169-171 PEKA PEKA ROAD, WAIKANAE

WAIKANAE NORTH DEVELOPMENTS LTD (WNDL)

STORMWATER MANAGEMENT PLAN (SMP) – DEVELOPMENT AREAS

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DOCUMENT CONTROL

Client	WAIKANAE NORTH DEVELOPMENTS LTD (WNDL)
Project	171 PEKA PEKA ROAD
Landlink Project No.	2911
Date of Issue	26 March 2026
Status	For Consent
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This SMP should be read alongside Earthworks Plans (Sheets 200–299) and Stormwater Plans (Sheets 400–499).

GLOSSARY

LDA08	Land Drainage Act 1908
NZS 4404:2010	Code of practice for Land Development and Subdivision Infrastructure
NZS 4431:1989	Code of Practice for Earthfill for Residential Development
LDMR22	Kāpiti Coast District Council Land Development Minimum Requirements 2022
SNZ PAS 4509:2008	New Zealand Fire Service Firefighting Water Supplies Code of Practice
KCDC LIUDD (2012)	Kāpiti Coast District Council – Low Impact Urban Design and Development Guidelines
GWRC Schedule 29 SMP	Stormwater Management Plan requirements under the Proposed Natural Resources Plan (Plan Change 1)
GD04 (2017)	Auckland Council – Water Sensitive Design for Stormwater
GD01 (2017)	Auckland Council – Stormwater Management Devices: Design Guidelines Manual (formerly TP10)
TP10 (2003)	Auckland Regional Council – Stormwater Management Devices: Design Guidelines Manual (superseded but still referenced)
HIRDS v4	NIWA High Intensity Rainfall Design System Version 4
MfE RCP Guidance	Ministry for the Environment – Climate Change Projections and Guidance (Representative Concentration Pathways, e.g. RCP8.5)
WQV	Water Quality Volume (⅓ × 50% AEP, 24 h Storm)
SHGW	Seasonal High Groundwater
Direct-Discharge lot	Lot with water-reuse storage only (no attenuation/treatment)
Private-Soakage lot	Lot required to infiltrate to ground up to the 1% AEP with no connection to public SW
HEC-HMS	HEC-HMS stands for Hydrologic Engineering Center – Hydrologic Modeling System. Software package developed by the U.S. Army Corps of Engineers for simulating rainfall-runoff and watershed hydrology.

1.0 EXECUTIVE SUMMARY

This Stormwater Management Plan (SMP) supports a fast-track consent application under the Fast-track Approvals Act 2023 for 169-171 Peka Peka Road, Waikanae, by Waikanae North Developments Ltd (WNDL).

The proposed development provides approximately 1,200 private residential dwellings across the site. This is primarily comprised of standard residential lots, with a smaller component of medium-density housing, terrace housing, apartment units, and some commercial areas.

The report follows the structure of GWRC Schedule 29 (Stormwater Impact Assessment) for consistency but adapts it to the Kāpiti District context. Contaminant-treatment design aligns with Schedule 28 and GD01/GD04, and hydraulic-neutrality requirements follow KCDC LDMR 2022.

This SMP confirms:

- All road runoff and direct-discharge sub-catchments receive water-quality treatment via bioretention basins/swales sized from a representative 1-ha post-development model run.
- Site-wide hydraulic neutrality is achieved overall. Selected catchments intentionally release treated flows from development areas to Te Harakeke Swamp without soakage or attenuation to support restoration, with no adverse off-site effects confirmed by macro-modelling.
- Primary conveyance (10% AEP) sits within road corridors; exceedance (1% AEP) follows mapped overland paths to drain and wetland corridors.
- Device layouts follow GD04/WSUD principles and the SMP template structure (resources, constraints, framework, responses), integrating with ecology and hydrology strategies.
- Groundwater treatment devices fit within reserve footprints. Where seasonal groundwater is high, lined bioretention with underdrains is adopted; where still constrained, proprietary filtration (e.g. Hynds Up-Flo, SPELFilter, Atlan) provides equivalent treatment in the same or smaller footprint. Peat removal may improve clearance for conventional WSUD basins. Device selection is confirmed at detailed design informed by ongoing groundwater monitoring.

