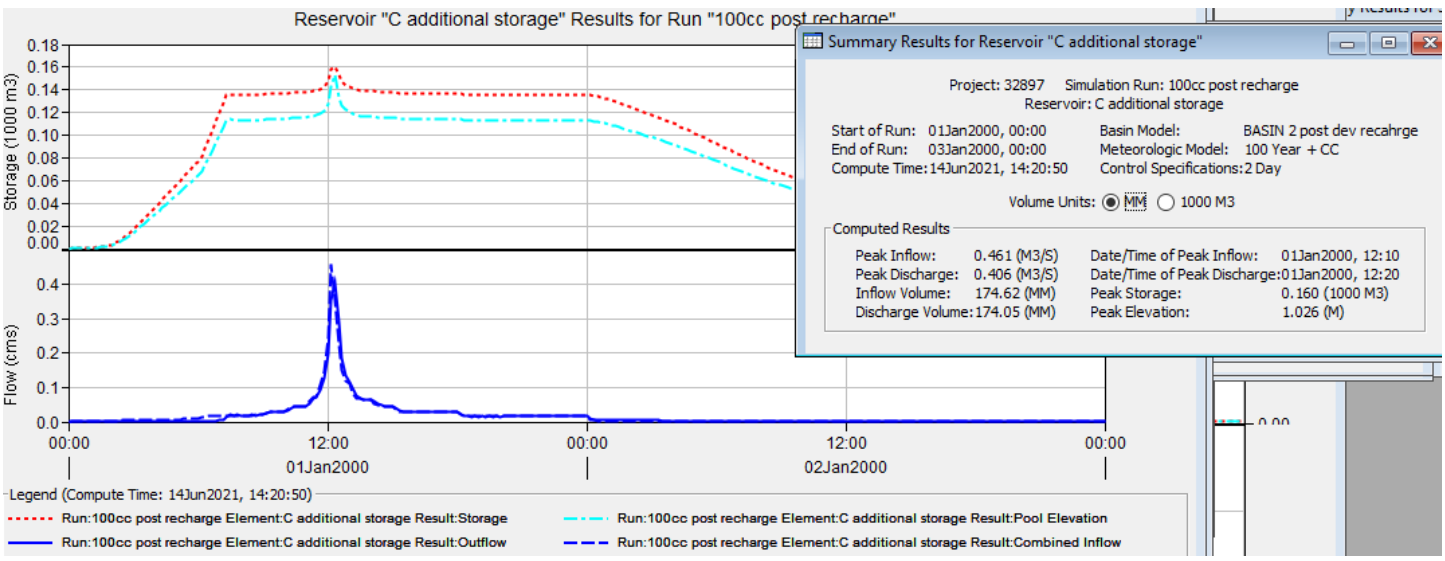
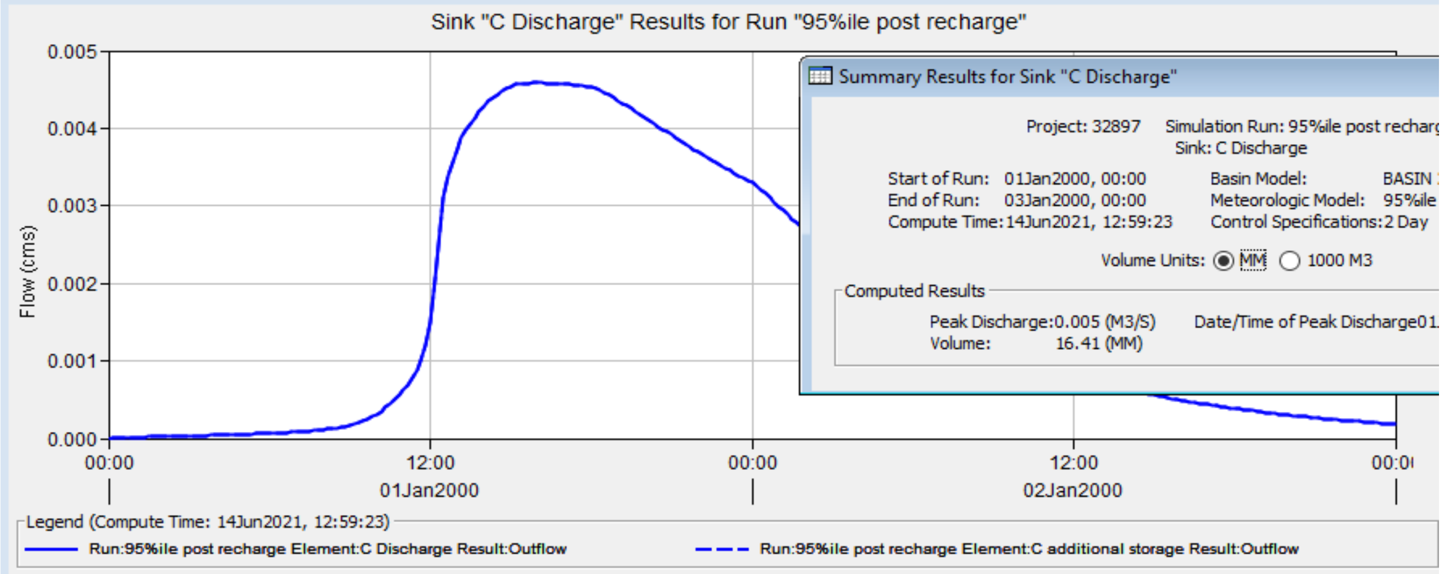


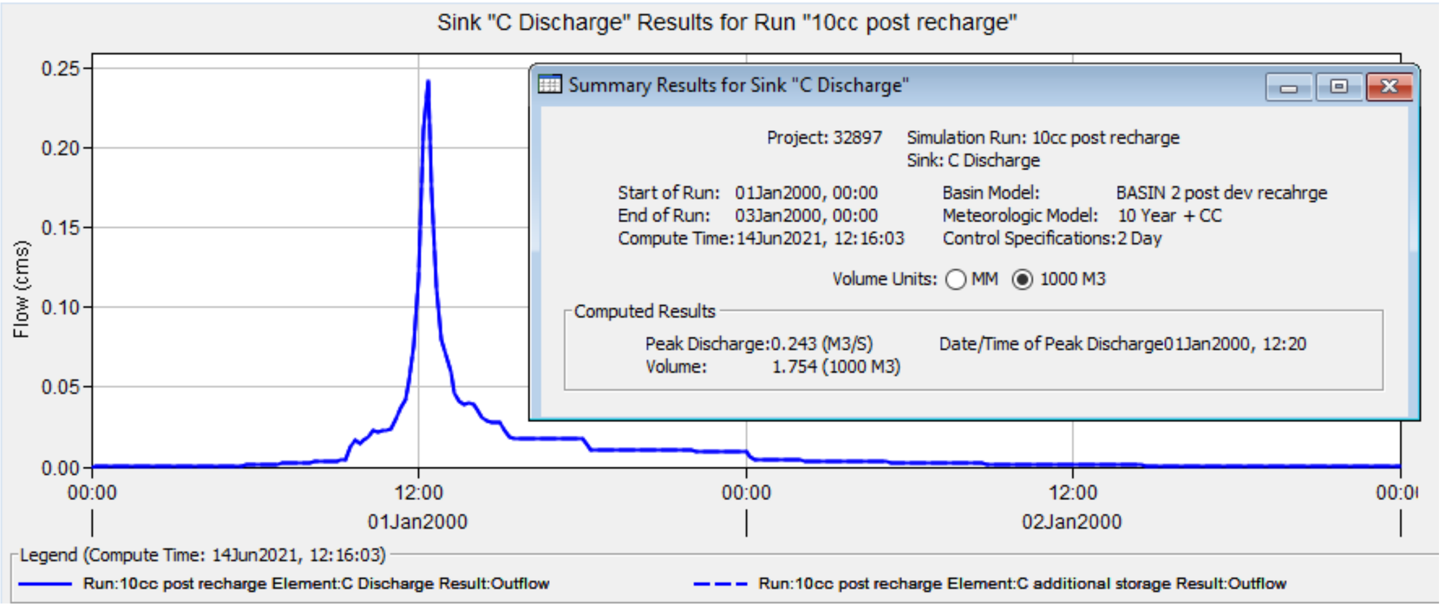
HEC-HMS MODEL RESULTS

Post development Node "C" discharge

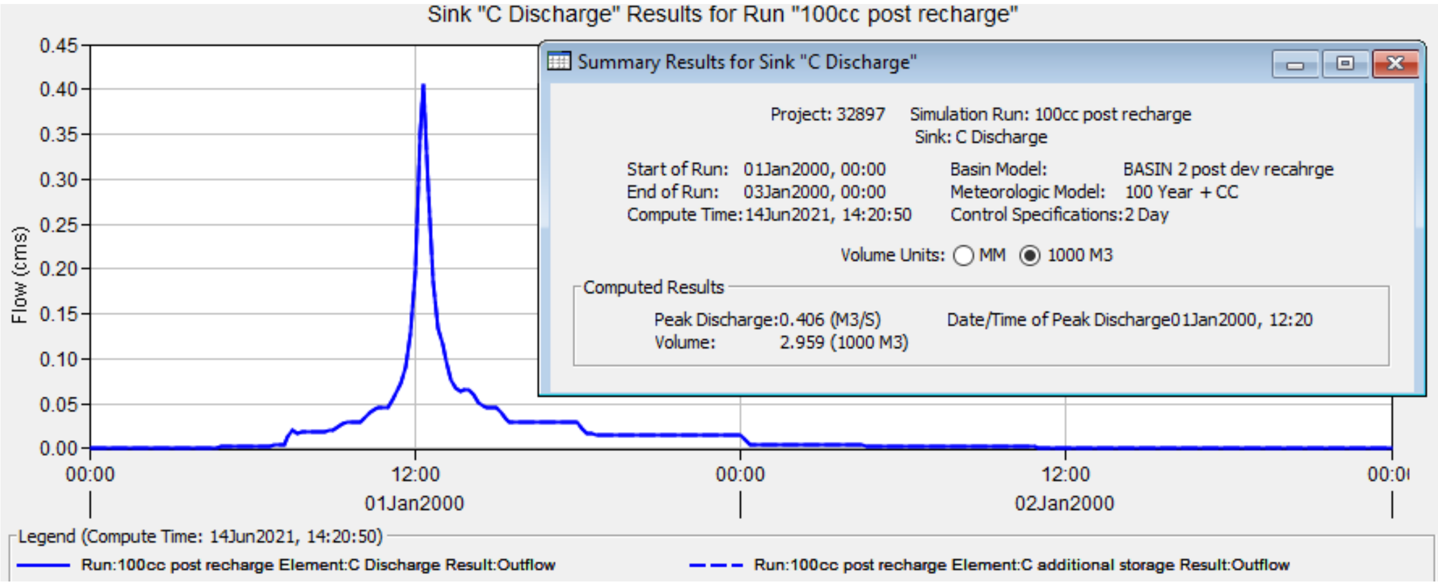
95th Percentile Storm



10% AEP Storm



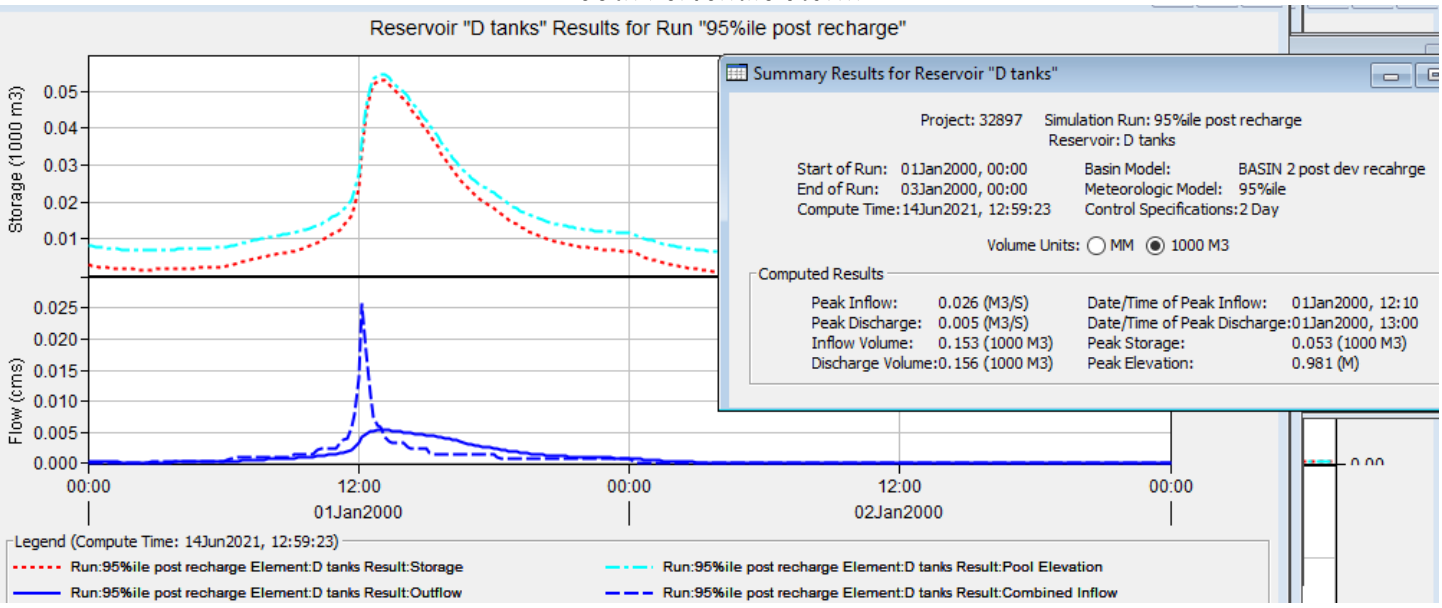
1% AEP Storm



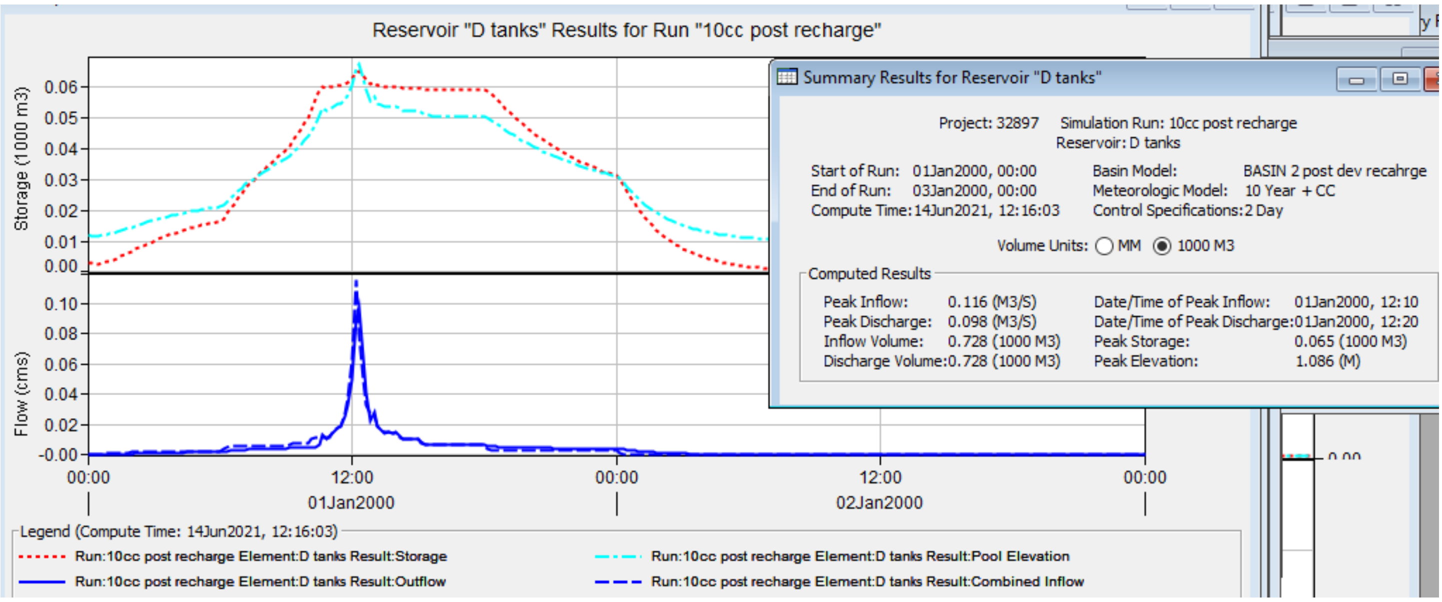
HEC-HMS MODEL RESULTS

Post development Catchment D Storage Tanks

95th Percentile Storm



10% AEP Storm



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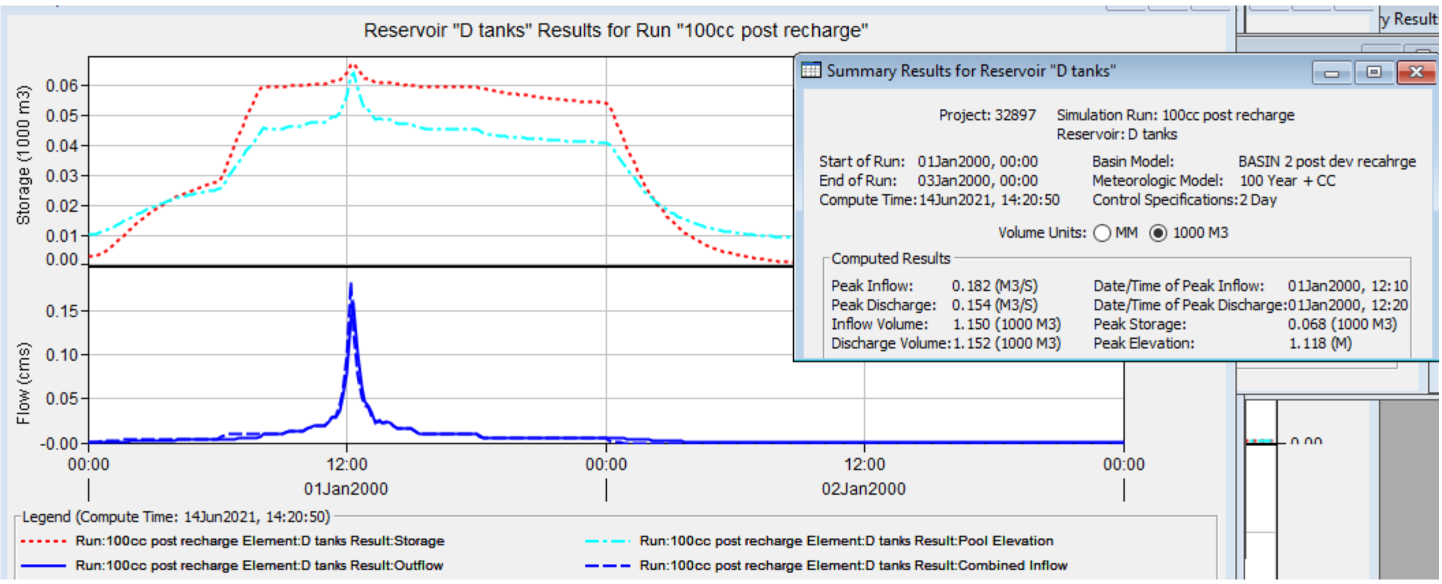

HEC-HMS MODEL RESULTS

Post development Catchment D Detention Storage

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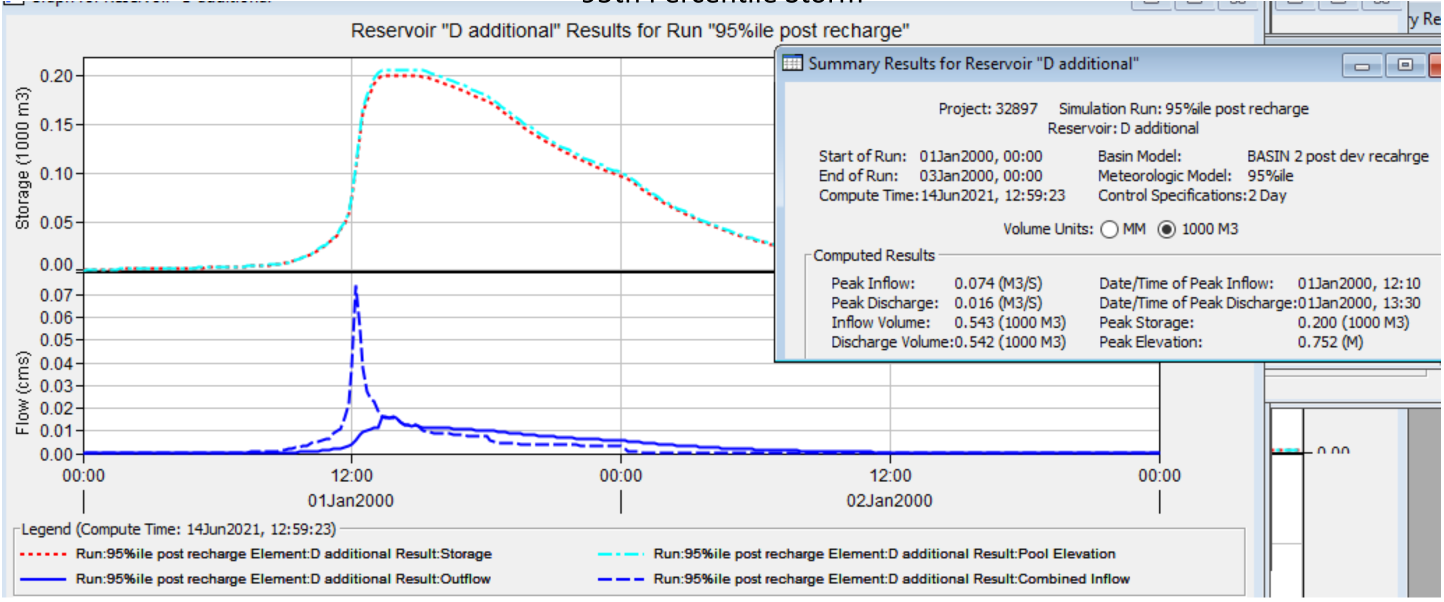
95th Percentile Storm



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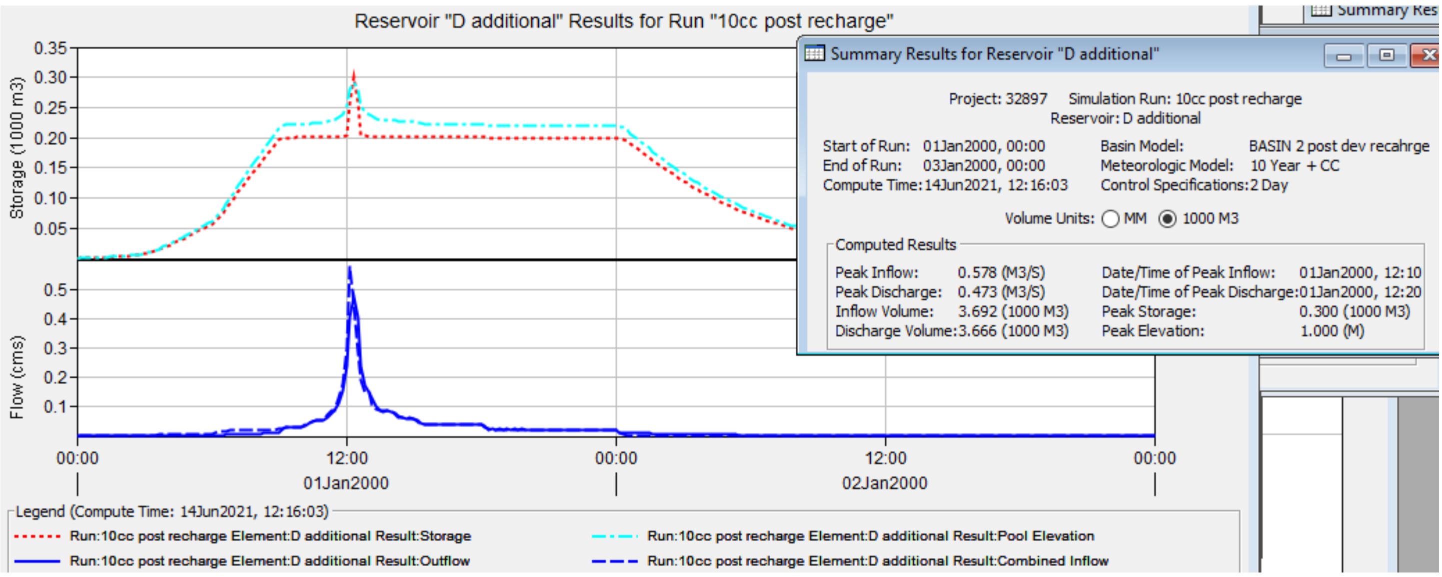

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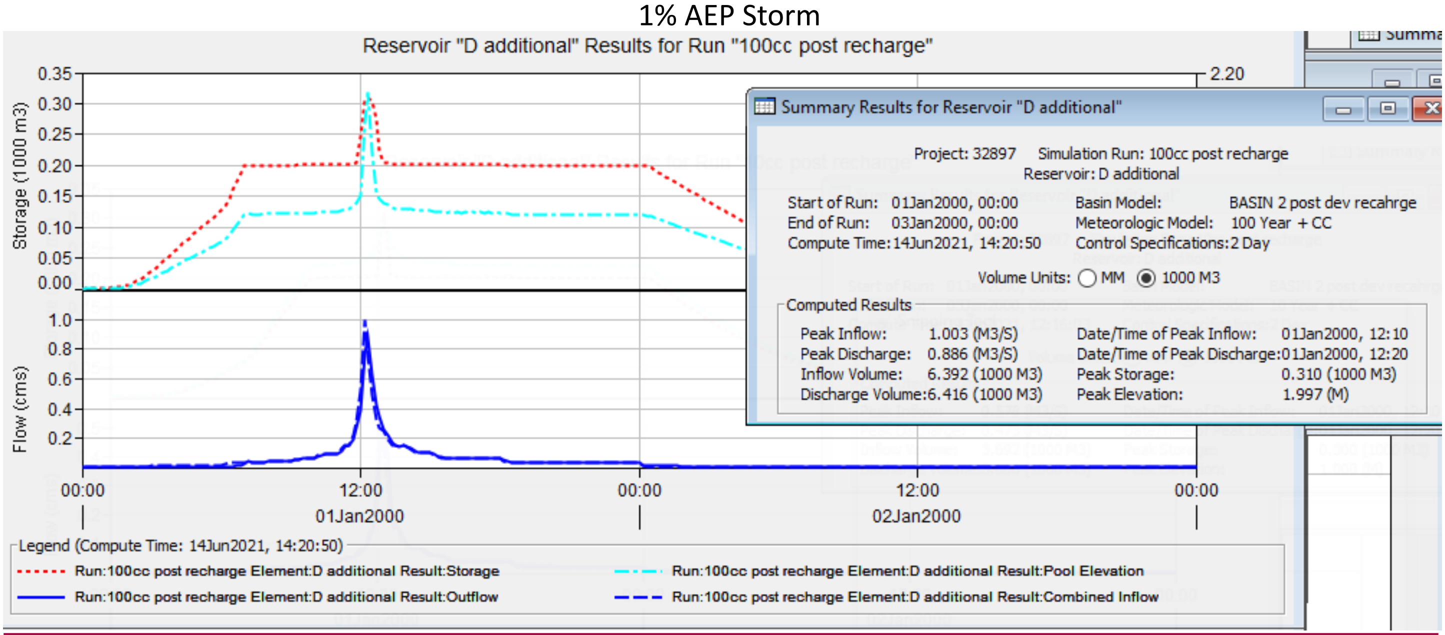

HEC-HMS MODEL RESULTS

Post development Node "D" Discharge

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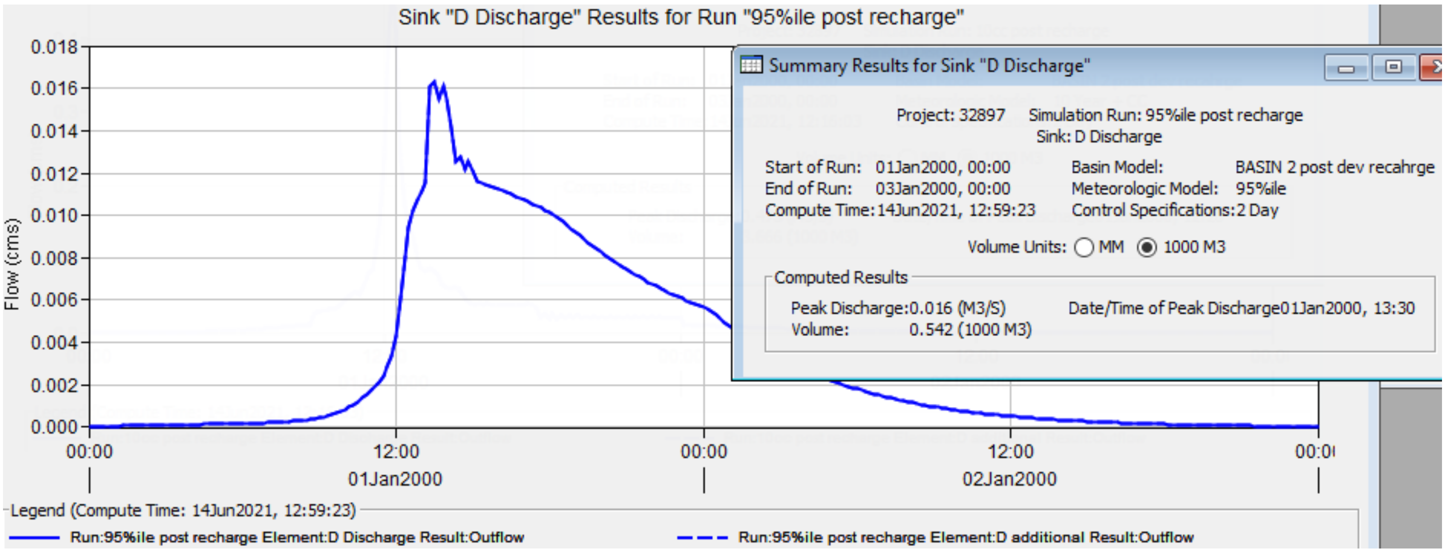
95th Percentile Storm