Expert Witness Code of Conduct

This report has been prepared by Joseph Harris, BE (Hons), Civil Engineering, a civil engineer experienced in stormwater management and land development infrastructure. I confirm that I have read and agree to comply with the Code of Conduct for Expert Witnesses set out in the Environment Court Practice Note 2023. This report has been prepared in accordance with that Code. The opinions expressed are within my area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from those opinions. I confirm that, to the best of my knowledge, I am not subject to any conflict of interest in providing this assessment.

2.0 INTRODUCTION

2.1 Purpose of Report

This Stormwater Management Plan (SMP) supports the Fast-Track consent for 169–171 Peka Peka Road. It demonstrates that stormwater management is feasible, environmentally appropriate, and aligned with GD01/GD04, GWRC Schedules 28/29 (structure and treatment performance), and KCDC LDMR 2022.

The SMP sets the site-wide framework: hydrology basis, catchment classification and lot rules, device sizing principles, groundwater responses, conveyance/exceedance routing, and O&M. It provides concept-level design sufficient for consent of the overall approach; detailed geometry is confirmed at engineering approval.

Read together with Stormwater Plans (Sheets 400–499) and the AWA (Macro Stormwater Modelling), CGW (Geotech), Hydrological Report (OCDL) and RMA Ecology reports.

2.2 Background and Context

The application site lies immediately north of Waikanae's existing urban boundary. The proposed development provides approximately 1,200 private residential dwellings across the site. This is primarily comprised of standard residential lots, with a smaller component of medium-density housing, terrace housing, apartment units, and some commercial areas.

The proposal will be supported by the provision of requisite infrastructure, including pedestrian and cycle facilities (including a connection to the neighbouring State Highway cycleway, walkway and bridleway) and open space areas. In addition, significant ecological restoration is proposed through the restoration of, and creation of new, wetland areas, and stream realignment and re-naturalisation. The site includes existing drains, wetlands, modified watercourses and low-lying peat areas.

Key site features:

- Topography: Predominantly flat to gently undulating, with coastal dune landforms in the west.
- Geology: Large portions of the eastern flats contain shallow peat deposits.
- Ecology: Numerous natural wetlands are distributed across the site.
- Hydrology: Wetlands and drains present, along with highly modified watercourses, with shallow groundwater within peat layers.
- Access: Initial access from Peka Peka Road, with future connections facilitated east, west and south.

The stormwater strategy has been developed in coordination with:

- Stormwater Impact Assessment (AWA Environmental): Macro flood modelling and flood risk verification, confirming site-wide hydraulic neutrality and flood level management, and setting the final development areas, roads, and lots with appropriate freeboard to modelled flood levels.

- Ecological Assessments (RMA Ecology): Aligning the stormwater strategy with wetland restoration priorities and ecological outcomes.
- Geotechnical Inputs (CGW): Defining peat extent, soakage rates, and groundwater levels to inform design and areas of peat removal.
- Masterplan and Earthworks Strategy: Establishing development areas and defining extents of peat removal.

This integrated approach demonstrates feasibility, environmental appropriateness, and alignment with the masterplan.

2.3 Alignment with Hydrology and Ecology Outcomes

The stormwater management approach has been developed to respond to the outcomes identified in the supporting hydrology and ecology assessments, rather than as a standalone drainage exercise.

At a project level, the relevant stormwater outcomes for the receiving environment can be summarised as follows:

- maintain, as far as practicable, the existing distribution of runoff pathways across the site
- avoid adverse increases in downstream flood effects or discharge concentration
- support and enhance the hydrological functioning of wetlands, including maintaining or increasing water levels and extent where required for ecological restoration, including where this requires treated runoff to be directed to those systems
- accept that, in selected catchments, treated runoff is intentionally directed to wetlands to support ecological outcomes, rather than enforcing strict hydraulic neutrality
- provide stormwater treatment for developed areas, particularly roads and direct-discharge catchments
- avoid reliance on infiltration in areas constrained by peat or high groundwater, unless supported by testing and groundwater clearance
- maintain clear separation between stormwater management measures required for hydraulic neutrality and rainwater reuse measures provided for water supply purposes.