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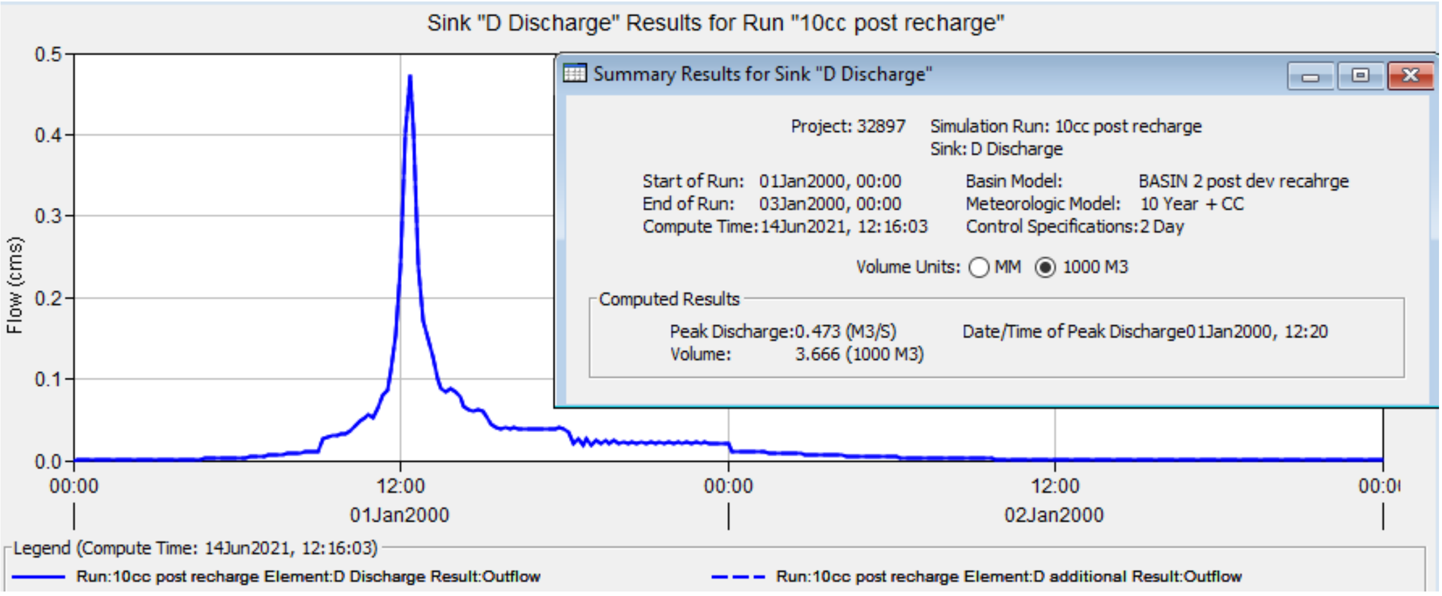

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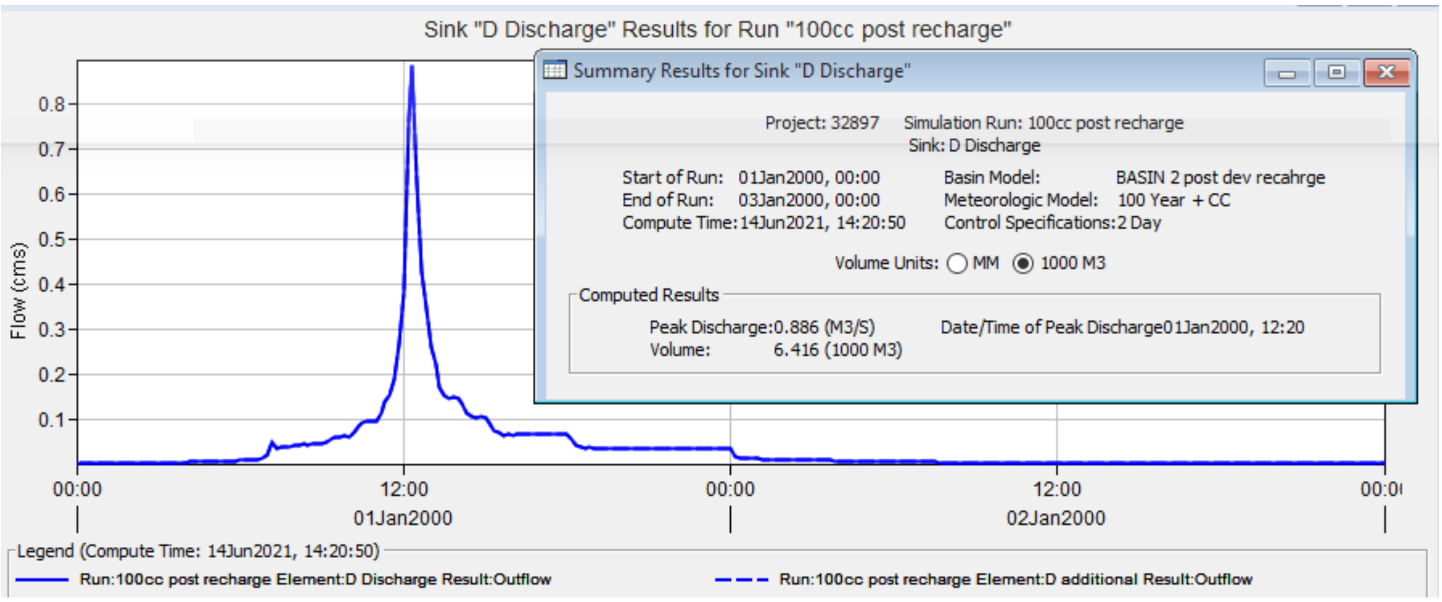
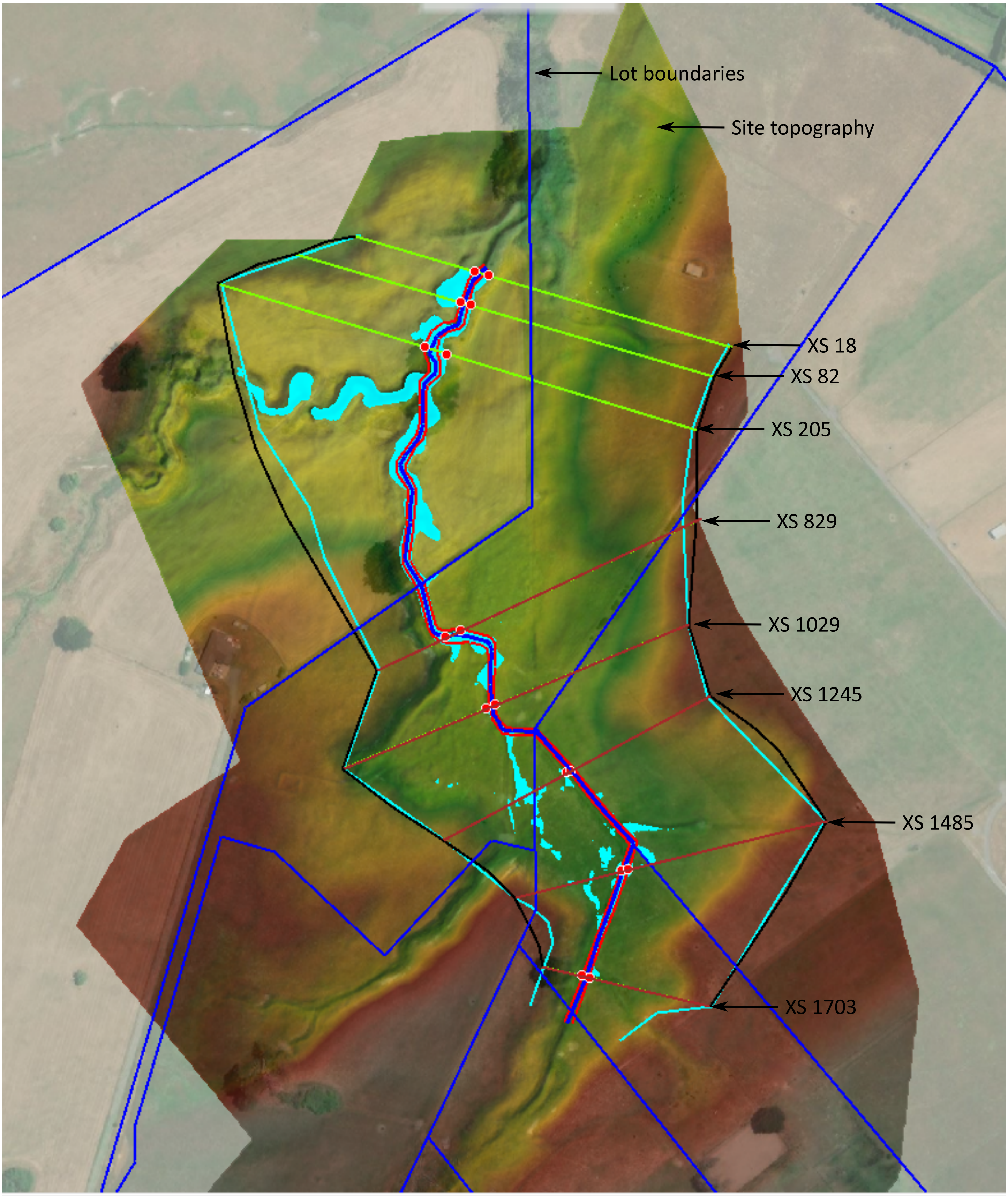


Appendix A3

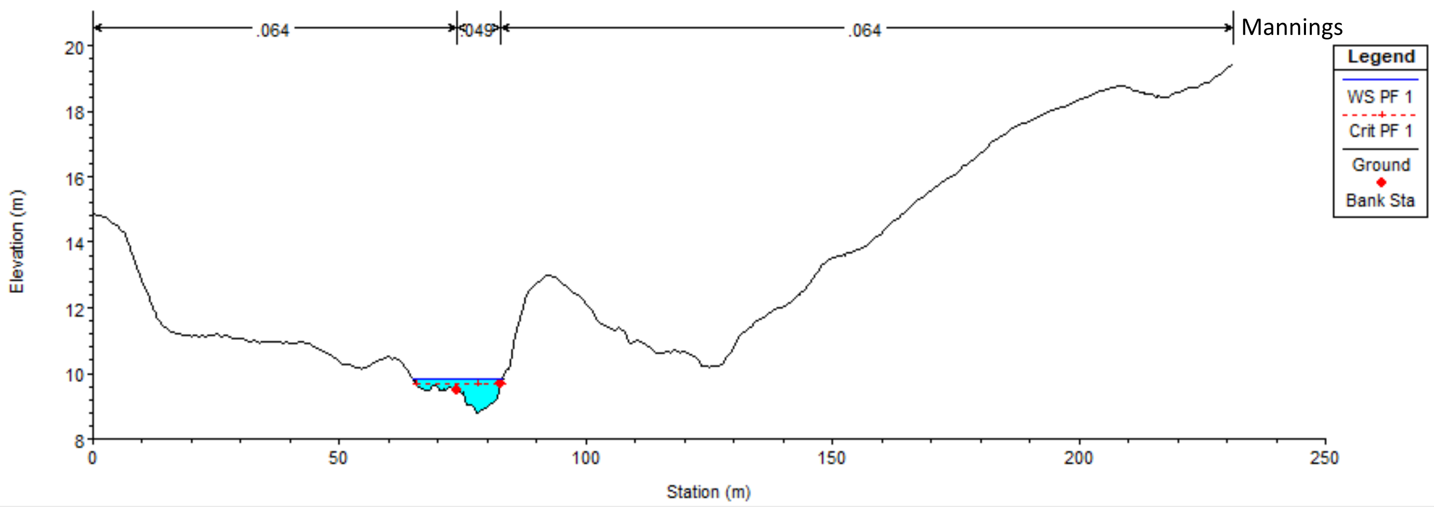
HEC-RAS Modelling Results of Rangiwhea Stream