The SMP responds as follows:

- **Lot-level controls and network interface requirements** are defined in Section 5, including on-lot attenuation, soakage (where appropriate), and management of areas without secondary flow paths
- **Treatment and conveyance responses** are defined in Section 7, including bioretention, wetlands, and discharge arrangements tailored to receiving environments
- **Catchment-scale responses vary across the site**, with hydraulic neutrality applied at the site-wide scale (not at the treatment basin discharge locations) with selected catchments (particularly those discharging to Te Harakeke wetland) intentionally directing additional runoff to wetlands to support ecological function

This approach means that stormwater management is not applied uniformly across the site; instead, responses are varied to align with both hydraulic and ecological outcomes, consistent with the supporting hydrology and ecology assessments.

This section establishes the linkage between the supporting hydrology and ecology assessments and the stormwater design response. The supporting reports define the receiving-environment outcomes; this SMP sets out how those outcomes are implemented in the stormwater design.

3.0 STORMWATER MANAGEMENT PHILOSOPHY

The SMP is guided by:

- **Water Sensitive Design (GD04):** treatment at source, through simple and robust devices.
- **Hydraulic neutrality (LDMR22):** site-wide neutrality achieved overall. Selected catchments deliberately direct treated flows to Te Harakeke Swamp to support restoration while remaining neutral at the wider catchment scale (per hydrology).
- **Ecological alignment:** flows directed to existing and proposed constructed wetlands in some catchments to enhance restoration outcomes.
- **Maintainability:** fewer, centralised devices with forebays to suit KCDC vesting preferences.

3.1 Functional Differences

This SMP adopts the Schedule 29 (SIA) structure to organise constraints, mapping and responses for clarity in the Fast-Track context. Schedule 28 (Contaminant Treatment) performance is met via GD01/GD04-compliant bioretention or equivalent proprietary filtration where groundwater limits depth. Applicability is framed to Kāpiti; use of S28/S29 is for structure and performance alignment, not statutory requirement of the Kāpiti whaitua.

4.0 STORMWATER DESIGN BASIS

Rainfall Data
Rainfall depths are based on NIWA HIRDS v4 with climate change allowance (RCP8.5, 2090 horizon).

Hydrologic Method
Stormwater flows were assessed using HEC-HMS with a representative 1-hectare development sub-catchment. This approach allows flows to be normalised per hectare, then scaled to the delineated catchments using lot-specific rules. Parameters adopted were:

- **Imperviousness:** 70% (per KCDC LDMR22 conservative urban development assumption)
- **Curve Number (CN):** 69 (LDMR22 for urbanised areas)
- **Time of Concentration (Tc):** 10 minutes, minimum TC adopted for concept design.
- **Initial Abstraction:** 5 mm. A 5 mm initial abstraction has been adopted as a standard concept-stage assumption.

Design Storm Application
The following table summarises the design storms, the HEC-HMS scenarios applied, how they relate to lot rules, and the purpose of each run. Representative 1-ha runs pre- and post-development scenarios (see Appendix A). Developed-area values for device sizing exclude lots with on-site storage for attenuation and/or treatment (hydraulically neutral at the communal network interface). The representative 1 ha approach is used for concept sizing only, with catchment-scale effects assessed in the AWA modelling.

Table 4-1 – Design Storm

Design Storm	HEC-HMS Scenario Used	Applied To *(Refer to Section 5 for description of lot types described in this table)*	Peak Flow ($m^3/s/ha$)	Purpose
Water Quality (1/3 × 50% AEP, 24h)	Post-development, 70% impervious, CN 69	All direct discharge lots and roads	~0.05	Defines flows/volumes to be treated in bioretention/swales; basis for treatment footprint sizing.