HEC-RAS MODEL RESULTS

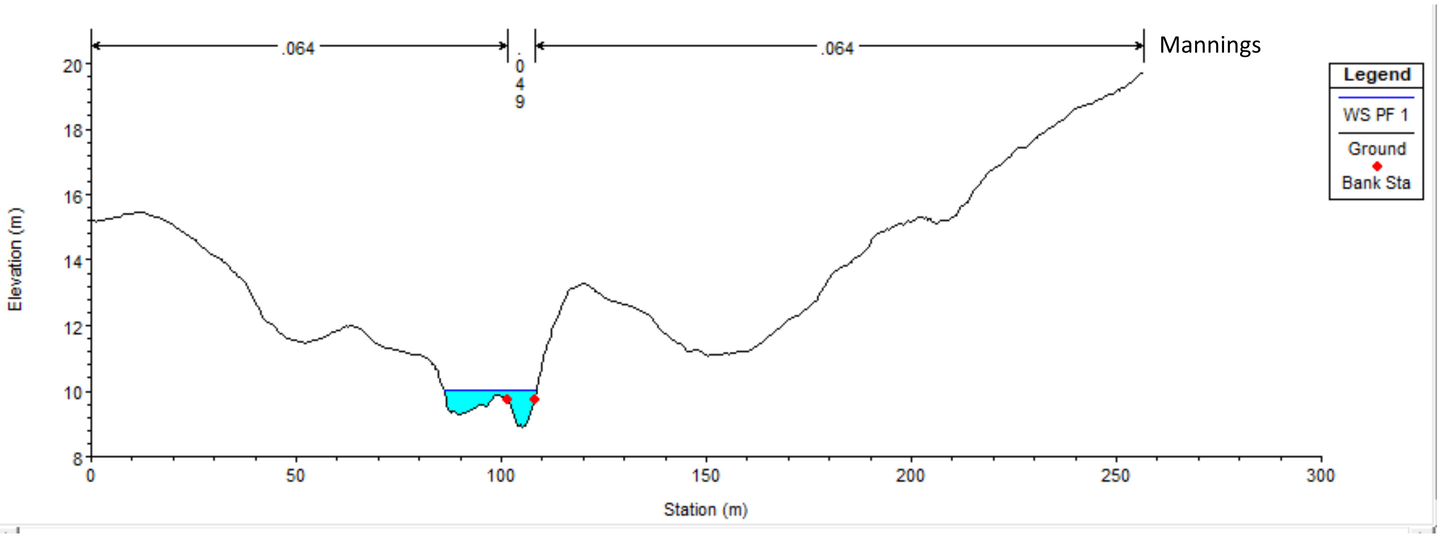
Model Setup



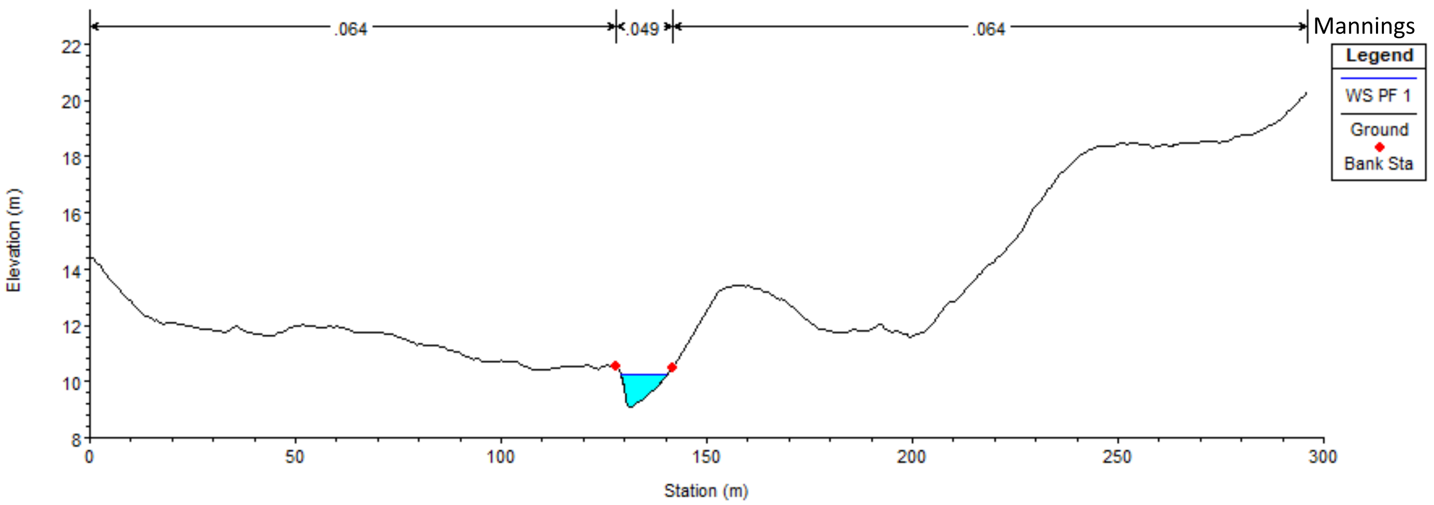
XS 18



XS 82



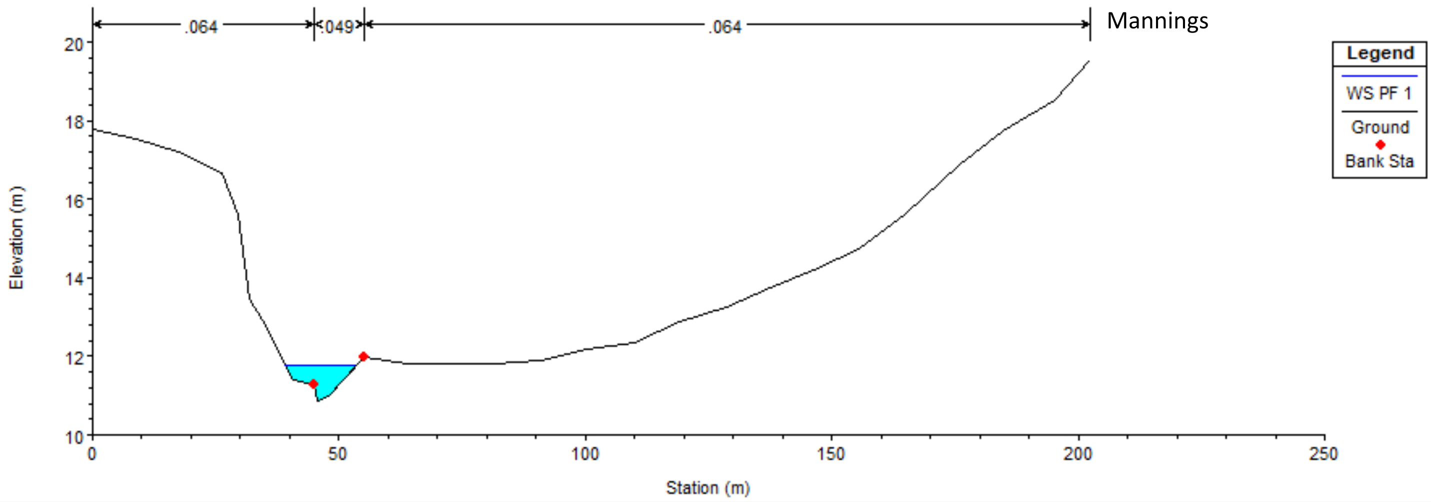
XS 205



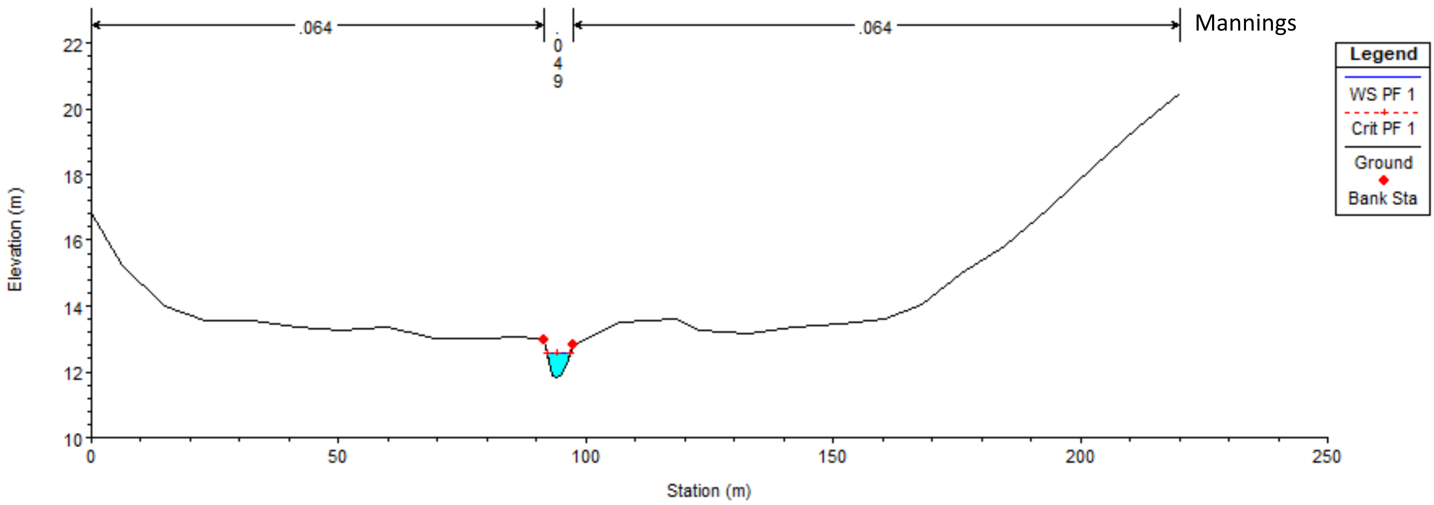
HEC-RAS MODEL RESULTS

Predevelopment Cross Sections

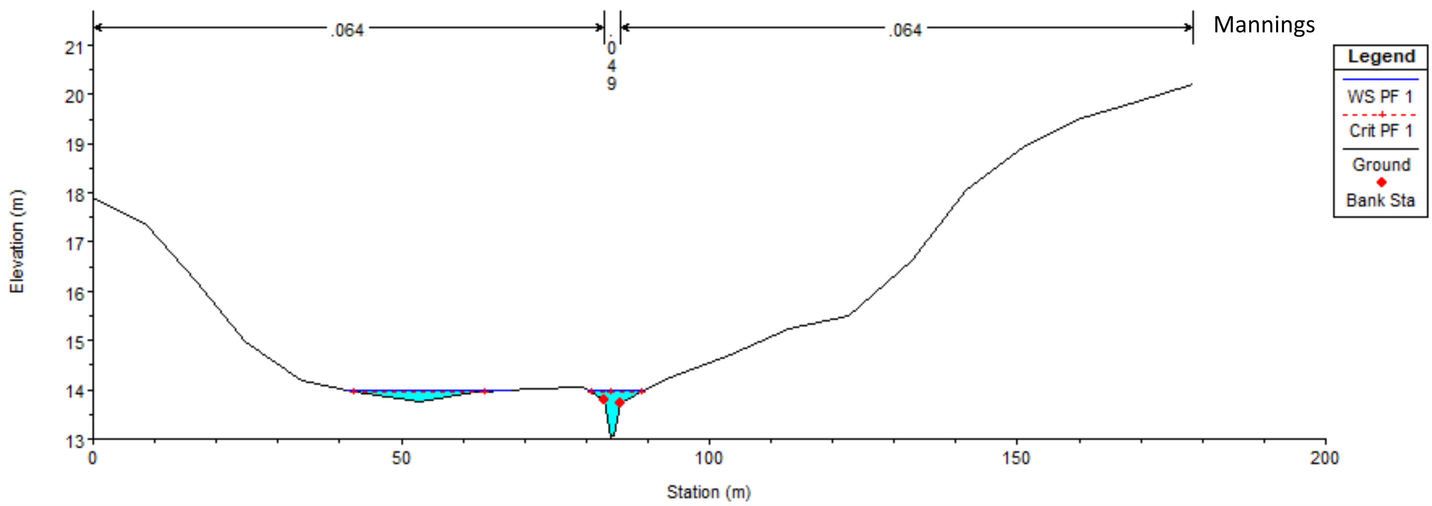
XS 829



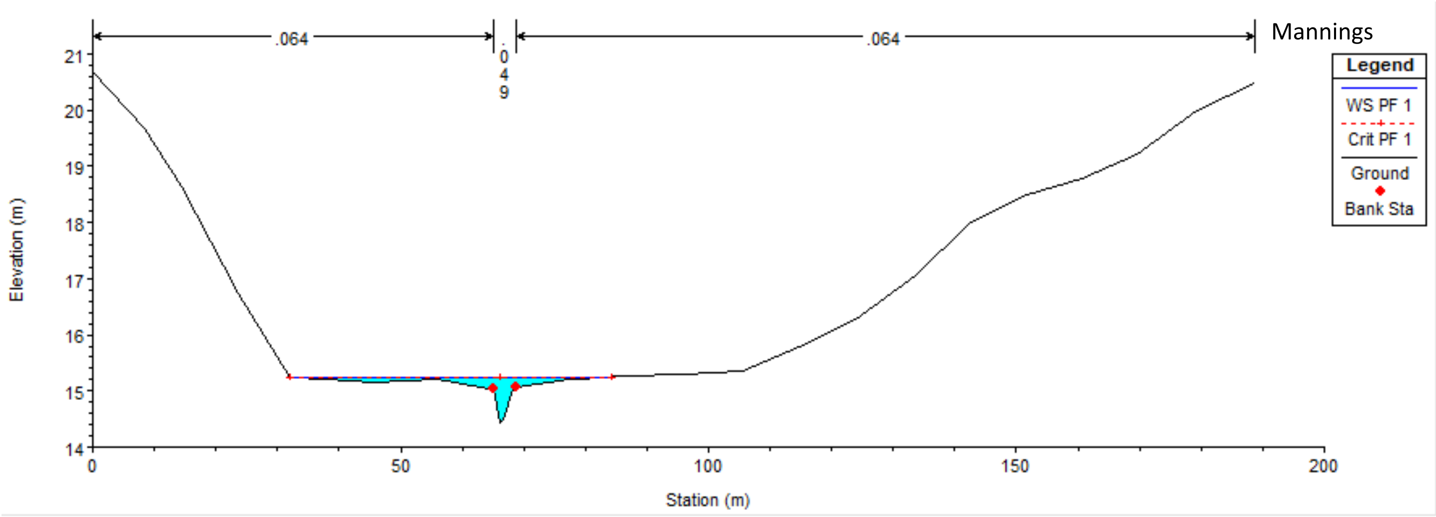
XS 1029



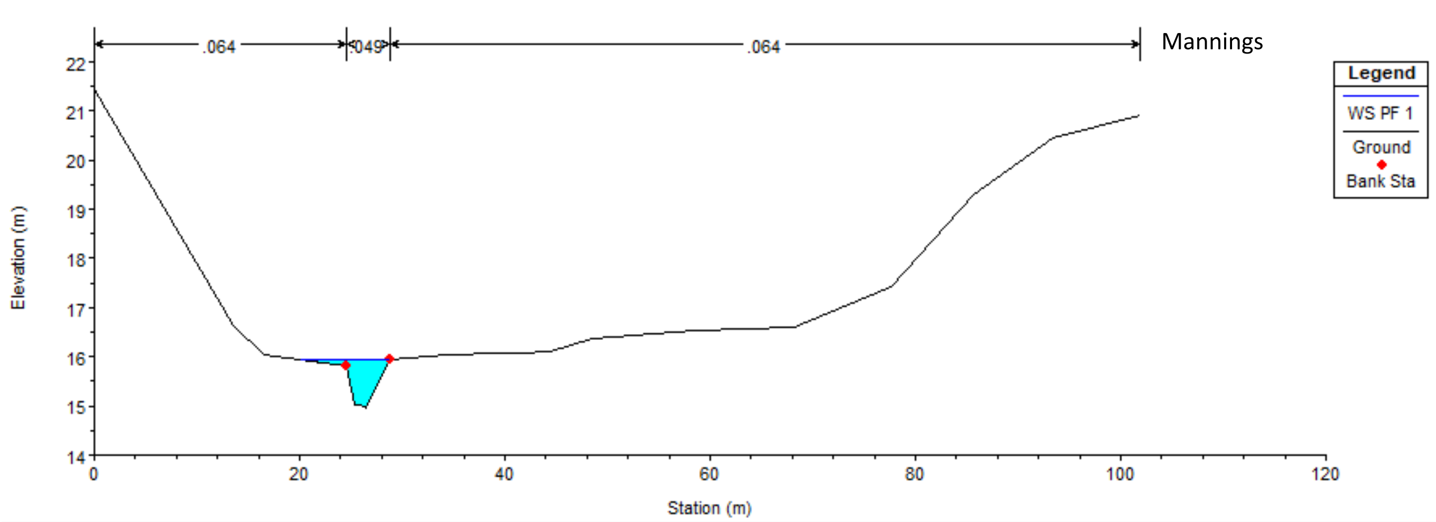
XS 1245



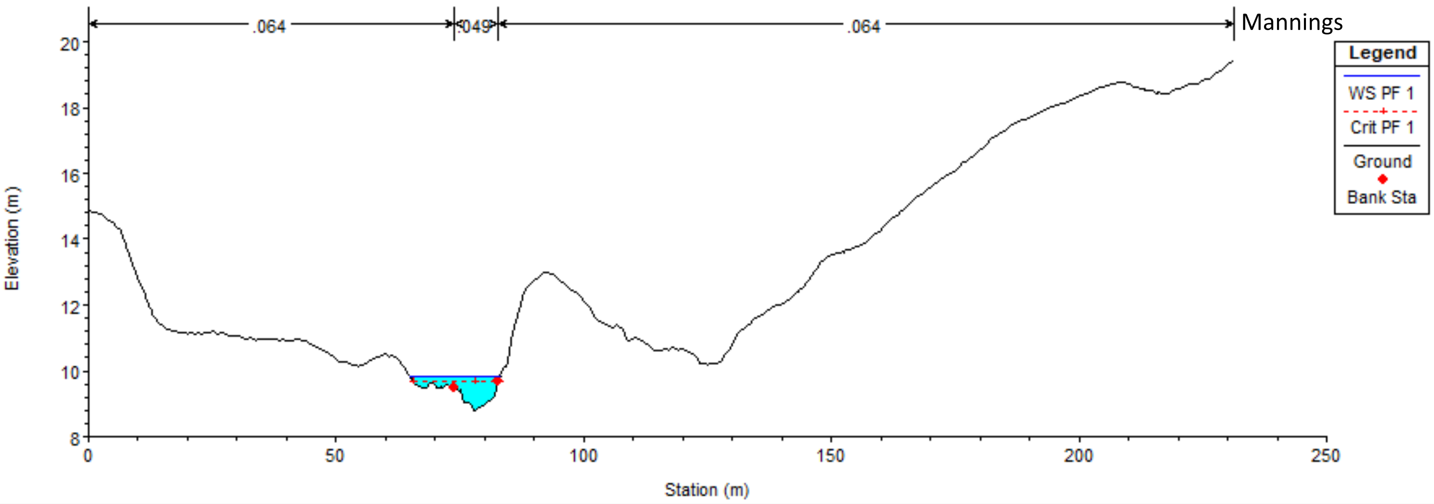
XS 1485



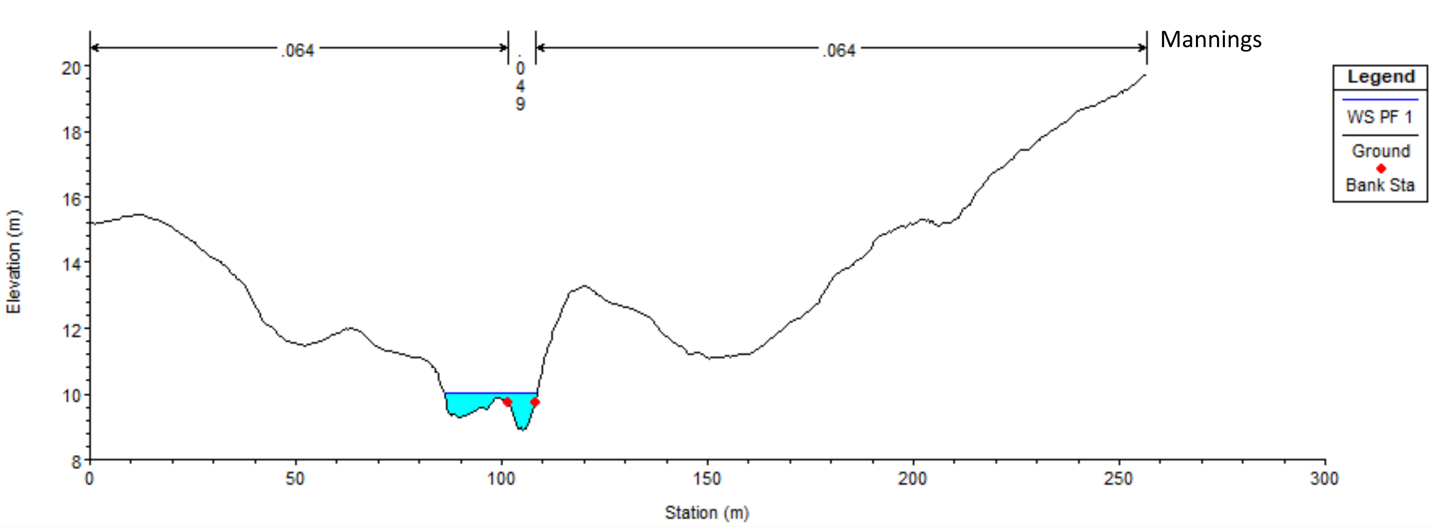
XS 1703



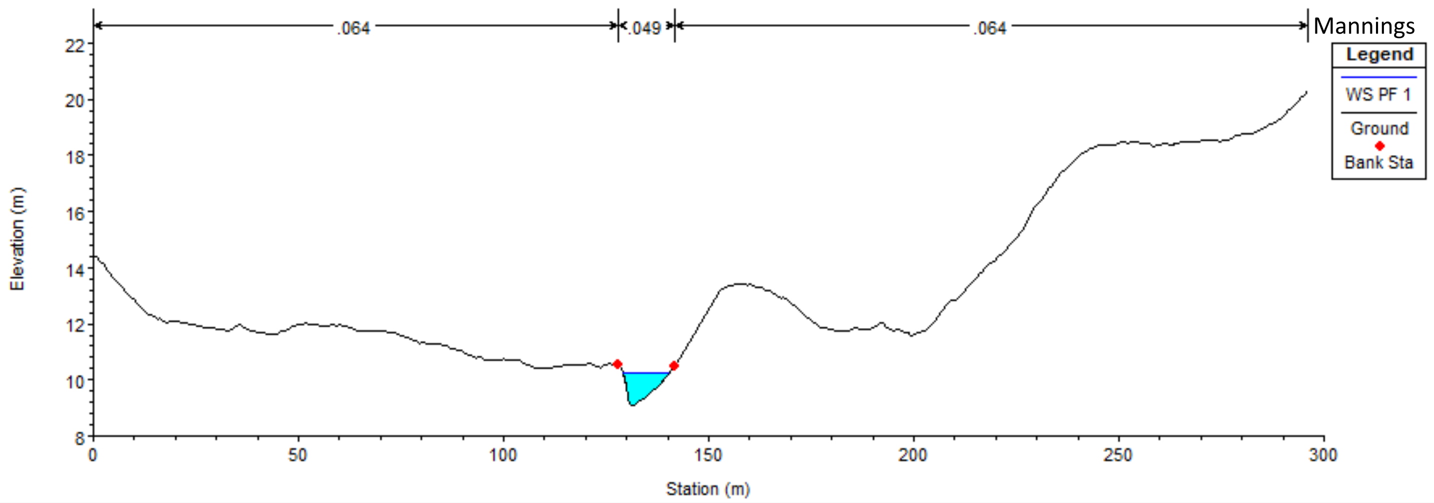
XS 18

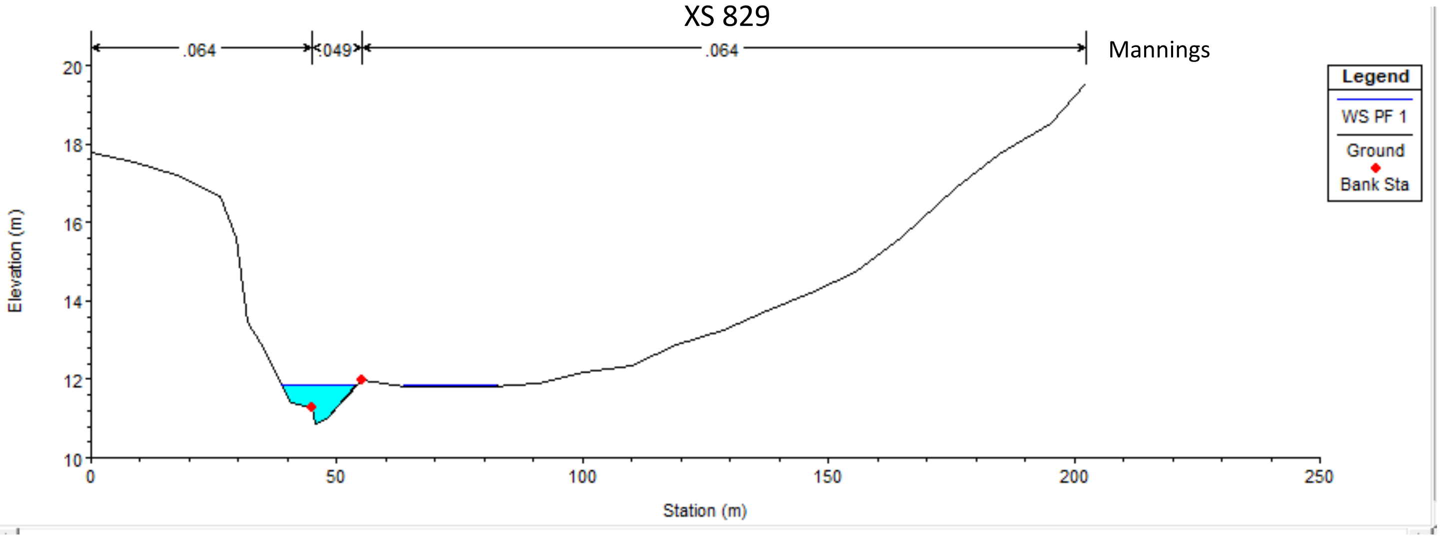


XS 82

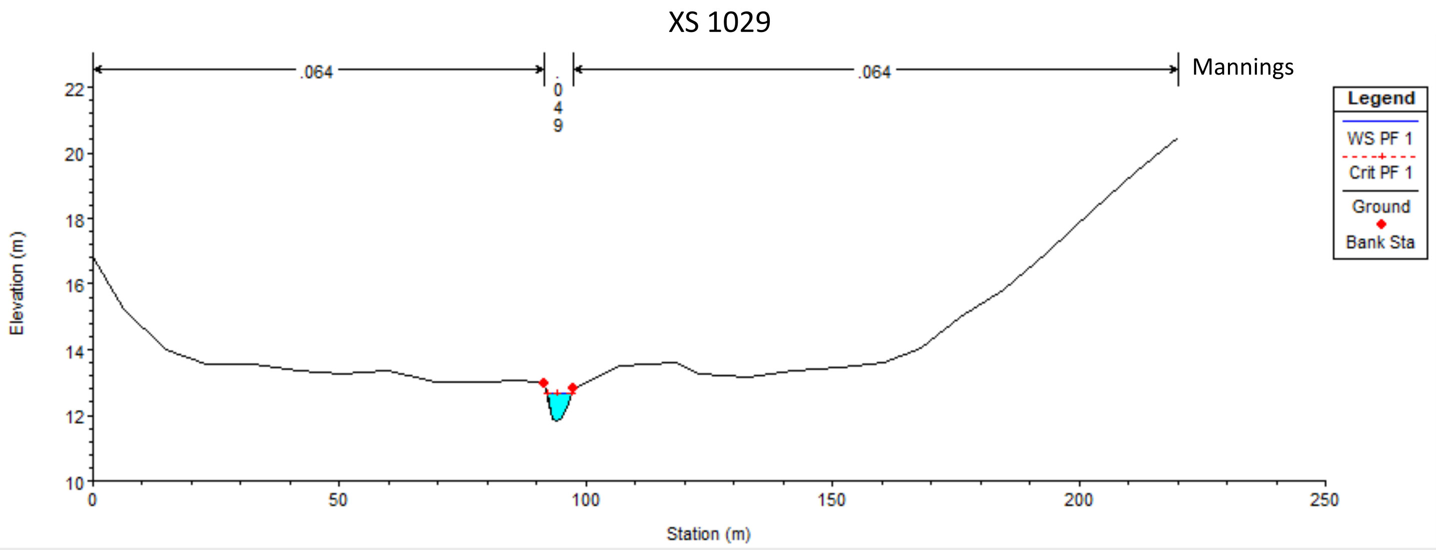


XS 205





XS 829
.064
.049
.064
Mannings
Legend
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)



XS 1029
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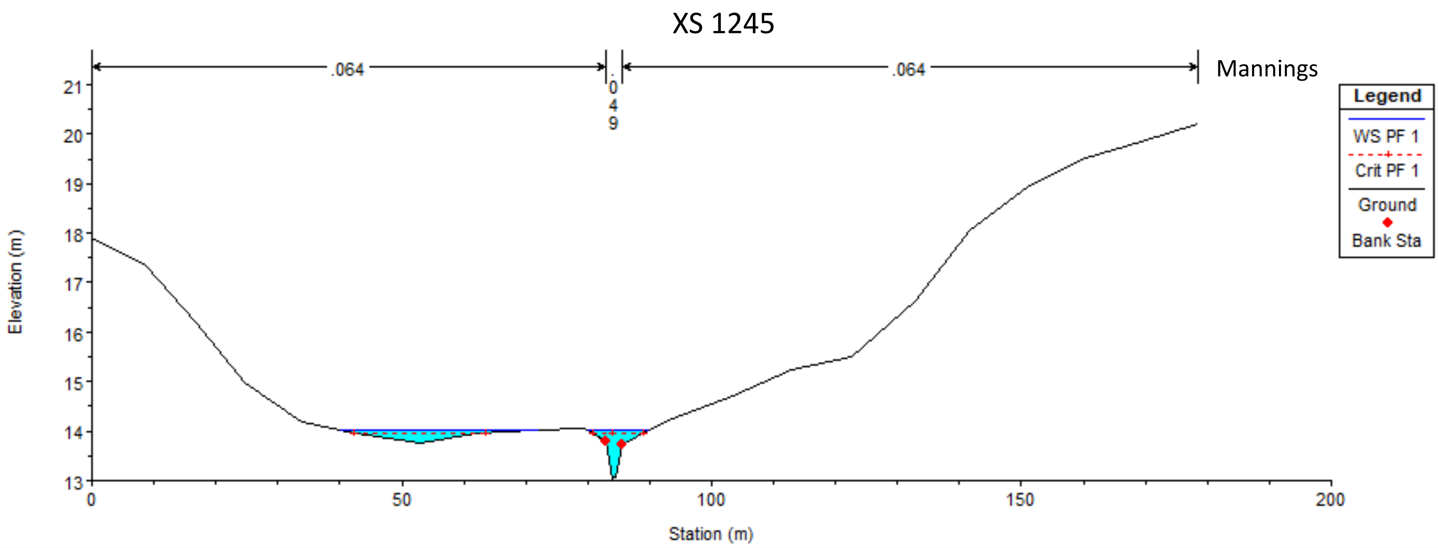
.049
.064
Mannings
Legend
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (m)
Station (m)



XS 1245
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.049
.064
Mannings
Legend
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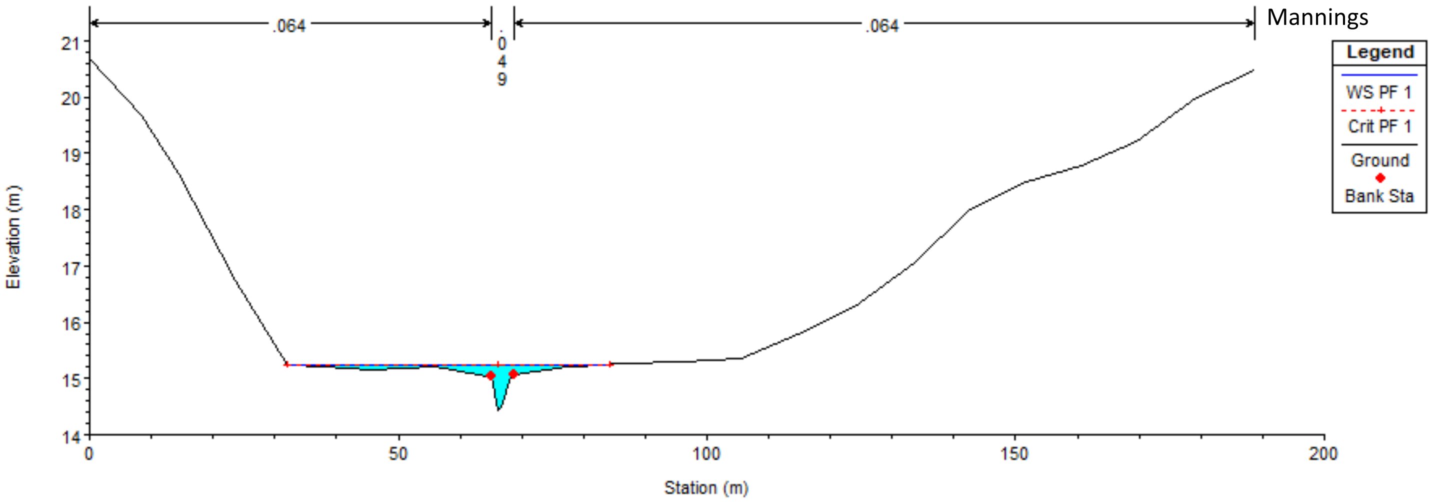
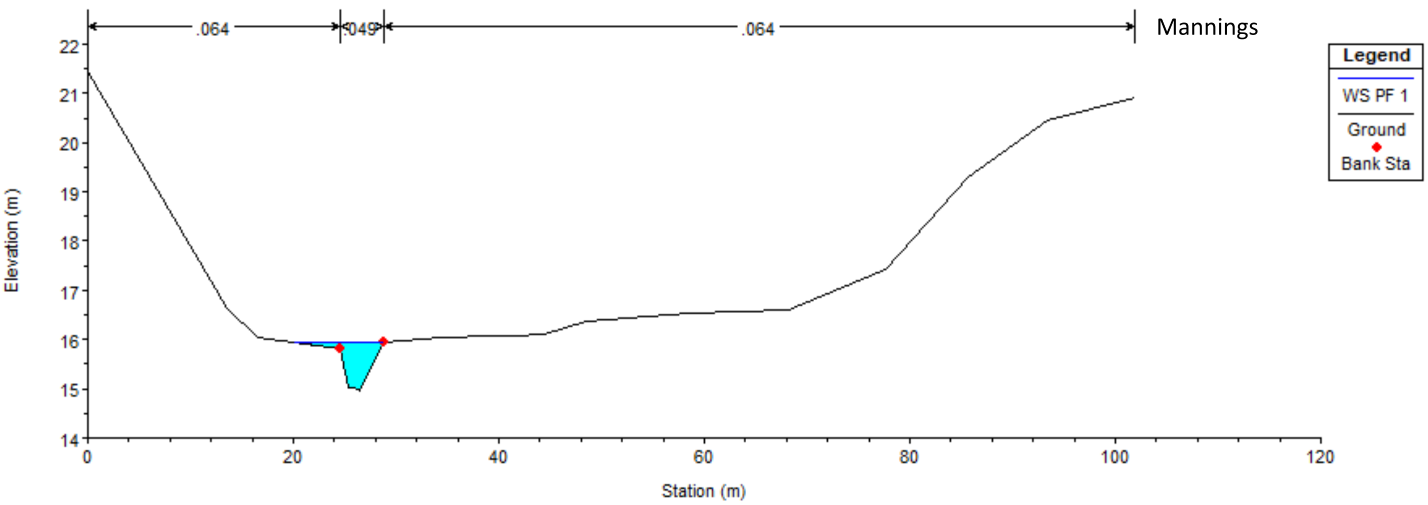
Crit PF 1
Ground
Bank Sta
Elevation (m)
Station (m)

XS 1485



XS 1703



Predevelopment Flows Summary

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach 1	1703	PF 1	3.50	14.96	15.93		16.02	0.009730	1.33	2.84	8.67	0.55
Reach 1	1485	PF 1	3.50	14.44	15.25	15.25	15.31	0.010733	1.30	5.54	52.31	0.58
Reach 1	1245	PF 1	3.50	13.03	13.98	13.95	14.05	0.009446	1.34	5.19	36.13	0.53
Reach 1	1029	PF 1	5.20	11.82	12.57	12.57	12.82	0.033264	2.23	2.33	4.65	1.01
Reach 1	829	PF 1	5.20	10.87	11.78		11.81	0.004102	0.86	6.93	14.43	0.37
Reach 1	205	PF 1	11.50	9.11	10.25		10.37	0.010524	1.54	7.47	11.44	0.61
Reach 1	82	PF 1	11.50	8.91	10.02		10.07	0.005754	1.28	12.30	22.56	0.46
Reach 1	18	PF 1	11.50	8.79	9.81	9.69	9.93	0.010003	1.58	8.69	18.28	0.60

Post Development Flows Summary

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach 1	1703	PF 1	3.50	14.96	15.93		16.02	0.009723	1.33	2.84	8.68	0.55
Reach 1	1485	PF 1	3.50	14.44	15.25	15.25	15.31	0.010733	1.30	5.54	52.31	0.58
Reach 1	1245	PF 1	3.50	13.03	14.01	13.95	14.06	0.006858	1.17	6.28	42.18	0.46
Reach 1	1029	PF 1	6.60	11.82	12.67	12.67	12.95	0.032267	2.36	2.80	5.03	1.01
Reach 1	829	PF 1	6.60	10.87	11.83		11.88	0.004881	0.97	8.08	33.96	0.41
Reach 1	205	PF 1	11.70	9.11	10.25		10.38	0.010610	1.55	7.54	11.49	0.61
Reach 1	82	PF 1	11.70	8.91	10.02		10.08	0.005745	1.28	12.45	22.58	0.46
Reach 1	18	PF 1	11.70	8.79	9.82	9.69	9.93	0.010003	1.59	8.80	18.32	0.60

Appendix A4

Constable Road Stormwater (10% AEP Predevelopment)

Project Description

File Name .... 32897 Constable road predev V2.SPF
Description ....
P:\32 series\32897 Brookdale Waiuku PPC\02 Civil3D Models\32897 Model SW constable road.dwg

Project Options

Flow Units	CMS
Elevation Type	Elevation
Hydrology Method	HEC-1
HEC-1 unit hydrograph method	SCS Dimensionless
HEC-1 loss method	SCS Curve Number
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods ..	NO

Analysis Options

Start Analysis On	Jun 04, 2021	00:00:00
End Analysis On	Jun 06, 2021	00:00:00
Start Reporting On	Jun 04, 2021	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	5	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins..	10
Nodes..	10
Junctions	8
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links..	10
Channels	0
Pipes	10
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (mm)	Rainfall Distribution
1	Rain	Time Series	10Yr	Cumulative	mm				0.00	

Subbasin Summary

SN	Subbasin ID	Area (ha)	Total Rainfall (mm)	Total Runoff (mm)	Total Runoff Volume (ha-mm)	Peak Runoff (cms)
1	Sub-45imp	1.98	140.15	134.50	266.31	0.44
2	Sub-45perv	1.32	140.15	61.54	81.23	0.12
3	Sub-55612	0.72	140.15	129.17	93.23	0.16
4	Sub-69474-imp	10.80	140.15	134.04	1447.66	2.13
5	Sub-69474-perv	7.20	140.15	61.39	442.00	0.57
6	Sub-72542-Imp	7.00	140.15	134.03	938.18	1.48
7	Sub-72542-Perv	3.00	140.15	61.29	183.88	0.22
8	Sub-grassUpstream-imp	36.00	140.15	61.38	2209.64	2.03
9	Sub-School-Imp	2.80	140.15	134.25	375.89	0.62
10	Sub-School-perv	1.20	140.15	60.79	72.95	0.13

Node Summary

SN	Element ID	Element Type	Invert Elevation (m)	Ground/Rim (Max) Elevation (m)	Initial Water Elevation (m)	Surcharge Elevation (m)	Ponded Area (m²)	Peak Inflow (cms)	Max HGL Elevation Attained (m)	Max Surcharge Depth Attained (m)	Min Freeboard Attained (m)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ha-mm)	Total Time Flooded (min)
1	Breakers900	Junction	13.38	15.00	0.00	0.00	0.00	2.03	15.00	0.00	0.00	0 12:45	24.34	26.00
2	MC_55612 (Constable Road)	Junction	5.86	8.42	5.86	8.42	0.00	0.15	6.03	0.00	2.39	0 00:00	0.00	0.00
3	MCC_69473	Junction	8.25	10.80	0.00	0.00	0.00	4.82	10.80	0.00	0.00	0 12:13	5.28	7.00
4	MCC_69474 (Constable Road)	Junction	7.30	10.48	7.30	0.00	0.00	4.60	9.91	0.00	0.57	0 00:00	0.00	0.00
5	MCC_7359 (Constable Road)	Junction	4.22	6.86	4.24	6.86	0.00	5.85	5.26	0.00	1.59	0 00:00	0.00	0.00
6	MCC_7362 (Constable Road)	Junction	5.24	7.27	5.24	7.27	0.00	1.25	5.84	0.00	1.43	0 00:00	0.00	0.00
7	MCC_7364 (Constable Road)	Junction	5.66	7.83	5.66	7.83	0.00	0.62	6.76	0.00	1.07	0 00:00	0.00	0.00
8	MCC_Unknown	Junction	6.78	10.19	0.00	0.00	0.00	4.60	7.64	0.00	2.55	0 00:00	0.00	0.00
9	Out-MCC_9577 (Constable Road)	Outfall	1.81					5.85	1.80					
10	MCC_72542 (Constable Road)up	Storage Node	6.50	8.78	6.50		0.00	1.65	8.78				37.05	18.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (m)	Inlet Invert Elevation (m)	Outlet Invert Elevation (m)	Average Slope (%)	Diameter or Height (mm)	Manning's Roughness	Peak Flow (cms)	Design Flow Capacity (cms)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (m/sec)	Peak Flow Depth (m)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	{Constable Road}.56610 (Constable Road)	Pipe	MC 55612 (Constable Road)	MCC 7362 (Constable Road)	48.16	5.86	5.42	0.9100	1067.000	0.0120	0.15	2.95	0.05	0.78	0.29	0.27	0.00	Calculated
2	{Constable Road}.69508 (Constable Road)	Pipe	MCC 72542 (Constable Road)up	MCC 7364 (Constable Road)	100.37	6.50	5.66	0.8400	533.000	0.0120	0.62	0.44	1.39	2.77	0.53	1.00	41.00	SURCHARGED
3	{Constable Road}.8309 (Constable Road)	Pipe	MCC_7359 (Constable Road)	Out-MCC_9577 (Constable Road)	97.16	4.22	2.68	1.5900	1650.000	0.0120	5.85	12.43	0.47	4.78	0.92	0.56	0.00	Calculated
4	{Constable Road}.8538 (Constable Road)	Pipe	MCC 7362 (Constable Road)	MCC 7359 (Constable Road)	7.69	5.42	4.68	9.6200	1219.000	0.0120	1.25	13.67	0.09	4.21	0.50	0.41	0.00	Calculated
5	{Constable Road}.8540 (Constable Road)	Pipe	MCC 7364 (Constable Road)	MCC 7362 (Constable Road)	27.77	5.66	5.42	0.8600	533.000	0.0120	0.62	0.45	1.37	2.80	0.51	0.97	0.00	> CAPACITY
6	{Constable Road}.8987 (Constable Road)	Pipe	MCC_72542 (Constable Road)up	MCC_7362 (Constable Road)	117.08	6.50	5.42	0.9200	457.000	0.0120	0.48	0.31	1.54	2.92	0.45	0.98	0.00	> CAPACITY
7	{Constable Road}.8988 downstream	Pipe	MCC Unknown	MCC 7359 (Constable Road)	77.16	6.78	4.24	3.2900	1219.000	0.0120	4.61	7.99	0.58	4.79	0.94	0.77	0.00	Calculated
8	Breakers900reach	Pipe	Breakers900	MCC 69473	627.00	13.38	8.55	0.7700	900.000	0.0120	1.85	1.72	1.08	3.01	0.90	1.00	9.00	SURCHARGED
9	MCC_69486	Pipe	MCC_69473	MCC_69474 (Constable Road)	38.02	8.25	7.36	2.3400	1219.000	0.0120	4.60	6.74	0.68	3.94	1.22	1.00	31.00	SURCHARGED
10	MCC 8988upstream	Pipe	MCC 69474 (Constable Road)	MCC Unknown	78.13	7.30	6.82	0.6100	1219.000	0.0120	4.60	3.45	1.33	4.00	1.17	0.96	0.00	> CAPACITY

Junction Input

SN	Element ID	Invert Elevation (m)	Ground/Rim (Max) Elevation (m)	Ground/Rim (Max) Offset (m)	Initial Water Elevation (m)	Initial Water Depth (m)	Surcharge Elevation (m)	Surcharge Depth (m)	Ponded Area (m²)	Minimum Pipe Cover (mm)
1	Breakers900	13.38	15.00	1.62	0.00	-13.38	0.00	-15.00	0.00	720.00
2	MC 55612 (Constable Road)	5.86	8.42	2.56	5.86	0.00	8.42	0.00	0.00	1493.00
3	MCC 69473	8.25	10.80	2.55	0.00	-8.25	0.00	-10.80	0.00	1331.00
4	MCC_69474 (Constable Road)	7.30	10.48	3.18	7.30	0.00	0.00	-10.48	0.00	1901.00
5	MCC 7359 (Constable Road)	4.22	6.86	2.64	4.24	0.02	6.86	0.00	0.00	958.00
6	MCC 7362 (Constable Road)	5.24	7.27	2.03	5.24	0.00	7.27	0.00	0.00	631.00
7	MCC_7364 (Constable Road)	5.66	7.83	2.17	5.66	0.00	7.83	0.00	0.00	1640.00
8	MCC Unknown	6.78	10.19	3.41	0.00	-6.78	0.00	-10.19	0.00	2151.00

Junction Results

SN	Element ID	Peak Inflow (cms)	Peak Lateral Inflow (cms)	Max HGL Elevation Attained (m)	Max HGL Depth Attained (m)	Max Surcharge Depth Attained (m)	Min Freeboard Attained (m)	Average HGL Elevation Attained (m)	Average HGL Depth Attained (m)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ha-mm)	Total Time Flooded (min)
1	Breakers900	2.03	2.03	15.00	1.62	0.00	0.00	13.52	0.14	0 12:36	0 12:45	24.34	26.00
2	MC 55612 (Constable Road)	0.15	0.15	6.03	0.17	0.00	2.39	5.89	0.03	0 12:15	0 00:00	0.00	0.00
3	MCC_69473	4.82	3.86	10.80	2.55	0.00	0.00	8.46	0.21	0 12:13	0 12:13	5.28	7.00
4	MCC 69474 (Constable Road)	4.60	0.00	9.91	2.61	0.00	0.57	7.55	0.25	0 12:14	0 00:00	0.00	0.00
5	MCC 7359 (Constable Road)	5.85	0.00	5.26	1.04	0.00	1.59	4.39	0.17	0 12:18	0 00:00	0.00	0.00
6	MCC_7362 (Constable Road)	1.25	0.00	5.84	0.60	0.00	1.43	5.48	0.24	0 12:18	0 00:00	0.00	0.00
7	MCC 7364 (Constable Road)	0.62	0.00	6.76	1.10	0.00	1.07	5.77	0.11	0 12:14	0 00:00	0.00	0.00
8	MCC Unknown	4.60	0.00	7.64	0.86	0.00	2.55	6.91	0.13	0 12:18	0 00:00	0.00	0.00

Pipe Input

SN	Element ID	Length (m)	Inlet Invert Elevation (m)	Inlet Invert Offset (m)	Outlet Invert Elevation (m)	Outlet Invert Offset (m)	Total Drop (m)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (mm)	Pipe Width (mm)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cms)	Flap Gate	No. of Barrels
1	{Constable Road}.56610 (Constable Road)	48.16	5.86	0.00	5.42	0.18	0.44	0.9100	CIRCULAR	1070.000	1070.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2	{Constable Road}.69508 (Constable Road)	100.37	6.50	0.00	5.66	0.00	0.84	0.8400	CIRCULAR	530.000	530.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
3	{Constable Road}.8309 (Constable Road)	97.16	4.22	0.00	2.68	0.88	1.54	1.5900	CIRCULAR	1650.000	1650.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
4	{Constable Road}.8538 (Constable Road)	7.69	5.42	0.18	4.68	0.46	0.74	9.6200	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
5	{Constable Road}.8540 (Constable Road)	27.77	5.66	0.00	5.42	0.18	0.24	0.8600	CIRCULAR	530.000	530.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
6	{Constable Road}.8987 (Constable Road)	117.08	6.50	0.00	5.42	0.18	1.08	0.9200	CIRCULAR	460.000	460.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
7	{Constable Road}.8988 downstream	77.16	6.78	0.00	4.24	0.02	2.54	3.2900	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
8	Breakers900reach	627.00	13.38	0.00	8.55	0.30	4.83	0.7700	CIRCULAR	900.000	900.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
9	MCC_69486	38.02	8.25	0.00	7.36	0.06	0.89	2.3400	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
10	MCC_8988upstream	78.13	7.30	0.00	6.82	0.04	0.48	0.6100	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow (cms)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cms)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (m/sec)	Travel Time (min)	Peak Flow Depth (m)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	{Constable Road}.56610 (Constable Road)	0.15	0 12:15	2.95	0.05	0.78	1.03	0.29	0.27	0.00		Calculated
2	{Constable Road}.69508 (Constable Road)	0.62	0 12:14	0.44	1.39	2.77	0.60	0.53	1.00	41.00		SURCHARGED
3	{Constable Road}.8309 (Constable Road)	5.85	0 12:19	12.43	0.47	4.78	0.34	0.92	0.56	0.00		Calculated
4	{Constable Road}.8538 (Constable Road)	1.25	0 12:15	13.67	0.09	4.21	0.03	0.50	0.41	0.00		Calculated
5	{Constable Road}.8540 (Constable Road)	0.62	0 12:14	0.45	1.37	2.80	0.17	0.51	0.97	0.00		> CAPACITY
6	{Constable Road}.8987 (Constable Road)	0.48	0 12:29	0.31	1.54	2.92	0.67	0.45	0.98	0.00		> CAPACITY
7	{Constable Road}.8988 downstream	4.61	0 12:18	7.99	0.58	4.79	0.27	0.94	0.77	0.00		Calculated
8	Breakers900reach	1.85	0 12:46	1.72	1.08	3.01	3.47	0.90	1.00	9.00		SURCHARGED
9	MCC_69486	4.60	0 12:22	6.74	0.68	3.94	0.16	1.22	1.00	31.00		SURCHARGED
10	MCC_8988upstream	4.60	0 12:22	3.45	1.33	4.00	0.33	1.17	0.96	0.00		> CAPACITY