10% AEP Post-development	70% impervious, CN 69	Direct discharge lots + roads	~0.23	Used to size the primary network conveyance and basin outlets.
10% AEP Pre-development	0% impervious, CN 69	Lots with on-site storage for attenuation and/or soakage + greenfield areas	~0.14	Provides estimated flows from attenuated and greenfield lots to check conveyance and scour protection; also informs concept pipe sizing.
1% AEP Post-development	70% impervious, CN 69	Direct discharge lots + roads	~0.35	Defines development exceedance flows; informs flood routing and scour protection sizing.
1% AEP Pre-development	0% impervious, CN 69	Lots with on-site storage for attenuation and/or soakage + greenfield areas	~0.25	Provides estimated flows from attenuated and greenfield lots under exceedance conditions.

Summary
These per-hectare flows are scaled to delineated catchments. This provides concept sizing for water-quality treatment, confirms the primary network conveys the 10% AEP, and that exceedance (1% AEP) is safely routed.

5.0 CATCHMENT CLASSIFICATION AND PERFORMANCE CRITERIA

The stormwater management approach varies across the site in response to topography, receiving environments, and ecological objectives.

The strategy is defined through two complementary plans which operate together to describe the full system:

Table 5-1 – Overview Strategy Plans

Plan	What it describes
The Catchment Plan (Drawing SW-400)	Defines the catchment-scale stormwater management response, including treatment devices, wetland attenuation and downstream control structures.
Lot Control Plan (Drawing SW-401	Defines the stormwater management requirements that apply to individual lots within those catchments, including where on-lot attenuation, soakage or direct discharge is permitted.

Together, these plans define:

- how runoff is managed at the lot scale, and
- how it is managed collectively at the catchment scale.