Storage Nodes

Storage Node : MCC_72542 (Constable Road)up

Input Data

Invert Elevation (m)	6.50
Max (Rim) Elevation (m)	8.78
Max (Rim) Offset (m)	2.28
Initial Water Elevation (m)	6.50
Initial Water Depth (m)	0.00
Ponded Area (m²)	0.00
Evaporation Loss	0.00

Output Summary Results

Peak Inflow (cms)	1.65
Peak Lateral Inflow (cms)	1.65
Peak Outflow (cms)	1.10
Peak Exfiltration Flow Rate (cmm)	0.00
Max HGL Elevation Attained (m)	8.78
Max HGL Depth Attained (m)	2.28
Average HGL Elevation Attained (m)	6.66
Average HGL Depth Attained (m)	0.16
Time of Max HGL Occurrence (days hh:mm)	0 12:12
Total Exfiltration Volume (1000-m³)	0.000
Total Flooded Volume (ha-mm)	37.05
Total Time Flooded (min)	18
Total Retention Time (sec)	0.00

Appendix A5

Constable Road Stormwater
(1% AEP Predevelopment)

Project Description

File Name .... 32897 Constable road predev V2.SPF
Description ....
P:\32 series\32897 Brookdale Waiuku PPC\02 Civil3D Models\32897 Model SW constable road.dwg

Project Options

Flow Units .... CMS
Elevation Type .... Elevation
Hydrology Method HEC-1
HEC-1 unit hydrograph method .... SCS Dimensionless
HEC-1 loss method .... SCS Curve Number
Link Routing Method .... Hydrodynamic
Enable Overflow Ponding at Nodes .... YES
Skip Steady State Analysis Time Periods .. NO

Analysis Options

Start Analysis On	Jun 04, 2021	00:00:00
End Analysis On	Jun 06, 2021	00:00:00
Start Reporting On	Jun 04, 2021	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	5	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins..	10
Nodes..	10
Junctions	8
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links..	10
Channels	0
Pipes	10
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (mm)	Rainfall Distribution
1	Rain	Time Series	100yr	Cumulative	mm				0.00	

Subbasin Summary

SN	Subbasin ID	Area (ha)	Total Rainfall (mm)	Total Runoff (mm)	Total Runoff Volume (ha-mm)	Peak Runoff (cms)
1	Sub-45imp	1.98	218.49	212.52	420.79	0.68
2	Sub-45perv	1.32	218.49	120.99	159.70	0.24
3	Sub-55612	0.72	218.49	205.35	148.21	0.25
4	Sub-69474-imp	10.80	218.49	212.35	2293.42	3.32
5	Sub-69474-perv	7.20	218.49	121.22	872.78	1.14
6	Sub-72542-Imp	7.00	218.49	212.38	1486.63	2.31
7	Sub-72542-Perv	3.00	218.49	121.35	364.04	0.45
8	Sub-grassUpstream-imp	36.00	218.49	121.23	4364.42	4.08
9	Sub-School-Imp	2.80	218.49	212.59	595.25	0.97
10	Sub-School-perv	1.20	218.49	121.31	145.57	0.25

Node Summary

SN	Element ID	Element Type	Invert Elevation (m)	Ground/Rim (Max) Elevation (m)	Initial Water Elevation (m)	Surcharge Elevation (m)	Ponded Area (m²)	Peak Inflow (cms)	Max HGL Elevation Attained (m)	Max Surcharge Depth Attained (m)	Min Freeboard Attained (m)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ha-mm)	Total Time Flooded (min)
1	Breakers900	Junction	13.38	15.00	0.00	0.00	0.00	4.08	15.00	0.00	0.00	0 12:45	718.62	91.00
2	MC_55612 (Constable Road)	Junction	5.86	8.42	5.86	8.42	0.00	0.24	6.07	0.00	2.35	0 00:00	0.00	0.00
3	MCC 69473	Junction	8.25	10.80	0.00	0.00	0.00	7.92	10.80	0.00	0.00	0 12:20	362.23	35.00
4	MCC 69474 (Constable Road)	Junction	7.30	10.48	7.30	0.00	0.00	4.60	9.94	0.00	0.54	0 00:00	0.00	0.00
5	MCC_7359 (Constable Road)	Junction	4.22	6.86	4.24	6.86	0.00	5.95	5.27	0.00	1.58	0 00:00	0.00	0.00
6	MCC 7362 (Constable Road)	Junction	5.24	7.27	5.24	7.27	0.00	1.34	5.86	0.00	1.41	0 00:00	0.00	0.00
7	MCC 7364 (Constable Road)	Junction	5.66	7.83	5.66	7.83	0.00	0.62	6.76	0.00	1.07	0 00:00	0.00	0.00
8	MCC_Unknown	Junction	6.78	10.19	0.00	0.00	0.00	4.60	7.64	0.00	2.55	0 00:00	0.00	0.00
9	Out-MCC 9577 (Constable Road)	Outfall	1.81					5.95	1.80					
10	MCC 72542 (Constable Road)up	Storage Node	6.50	8.78	6.50		0.00	2.66	8.78				187.87	41.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (m)	Inlet Invert Elevation (m)	Outlet Invert Elevation (m)	Average Slope (%)	Diameter or Height (mm)	Manning's Roughness	Peak Flow (cms)	Design Flow Capacity (cms)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (m/sec)	Peak Flow Depth (m)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	{Constable Road}.56610 (Constable Road)	Pipe	MC 55612 (Constable Road)	MCC 7362 (Constable Road)	48.16	5.86	5.42	0.9100	1067.000	0.0120	0.24	2.95	0.08	1.05	0.33	0.31	0.00	Calculated
2	{Constable Road}.69508 (Constable Road)	Pipe	MCC_72542 (Constable Road)up	MCC_7364 (Constable Road)	100.37	6.50	5.66	0.8400	533.000	0.0120	0.62	0.44	1.39	2.77	0.53	1.00	78.00	SURCHARGED
3	{Constable Road}.8309 (Constable Road)	Pipe	MCC 7359 (Constable Road)	Out-MCC 9577 (Constable Road)	97.16	4.22	2.68	1.5900	1650.000	0.0120	5.95	12.43	0.48	4.79	0.93	0.56	0.00	Calculated
4	{Constable Road}.8538 (Constable Road)	Pipe	MCC 7362 (Constable Road)	MCC 7359 (Constable Road)	7.69	5.42	4.68	9.6200	1219.000	0.0120	1.34	13.67	0.10	4.13	0.52	0.43	0.00	Calculated
5	{Constable Road}.8540 (Constable Road)	Pipe	MCC_7364 (Constable Road)	MCC_7362 (Constable Road)	27.77	5.66	5.42	0.8600	533.000	0.0120	0.62	0.45	1.37	2.80	0.51	0.97	0.00	> CAPACITY
6	{Constable Road}.8987 (Constable Road)	Pipe	MCC 72542 (Constable Road)up	MCC 7362 (Constable Road)	117.08	6.50	5.42	0.9200	457.000	0.0120	0.48	0.31	1.55	2.93	0.45	0.99	0.00	> CAPACITY
7	{Constable Road}.8988 downstream	Pipe	MCC Unknown	MCC 7359 (Constable Road)	77.16	6.78	4.24	3.2900	1219.000	0.0120	4.61	7.99	0.58	4.80	0.94	0.78	0.00	Calculated
8	Breakers900reach	Pipe	Breakers900	MCC_69473	627.00	13.38	8.55	0.7700	900.000	0.0120	1.86	1.72	1.08	3.01	0.90	1.00	57.00	SURCHARGED
9	MCC 69486	Pipe	MCC 69473	MCC 69474 (Constable Road)	38.02	8.25	7.36	2.3400	1219.000	0.0120	4.60	6.74	0.68	3.94	1.22	1.00	68.00	SURCHARGED
10	MCC 8988upstream	Pipe	MCC 69474 (Constable Road)	MCC Unknown	78.13	7.30	6.82	0.6100	1219.000	0.0120	4.60	3.45	1.33	4.00	1.17	0.96	0.00	> CAPACITY

Junction Input

SN	Element ID	Invert Elevation (m)	Ground/Rim (Max) Elevation (m)	Ground/Rim (Max) Offset (m)	Initial Water Elevation (m)	Initial Water Depth (m)	Surcharge Elevation (m)	Surcharge Depth (m)	Ponded Area (m²)	Minimum Pipe Cover (mm)
1	Breakers900	13.38	15.00	1.62	0.00	-13.38	0.00	-15.00	0.00	720.00
2	MC 55612 (Constable Road)	5.86	8.42	2.56	5.86	0.00	8.42	0.00	0.00	1493.00
3	MCC_69473	8.25	10.80	2.55	0.00	-8.25	0.00	-10.80	0.00	1331.00
4	MCC 69474 (Constable Road)	7.30	10.48	3.18	7.30	0.00	0.00	-10.48	0.00	1901.00
5	MCC 7359 (Constable Road)	4.22	6.86	2.64	4.24	0.02	6.86	0.00	0.00	958.00
6	MCC_7362 (Constable Road)	5.24	7.27	2.03	5.24	0.00	7.27	0.00	0.00	631.00
7	MCC 7364 (Constable Road)	5.66	7.83	2.17	5.66	0.00	7.83	0.00	0.00	1640.00
8	MCC Unknown	6.78	10.19	3.41	0.00	-6.78	0.00	-10.19	0.00	2151.00

Junction Results

SN	Element ID	Peak Inflow (cms)	Peak Lateral Inflow (cms)	Max HGL Elevation Attained (m)	Max HGL Depth Attained (m)	Max Surcharge Depth Attained (m)	Min Freeboard Attained (m)	Average HGL Elevation Attained (m)	Average HGL Depth Attained (m)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ha-mm)	Total Time Flooded (min)
1	Breakers900	4.08	4.08	15.00	1.62	0.00	0.00	13.64	0.26	0 12:15	0 12:45	718.62	91.00
2	MC_55612 (Constable Road)	0.24	0.24	6.07	0.21	0.00	2.35	5.89	0.03	0 12:15	0 00:00	0.00	0.00
3	MCC_69473	7.92	6.38	10.80	2.55	0.00	0.00	8.59	0.34	0 12:03	0 12:20	362.23	35.00
4	MCC_69474 (Constable Road)	4.60	0.00	9.94	2.64	0.00	0.54	7.69	0.39	0 12:03	0 00:00	0.00	0.00
5	MCC_7359 (Constable Road)	5.95	0.00	5.27	1.05	0.00	1.58	4.46	0.24	0 12:15	0 00:00	0.00	0.00
6	MCC_7362 (Constable Road)	1.34	0.00	5.86	0.62	0.00	1.41	5.51	0.27	0 12:15	0 00:00	0.00	0.00
7	MCC_7364 (Constable Road)	0.62	0.00	6.76	1.10	0.00	1.07	5.83	0.17	0 12:03	0 00:00	0.00	0.00
8	MCC_Unknown	4.60	0.00	7.64	0.86	0.00	2.55	6.97	0.19	0 12:06	0 00:00	0.00	0.00

Pipe Input

SN	Element ID	Length (m)	Inlet Invert Elevation (m)	Inlet Invert Offset (m)	Outlet Invert Elevation (m)	Outlet Invert Offset (m)	Total Drop (m)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (mm)	Pipe Width (mm)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cms)	Flap Gate	No. of Barrels
1	{Constable Road}.56610 (Constable Road)	48.16	5.86	0.00	5.42	0.18	0.44	0.9100	CIRCULAR	1070.000	1070.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2	{Constable Road}.69508 (Constable Road)	100.37	6.50	0.00	5.66	0.00	0.84	0.8400	CIRCULAR	530.000	530.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
3	{Constable Road}.8309 (Constable Road)	97.16	4.22	0.00	2.68	0.88	1.54	1.5900	CIRCULAR	1650.000	1650.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
4	{Constable Road}.8538 (Constable Road)	7.69	5.42	0.18	4.68	0.46	0.74	9.6200	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
5	{Constable Road}.8540 (Constable Road)	27.77	5.66	0.00	5.42	0.18	0.24	0.8600	CIRCULAR	530.000	530.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
6	{Constable Road}.8987 (Constable Road)	117.08	6.50	0.00	5.42	0.18	1.08	0.9200	CIRCULAR	460.000	460.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
7	{Constable Road}.8988 downstream	77.16	6.78	0.00	4.24	0.02	2.54	3.2900	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
8	Breakers900reach	627.00	13.38	0.00	8.55	0.30	4.83	0.7700	CIRCULAR	900.000	900.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
9	MCC_69486	38.02	8.25	0.00	7.36	0.06	0.89	2.3400	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
10	MCC_8988upstream	78.13	7.30	0.00	6.82	0.04	0.48	0.6100	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow (cms)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cms)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (m/sec)	Travel Time (min)	Peak Flow Depth (m)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	{Constable Road}.56610 (Constable Road)	0.24	0 12:15	2.95	0.08	1.05	0.76	0.33	0.31	0.00		Calculated
2	{Constable Road}.69508 (Constable Road)	0.62	0 12:11	0.44	1.39	2.77	0.60	0.53	1.00	78.00		SURCHARGED
3	{Constable Road}.8309 (Constable Road)	5.95	0 12:15	12.43	0.48	4.79	0.34	0.93	0.56	0.00		Calculated
4	{Constable Road}.8538 (Constable Road)	1.34	0 12:15	13.67	0.10	4.13	0.03	0.52	0.43	0.00		Calculated
5	{Constable Road}.8540 (Constable Road)	0.62	0 12:06	0.45	1.37	2.80	0.17	0.51	0.97	0.00		> CAPACITY
6	{Constable Road}.8987 (Constable Road)	0.48	0 12:15	0.31	1.55	2.93	0.67	0.45	0.99	0.00		> CAPACITY
7	{Constable Road}.8988 downstream	4.61	0 12:06	7.99	0.58	4.80	0.27	0.94	0.78	0.00		Calculated
8	Breakers900reach	1.86	0 13:13	1.72	1.08	3.01	3.47	0.90	1.00	57.00		SURCHARGED
9	MCC 69486	4.60	0 12:12	6.74	0.68	3.94	0.16	1.22	1.00	68.00		SURCHARGED
10	MCC 8988upstream	4.60	0 12:27	3.45	1.33	4.00	0.33	1.17	0.96	0.00		> CAPACITY

Storage Nodes

Storage Node : MCC_72542 (Constable Road)up

Input Data

Invert Elevation (m) 6.50
Max (Rim) Elevation (m) 8.78
Max (Rim) Offset (m) 2.28
Initial Water Elevation (m) 6.50
Initial Water Depth (m) 0.00
Ponded Area (m²) 0.00
Evaporation Loss 0.00

Output Summary Results

Peak Inflow (cms) 2.66
Peak Lateral Inflow (cms) 2.66
Peak Outflow (cms) 1.10
Peak Exfiltration Flow Rate (cmm) 0.00
Max HGL Elevation Attained (m) 8.78
Max HGL Depth Attained (m) 2.28
Average HGL Elevation Attained (m) 6.75
Average HGL Depth Attained (m) 0.25
Time of Max HGL Occurrence (days hh:mm) 0 12:03
Total Exfiltration Volume (1000-m³) 0.000
Total Flooded Volume (ha-mm) 187.87
Total Time Flooded (min) 41
Total Retention Time (sec) 0.00

Appendix A6

Constable Road Stormwater (10% AEP Post Development)

Project Description

File Name .... 32897 Constable road.SPF
Description ....
P:\32 series\32897 Brookdale Waiuku PPC\02 Civil3D Models\32897 Model SW constable road.dwg

Project Options

Flow Units .... CMS
Elevation Type .... Elevation
Hydrology Method HEC-1
HEC-1 unit hydrograph method .... SCS Dimensionless
HEC-1 loss method .... SCS Curve Number
Link Routing Method .... Hydrodynamic
Enable Overflow Ponding at Nodes .... YES
Skip Steady State Analysis Time Periods .. NO

Analysis Options

Start Analysis On	Jun 04, 2021	00:00:00
End Analysis On	Jun 06, 2021	00:00:00
Start Reporting On	Jun 04, 2021	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	2	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins..	21
Nodes..	21
Junctions	15
Outfalls	2
Flow Diversions	1
Inlets	0
Storage Nodes	3
Links..	23
Channels	0
Pipes	18
Pumps	0
Orifices	4
Weirs	0
Outlets	1
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (mm)	Rainfall Distribution
1	Rain	Time Series	10Yr	Cumulative	mm				0.00	

Subbasin Summary

SN	Subbasin ID	Area (ha)	Total Rainfall (mm)	Total Runoff (mm)	Total Runoff Volume (ha-mm)	Peak Runoff (cms)
1	Sub-45A-Imp	1.98	140.15	134.50	266.31	0.44
2	Sub-45A-perv	1.32	140.15	61.56	81.26	0.12
3	Sub-45imp	1.98	140.15	134.50	266.31	0.44
4	Sub-45perv	1.32	140.15	61.54	81.23	0.12
5	Sub-55612	0.72	140.15	129.17	93.23	0.16
6	Sub-69474-imp	10.80	140.15	134.04	1447.66	2.13
7	Sub-69474-perv	7.20	140.15	61.39	442.00	0.57
8	Sub-72542-Imp	7.00	140.15	134.03	938.18	1.48
9	Sub-72542-Perv	3.00	140.15	61.29	183.88	0.22
10	Sub-C2-imp	0.28	140.15	134.18	37.20	0.06
11	Sub-C2-perv	0.26	140.15	57.95	15.30	0.03
12	Sub-C2-roof	0.12	140.15	133.26	15.78	0.03
13	Sub-D1-Imp	0.54	140.15	133.48	71.81	0.12
14	Sub-D1-perv	0.95	140.15	60.94	58.01	0.10
15	Sub-D1-Roof	0.23	140.15	131.07	30.15	0.05
16	Sub-E1-imp	0.45	140.15	134.45	60.50	0.10
17	Sub-E1-perv	0.93	140.15	60.77	56.51	0.10
18	Sub-E1-Roof	0.19	140.15	131.35	24.96	0.04
19	Sub-grassUpstream-imp	32.00	140.15	61.38	1964.19	1.80
20	Sub-School-Imp	2.80	140.15	134.25	375.89	0.62
21	Sub-School-perv	1.20	140.15	60.79	72.95	0.13

Node Summary

SN	Element ID	Element Type	Invert Elevation (m)	Ground/Rim (Max) Elevation (m)	Initial Water Elevation (m)	Surcharge Elevation (m)	Ponded Area (m²)	Peak Inflow (cms)	Max HGL Elevation Attained (m)	Max Surcharge Depth Attained (m)	Min Freeboard Attained (m)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ha-mm)	Total Time Flooded (min)
1	45AInlet	Junction	15.04	20.33	0.00	0.00	0.00	0.00	15.04	0.00	5.29	0 00:00	0.00	0.00
2	Breakers900	Junction	13.38	15.00	0.00	0.00	0.00	1.80	14.12	0.00	0.88	0 00:00	0.00	0.00
3	MC 55612 (Constable Road)	Junction	5.86	8.42	5.86	8.42	0.00	0.15	6.03	0.00	2.39	0 00:00	0.00	0.00
4	MCC 69473	Junction	8.25	10.80	0.00	0.00	0.00	3.61	9.97	0.00	0.83	0 00:00	0.00	0.00
5	MCC_69474 (Constable Road)	Junction	7.30	10.48	7.30	0.00	0.00	3.61	9.10	0.00	1.38	0 00:00	0.00	0.00
6	MCC 7359 (Constable Road)	Junction	4.22	6.86	4.22	6.86	0.00	7.01	5.41	0.00	1.45	0 00:00	0.00	0.00
7	MCC 7362 (Constable Road)	Junction	5.24	7.27	5.24	7.27	0.00	1.25	5.86	0.00	1.41	0 00:00	0.00	0.00
8	MCC_7364 (Constable Road)	Junction	5.66	7.83	5.66	7.83	0.00	0.62	6.76	0.00	1.08	0 00:00	0.00	0.00
9	MCC UNKNOWN	Junction	6.78	10.19	0.00	0.00	0.00	3.61	7.49	0.00	2.70	0 00:00	0.00	0.00
10	MH1 (Constable Road)	Junction	4.77	6.87	5.00	6.87	0.00	3.99	6.64	0.00	0.22	0 00:00	0.00	0.00
11	MH2 (Constable Road)	Junction	8.44	11.61	9.56	11.61	0.00	2.37	9.56	0.00	2.06	0 00:00	0.00	0.00
12	MH3 (Constable Road)	Junction	9.35	12.03	10.00	11.84	0.00	2.37	10.15	0.00	1.88	0 00:00	0.00	0.00
13	MH4 (Constable Road)	Junction	10.18	12.86	10.35	12.73	0.00	1.67	11.14	0.00	1.72	0 00:00	0.00	0.00
14	MH5 (Constable Road)	Junction	11.61	14.51	12.05	14.17	0.00	1.68	12.32	0.00	2.19	0 00:00	0.00	0.00
15	MH6 (Constable Road)	Junction	11.63	14.92	13.65	14.92	0.00	0.61	13.65	0.00	1.27	0 00:00	0.00	0.00
16	45AOLFP	Outfall	0.00					0.00	0.00					
17	Out-MCC 9577 (Constable Road)	Outfall	1.81					6.96	1.80					
18	45A-div	Flow Diversions	15.04	20.33	0.00		0.00	0.53	15.69				0.00	0.00
19	Dadditional	Storage Node	15.00	18.00	10.00		0.00	0.61	16.19				0.00	0.00
20	D-Tanks	Storage Node	20.00	22.00	20.80		0.00	0.12	21.04				0.00	0.00
21	MCC_72542 (Constable Road)up	Storage Node	6.50	8.78	6.50		0.00	1.65	8.78				37.00	18.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (m)	Inlet Invert Elevation (m)	Outlet Invert Elevation (m)	Average Slope (%)	Diameter or Height (mm)	Manning's Roughness	Peak Flow (cms)	Design Flow Capacity (cms)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (m/sec)	Peak Flow Depth (m)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	{Constable Road}.56610 (Constable Road)	Pipe	MC 55612 (Constable Road)	MCC 7362 (Constable Road)	48.15	5.86	5.42	0.9100	1067.000	0.0120	0.15	2.95	0.05	0.77	0.30	0.28	0.00	Calculated
2	{Constable Road}.69508 (Constable Road)	Pipe	MCC_72542 (Constable Road)up	MCC_7364 (Constable Road)	100.49	6.50	5.66	0.8400	533.000	0.0120	0.62	0.44	1.39	2.77	0.53	1.00	41.00	SURCHARGED
3	{Constable Road}.8309 (Constable Road)	Pipe	MCC 7359 (Constable Road)	Out-MCC 9577 (Constable Road)	97.16	4.22	2.68	1.5900	1650.000	0.0120	6.96	12.43	0.56	4.93	1.03	0.63	0.00	Calculated
4	{Constable Road}.8538 (Constable Road)	Pipe	MCC 7362 (Constable Road)	MCC 7359 (Constable Road)	7.66	5.42	4.68	9.6600	1219.000	0.0120	1.25	13.69	0.09	4.14	0.58	0.48	0.00	Calculated
5	{Constable Road}.8540 (Constable Road)	Pipe	MCC_7364 (Constable Road)	MCC_7362 (Constable Road)	27.77	5.66	5.42	0.8600	533.000	0.0120	0.62	0.45	1.37	2.80	0.51	0.97	0.00	> CAPACITY
6	{Constable Road}.8987 (Constable Road)	Pipe	MCC 72542 (Constable Road)up	MCC 7362 (Constable Road)	116.87	6.50	5.42	0.9200	457.000	0.0120	0.48	0.31	1.55	2.93	0.45	0.98	0.00	> CAPACITY
7	{Constable Road}.8988 downstream	Pipe	MCC UNKNOWN	MCC 7359 (Constable Road)	77.16	6.78	4.24	3.2900	1219.000	0.0120	3.63	7.99	0.45	4.15	0.93	0.77	0.00	Calculated
8	{Constable Road}.LINE 1 (Constable Road)	Pipe	MH1 (Constable Road)	MCC_7359 (Constable Road)	10.98	4.77	4.61	1.4600	1200.000	0.0120	3.86	5.10	0.76	3.87	0.89	0.83	0.00	Calculated
9	{Constable Road}.LINE 2 (Constable Road)	Pipe	MH2 (Constable Road)	MH1 (Constable Road)	116.43	8.44	4.82	3.1100	1200.000	0.0120	3.99	7.45	0.54	4.41	0.72	0.78	0.00	Calculated
10	{Constable Road}.LINE 3 (Constable Road)	Pipe	MH3 (Constable Road)	MH2 (Constable Road)	85.44	9.30	8.49	0.9500	1200.000	0.0120	2.37	4.24	0.56	3.35	0.72	0.71	0.00	Calculated
11	{Constable Road}.LINE 4 (Constable Road)	Pipe	MH4 (Constable Road)	MH3 (Constable Road)	66.74	10.00	9.61	0.5800	918.000	0.0120	1.67	1.91	0.87	2.84	0.79	0.86	0.00	Calculated
12	{Constable Road}.LINE 5 (Constable Road)	Pipe	MH5 (Constable Road)	MH4 (Constable Road)	99.80	11.63	10.33	1.3000	918.000	0.0120	1.67	2.36	0.71	3.17	0.75	0.82	0.00	Calculated
13	{Constable Road}.LINE 6 (Constable Road)	Pipe	MH6 (Constable Road)	MH5 (Constable Road)	119.11	12.22	11.69	0.4400	825.000	0.0120	1.08	1.04	1.04	2.27	0.56	0.88	0.00	> CAPACITY
14	45AOLFP	Pipe	45A-div	45AOLFP	130.28	16.00	0.00	12.2800	1500.000	0.0120	0.00	26.84	0.00	0.00	0.00	0.00	0.00	Calculated
15	45Apipe	Pipe	45A-div	MH5 (Constable Road)	188.97	15.40	11.61	2.0100	750.000	0.0120	0.53	1.71	0.31	1.76	0.50	0.67	0.00	Calculated
16	Breakers900Reach	Pipe	Breakers900	MCC 69473	505.33	13.38	8.55	0.9600	900.000	0.0120	1.79	1.92	0.94	3.31	0.72	0.82	0.00	Calculated
17	MCC 69486	Pipe	MCC 69473	MCC 69474 (Constable Road)	38.02	8.25	7.36	2.3400	1219.000	0.0120	3.61	6.74	0.54	3.09	1.22	1.00	8.00	SURCHARGED
18	mcc_8988Upstream	Pipe	MCC_69474 (Constable Road)	MCC_UNKNOWN	78.13	7.30	6.82	0.6100	1219.000	0.0120	3.61	3.45	1.04	3.20	1.12	0.92	0.00	> CAPACITY
19	D add 10yr	Orifice	Dadditional	MH6 (Constable Road)		15.00	11.63		600.000		0.27							
20	D add 95th	Orifice	Dadditional	MH6 (Constable Road)		15.00	11.63		80.000		0.02							
21	D-tanks1	Orifice	D-Tanks	Dadditional		20.00	15.00		2000.000		0.11							
22	Orifice-06	Orifice	Dadditional	MH6 (Constable Road)		15.00	11.63		2000.000		0.33							
23	Dtanksoutlet	Outlet	D-Tanks	Dadditional		20.00	15.00				0.01							

Junction Input

SN	Element ID	Invert Elevation (m)	Ground/Rim (Max) Elevation (m)	Ground/Rim (Max) Offset (m)	Initial Water Elevation (m)	Initial Water Depth (m)	Surcharge Elevation (m)	Surcharge Depth (m)	Ponded Area (m²)	Minimum Pipe Cover (mm)
1	45AInlet	15.04	20.33	5.29	0.00	-15.04	0.00	-20.33	0.00	0.00
2	Breakers900	13.38	15.00	1.62	0.00	-13.38	0.00	-15.00	0.00	720.00
3	MC_55612 (Constable Road)	5.86	8.42	2.56	5.86	0.00	8.42	0.00	0.00	1493.00
4	MCC_69473	8.25	10.80	2.55	0.00	-8.25	0.00	-10.80	0.00	1331.00
5	MCC_69474 (Constable Road)	7.30	10.48	3.18	7.30	0.00	0.00	-10.48	0.00	1901.00
6	MCC_7359 (Constable Road)	4.22	6.86	2.64	4.22	0.00	6.86	0.00	0.00	958.00
7	MCC_7362 (Constable Road)	5.24	7.27	2.03	5.24	0.00	7.27	0.00	0.00	631.00
8	MCC_7364 (Constable Road)	5.66	7.83	2.17	5.66	0.00	7.83	0.00	0.00	1640.00
9	MCC_UNKNOWN	6.78	10.19	3.41	0.00	-6.78	0.00	-10.19	0.00	2151.00
10	MH1 (Constable Road)	4.77	6.87	2.10	5.00	0.23	6.87	0.00	0.00	849.00
11	MH2 (Constable Road)	8.44	11.61	3.17	9.56	1.12	11.61	0.00	0.00	1924.00
12	MH3 (Constable Road)	9.35	12.03	2.68	10.00	0.65	11.84	-0.19	0.00	1502.00
13	MH4 (Constable Road)	10.18	12.86	2.68	10.35	0.17	12.73	-0.13	0.00	1612.00
14	MH5 (Constable Road)	11.61	14.51	2.90	12.05	0.44	14.17	-0.35	0.00	1962.00
15	MH6 (Constable Road)	11.63	14.92	3.29	13.65	2.02	14.92	0.00	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cms)	Peak Lateral Inflow (cms)	Max HGL Elevation Attained (m)	Max HGL Depth Attained (m)	Max Surcharge Depth Attained (m)	Min Freeboard Attained (m)	Average HGL Elevation Attained (m)	Average HGL Depth Attained (m)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ha-mm)	Total Time Flooded (min)
1	45AInlet	0.00	0.00	15.04	0.00	0.00	5.29	15.04	0.00	0 00:00	0 00:00	0.00	0.00
2	Breakers900	1.80	1.80	14.12	0.74	0.00	0.88	13.47	0.09	0 12:51	0 00:00	0.00	0.00
3	MC_55612 (Constable Road)	0.15	0.15	6.03	0.17	0.00	2.39	5.88	0.02	0 12:15	0 00:00	0.00	0.00
4	MCC_69473	3.61	2.62	9.97	1.72	0.00	0.83	8.37	0.12	0 12:23	0 00:00	0.00	0.00
5	MCC_69474 (Constable Road)	3.61	0.00	9.10	1.80	0.00	1.38	7.46	0.16	0 12:23	0 00:00	0.00	0.00
6	MCC_7359 (Constable Road)	7.01	0.00	5.41	1.19	0.00	1.45	4.37	0.15	0 12:24	0 00:00	0.00	0.00
7	MCC_7362 (Constable Road)	1.25	0.00	5.86	0.62	0.00	1.41	5.47	0.23	0 12:21	0 00:00	0.00	0.00
8	MCC_7364 (Constable Road)	0.62	0.00	6.76	1.10	0.00	1.08	5.74	0.08	0 12:20	0 00:00	0.00	0.00
9	MCC_UNKNOWN	3.61	0.00	7.49	0.71	0.00	2.70	6.87	0.09	0 12:24	0 00:00	0.00	0.00
10	MH1 (Constable Road)	3.99	0.00	6.64	1.87	0.00	0.22	4.87	0.10	0 00:00	0 00:00	0.00	0.00
11	MH2 (Constable Road)	2.37	0.00	9.56	1.12	0.00	2.06	8.51	0.07	0 00:00	0 00:00	0.00	0.00
12	MH3 (Constable Road)	2.37	0.74	10.15	0.80	0.00	1.88	9.44	0.09	0 12:20	0 00:00	0.00	0.00
13	MH4 (Constable Road)	1.67	0.00	11.14	0.96	0.00	1.72	10.27	0.09	0 12:20	0 00:00	0.00	0.00
14	MH5 (Constable Road)	1.68	0.53	12.32	0.71	0.00	2.19	11.71	0.10	0 12:20	0 00:00	0.00	0.00
15	MH6 (Constable Road)	0.61	0.00	13.65	2.02	0.00	1.27	12.28	0.65	0 00:00	0 00:00	0.00	0.00

Pipe Input

SN	Element ID	Length (m)	Inlet Invert Elevation (m)	Inlet Invert Offset (m)	Outlet Invert Elevation (m)	Outlet Invert Offset (m)	Total Drop (m)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (mm)	Pipe Width (mm)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cms)	Flap Gate	No. of Barrels
1	{Constable Road}.56610 (Constable Road)	48.15	5.86	0.00	5.42	0.18	0.44	0.9100	CIRCULAR	1070.000	1070.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2	{Constable Road}.69508 (Constable Road)	100.49	6.50	0.00	5.66	0.00	0.84	0.8400	CIRCULAR	530.000	530.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
3	{Constable Road}.8309 (Constable Road)	97.16	4.22	0.00	2.68	0.88	1.54	1.5900	CIRCULAR	1650.000	1650.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
4	{Constable Road}.8538 (Constable Road)	7.66	5.42	0.18	4.68	0.46	0.74	9.6600	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
5	{Constable Road}.8540 (Constable Road)	27.77	5.66	0.00	5.42	0.18	0.24	0.8600	CIRCULAR	530.000	530.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
6	{Constable Road}.8987 (Constable Road)	116.87	6.50	0.00	5.42	0.18	1.08	0.9200	CIRCULAR	460.000	460.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
7	{Constable Road}.8988 downstream	77.16	6.78	0.00	4.24	0.02	2.54	3.2900	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
8	{Constable Road}.LINE 1 (Constable Road)	10.98	4.77	0.00	4.61	0.39	0.16	1.4600	CIRCULAR	1200.000	1200.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
9	{Constable Road}.LINE 2 (Constable Road)	116.43	8.44	0.00	4.82	0.05	3.62	3.1100	CIRCULAR	1200.000	1200.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
10	{Constable Road}.LINE 3 (Constable Road)	85.44	9.30	-0.05	8.49	0.05	0.81	0.9500	CIRCULAR	1200.000	1200.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
11	{Constable Road}.LINE 4 (Constable Road)	66.74	10.00	-0.18	9.61	0.26	0.39	0.5800	CIRCULAR	920.000	920.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
12	{Constable Road}.LINE 5 (Constable Road)	99.80	11.63	0.02	10.33	0.15	1.30	1.3000	CIRCULAR	920.000	920.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
13	{Constable Road}.LINE 6 (Constable Road)	119.11	12.22	0.59	11.69	0.08	0.53	0.4400	CIRCULAR	820.000	820.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
14	45AOLFP	130.28	16.00	0.96	0.00	0.00	16.00	12.2800	CIRCULAR	1500.000	1500.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
15	45Apipe	188.97	15.40	0.36	11.61	0.00	3.79	2.0100	CIRCULAR	750.000	750.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
16	Breakers900Reach	505.33	13.38	0.00	8.55	0.30	4.83	0.9600	CIRCULAR	900.000	900.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
17	MCC 69486	38.02	8.25	0.00	7.36	0.06	0.89	2.3400	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
18	mcc 8988Upstream	78.13	7.30	0.00	6.82	0.04	0.48	0.6100	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow (cms)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cms)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (m/sec)	Travel Time (min)	Peak Flow Depth (m)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	{Constable Road}.56610 (Constable Road)	0.15	0 12:15	2.95	0.05	0.77	1.04	0.30	0.28	0.00		Calculated
2	{Constable Road}.69508 (Constable Road)	0.62	0 12:16	0.44	1.39	2.77	0.60	0.53	1.00	41.00		SURCHARGED
3	{Constable Road}.8309 (Constable Road)	6.96	0 12:24	12.43	0.56	4.93	0.33	1.03	0.63	0.00		Calculated
4	{Constable Road}.8538 (Constable Road)	1.25	0 12:15	13.69	0.09	4.14	0.03	0.58	0.48	0.00		Calculated
5	{Constable Road}.8540 (Constable Road)	0.62	0 12:16	0.45	1.37	2.80	0.17	0.51	0.97	0.00		> CAPACITY
6	{Constable Road}.8987 (Constable Road)	0.48	0 12:21	0.31	1.55	2.93	0.66	0.45	0.98	0.00		> CAPACITY
7	{Constable Road}.8988 downstream	3.63	0 12:24	7.99	0.45	4.15	0.31	0.93	0.77	0.00		Calculated
8	{Constable Road}.LINE 1 (Constable Road)	3.86	0 00:00	5.10	0.76	3.87	0.05	0.89	0.83	0.00		Calculated
9	{Constable Road}.LINE 2 (Constable Road)	3.99	0 00:00	7.45	0.54	4.41	0.44	0.72	0.78	0.00		Calculated
10	{Constable Road}.LINE 3 (Constable Road)	2.37	0 12:20	4.24	0.56	3.35	0.43	0.72	0.71	0.00		Calculated
11	{Constable Road}.LINE 4 (Constable Road)	1.67	0 12:20	1.91	0.87	2.84	0.39	0.79	0.86	0.00		Calculated
12	{Constable Road}.LINE 5 (Constable Road)	1.67	0 12:18	2.36	0.71	3.17	0.52	0.75	0.82	0.00		Calculated
13	{Constable Road}.LINE 6 (Constable Road)	1.08	0 00:00	1.04	1.04	2.27	0.87	0.56	0.88	0.00		> CAPACITY
14	45AOLFP	0.00	0 00:00	26.84	0.00	0.00		0.00	0.00	0.00		Calculated
15	45Apipe	0.53	0 12:20	1.71	0.31	1.76	1.79	0.50	0.67	0.00		Calculated
16	Breakers900Reach	1.79	0 12:51	1.92	0.94	3.31	2.54	0.72	0.82	0.00		Calculated
17	MCC_69486	3.61	0 12:25	6.74	0.54	3.09	0.21	1.22	1.00	8.00		SURCHARGED
18	mcc_8988Upstream	3.61	0 12:25	3.45	1.04	3.20	0.41	1.12	0.92	0.00		> CAPACITY

Storage Nodes

Storage Node : Dadditional

Input Data

Invert Elevation (m) 15.00
Max (Rim) Elevation (m) 18.00
Max (Rim) Offset (m) 3.00
Initial Water Elevation (m) 10.00
Initial Water Depth (m) .... -5.00
Ponded Area (m²) 0.00
Evaporation Loss 0.00

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (mm)	Rectangular Orifice Height (mm)	Rectangular Orifice Width (mm)	Orifice Invert Elevation (m)	Orifice Coefficient
1	D add 10yr	Side	CIRCULAR	No	600.00			15.75	0.61
2	D add 95th	Side	CIRCULAR	No	80.00			15.00	0.61
3	Orifice-06	Bottom	CIRCULAR	No	2000.00			16.10	0.61

Output Summary Results

Peak Inflow (cms) 0.61
Peak Lateral Inflow (cms) 0.50
Peak Outflow (cms) 0.61
Peak Exfiltration Flow Rate (cmm) 0.00
Max HGL Elevation Attained (m) 16.19
Max HGL Depth Attained (m) 1.19
Average HGL Elevation Attained (m) 15.38
Average HGL Depth Attained (m) 0.38
Time of Max HGL Occurrence (days hh:mm) 0 12:17
Total Exfiltration Volume (1000-m³) 0.000
Total Flooded Volume (ha-mm) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0.00

Storage Node : D-Tanks

Input Data

Invert Elevation (m) 20.00
Max (Rim) Elevation (m) 22.00
Max (Rim) Offset (m) 2.00
Initial Water Elevation (m) 20.80
Initial Water Depth (m) 0.80
Ponded Area (m²) 0.00
Evaporation Loss 0.00

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (mm)	Rectangular Orifice Height (mm)	Rectangular Orifice Width (mm)	Orifice Invert Elevation (m)	Orifice Coefficient
1	D-tanks1	Bottom	CIRCULAR	No	2000.00			21.00	100.00

Output Summary Results

Peak Inflow (cms) 0.12
Peak Lateral Inflow (cms) 0.12
Peak Outflow (cms) 0.12
Peak Exfiltration Flow Rate (cmm) 0.00
Max HGL Elevation Attained (m) 21.04
Max HGL Depth Attained (m) 1.04
Average HGL Elevation Attained (m) 20.87
Average HGL Depth Attained (m) 0.87
Time of Max HGL Occurrence (days hh:mm) 0 12:17
Total Exfiltration Volume (1000-m³) 0.000
Total Flooded Volume (ha-mm) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0.00

Storage Node : MCC_72542 (Constable Road)up

Input Data

Invert Elevation (m) 6.50
Max (Rim) Elevation (m) 8.78
Max (Rim) Offset (m) 2.28
Initial Water Elevation (m) 6.50
Initial Water Depth (m) 0.00
Ponded Area (m²) 0.00
Evaporation Loss 0.00

Output Summary Results

Peak Inflow (cms) 1.65
Peak Lateral Inflow (cms) 1.65
Peak Outflow (cms) 1.10
Peak Exfiltration Flow Rate (cmm) 0.00
Max HGL Elevation Attained (m) 8.78
Max HGL Depth Attained (m) 2.28
Average HGL Elevation Attained (m) 6.60
Average HGL Depth Attained (m) 0.1
Time of Max HGL Occurrence (days hh:mm) 0 12:12
Total Exfiltration Volume (1000-m³) 0.000
Total Flooded Volume (ha-mm) 37.00
Total Time Flooded (min) 18
Total Retention Time (sec) 0.00

Appendix A7

Constable Road Stormwater (1% AEP Post Development)

Project Description

File Name .... 32897 Constable road.SPF
Description ....
P:\32 series\32897 Brookdale Waiuku PPC\02 Civil3D Models\32897 Model SW constable road.dwg

Project Options

Flow Units .... CMS
Elevation Type .... Elevation
Hydrology Method HEC-1
HEC-1 unit hydrograph method .... SCS Dimensionless
HEC-1 loss method .... SCS Curve Number
Link Routing Method .... Hydrodynamic
Enable Overflow Ponding at Nodes .... YES
Skip Steady State Analysis Time Periods .. NO

Analysis Options

Start Analysis On	Jun 04, 2021	00:00:00
End Analysis On	Jun 06, 2021	00:00:00
Start Reporting On	Jun 04, 2021	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	2	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins..	21
Nodes..	21
Junctions	15
Outfalls	2
Flow Diversions	1
Inlets	0
Storage Nodes	3
Links..	23
Channels	0
Pipes	18
Pumps	0
Orifices	4
Weirs	0
Outlets	1
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (mm)	Rainfall Distribution
1	Rain	Time Series	100yr	Cumulative	mm				0.00	

Subbasin Summary

SN	Subbasin ID	Area (ha)	Total Rainfall (mm)	Total Runoff (mm)	Total Runoff Volume (ha-mm)	Peak Runoff (cms)
1	Sub-45A-Imp	1.98	218.49	212.52	420.79	0.68
2	Sub-45A-perv	1.32	218.49	121.01	159.73	0.24
3	Sub-45imp	1.98	218.49	212.52	420.79	0.68
4	Sub-45perv	1.32	218.49	120.99	159.70	0.24
5	Sub-55612	0.72	218.49	205.35	148.21	0.25
6	Sub-69474-imp	10.80	218.49	212.35	2293.42	3.32
7	Sub-69474-perv	7.20	218.49	121.22	872.78	1.14
8	Sub-72542-Imp	7.00	218.49	212.38	1486.63	2.31
9	Sub-72542-Perv	3.00	218.49	121.35	364.04	0.45
10	Sub-C2-imp	0.28	218.49	214.80	59.54	0.10
11	Sub-C2-perv	0.26	218.49	118.28	31.23	0.06
12	Sub-C2-roof	0.12	218.49	210.53	24.93	0.04
13	Sub-D1-Imp	0.54	218.49	211.54	113.81	0.19
14	Sub-D1-perv	0.95	218.49	121.15	115.34	0.20
15	Sub-D1-Roof	0.23	218.49	208.41	47.93	0.08
16	Sub-E1-imp	0.45	218.49	211.24	95.06	0.16
17	Sub-E1-perv	0.93	218.49	120.57	112.13	0.20
18	Sub-E1-Roof	0.19	218.49	211.08	40.11	0.07
19	Sub-grassUpstream-imp	32.00	218.49	121.22	3879.14	3.62
20	Sub-School-Imp	2.80	218.49	212.59	595.25	0.97
21	Sub-School-perv	1.20	218.49	121.31	145.57	0.25

Node Summary

SN	Element ID	Element Type	Invert Elevation (m)	Ground/Rim (Max) Elevation (m)	Initial Water Elevation (m)	Surcharge Elevation (m)	Ponded Area (m²)	Peak Inflow (cms)	Max HGL Elevation Attained (m)	Max Surcharge Depth Attained (m)	Min Freeboard Attained (m)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ha-mm)	Total Time Flooded (min)
1	45AInlet	Junction	15.04	20.33	0.00	0.00	0.00	0.00	15.04	0.00	5.29	0 00:00	0.00	0.00
2	Breakers900	Junction	13.38	15.00	0.00	0.00	0.00	3.62	15.00	0.00	0.00	0 12:45	441.52	73.00
3	MC 55612 (Constable Road)	Junction	5.86	8.42	5.86	8.42	0.00	0.24	6.07	0.00	2.35	0 00:00	0.00	0.00
4	MCC 69473	Junction	8.25	10.80	0.00	0.00	0.00	6.02	10.80	0.00	0.00	0 12:20	113.97	23.00
5	MCC_69474 (Constable Road)	Junction	7.30	10.48	7.30	0.00	0.00	4.60	9.67	0.00	0.81	0 00:00	0.00	0.00
6	MCC 7359 (Constable Road)	Junction	4.22	6.86	4.22	6.86	0.00	9.58	6.04	0.00	0.82	0 00:00	0.00	0.00
7	MCC 7362 (Constable Road)	Junction	5.24	7.27	5.24	7.27	0.00	1.34	6.05	0.00	1.22	0 00:00	0.00	0.00
8	MCC_7364 (Constable Road)	Junction	5.66	7.83	5.66	7.83	0.00	0.62	6.85	0.00	0.98	0 00:00	0.00	0.00
9	MCC UNKNOWN	Junction	6.78	10.19	0.00	0.00	0.00	4.60	7.78	0.00	2.41	0 00:00	0.00	0.00
10	MH1 (Constable Road)	Junction	4.77	6.87	5.00	6.87	0.00	3.99	6.66	0.00	0.21	0 00:00	0.00	0.00
11	MH2 (Constable Road)	Junction	8.44	11.61	9.56	11.61	0.00	3.69	9.56	0.00	2.06	0 00:00	0.00	0.00
12	MH3 (Constable Road)	Junction	9.35	12.03	10.00	11.84	0.00	3.69	11.22	0.00	0.81	0 00:00	0.00	0.00
13	MH4 (Constable Road)	Junction	10.18	12.86	10.35	12.73	0.00	2.50	12.69	0.00	0.17	0 00:00	0.00	0.00
14	MH5 (Constable Road)	Junction	11.61	14.51	12.05	14.17	0.00	2.55	14.51	0.00	0.00	0 12:11	1.91	6.00
15	MH6 (Constable Road)	Junction	11.63	14.92	13.65	14.92	0.00	1.06	14.92	0.00	0.00	0 12:16	11.62	9.00
16	45AOLFP	Outfall	0.00					0.00	0.00					
17	Out-MCC 9577 (Constable Road)	Outfall	1.81					9.58	1.80					
18	45A-div	Flow Diversions	15.04	20.33	0.00		0.00	0.88	15.91				0.00	0.00
19	Dadditional	Storage Node	15.00	18.00	10.00		0.00	1.06	16.26				0.00	0.00
20	D-Tanks	Storage Node	20.00	22.00	20.80		0.00	0.18	21.06				0.00	0.00
21	MCC_72542 (Constable Road)up	Storage Node	6.50	8.78	6.50		0.00	2.66	8.78				189.52	41.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (m)	Inlet Invert Elevation (m)	Outlet Invert Elevation (m)	Average Slope (%)	Diameter or Height (mm)	Manning's Roughness	Peak Flow (cms)	Design Flow Capacity (cms)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (m/sec)	Peak Flow Depth (m)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	{Constable Road}.56610 (Constable Road)	Pipe	MC 55612 (Constable Road)	MCC 7362 (Constable Road)	48.15	5.86	5.42	0.9100	1067.000	0.0120	0.24	2.95	0.08	1.07	0.41	0.39	0.00	Calculated
2	{Constable Road}.69508 (Constable Road)	Pipe	MCC_72542 (Constable Road)up	MCC_7364 (Constable Road)	100.49	6.50	5.66	0.8400	533.000	0.0120	0.62	0.44	1.40	2.77	0.53	1.00	78.00	SURCHARGED
3	{Constable Road}.8309 (Constable Road)	Pipe	MCC 7359 (Constable Road)	Out-MCC 9577 (Constable Road)	97.16	4.22	2.68	1.5900	1650.000	0.0120	9.58	12.43	0.77	5.10	1.37	0.83	0.00	Calculated
4	{Constable Road}.8538 (Constable Road)	Pipe	MCC 7362 (Constable Road)	MCC 7359 (Constable Road)	7.66	5.42	4.68	9.6600	1219.000	0.0120	1.32	13.69	0.10	4.04	0.92	0.76	0.00	Calculated
5	{Constable Road}.8540 (Constable Road)	Pipe	MCC_7364 (Constable Road)	MCC_7362 (Constable Road)	27.77	5.66	5.42	0.8600	533.000	0.0120	0.62	0.45	1.37	2.80	0.53	1.00	8.00	SURCHARGED
6	{Constable Road}.8987 (Constable Road)	Pipe	MCC 72542 (Constable Road)up	MCC 7362 (Constable Road)	116.87	6.50	5.42	0.9200	457.000	0.0120	0.48	0.31	1.55	2.93	0.46	1.00	10.00	SURCHARGED
7	{Constable Road}.8988 downstream	Pipe	MCC UNKNOWN	MCC 7359 (Constable Road)	77.16	6.78	4.24	3.2900	1219.000	0.0120	4.62	7.99	0.58	4.31	1.11	0.91	0.00	Calculated
8	{Constable Road}.LINE 1 (Constable Road)	Pipe	MH1 (Constable Road)	MCC_7359 (Constable Road)	10.98	4.77	4.61	1.4600	1200.000	0.0120	3.86	5.10	0.76	3.87	1.20	1.00	12.00	SURCHARGED
9	{Constable Road}.LINE 2 (Constable Road)	Pipe	MH2 (Constable Road)	MH1 (Constable Road)	116.43	8.44	4.82	3.1100	1200.000	0.0120	3.99	7.45	0.54	4.41	0.96	0.80	0.00	Calculated
10	{Constable Road}.LINE 3 (Constable Road)	Pipe	MH3 (Constable Road)	MH2 (Constable Road)	85.44	9.30	8.49	0.9500	1200.000	0.0120	3.69	4.24	0.87	3.57	1.03	0.86	0.00	Calculated
11	{Constable Road}.LINE 4 (Constable Road)	Pipe	MH4 (Constable Road)	MH3 (Constable Road)	66.74	10.00	9.61	0.5800	918.000	0.0120	2.50	1.91	1.31	3.78	0.92	1.00	9.00	SURCHARGED
12	{Constable Road}.LINE 5 (Constable Road)	Pipe	MH5 (Constable Road)	MH4 (Constable Road)	99.80	11.63	10.33	1.3000	918.000	0.0120	2.50	2.36	1.06	3.78	0.92	1.00	19.00	SURCHARGED
13	{Constable Road}.LINE 6 (Constable Road)	Pipe	MH6 (Constable Road)	MH5 (Constable Road)	119.11	12.22	11.69	0.4400	825.000	0.0120	1.08	1.04	1.04	2.27	0.82	1.00	17.00	SURCHARGED
14	45AOLFP	Pipe	45A-div	45AOLFP	130.28	16.00	0.00	12.2800	1500.000	0.0120	0.00	26.84	0.00	0.00	0.00	0.00	0.00	Calculated
15	45Apipe	Pipe	45A-div	MH5 (Constable Road)	188.97	15.40	11.61	2.0100	750.000	0.0120	0.88	1.71	0.52	2.23	0.63	0.84	0.00	Calculated
16	Breakers900Reach	Pipe	Breakers900	MCC 69473	505.33	13.38	8.55	0.9600	900.000	0.0120	2.04	1.92	1.06	3.33	0.90	1.00	39.00	SURCHARGED
17	MCC 69486	Pipe	MCC 69473	MCC 69474 (Constable Road)	38.02	8.25	7.36	2.3400	1219.000	0.0120	4.60	6.74	0.68	3.94	1.22	1.00	47.00	SURCHARGED
18	mcc_8988Upstream	Pipe	MCC_69474 (Constable Road)	MCC_UNKNOWN	78.13	7.30	6.82	0.6100	1219.000	0.0120	4.60	3.45	1.33	4.00	1.17	0.96	0.00	> CAPACITY
19	D add 10yr	Orifice	Dadditional	MH6 (Constable Road)		15.00	11.63		600.000		0.33							
20	D add 95th	Orifice	Dadditional	MH6 (Constable Road)		15.00	11.63		80.000		0.02							
21	D-tanks1	Orifice	D-Tanks	Dadditional		20.00	15.00		2000.000		0.18							
22	Orifice-06	Orifice	Dadditional	MH6 (Constable Road)		15.00	11.63		2000.000		0.72							
23	Dtanksoutlet	Outlet	D-Tanks	Dadditional		20.00	15.00				0.01							

Junction Input

SN	Element ID	Invert Elevation (m)	Ground/Rim (Max) Elevation (m)	Ground/Rim (Max) Offset (m)	Initial Water Elevation (m)	Initial Water Depth (m)	Surcharge Elevation (m)	Surcharge Depth (m)	Ponded Area (m²)	Minimum Pipe Cover (mm)
1	45AInlet	15.04	20.33	5.29	0.00	-15.04	0.00	-20.33	0.00	0.00
2	Breakers900	13.38	15.00	1.62	0.00	-13.38	0.00	-15.00	0.00	720.00
3	MC_55612 (Constable Road)	5.86	8.42	2.56	5.86	0.00	8.42	0.00	0.00	1493.00
4	MCC_69473	8.25	10.80	2.55	0.00	-8.25	0.00	-10.80	0.00	1331.00
5	MCC_69474 (Constable Road)	7.30	10.48	3.18	7.30	0.00	0.00	-10.48	0.00	1901.00
6	MCC_7359 (Constable Road)	4.22	6.86	2.64	4.22	0.00	6.86	0.00	0.00	958.00
7	MCC_7362 (Constable Road)	5.24	7.27	2.03	5.24	0.00	7.27	0.00	0.00	631.00
8	MCC_7364 (Constable Road)	5.66	7.83	2.17	5.66	0.00	7.83	0.00	0.00	1640.00
9	MCC_UNKNOWN	6.78	10.19	3.41	0.00	-6.78	0.00	-10.19	0.00	2151.00
10	MH1 (Constable Road)	4.77	6.87	2.10	5.00	0.23	6.87	0.00	0.00	849.00
11	MH2 (Constable Road)	8.44	11.61	3.17	9.56	1.12	11.61	0.00	0.00	1924.00
12	MH3 (Constable Road)	9.35	12.03	2.68	10.00	0.65	11.84	-0.19	0.00	1502.00
13	MH4 (Constable Road)	10.18	12.86	2.68	10.35	0.17	12.73	-0.13	0.00	1612.00
14	MH5 (Constable Road)	11.61	14.51	2.90	12.05	0.44	14.17	-0.35	0.00	1962.00
15	MH6 (Constable Road)	11.63	14.92	3.29	13.65	2.02	14.92	0.00	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cms)	Peak Lateral Inflow (cms)	Max HGL Elevation Attained (m)	Max HGL Depth Attained (m)	Max Surcharge Depth Attained (m)	Min Freeboard Attained (m)	Average HGL Elevation Attained (m)	Average HGL Depth Attained (m)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ha-mm)	Total Time Flooded (min)
1	45AInlet	0.00	0.00	15.04	0.00	0.00	5.29	15.04	0.00	0 00:00	0 00:00	0.00	0.00
2	Breakers900	3.62	3.62	15.00	1.62	0.00	0.00	13.55	0.17	0 12:19	0 12:45	441.52	73.00
3	MC 55612 (Constable Road)	0.24	0.24	6.07	0.21	0.00	2.35	5.89	0.03	0 12:15	0 00:00	0.00	0.00
4	MCC 69473	6.02	4.32	10.80	2.55	0.00	0.00	8.45	0.20	0 12:09	0 12:20	113.97	23.00
5	MCC_69474 (Constable Road)	4.60	0.00	9.67	2.37	0.00	0.81	7.54	0.24	0 12:09	0 00:00	0.00	0.00
6	MCC 7359 (Constable Road)	9.58	0.00	6.04	1.82	0.00	0.82	4.43	0.21	0 12:17	0 00:00	0.00	0.00
7	MCC 7362 (Constable Road)	1.34	0.00	6.05	0.81	0.00	1.22	5.49	0.25	0 12:17	0 00:00	0.00	0.00
8	MCC_7364 (Constable Road)	0.62	0.00	6.85	1.19	0.00	0.98	5.78	0.12	0 12:17	0 00:00	0.00	0.00
9	MCC UNKNOWN	4.60	0.00	7.78	1.00	0.00	2.41	6.91	0.13	0 12:17	0 00:00	0.00	0.00
10	MH1 (Constable Road)	3.99	0.00	6.66	1.89	0.00	0.21	4.91	0.14	0 12:17	0 00:00	0.00	0.00
11	MH2 (Constable Road)	3.69	0.00	9.56	1.12	0.00	2.06	8.53	0.09	0 00:00	0 00:00	0.00	0.00
12	MH3 (Constable Road)	3.69	1.21	11.22	1.87	0.00	0.81	9.47	0.12	0 12:14	0 00:00	0.00	0.00
13	MH4 (Constable Road)	2.50	0.00	12.69	2.51	0.00	0.17	10.31	0.13	0 12:14	0 00:00	0.00	0.00
14	MH5 (Constable Road)	2.55	0.89	14.51	2.90	0.00	0.00	11.75	0.14	0 12:11	0 12:11	1.91	6.00
15	MH6 (Constable Road)	1.06	0.00	14.92	3.29	0.00	0.00	12.32	0.69	0 12:14	0 12:16	11.62	9.00