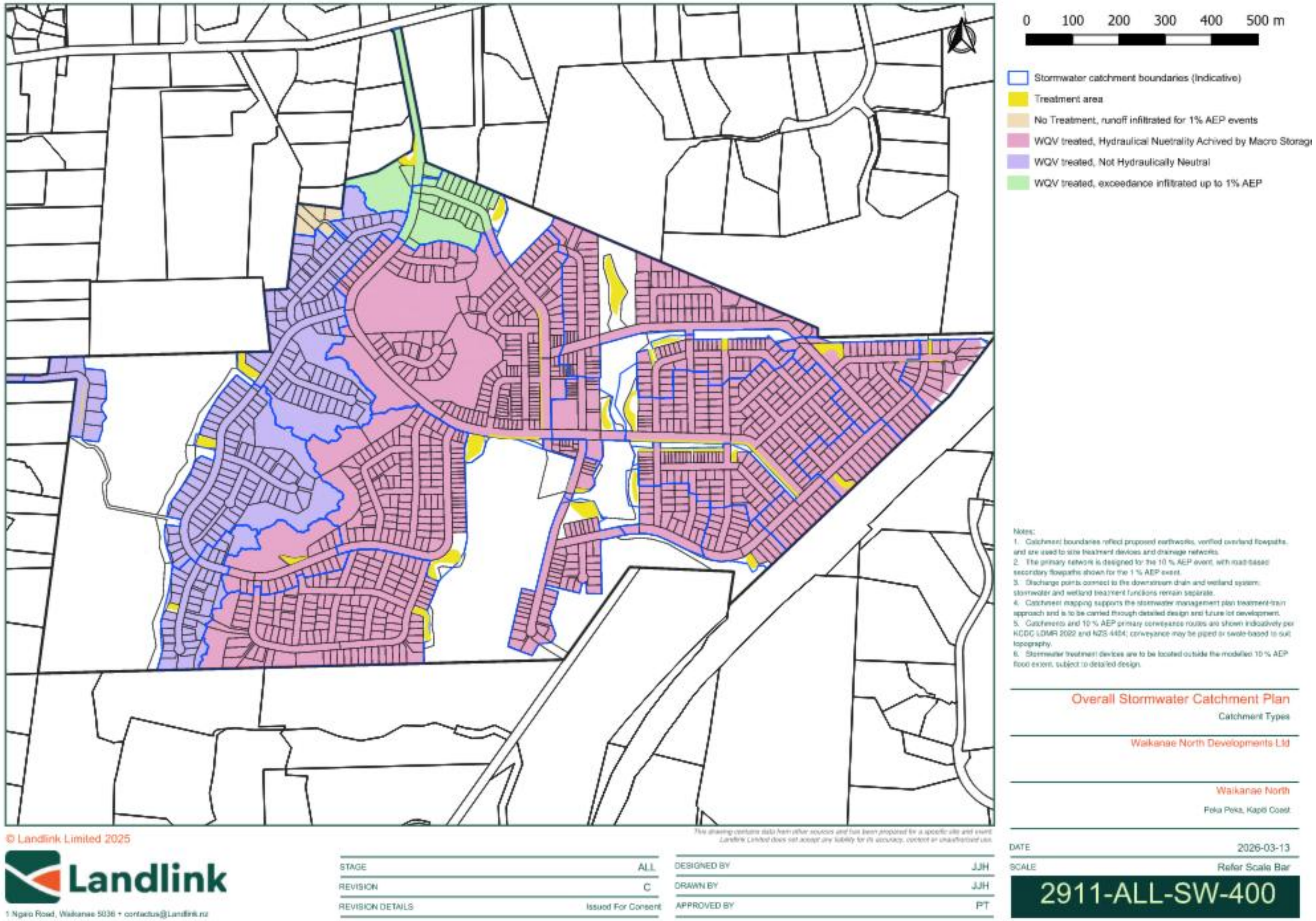


Figure 5-1 – Overall Stormwater Catchment Plan (SW-400)

Eastern Catchments (Pink): Runoff is treated and directed to wetlands and macro-storage, with discharge controlled via downstream structures. This achieves hydraulic neutrality at a catchment scale, with wetlands providing treatment and attenuation. Increased flows to wetlands are intentional and support ecological function, rather than indicating inconsistency.

Western Catchments (Purple): Runoff is treated and discharged to wetlands without downstream flow control. These areas are not strictly hydraulically neutral and instead rely on wetland storage and attenuation.

Local Infiltration Areas (Green): Runoff is treated and managed via local infiltration, with exceedance contained within the site. This approach is driven by the absence of secondary flow paths.

Private Treatment Areas (Yellow): Private, lot-level treatment and soakage systems, not part of the public network.