Pipe Input

SN	Element ID	Length (m)	Inlet Invert Elevation (m)	Inlet Invert Offset (m)	Outlet Invert Elevation (m)	Outlet Invert Offset (m)	Total Drop (m)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (mm)	Pipe Width (mm)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cms)	Flap Gate	No. of Barrels
1	{Constable Road}.56610 (Constable Road)	48.15	5.86	0.00	5.42	0.18	0.44	0.9100	CIRCULAR	1070.000	1070.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2	{Constable Road}.69508 (Constable Road)	100.49	6.50	0.00	5.66	0.00	0.84	0.8400	CIRCULAR	530.000	530.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
3	{Constable Road}.8309 (Constable Road)	97.16	4.22	0.00	2.68	0.88	1.54	1.5900	CIRCULAR	1650.000	1650.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
4	{Constable Road}.8538 (Constable Road)	7.66	5.42	0.18	4.68	0.46	0.74	9.6600	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
5	{Constable Road}.8540 (Constable Road)	27.77	5.66	0.00	5.42	0.18	0.24	0.8600	CIRCULAR	530.000	530.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
6	{Constable Road}.8987 (Constable Road)	116.87	6.50	0.00	5.42	0.18	1.08	0.9200	CIRCULAR	460.000	460.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
7	{Constable Road}.8988 downstream	77.16	6.78	0.00	4.24	0.02	2.54	3.2900	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
8	{Constable Road}.LINE 1 (Constable Road)	10.98	4.77	0.00	4.61	0.39	0.16	1.4600	CIRCULAR	1200.000	1200.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
9	{Constable Road}.LINE 2 (Constable Road)	116.43	8.44	0.00	4.82	0.05	3.62	3.1100	CIRCULAR	1200.000	1200.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
10	{Constable Road}.LINE 3 (Constable Road)	85.44	9.30	-0.05	8.49	0.05	0.81	0.9500	CIRCULAR	1200.000	1200.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
11	{Constable Road}.LINE 4 (Constable Road)	66.74	10.00	-0.18	9.61	0.26	0.39	0.5800	CIRCULAR	920.000	920.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
12	{Constable Road}.LINE 5 (Constable Road)	99.80	11.63	0.02	10.33	0.15	1.30	1.3000	CIRCULAR	920.000	920.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
13	{Constable Road}.LINE 6 (Constable Road)	119.11	12.22	0.59	11.69	0.08	0.53	0.4400	CIRCULAR	820.000	820.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
14	45AOLFP	130.28	16.00	0.96	0.00	0.00	16.00	12.2800	CIRCULAR	1500.000	1500.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
15	45Apipe	188.97	15.40	0.36	11.61	0.00	3.79	2.0100	CIRCULAR	750.000	750.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
16	Breakers900Reach	505.33	13.38	0.00	8.55	0.30	4.83	0.9600	CIRCULAR	900.000	900.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
17	MCC 69486	38.02	8.25	0.00	7.36	0.06	0.89	2.3400	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
18	mcc 8988Upstream	78.13	7.30	0.00	6.82	0.04	0.48	0.6100	CIRCULAR	1220.000	1220.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow (cms)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cms)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (m/sec)	Travel Time (min)	Peak Flow Depth (m)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	{Constable Road}.56610 (Constable Road)	0.24	0 12:15	2.95	0.08	1.07	0.75	0.41	0.39	0.00		Calculated
2	{Constable Road}.69508 (Constable Road)	0.62	0 12:15	0.44	1.40	2.77	0.60	0.53	1.00	78.00		SURCHARGED
3	{Constable Road}.8309 (Constable Road)	9.58	0 12:17	12.43	0.77	5.10	0.32	1.37	0.83	0.00		Calculated
4	{Constable Road}.8538 (Constable Road)	1.32	0 12:14	13.69	0.10	4.04	0.03	0.92	0.76	0.00		Calculated
5	{Constable Road}.8540 (Constable Road)	0.62	0 12:15	0.45	1.37	2.80	0.17	0.53	1.00	8.00		SURCHARGED
6	{Constable Road}.8987 (Constable Road)	0.48	0 12:08	0.31	1.55	2.93	0.66	0.46	1.00	10.00		SURCHARGED
7	{Constable Road}.8988 downstream	4.62	0 12:26	7.99	0.58	4.31	0.30	1.11	0.91	0.00		Calculated
8	{Constable Road}.LINE 1 (Constable Road)	3.86	0 00:00	5.10	0.76	3.87	0.05	1.20	1.00	12.00		SURCHARGED
9	{Constable Road}.LINE 2 (Constable Road)	3.99	0 00:00	7.45	0.54	4.41	0.44	0.96	0.80	0.00		Calculated
10	{Constable Road}.LINE 3 (Constable Road)	3.69	0 12:14	4.24	0.87	3.57	0.40	1.03	0.86	0.00		Calculated
11	{Constable Road}.LINE 4 (Constable Road)	2.50	0 12:14	1.91	1.31	3.78	0.29	0.92	1.00	9.00		SURCHARGED
12	{Constable Road}.LINE 5 (Constable Road)	2.50	0 12:14	2.36	1.06	3.78	0.44	0.92	1.00	19.00		SURCHARGED
13	{Constable Road}.LINE 6 (Constable Road)	1.08	0 00:00	1.04	1.04	2.27	0.87	0.82	1.00	17.00		SURCHARGED
14	45AOLFP	0.00	0 00:00	26.84	0.00	0.00		0.00	0.00	0.00		Calculated
15	45Apipe	0.88	0 12:20	1.71	0.52	2.23	1.41	0.63	0.84	0.00		Calculated
16	Breakers900Reach	2.04	0 13:01	1.92	1.06	3.33	2.53	0.90	1.00	39.00		SURCHARGED
17	MCC 69486	4.60	0 12:14	6.74	0.68	3.94	0.16	1.22	1.00	47.00		SURCHARGED
18	mcc_8988Upstream	4.60	0 12:14	3.45	1.33	4.00	0.33	1.17	0.96	0.00		> CAPACITY

Storage Nodes

Storage Node : Dadditional

Input Data

Invert Elevation (m) 15.00
Max (Rim) Elevation (m) 18.00
Max (Rim) Offset (m) 3.00
Initial Water Elevation (m) 10.00
Initial Water Depth (m) .... -5.00
Ponded Area (m²) 0.00
Evaporation Loss 0.00

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (mm)	Rectangular Orifice Height (mm)	Rectangular Orifice Width (mm)	Orifice Invert Elevation (m)	Orifice Coefficient
1	D add 10yr	Side	CIRCULAR	No	600.00			15.75	0.61
2	D add 95th	Side	CIRCULAR	No	80.00			15.00	0.61
3	Orifice-06	Bottom	CIRCULAR	No	2000.00			16.10	0.61

Output Summary Results

Peak Inflow (cms) 1.06
Peak Lateral Inflow (cms) 0.89
Peak Outflow (cms) 1.06
Peak Exfiltration Flow Rate (cmm) 0.00
Max HGL Elevation Attained (m) 16.26
Max HGL Depth Attained (m) 1.26
Average HGL Elevation Attained (m) 15.45
Average HGL Depth Attained (m) 0.45
Time of Max HGL Occurrence (days hh:mm) 0 12:16
Total Exfiltration Volume (1000-m³) 0.000
Total Flooded Volume (ha-mm) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0.00

Storage Node : D-Tanks

Input Data

Invert Elevation (m) 20.00
Max (Rim) Elevation (m) 22.00
Max (Rim) Offset (m) 2.00
Initial Water Elevation (m) 20.80
Initial Water Depth (m) 0.80
Ponded Area (m²) 0.00
Evaporation Loss 0.00

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (mm)	Rectangular Orifice Height (mm)	Rectangular Orifice Width (mm)	Orifice Invert Elevation (m)	Orifice Coefficient
1	D-tanks1	Bottom	CIRCULAR	No	2000.00			21.00	100.00

Output Summary Results

Peak Inflow (cms) 0.18
Peak Lateral Inflow (cms) 0.18
Peak Outflow (cms) 0.18
Peak Exfiltration Flow Rate (cmm) 0.00
Max HGL Elevation Attained (m) 21.06
Max HGL Depth Attained (m) 1.06
Average HGL Elevation Attained (m) 20.89
Average HGL Depth Attained (m) 0.89
Time of Max HGL Occurrence (days hh:mm) 0 12:17
Total Exfiltration Volume (1000-m³) 0.000
Total Flooded Volume (ha-mm) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0.00

Storage Node : MCC_72542 (Constable Road)up

Input Data

Invert Elevation (m) 6.50
Max (Rim) Elevation (m) 8.78
Max (Rim) Offset (m) 2.28
Initial Water Elevation (m) 6.50
Initial Water Depth (m) 0.00
Ponded Area (m²) 0.00
Evaporation Loss 0.00

Output Summary Results

Peak Inflow (cms) 2.66
Peak Lateral Inflow (cms) 2.66
Peak Outflow (cms) 1.10
Peak Exfiltration Flow Rate (cmm) 0.00
Max HGL Elevation Attained (m) 8.78
Max HGL Depth Attained (m) 2.28
Average HGL Elevation Attained (m) 6.64
Average HGL Depth Attained (m) 0.14
Time of Max HGL Occurrence (days hh:mm) 0 12:03
Total Exfiltration Volume (1000-m³) 0.000
Total Flooded Volume (ha-mm) 189.52
Total Time Flooded (min) 41
Total Retention Time (sec) 0.00

Appendix A8

Constable Road Stormwater Overflows Summary

CONSTABLE ROAD MODEL RESULTS

Predevelopment 10% AEP Flooding Summary

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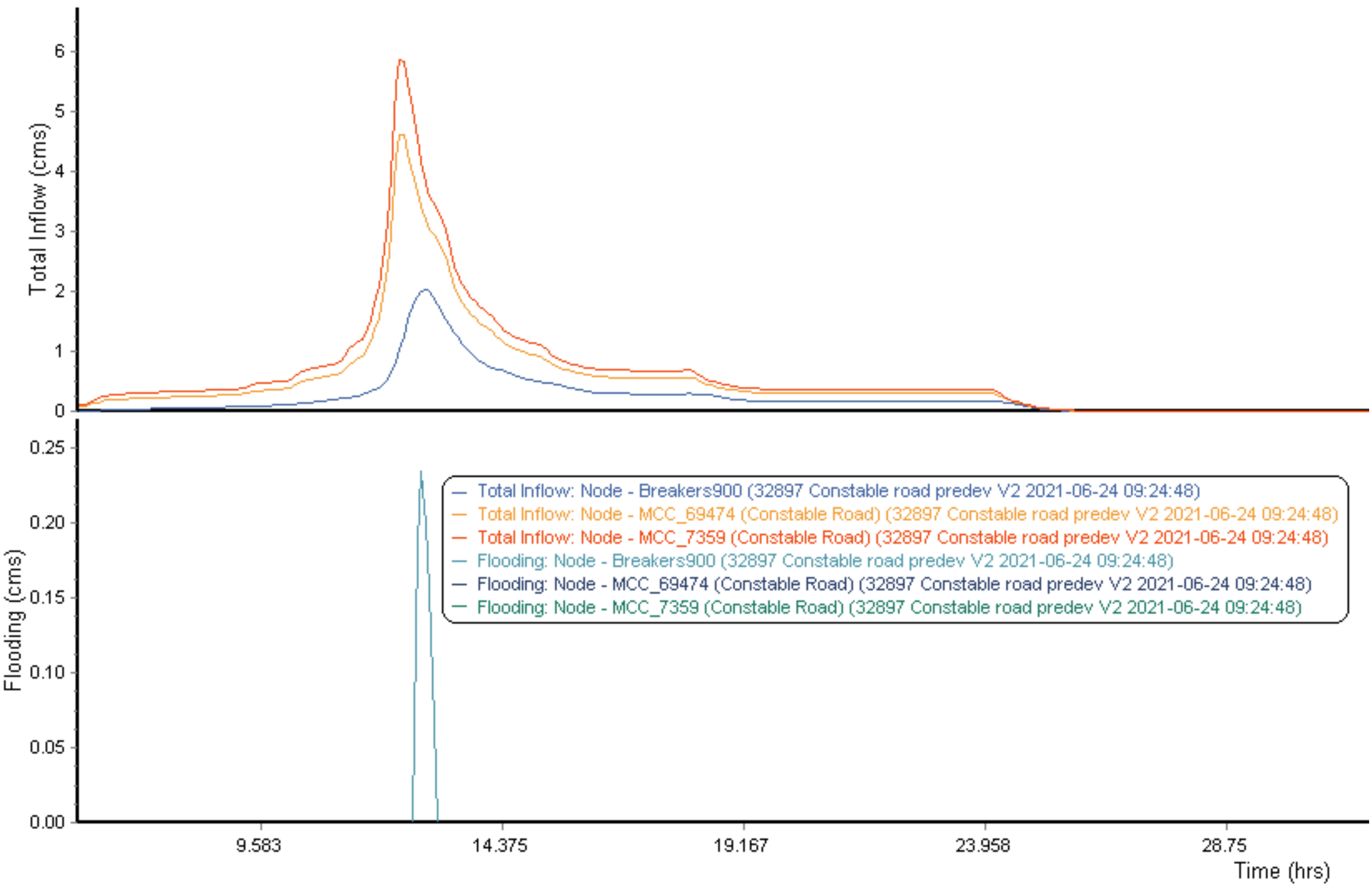
Flooding at Key Nodes



Flooding Summary Table

/2021, 12:00:00 AM

/2021, 12:00:00 AM

Element ID	Breakers900	MCC_69474 (Constable Road)	MCC_7359 (Constable Road)
Maximum Flooding (cms)	0.23	0.00	0.00
Minimum Flooding (cms)	0.00	0.00	0.00
Event Mean Flooding (cms)	0.00	0.00	0.00
Duration of Exceedances (hrs)	N/A	N/A	N/A
Duration of Deficits (hrs)	N/A	N/A	N/A
Number of Exceedances	N/A	N/A	N/A
Number of Deficits	N/A	N/A	N/A
Volume of Exceedance (m³)	N/A	N/A	N/A
Volume of Deficit (m³)	N/A	N/A	N/A
Total Flooding (m³)	252.47	0	0
Detention Storage (m³)	N/A	N/A	N/A

CONSTABLE ROAD MODEL RESULTS

Predevelopment 1% AEP Flooding Summary

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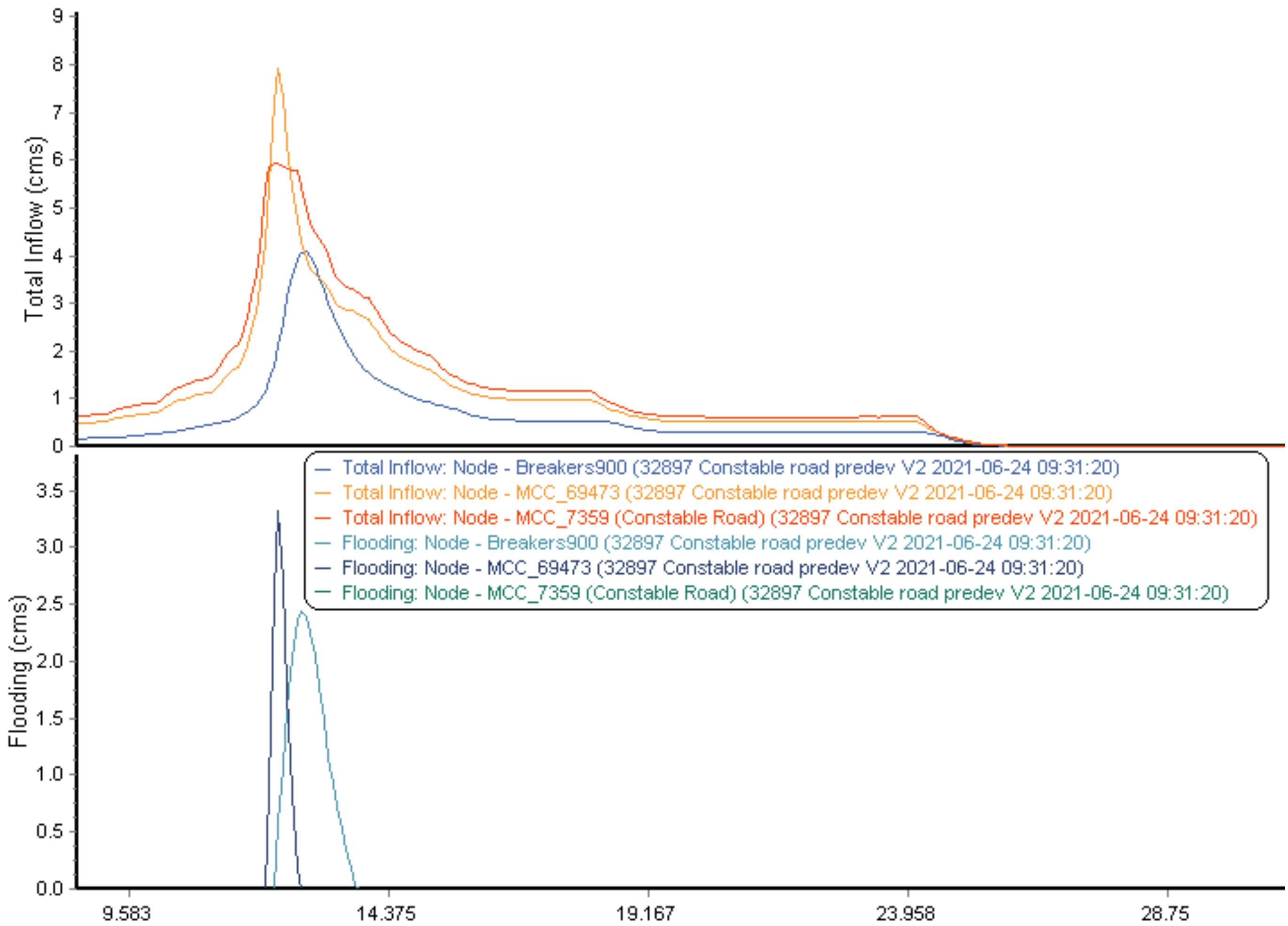
Flooding at Key Nodes

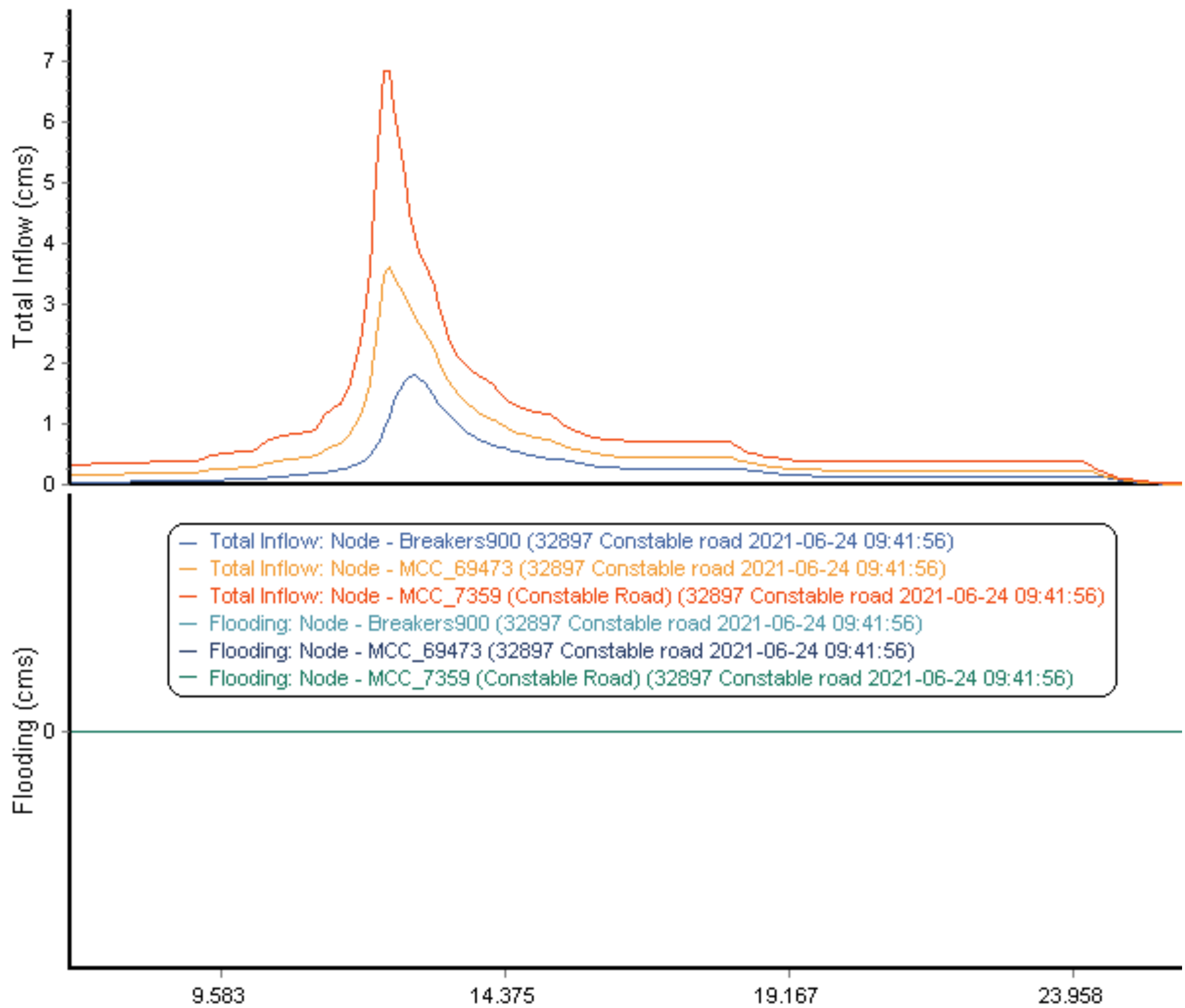


Flooding Sum

06/04/2021, 12:00:00 AM
06/06/2021, 12:00:00 AM

Element ID	Breakers900	MCC_69473	MCC_7359 (Constable Road)
Maximum Flooding (cms)	2.44	3.32	0.00
Minimum Flooding (cms)	0.00	0.00	0.00
Event Mean Flooding (cms)	0.04	0.02	0.00
Duration of Exceedances (hrs)	N/A	N/A	N/A
Duration of Deficits (hrs)	N/A	N/A	N/A
Number of Exceedances	N/A	N/A	N/A
Number of Deficits	N/A	N/A	N/A
Volume of Exceedance (m³)	N/A	N/A	N/A
Volume of Deficit (m³)	N/A	N/A	N/A
Total Flooding (m³)	7168.48	3672.58	0
Detention Storage (m³)	N/A	N/A	N/A

Flooding at Key Nodes



/2021, 12:00:00 AM
/2021, 12:00:00 AM

Element ID	Breakers900	MCC_69473	MCC_7359 (Constable Road)
Maximum Flooding (cms)	0.00	0.00	0.00
Minimum Flooding (cms)	0.00	0.00	0.00
Event Mean Flooding (cms)	0.00	0.00	0.00
Duration of Exceedances (hrs)	N/A	N/A	N/A
Duration of Deficits (hrs)	N/A	N/A	N/A
Number of Exceedances	N/A	N/A	N/A
Number of Deficits	N/A	N/A	N/A
Volume of Exceedance (m³)	N/A	N/A	N/A
Volume of Deficit (m³)	N/A	N/A	N/A
Total Flooding (m³)	0	0	0
Detention Storage (m³)	N/A	N/A	N/A

CONSTABLE ROAD MODEL RESULTS

Post Development 1% AEP Flooding Summary

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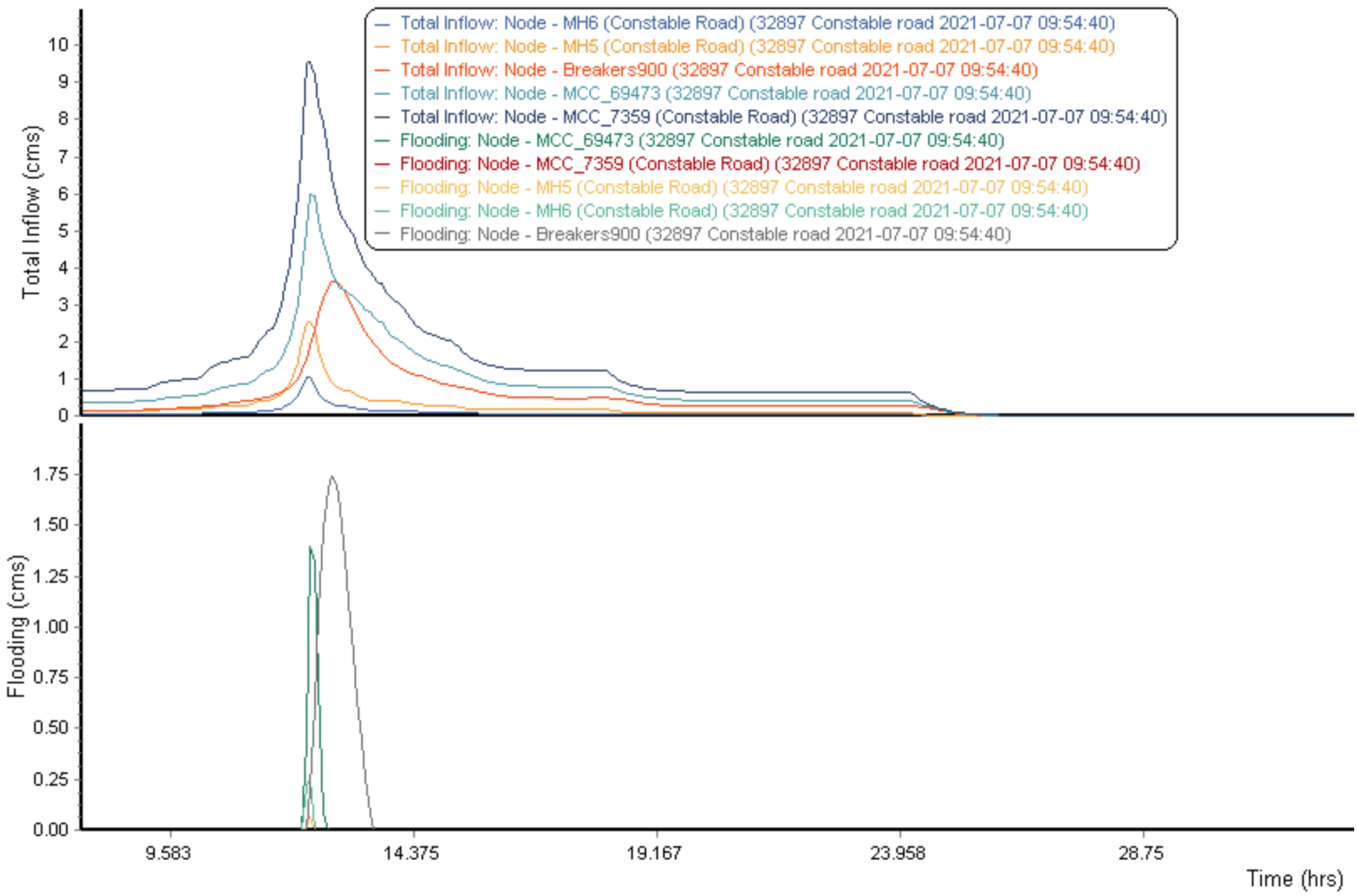
Flooding at Key Nodes



Flooding Summary Table

'2021, 12:00:00 AM

'2021, 12:00:00 AM

Element ID	MCC_69473	MCC_7359 (Constable Road)	MH5 (Constable Road)	MH6 (Constable Road)	Breakers900
Maximum Flooding (cms)	1.40	0.00	0.06	0.26	1.74
Minimum Flooding (cms)	0.00	0.00	0.00	0.00	0.00
Event Mean Flooding (cms)	0.01	0.00	0.00	0.00	0.03
Duration of Exceedances (hrs)	N/A	N/A	N/A	N/A	N/A
Duration of Deficits (hrs)	N/A	N/A	N/A	N/A	N/A
Number of Exceedances	N/A	N/A	N/A	N/A	N/A
Number of Deficits	N/A	N/A	N/A	N/A	N/A
Volume of Exceedance (m³)	N/A	N/A	N/A	N/A	N/A
Volume of Deficit (m³)	N/A	N/A	N/A	N/A	N/A
Total Flooding (m³)	1183.96	0	25.14	142.03	4448.36
Detention Storage (m³)	N/A	N/A	N/A	N/A	N/A

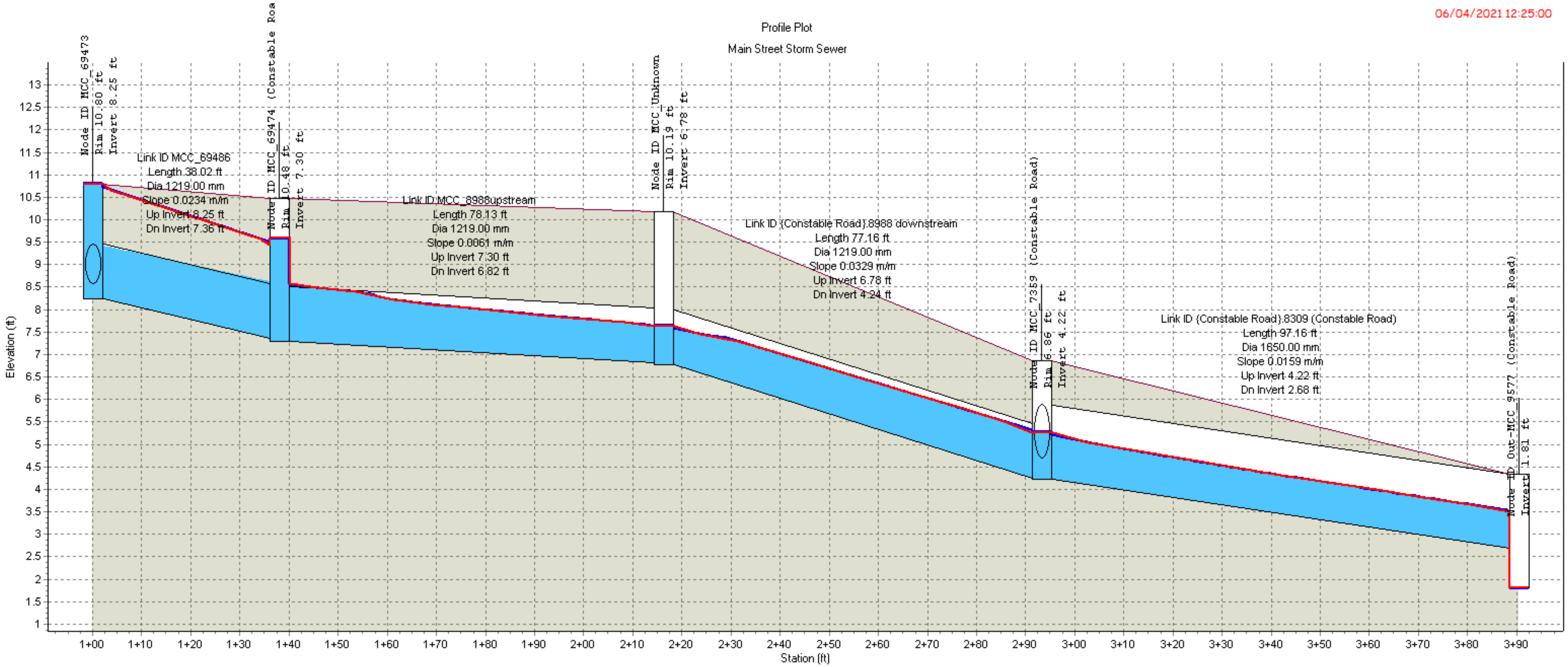
Appendix A9

Constable Road Stormwater Pipe Long Sections

CONSTABLE ROAD MODEL RESULTS

Predevelopment 10% AEP SW Long Section

Existing Stormwater System



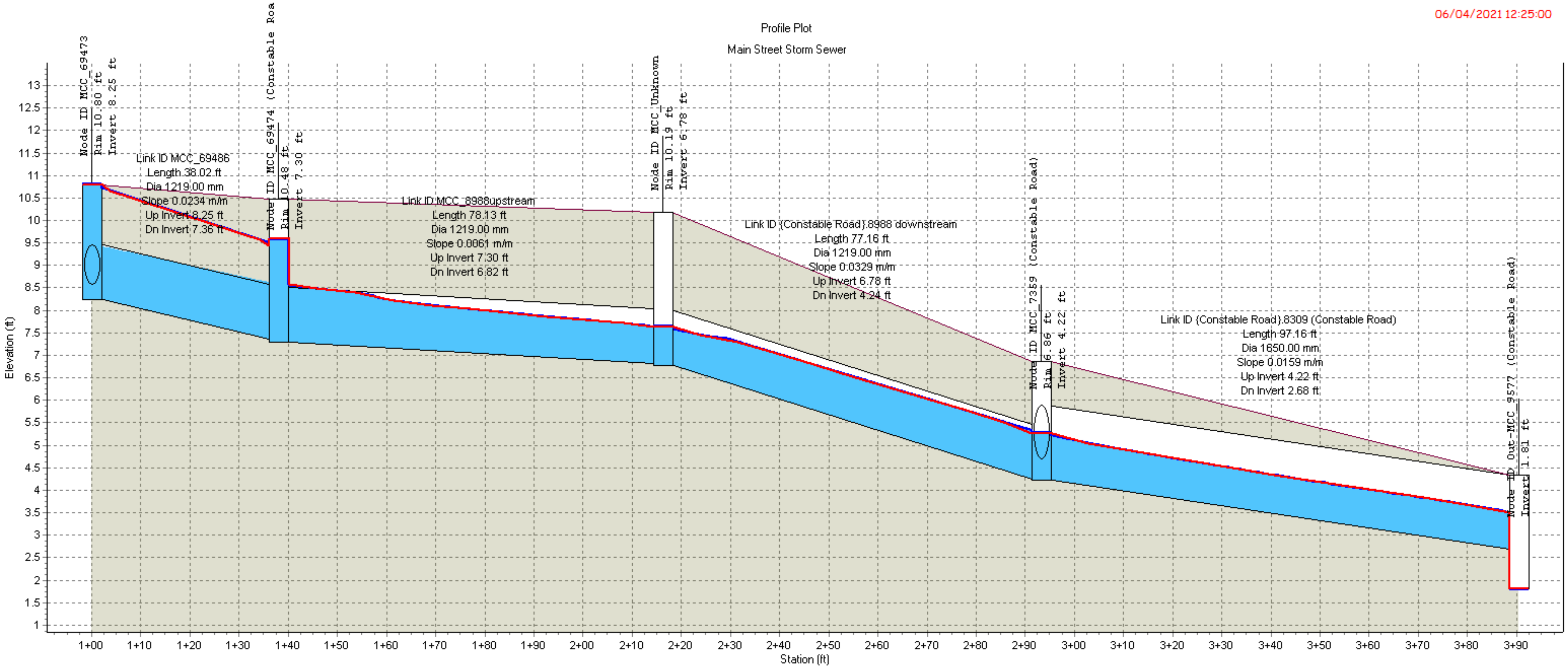
Node ID:	MCC_69473	MCC_69474 (Constable Road)	MCC_Unknown	MCC_7359 (Constable Road)	
Rim (ft):	10.80	10.48	10.19	6.86	
Invert (ft):	8.25	7.30	6.78	4.22	1.81
Min Pipe Cover (m):	1.33	1.90	2.15	0.96	
Max HGL (ft):	10.80	9.91	7.64	5.26	1.80

Link ID:	MCC_69486	MCC_8988upstream	{Constable Road}.8988 downstream	{Constable Road}.8309 (Constable Road)
Length (ft):	38.02	78.13	77.16	97.16
Dia (mm):	1219.00	1219.00	1219.00	1650.00
Slope (m/m):	0.0234	0.0061	0.0329	0.0159
Up Invert (ft):	8.25	7.30	6.78	4.22
Dn Invert (ft):	7.36	6.82	4.24	2.68
Max Q (cms):	4.60	4.60	4.61	5.85
Max Vel (ft/s):	3.94	4.00	4.79	4.78
Max Depth (m):	1.22	1.17	0.94	0.92

CONSTABLE ROAD MODEL RESULTS

Predevelopment 1% AEP SW Long Section

Existing Stormwater System



Node ID:	MCC_69473	MCC_69474 (Constable Road)	MCC_Unknown	MCC_7359 (Constable Road)	
Rim (ft):	10.80	10.48	10.19	6.86	
Invert (ft):	8.25	7.30	6.78	4.22	1.81
Min Pipe Cover (m):	1.33	1.90	2.15	0.96	
Max HGL (ft):	10.80	9.94	7.64	5.27	1.80

Link ID:	MCC_69486	MCC_8988upstream	{Constable Road}.8988 downstream	{Constable Road}.8309 (Constable Road)
Length (ft):	38.02	78.13	77.16	97.16
Dia (mm):	1219.00	1219.00	1219.00	1650.00
Slope (m/m):	0.0234	0.0061	0.0329	0.0159
Up Invert (ft):	8.25	7.30	6.78	4.22
Dn Invert (ft):	7.36	6.82	4.24	2.68
Max Q (cms):	4.60	4.60	4.61	5.95
Max Vel (ft/s):	3.94	4.00	4.80	4.79
Max Depth (m):	1.22	1.17	0.94	0.93

CONSTABLE ROAD MODEL RESULTS

Post Development 10% AEP SW Long Section

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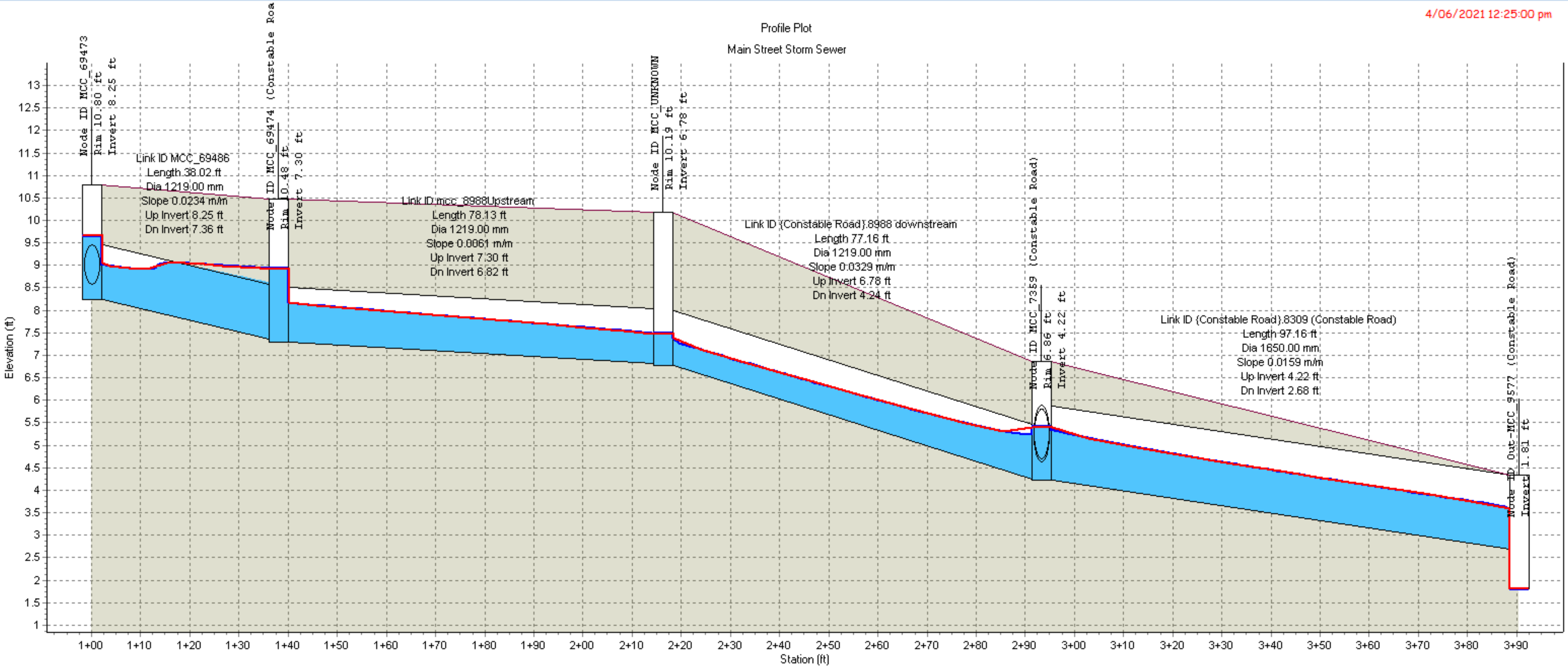
Existing Stormwater System



Node ID:	MCC_69473	MCC_69474 (Constable Road)	MCC_UNKNOWN	MCC_7359 (Constable Road)	
Rim (ft):	10.80	10.48	10.19	6.86	
Invert (ft):	8.25	7.30	6.78	4.22	1.81
Min Pipe Cover (m):	1.33	1.90	2.15	0.96	
Max HGL (ft):	9.97	9.10	7.49	5.40	1.80

Link ID:	MCC_69486	mcc_8988Upstream	{Constable Road}.8988 downstream	{Constable Road}.8309 (Constable Road)
Length (ft):	38.02	78.13	77.16	97.16
Dia (mm):	1219.00	1219.00	1219.00	1650.00
Slope (m/m):	0.0234	0.0061	0.0329	0.0159
Up Invert (ft):	8.25	7.30	6.78	4.22
Dn Invert (ft):	7.36	6.82	4.24	2.68
Max Q (cms):	3.61	3.61	3.63	6.92
Max Vel (ft/s):	3.09	3.20	4.15	4.92
Max Depth (m):	1.22	1.12	0.93	1.03

CONSTABLE ROAD MODEL RESULTS

Post Development 10% AEP SW Long Section

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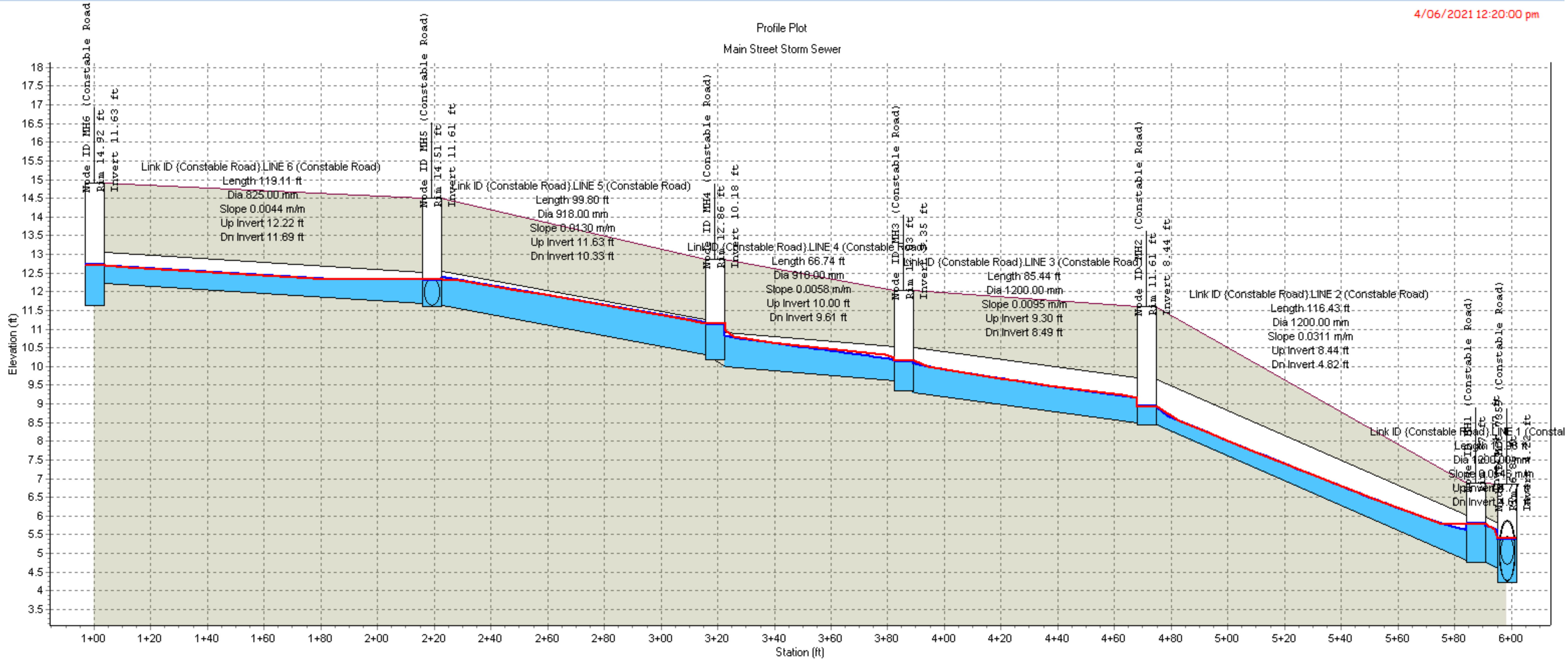
Proposed Stormwater System



Node ID:		MH5 (Constable Road)	MH4 (Constable Road)	MH3 (Constable Road)	MH2 (Constable Road)	MH1 (Constable Road)	
Rim (ft):	14.92	14.51	12.86	12.03	11.61	6.87	6.86
Invert (ft):	11.63	11.61	10.18	9.35	8.44	4.77	4.22
Min Pipe Cover (m):	0.00	1.96	1.61	1.50	1.92	0.85	0.96
Max HGL (ft):	13.65	12.32	11.14	10.15	9.56	6.64	5.41

Link ID:	{Constable Road}.LINE 6 (Constable Road)	{Constable Road}.LINE 5 (Constable Road)	{Constable Road}.LINE 4 (Constable Road)	{Constable Road}.LINE 3 (Constable Road)	{Constable Road}.LINE 2 (Constable Road)	
Length (ft):	119.11	99.80	66.74	85.44	116.43	10.98
Dia (mm):	825.00	918.00	918.00	1200.00	1200.00	1200.00
Slope (m/m):	0.0044	0.0130	0.0058	0.0095	0.0311	0.0146
Up Invert (ft):	12.22	11.63	10.00	9.30	8.44	4.77
Dn Invert (ft):	11.69	10.33	9.61	8.49	4.82	4.61
Max Q (cms):	1.08	1.67	1.67	2.37	3.99	3.86
Max Vel (ft/s):	2.27	3.17	2.84	3.35	4.41	3.87
Max Depth (m):	0.56	0.75	0.79	0.72	0.72	0.89

CONSTABLE ROAD MODEL RESULTS

Post Development 1% AEP SW Long Section

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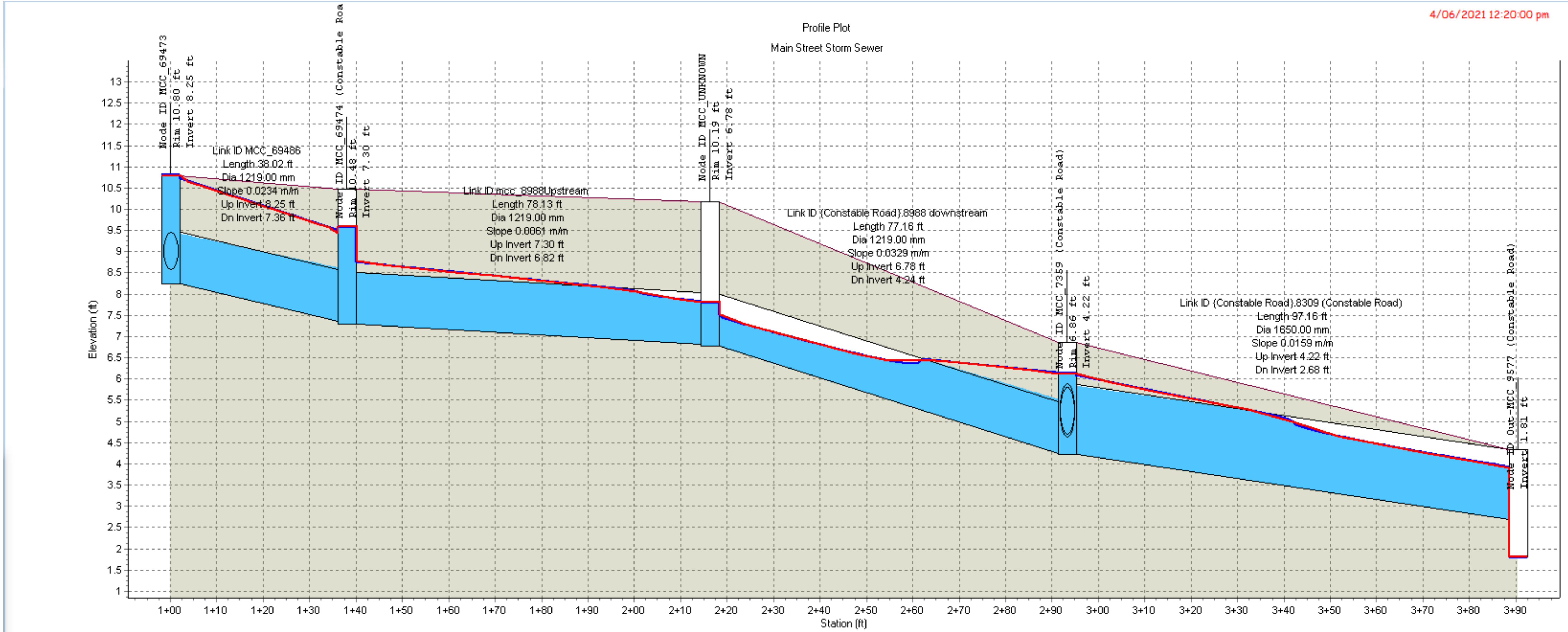
Existing Stormwater System



Node ID:	MCC_69473	MCC_69474 (Constable Road)	MCC_UNKNOWN	MCC_7359 (Constable Road)	
Rim (ft):	10.80	10.48	10.19	6.86	
Invert (ft):	8.25	7.30	6.78	4.22	1.81
Min Pipe Cover (m):	1.33	1.90	2.15	0.96	
Max HGL (ft):	10.80	9.92	7.81	6.14	1.80

Link ID:	MCC_69486	mcc_8988Upstream	{Constable Road}.8988 downstream	{Constable Road}.8309 (Constable Road)
Length (ft):	38.02	78.13	77.16	97.16
Dia (mm):	1219.00	1219.00	1219.00	1650.00
Slope (m/m):	0.0234	0.0061	0.0329	0.0159
Up Invert (ft):	8.25	7.30	6.78	4.22
Dn Invert (ft):	7.36	6.82	4.24	2.68
Max Q (cms):	4.60	4.60	4.62	9.78
Max Vel (ft/s):	3.94	4.00	4.32	5.13
Max Depth (m):	1.22	1.17	1.12	1.38

CONSTABLE ROAD MODEL RESULTS

Post Development 1% AEP SW Long Section

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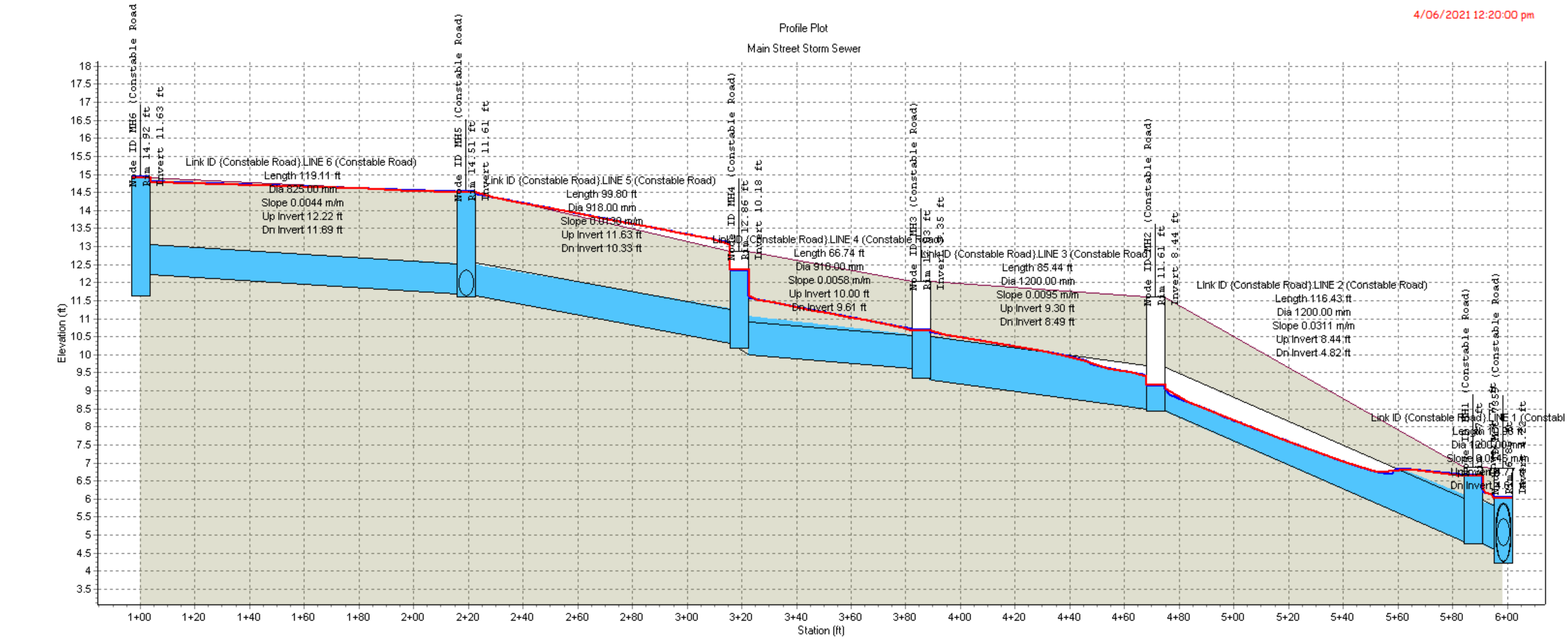
Proposed Stormwater System



Node ID:		MH5 (Constable Road)	MH4 (Constable Road)	MH3 (Constable Road)	MH2 (Constable Road)	MH1 (Constable Road)	
Rim (ft):	14.92	14.51	12.86	12.03	11.61	6.87	6.86
Invert (ft):	11.63	11.61	10.18	9.35	8.44	4.77	4.22
Min Pipe Cover (m):	0.00	1.96	1.61	1.50	1.92	0.85	0.96
Max HGL (ft):	14.92	14.51	12.69	11.22	9.56	6.66	6.04

Link ID:	{Constable Road}.LINE 6 (Constable Road)	{Constable Road}.LINE 5 (Constable Road)	{Constable Road}.LINE 4 (Constable Road)	{Constable Road}.LINE 3 (Constable Road)	{Constable Road}.LINE 2 (Constable Road)	
Length (ft):	119.11	99.80	66.74	85.44	116.43	10.98
Dia (mm):	825.00	918.00	918.00	1200.00	1200.00	1200.00
Slope (m/m):	0.0044	0.0130	0.0058	0.0095	0.0311	0.0146
Up Invert (ft):	12.22	11.63	10.00	9.30	8.44	4.77
Dn Invert (ft):	11.69	10.33	9.61	8.49	4.82	4.61
Max Q (cms):	1.08	2.50	2.50	3.69	3.99	3.86
Max Vel (ft/s):	2.27	3.78	3.78	3.57	4.41	3.87
Max Depth (m):	0.82	0.92	0.92	1.03	0.96	1.20

Appendix B

Stormwater Management Options Assessment

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MEMORANDUM – 32897 SMP APPENDIX B

Date: 16 November 2021

From: Sean Finnigan/Tim Bohles

Subject: O'Hara Waiuku Plan Change - Stormwater System Options Assessment

To: File

PROPOSED STORMWATER MANAGEMENT OPTIONS ASSESSMENT

FTL investigated a number of stormwater management options for the proposed development early in the plan change process (up to around March 2021), with these being refined during further work. This memo summarises this options assessment – it was originally written in March 2021, but has been updated here to reflect ongoing work, involving minor edits. Note that some of the numbers and details have changed since March 2021, as a result of ongoing design, but this has not changed the findings of this options assessment.

1.0 STORMWATER SYSTEM OVERVIEW

The existing stormwater catchments have been defined for and around the site as shown in FTL drawing C01. A breakdown of the catchments is:

A) Catchments downstream of the north west corner of the site
B) Catchments upstream of the north west corner of the site.
C) Catchments discharging to the southernmost Constable Road culvert
D) Catchments discharging to the northern Constable Road culvert
E) Catchments discharging to the Constable Road drain
F) Catchments discharging through 45A Constable Road to Council land
G) Catchments discharging directly to Council land

This memo primarily addresses the catchments that currently do not discharge to Constable Road (catchments B, F and G). These catchments cover the majority of the site. There are four critical storm events that have been considered in this assessment:

- The 2 year storm event (for stream erosion protection)
- The 10 year storm event (stormwater pipes are sized to this event)
- The 100 year storm event (current flooding issues)
- The 100 year storm event including climate change (future flooding issues)

It also comments on detention requirements for catchments C, D and E that discharge directly to Constable Road.

During site development, a stormwater network will be installed to collect and convey the 10 year rainfall event. This network needs to discharge either to a downstream piped network, engineered open channel or watercourse. There are no existing public stormwater pipes, open channels or watercourses downstream of the discharge points from catchments F and G (a significant portion of the site) and hence piped flows from these areas need to be diverted to another location, or a new channel/pipe system installed through the downgradient land to connect into the existing downstream stormwater network closer to King St, subject to this system having sufficient capacity. Review of Geomaps stormwater pipe data indicates all downstream stormwater pipes are relatively small diameter and hence it is unlikely this would be possible, unless the downstream pipe network was upgraded as well.

The alternative option of diverting piped flows from these areas to another location needs careful consideration. In particular, stormwater flows offsite should not increase the flooding hazard to downstream properties. Changing the discharge location of these large catchments needs careful evaluation to achieve this, and potentially large amounts of storage could be required to detain stormwater flows to prevent increased downstream flooding.

2.0 OPTIONS

A number of options and sub-options have been investigated for stormwater management with a focus on catchments F and G. These options take into account the client's proposal to have a stormwater management feature (wetland, pond or similar) in the north-western corner of the site that can provide for treatment and detention of stormwater runoff and be an amenity feature (referred to in this memo as the "stormwater wetland"). These options are listed below and illustrated on the attached markups:

1. Regrade catchments F1 and G1 to the proposed stormwater wetland. Regrade a portion of catchments C, D and E to the stormwater wetland. This will require more earthworks but the stormwater pipe network will be shallower and overland flows will be redirected to the stormwater wetland area.
2. Maintain catchments unchanged, but use deeper stormwater pipes to bring stormwater (up to 10 year event) to the stormwater wetland. Overland flowpaths in excess of the 10 year storm event will be maintained the same as the existing situation.
3. Regrade some catchment areas to Constable Road and construct a new large stormwater pipe along Constable Road to discharge into the Tiware Stream at the deep gully feature immediately north of Leonard St and hence to the estuary - approximately 300m in length and likely additional 300m of pipe upgrade (or alternatively another 300m of new pipe).
4. Request Council's permission to construct a swale (open channel drain) on the sports field to discharge to. Discharge most of site runoff to the new swale. Alter catchments such that post development 1% AEP rainfall event doesn't increase peak flows to the field. New or upgraded pipe infrastructure will also be required at the discharge point of the swale for it to discharge its flows into.

Table 1 shows the pros and cons of each option.

2.1 Sub-Options

A) The Rangiwhea Stream runs along the western side of the site. Below the site, it has some very large catchments connecting into it (A2 = 93ha, A3 = 87ha). These catchments have longer "times of concentration" than future discharges from the development area, the time of concentration being the time it takes for the peak flow to reach the catchment discharge point. If the proposed stormwater system can discharge an appropriate proportion of its stormwater runoff more quickly than these external catchments, then peak flows downstream can be maintained at pre-development levels and the amount of storm detention reduced. Some treatment and detention storage will also still be required for stormwater treatment and stream erosion protection objectives, but the total storm detention requirement would be reduced. This option works best with option 1. This approach is acceptable and good practice for sites located in the lower part of a catchment, releasing storm flows first before the upper catchment area peak flows come through. It represents a catchment specific design approach. Practically, this can be achieved by having an inlet chamber to the wetland, which allows low flows to enter it, with higher flows above a specified threshold (selected at 1.6 m^3/s for preliminary model) being directed over a weir and bypassing the wetland.

B) Provide for significant amounts of detention to reduce peak flows offsite at the site boundary. This approach is a site specific design approach, but does not take into account wider catchment considerations and relative times of flow and flow magnitudes from different catchments within the Rangiwhea Stream catchment. It is not appropriate in this case.

C) Use designated green space partly as stormwater swales to provide for stormwater treatment and conveyance and reduce the need for stormwater pipes.

D) Direct a portion of 100 year peak flows off-site towards the sportsfield. This would involve some adjustments to catchment F and G boundaries, so as to optimise the amount of overland flow travelling both north (as per the existing situation) and to the stormwater wetland.

Table 1 shows the pros and cons of these sub-options.

3.0 STORMWATER DISCHARGE REQUIREMENTS

To meet the Network Discharge Consent, stormwater will need to be managed in the following ways:

Tmt: Treatment of impervious areas (roofing (except where relatively inert roofing materials used), paving and roading.

Retn: Retention of 5mm of rainfall from all impervious areas.

Detn: Detention of the difference in runoff volume from pre development to post development for a 95th percentile storm

10yr: No increases in peak flow for a 10% AEP event from the site, or demonstrating sufficient downstream capacity downstream of the site

100yr: No increases in downstream flooding for a 1% AEP event, for those areas where downstream flooding is currently a problem.

The options identified have been investigated as to how compliance of these requirements will be met. They are commented on in the right hand column of Table 1.

Table 1: Stormwater Options

Option	Pros	Cons	Discharge requirement compliance
1 (Catchment Regrading + Shallower Stormwater Network)	• Reduced cost of stormwater network (shallower system). • Potential flooding reduction in Waiuku township. • 45A Constable Rd needs to provide for local overland flow only and not from upgradient catchment F1. • Synergises well with sub option A, potentially reducing detention requirements significantly.	• More significant earthworks for regrading of catchments. • Increase consenting complexity, as involves a stormwater diversion (both piped flows and overland flowpaths). • Possible increased wastewater reticulation costs, as some site wastewater will flow by gravity to new pump station in NW corner and then be pumped by rising main back to Waiuku township.	Tmt: Swales and wetland to provide treatment Retn: Wetland to provide retention Detn: Wetland to provide detention 10yr & 100yr: Detention basin installed beside wetland prevents downstream flooding (see further comments on sub-option A).
2 (Catchments unchanged + deeper stormwater network)	• Reduced detention requirements for 1% AEP storm (as no change in catchment areas) • Less earthworks required. • Less wastewater piped to NW corner	• Overland flowpath required on 45A Constable Rd, potentially taking up ~2 lots and affecting building finished floor levels • More costly stormwater network (deeper) • May not be able to incorporate sub option C. • Most lots will require an individual detention tank to reduce wetland detention volume.	Tmt: Wetland to provide treatment Retn: Wetland to provide retention Detn: Wetland to provide detention 10yr & 100yr: Detention basin installed beside wetland prevents downstream flooding (see further comments on sub-option A).
3 (Partial Regrading and New Large SW pipe along Constable Rd)	• Reasonably large amount of earthworks required. • Wastewater reticulation could be run along same alignment as new stormwater pipe. • Likely only a small detention requirement for stream erosion protection and 10% AEP storm.	• Significant stormwater cost for upgrade of existing stormwater reticulation and new stormwater pipe along Constable Rd. • Potentially need to change green space layout to make this more efficient. • Overland flowpath still required allowing for partial pipe blockage in accordance with stormwater code of practice, otherwise signficant detention upstream of new pipe inlet still required.	Tmt: All roads to be treated by swales/raingardens. Roofing to be inert materials. Retn/Detn: Individual lots to have retention/detention tanks 10yr & 100yr: Detention may be required.