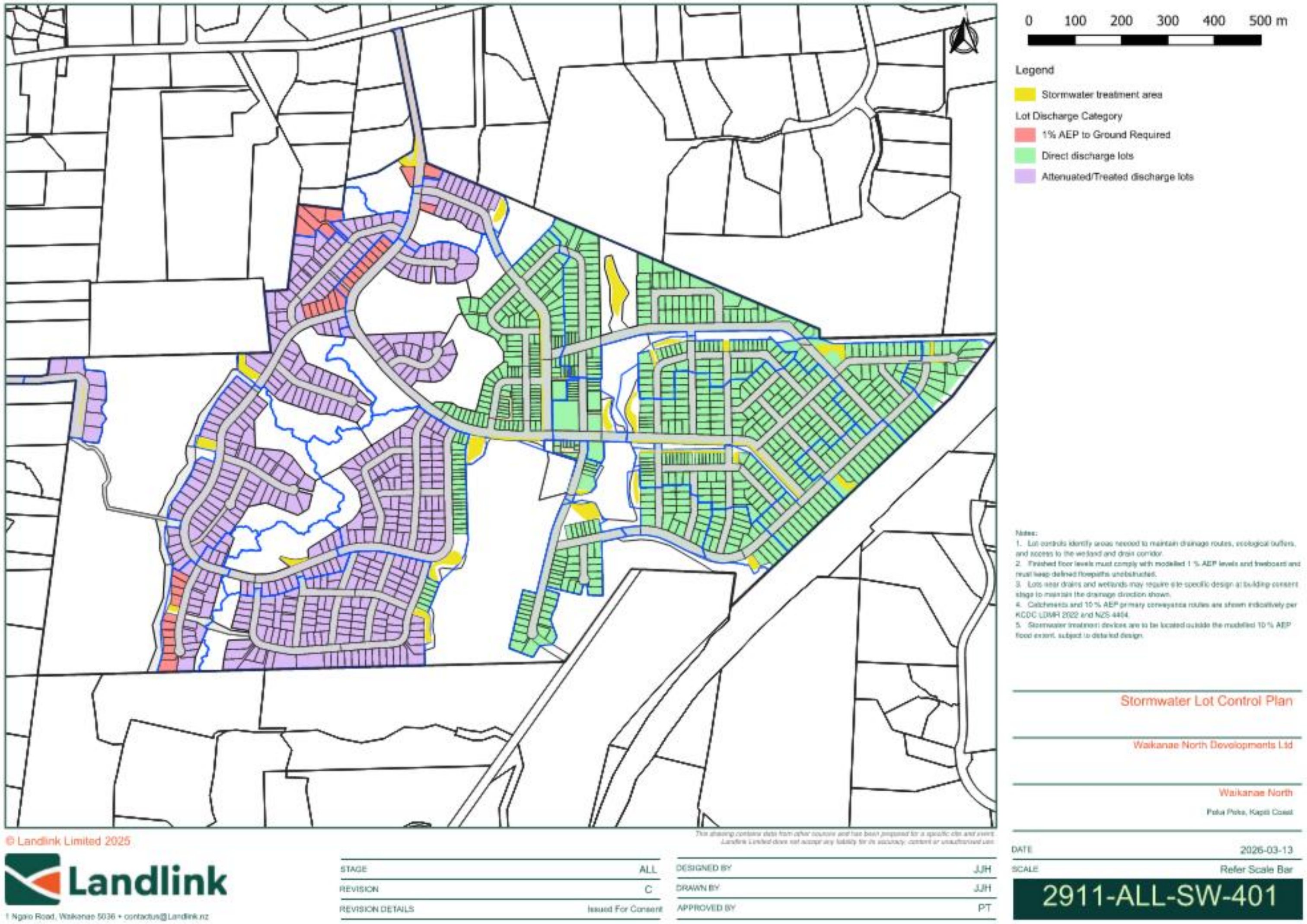


Figure 5-2 – Overall Lot Control Plan (SW-401)

Direct Discharge Lots (Green): Runoff may discharge directly to the public network. This is appropriate where downstream wetlands and basins provide treatment and attenuation, achieving hydraulic neutrality at a catchment scale. No on-lot attenuation is required.

Attenuated / Treated Discharge Lots (Purple): Runoff must be managed to achieve hydraulic neutrality at the lot level. This is typically achieved through attenuation tanks with restricted outlets or soakage systems that reduce peak flows. These measures operate independently of basin treatment and are not included in basin sizing.

Ground Disposal Lots (Red): Runoff must be discharged to ground at the lot level.This applies where no secondary flow path or network connection is available. Systems must accommodate runoff up to the 1% AEP event. These areas are also excluded from basin sizing.

5.1 Purpose and Rule Context

This section defines how lot-level controls and communal infrastructure operate together to deliver:

- water quality treatment,
- conveyance,
- exceedance management, and
- hydraulic neutrality (HN) across the site.

Design principles follow GD01 / GD04 and KCDC LIUDD (2012), with network performance aligned to LDMR (2022) requirements.

5.2 Hydraulic Neutrality Framework

Hydraulic neutrality (HN) is achieved across the site through a combination of lot-level and catchment-level controls.

Specifically:

- Standard lots achieve HN at the lot scale, through on-lot attenuation and controlled discharge.
- Direct discharge areas achieve HN at the catchment scale, through communal storage, treatment, and downstream controls.
- Wetland-integrated catchments do not apply strict point-based HN, with flows instead managed through wetland storage and attenuation consistent with ecological design objectives.