Option	Pros	Cons	Discharge requirement compliance
4 (Minor catchment adjustments and new swale through sportsfield)	• Reduced amount of detention requirement for significant portion of the site. • Less earthworks required. • Less cost of on-site stormwater network.	• Council (Community Facilities) may not agree. • Relatively significant detention required in each lot. • Will need to contribute to cost of swale and downstream stormwater upgrade costs.	Tmt: Retention tanks for lots discharging to swale; roadside swales or raingardens for treatment of road runoff. Wetland to provide treatment to rest of site. Retn/Detn: Retention/detention tanks for lots discharging to swale. Wetland provides retention/detention for rest of site. 10yr & 100yr: Large detention tanks for lots discharging to swale. Detention basin installed beside wetland prevents downstream flooding.
A (release flows above specified limit & detain rest)	• Appropriate in this context – release flows before upstream peak arrives. • Significantly reduced detention requirements • No increased downstream flooding effects for Waiuku	• Will need more detailed investigation to get Council approval (relative timing of peak flows from different catchments is critical)	N/A
B (detain all flows)		• Not appropriate due to site being located in lower part of large catchment. • More significant detention requirements - costly • Needs careful design such that it does not have downstream impacts on flood hazard.	N/A
C (Discharge to swales in greenways)	• Treatment of runoff • Flow path provides amenity feature	• Needs a continuous flow path, so will take a defined part of the greenspace. • Some adjustments to greenway locations may be required.	N/A
D (Adjusted split (partial) of overland flows)	• Some reduction in detention requirement • Potential reduction in earthworks volume	• Extent may be limited, as otherwise swales may become too deep, affecting greenways and adjacent areas.	N/A

4.0 BEST PRACTICABLE OPTION

4.1 March 2021 Initial Evaluation

Following the Table 1 evaluation, Options 1 and 2 and sub-options A-C were selected for further evaluation.

Preliminary modelling was completed to confirm the validity of Options 1 and 2 and sub-options A-C, and to compare with other approaches, including the effect of different on-site detention tanks on wetland volume requirements. Options 3 and 4 currently have not been investigated. Results from this modelling are summarised in Table 2.

Table 2: Required Detention Volumes

Option	Sub-Options	Detention tank volume per property (m^3)	Wetland Volume (m^3)
1	A, C	None	10,000
1	B	10.5 (5000m^3 over entire site)	13,000
1	A, B, C	5.0 (2500m^3 over entire site)	10,000
2	A, C	None	10,000

Note: Total site on-lot detention tank storage calculated based on 464 lots.

In our opinion, the best practicable option is Option 1 including sub-options A and C. This combination will result in the lowest infrastructure costs, and likely best outcome in regards to stormwater treatment, stream erosion protection and flood hazard.

Note that Option 2 A and C gives a lower wetland volume than Option 1 A and C. This is because Option 1 has a larger catchment area draining to the wetland. Option 2 would have additional on-lot detention requirements for catchments F1, F2 and G1 (not specified here) where increased overland flows will be discharged off-site to the north, as per the existing situation.

The modelling has shown that on-lot detention tanks, when used conventionally, do not reduce wetland volume requirements. They may have some merit for other reasons (e.g. reducing potable water demand) or if used in a similar approach to sub-option A – i.e. inflows into the detention tanks are controlled by an inlet chamber, with flows above a specified threshold bypassing the detention tank.

4.2 Post-March 2021: New Stormwater Pipe along Constable Road

Following further investigation and design work and discussion with the client, part of option 3, namely a new large stormwater pipe along Constable Road, was included within the preferred stormwater management approach, largely as a means of reducing existing overland flows/flooding in the Breaker Grove/O'Sullivan Place area, going beyond a minimum compliance approach.

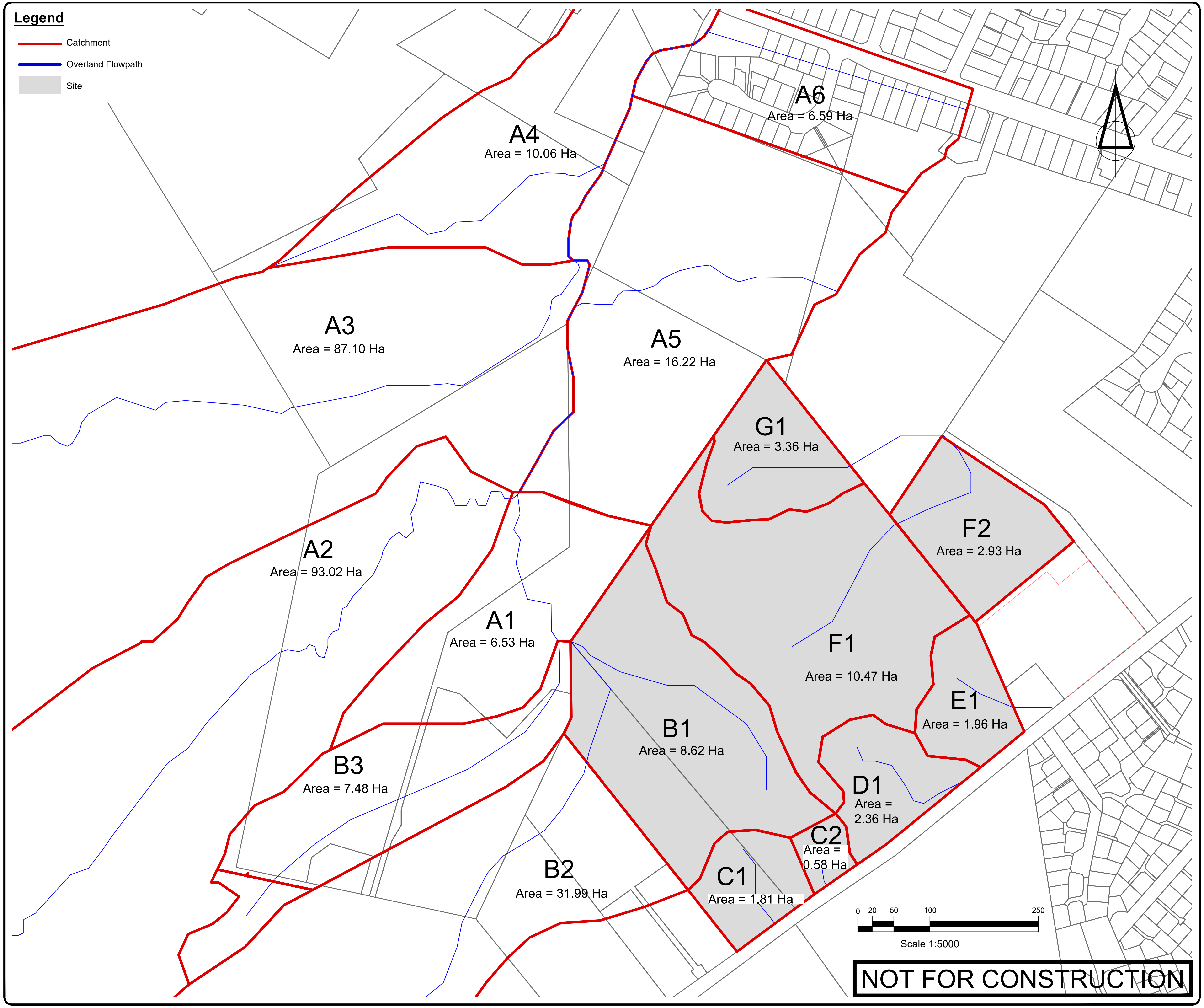
5.0 FURTHER WORK

From this preliminary assessment and subsequent work, Option 1 + A + C + new Constable Rd pipeline was adopted the preferred plan change stormwater management option.

A critical issue with modelling the preferred approach is checking the response to different rainfall events and relative timing of flows from different sub-catchments within the overall Rangiwhea catchment. For the Plan Change submission, this has been done by modelling the response of the preferred option to the 2, 10, 100yr and 100yr + CC (climate change) storms using the TP108 hydrograph. Some sensitivity testing could also be done checking the effect of changes to the relative timings of peak flows from the main sub-catchments within the model, as part of further design work.

Possible further work, post-plan change and prior to subdivision consent includes running different rainfall hydrographs through the model, including any actual storm event rainfall data from local rainfall gauges to check the preferred option's resilience to other rainfall events.

Modelling for catchment B to date has focussed on minimising the impact of peak flows. One additional option that could be considered is to upgrade the King Street culvert, to reduce flooding effects on the relatively low number of houses directly upstream of this culvert. This would allow higher peak flows to be conveyed down the stream, reducing the volume requirement of the wetland. This would result in some increases in peak flows along the stream. However, in general these will result in minimal increases in peak water level, given the significant flows of water from other rural catchments.



SURVEYED			APPROVED	DATE
DESIGNED				
DRAWN	TB	22/03/21		
CHECKED				

REVISION	CHANGES	CHECKED	DATE

NOTES

CLIENT
GARDON TRUST

PROJECT
GARDON TRUST WAIUKU PPC

TITLE
EXISTING CATCHMENT PLAN

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AUCKLAND 09 278 7078
NAPIER 06 211 2766
CHRISTCHURCH 03 358 5936
BLENHEIM 03 428 3293

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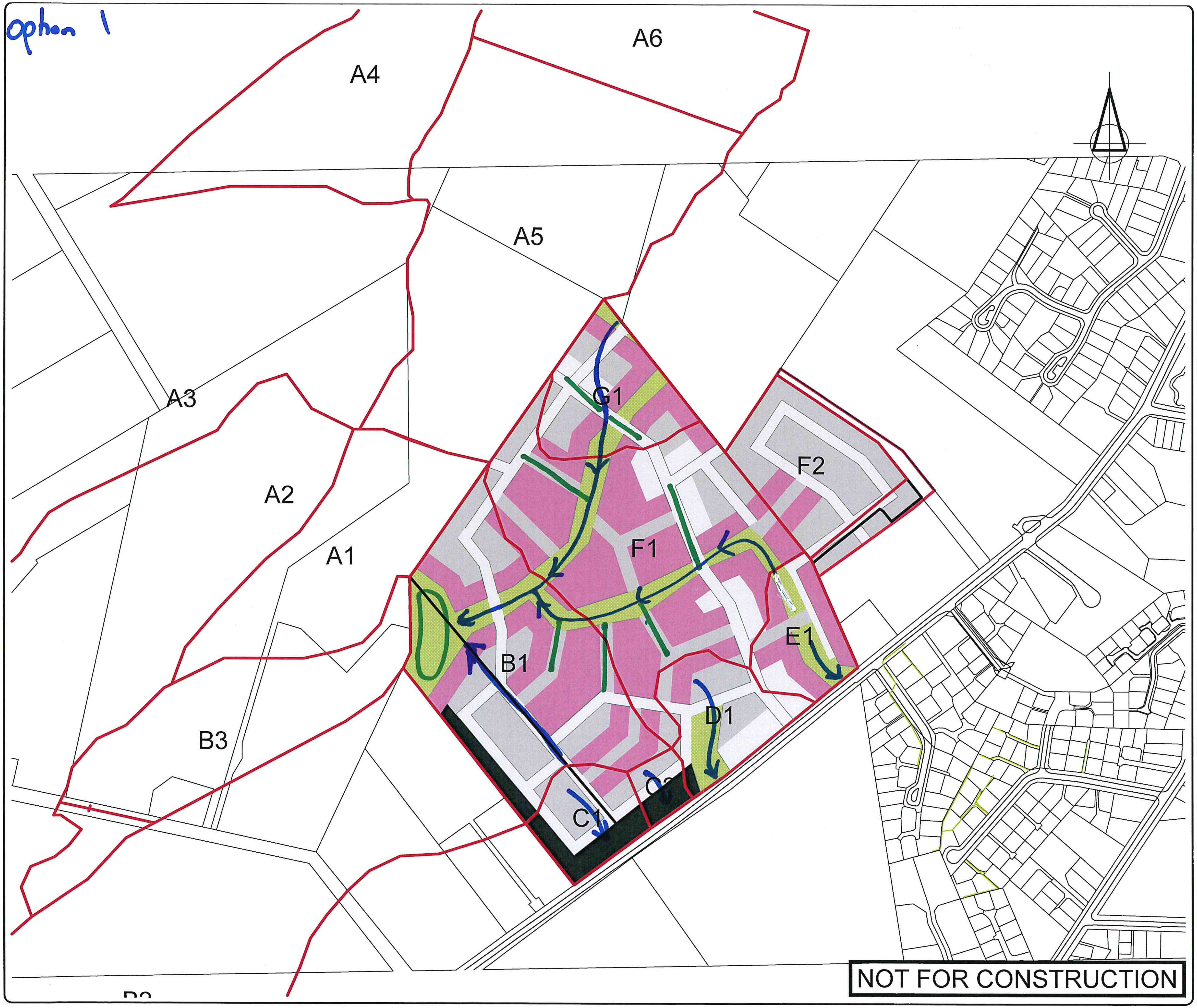
STATUS
PLAN CHANGE
Construction works shall commence only on receipt of and in accordance with the Council or Council organisation stamped approved drawings, unless otherwise indicated.

SCALE 1:5000 (A3)

DRAWING No 32897/C01
REVISION -

P:\32 series\32897 Brookdale Waiuku PPC\03 Drawings\32897-C01.dwg, C01, 23/03/2021 4:24:22 pm option 1



SURVEYED			APPROVED	DATE
DESIGNED				
DRAWN				
CHECKED				

REVISION	CHANGES	CHECKED	DATE

NOTES

OLFPs

SW network

CLIENT

PROJECT

TITLE

Fraser Thomas

ENGINEERS RESOURCE MANAGERS SURVEYORS

AUCKLAND	09 278 7078
NAPIER	06 211 2766
CHRISTCHURCH	03 358 5936
BLENHEIM	03 428 3293

www.fraserthomas.co.nz

STATUS

Construction works shall commence only on receipt of and in accordance with the Council or Council organisation stamped approved drawings, unless otherwise indicated.

SCALE (A3)

DRAWING No REVISION -

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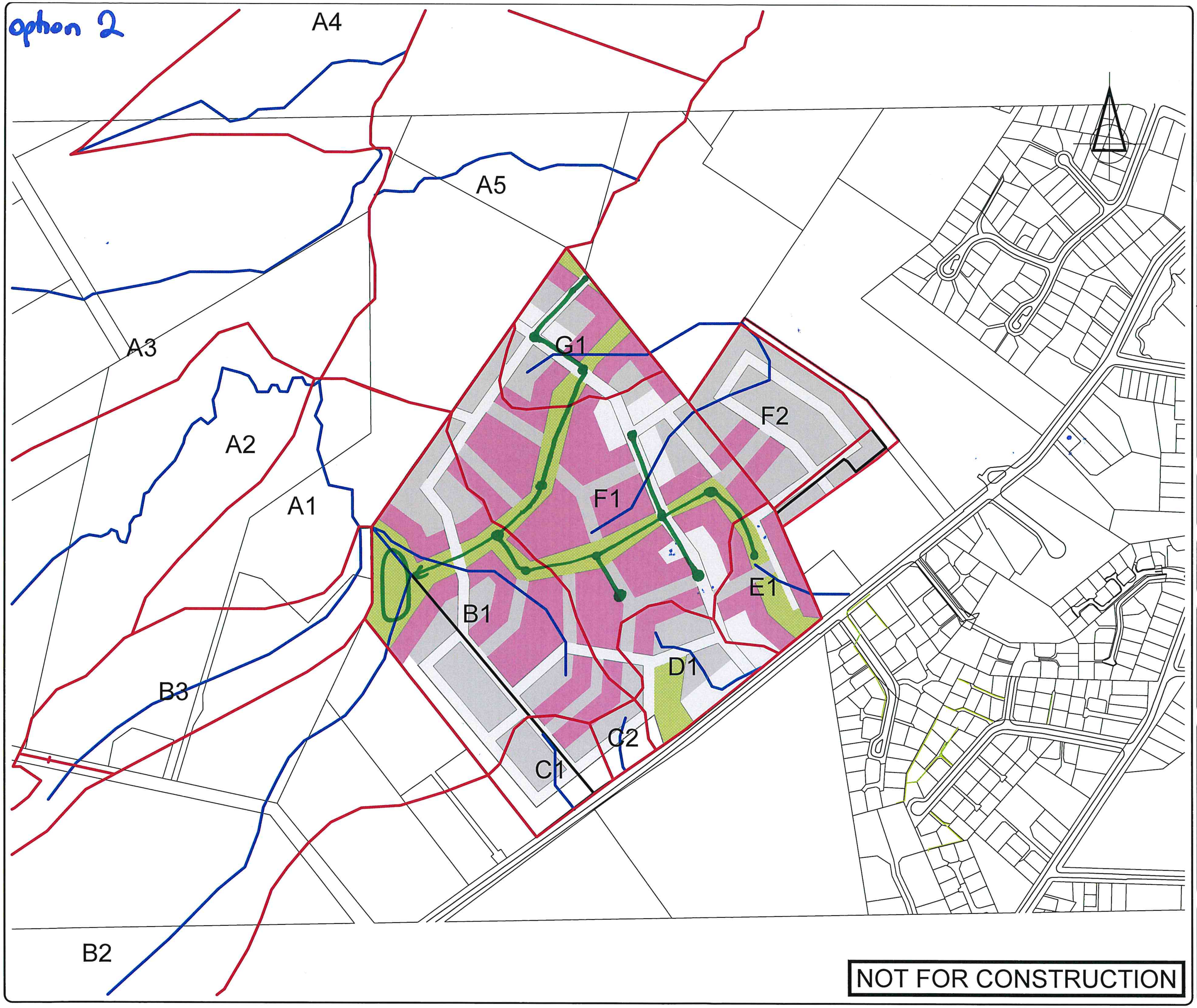

SURVEYED			APPROVED	DATE
DESIGNED				
DRAWN				
CHECKED				

REVISION	CHANGES	CHECKED	DATE

NOTES

— OLFPs

—● SW network

CLIENT

PROJECT

TITLE

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ENGINEERS RESOURCE MANAGERS SURVEYORS

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SCALE (A3)

DRAWING No REVISION -

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Option 3

NOT FOR CONSTRUCTION

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SURVEYED			APPROVED	DATE
DESIGNED				
DRAWN				
CHECKED				

REVISION	CHANGES	CHECKED	DATE

NOTES

— New pipe

— upgrade pipe

CLIENT

PROJECT

TITLE

Fraser Thomas

ENGINEERS RESOURCE MANAGERS SURVEYORS

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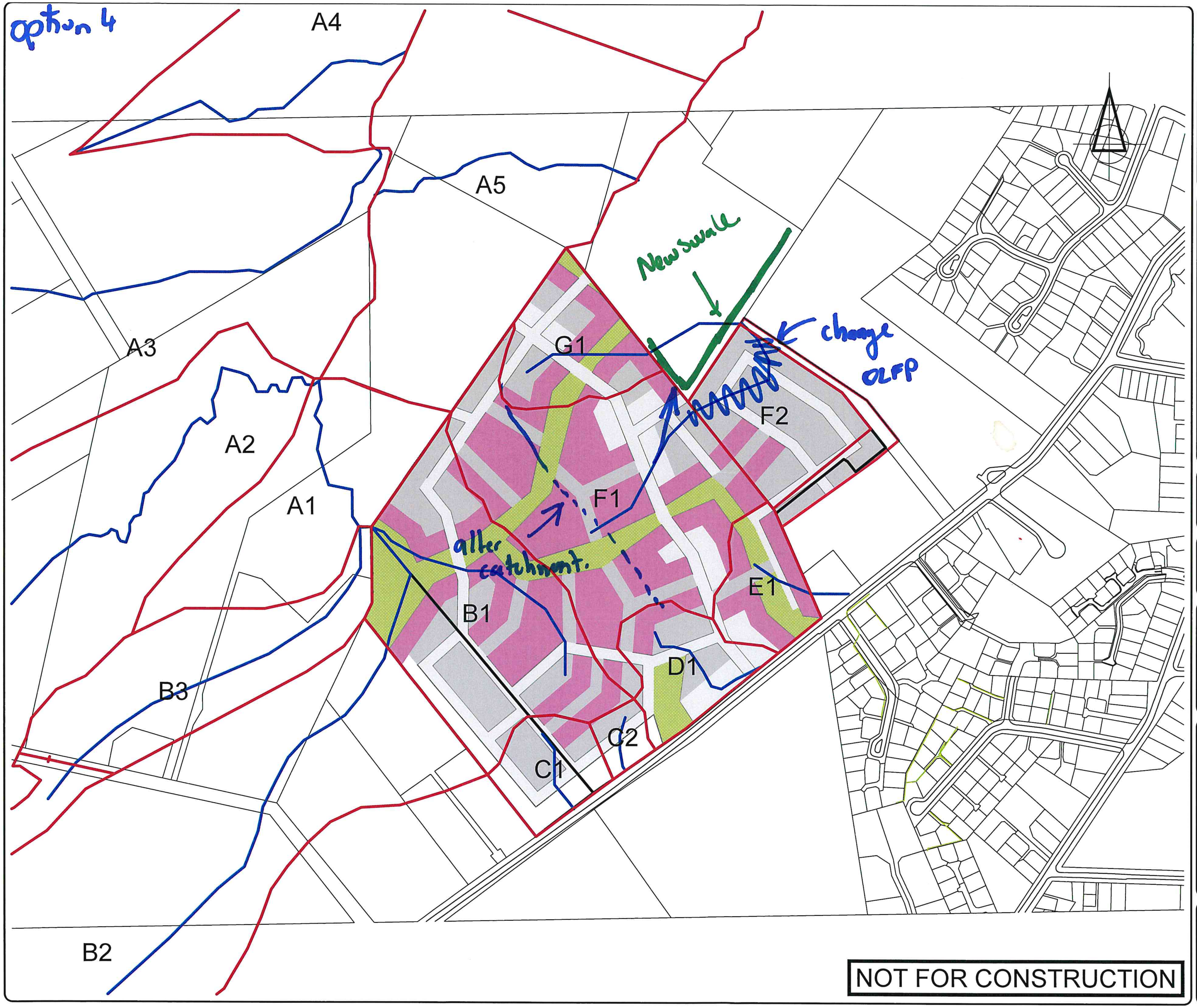
SCALE (A3)

DRAWING No

REVISION -



SURVEYED			APPROVED	DATE
DESIGNED				
DRAWN				
CHECKED				

REVISION	CHANGES	CHECKED	DATE

NOTES

CLIENT

PROJECT

TITLE

Fraser Thomas

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AUCKLAND	09 278 7078
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SCALE (A3)

DRAWING No

REVISION -

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Appendix C

Stormwater System Operation and Maintenance Plan

GARDON TRUST
O'HARA WAIUKU PLAN CHANGE – 45A, 92 AND 130 CONSTABLE ROAD

STORMWATER OPERATION AND MAINTENANCE PLAN

1.0 INTRODUCTION

This document provides a Stormwater Operation and Maintenance (O&M) Plan for the residential subdivision of the subject site.

1.1 SCOPE

This O&M Plan covers the following system components:

(a) Pre-treatment devices – e.g. gutter screens, in-line leaf and debris divertors, first flush divertors, sediment traps
(b) Catchpits
(c) Detention tanks
(d) Rain gardens
(e) Soakage devices
(f) Wetlands
(g) Major overland flowpaths (OLFPs).

1.2 RESPONSIBILITIES

Individual lot owners are responsible for the operation of the stormwater devices on their respective lots, including shared responsibility for those lots served by JOAWs (Jointly owned accessways) with stormwater management devices located on them. Auckland Council is not responsible for these tasks, nor does it have an oversight role in checking that individual households actually undertake these tasks. Generally, O&M inspections shall be undertaken by a suitably qualified/experienced company/individual contracted specifically for this purpose, arranged by each individual lot owner.

Auckland Council is responsible for the operation and maintenance of all public stormwater devices, including catchpits, pipe reticulation, rain gardens within the road reserve, wetlands and major OLFPs.

1.3 ASBUILT PLANS

Asbuilt plans of the stormwater management system for each lot are included in this Plan as an appendix (*to be added to final version)*.

2.0 OPERATION AND MAINTENANCE INSPECTIONS

2.1 INSPECTION TYPES

There are two basic types of inspections and associated operations and maintenance required. These are:

- Routine inspections
- Special inspections (e.g. following 5% or greater AEP storm events, request/complaint by householder or member of the public).

2.2 INSPECTION REQUIREMENTS

O&M requirements are summarised below. Associated checklists will be provided with the final O&M Plan. Initial inspection frequencies are specified below, which can be adjusted based on experience.

No.	Action	Frequency
	Pre-treatment Devices	
P1	Inspect all pre-treatment devices for signs of wear and tear, blockage, faulty parts and repair or replace as necessary, including removing any accumulated silt/sediment.	6 monthly
P2	Check any Enviropods and remove accumulated debris/silt/sediment and dispose of to an approved facility.	6-12 monthly
P3	Check condition of Enviropods and replace when necessary.	2 yearly
	Catchpits	
C1	Check inlet for any blockages or leaks, removing any litter/debris and other obstructions and repairing any leaks.	3 monthly or less
C2	Check sediment level in chamber. Arrange for vacuum truck contractor to remove sediment if depth is 300mm or more as required. Removed sediment must be disposed of to an approved facility.	1 yearly or less
	Detention Tanks	
D1	Inspect detention tanks for signs of wear and tear, broken/damaged inlet/outlet pipes, any inline filters or screens and repair or replace as necessary, including removing any accumulated silt/sediment	2 yearly
D2	Inspect detention tank orifices for blockage/damage and clean/repair/replace, as necessary	1 yearly
D3	Check sediment depth in tanks and clean out when 100mm in depth or 50% of designed sediment storage depth	3-5 yearly or more
	Rain Gardens	
R1	Undertake visual inspection to ensure rain garden is in good health. Mow grass strips, resowing seed if necessary. Remove rubbish or excess leaves, soil or mulch. Clear inflow points of rubbish and debris. Check for erosion and gauging. Check plant health and remove weeds.	3 monthly
R2	Inspect rain garden to ensure all water drains after 24 hours after heavy rain. Check topsoil and remove if crusted. Top up as needed. Check soil level is below hard surfaces. Use inspection well to check the underdrain and use a drainage test to check drainage capacity.	Annually
R3	Special inspection after 5% AEP or greater storm event - R1 and R2.	As required

	Soakage devices	
S1	Check condition of inlet, outlet, storage chamber (if any) and overflow structures/devices, etc. for debris accumulation, blockage and leaks and repair or replace as necessary.	3 monthly or less
S2	Check sediment level in soakage device. Arrange for vacuum truck contractor to remove sediment if depth is over 100mm or 50% of designed sediment storage depth as required. Removed sediment must be disposed of to an approved facility in a safe manner.	3-5 yearly
S3	Check water level in chamber and quality (sheen, smells, etc.). This should be dry provided there has been no heavy rainfall for 24hrs. If there is standing water in the soakage pit, repair or replace as necessary (see note 1). If water quality is suspect, investigate and rectify the cause.	2 yearly or less
S4	Special inspection after 5% AEP (or greater) storm events – S1, S2 and S3	As required
	Swales/Open Drains and Waterways (Greenways)	
SW1	Check main channel, embankments/banks, GPTs, culvert inlets/outlets and outfalls for any litter, debris, silt, overgrown vegetation and undercutting/scouring. Clean out and repair as necessary.	3 monthly
SW2	Check other structures such as wingwalls, gabion baskets, rock walls, energy dissipation structures for signs of cracking or damage and repair or replace as necessary	12 monthly
SW3	Undertake visual check of water quality: clarity, aquatic weeds, algal blooms, mosquitoes. Investigate and rectify any issues.	6 monthly
SW4	Special inspection after 5% AEP (or greater) storm events – SW1 and SW2	As required
	Wetlands	
W1	Regularly mow any grassed areas around the fringes of the wetland.	1-2 monthly or less
W2	Check inlet and outlet structures, including diversion weir, both inside (visual) and outside for any blockages or leaks, removing any litter/debris and other obstructions and repairing any leaks.	3-4 monthly or less
W3	Check the operation and integrity of all inlet/outlet structures, embankments and spillway. The embankment inspection shall include checking the upstream and downstream faces of the embankment for overgrowth, surface erosion, seepage, slips or slumps, bulging, or significant shrinkage cracks; the embankment crest for settlement, deformation, cracks and vermin damage; and the spillway area for damage scour and/or erosion. Any scour/erosion and structural faults shall be repaired.	3-6 monthly or less
W4	Check for terrestrial and aquatic weeds (e.g. oxygen weed, *Egeria densa* and Parrots Feather, *Myriophyllum aquaticum*) and remove as necessary, particularly any large rafts of weeds that may block the	3 monthly or less

	pond/wetland outlet and any terrestrial weeds (e.g. kikuya) smothering wetland plants.	
W5	Check sediment build-up volume. Desilt when the sediment volume in the forebay and main body of the pond/wetland reaches 30% and 15% of the permanent water depth respectively.	1 yearly or less
W6	Monitor wetland and amenity planting species presence, abundance and condition during winter and summer, both in and around the wetland. Remove nuisance weed species and mulch, fertilise, physically support, replant, and/or take other actions to remedy any causes of poor plant health.	6 monthly for first three years; thereafter annually
W7	Prune and thin wetland and amenity planting in and around the wetland to maintain the amenity and treatment/detention function of the wetland and to avoid excessive buildup of wetland plant material which may unduly impede flows through the pond, block inlet/outlet structures, etc.	Annually, after the first three years.
W8	Check for and remove any graffiti and repair any vandalism, including damage to signage, taking measures to prevent recurrence of these events.	3 monthly or less
W9	Special inspection after 5% AEP (or greater) storm events – items W2, W3, W5, W6	As required
	Major Overland Flow Paths (OLFPs)	
O1	Visually inspect the OLFP surface and clear it of any debris/litter/ weeds/obstructions that may affect proper operation, or debris that may adversely affect plant growth/health. This includes checking for and fixing any erosion/scour, removing any silt/sediment that if left, may settle/harden and detrimentally affect the OLFP performance; checking for and repairing damage by vermin, including rabbits.	3 monthly
O2	Regular inspect inlet/outlet points (road catchpits) and clear of any blockage, fix any erosion/scour and remove deposited silt/sediment.	3 monthly
O3	Special inspection after 5% AEP (or greater) storm events – items O1, O2	As required