5.3 System Design Summary

Table 5-2 – *System Design Summary*

System Component	Design Standard	Response
Water Quality Treatment	1/3 of 50% AEP (WQV)	Treated via bioretention devices. Or compliant on lot soakage or attenuation.
Primary Network	10% AEP	Conveyed via piped / formal drainage network
Secondary Network	1% AEP	Managed via overland flow paths or lot-level discharge controls

Lot-Level Controls	Up to 1% AEP (where required)	Managed via soakage or attenuation depending on lot type

5.4 Performance Criteria

System Definition

- Primary system = 10% AEP piped / formal drainage network
- Secondary system = 1% AEP overland flow paths via roads, reserves, or defined discharge paths
- Secondary flow paths are not directed across private lots

Water Quality Event (WQV)

- Capture and treat 1/3 of 50% AEP rainfall depth
- Devices to drain within 24 hours
- Bioretention systems designed in accordance with GD01/GD04
- Typical performance:
  - ~90% TSS removal
  - ~40% TN, ~60% TP
  - ~90% Zn and Cu
- Media to be approved by Wellington Water or KCDC

10% AEP Event (Primary Network)

- Convey post-development flows from roads and direct discharge lots
- Include attenuated contributions from standard lots
- Prevent flooding of dry basins from macro flows
- Provide scour protection at outlets

1% AEP Event (Exceedance)

- Safely convey exceedance flows to wetlands and drainage corridors
- Treatment devices may inundate but must remain functional
- Include attenuated lot contributions

- Avoid adverse effects on neighbouring properties

Groundwater Interaction

- Maintain separation from seasonal high groundwater where practicable
- Where not achievable, devices may be lined and drained where required by groundwater constraints.
- Concept levels informed by piezometer dataset (2025/2026)

Ecological Outcomes

- Direct flows to wetland systems where appropriate
- Integrate stormwater management with ecological restoration

6.0 TREATMENT DEVICES

6.1 Overview of Device Types

Three types of public treatment devices are proposed, selected to meet GD01/GD04 performance while fitting within available reserve footprints and groundwater constraints.

1. **Bioretention Basins** – serving larger contributing catchments; always including a sediment forebay for coarse particle capture and maintenance access.
2. **Bioretention Swales** – linear devices located within road reserves, treating carriageway runoff; these do not include forebays.
3. **Bioretention Basins with Soakage** – in selected catchments (those requiring soakage to the 1 % AEP), basins are coupled with subsurface soakage systems to provide both treatment and infiltration.

In addition to these treatment devices, the site incorporates site-wide flood-storage areas. These provide collective detention capacity and contribute to maintaining hydraulic neutrality across the development, operating in parallel with the local treatment devices described above.

Private soakage and attenuation systems—comprising on-lot attenuation tanks and soak pits—are also required for rights-of-way and individual lots in designated areas. These systems are privately owned and maintained. Where private tanks include a controlled kerb outlet, discharge to the public network may occur under designed exceedance conditions consistent with the site-wide neutrality framework.

Where seasonal groundwater limits basin depth, proprietary filtration units (e.g. Hynds Up-Flo, SPELFilter, Atlan filter system) may be adopted within the same or smaller footprint to achieve equivalent contaminant-removal performance. In zones of peat removal, groundwater constraints may lessen, enabling conventional bioretention basins. Final selection confirmed at detailed design.

A representative lot-scale calculation demonstrating concept feasibility is provided in Appendix C.

6.2 Functional Differences

- **Swales vs Basins:**
  - Swales are road-corridor devices, shallow and linear.
  - Basins are flexible in shape, often pond- or cell-like, and located in reserves. They include forebays.
- **Ponding Assumption:**
  - Because of high groundwater levels across much of the site, no extended ponding has been assumed at concept stage. Basins are treated as “dry” devices.
- **Soakage-Linked Basins:**
  - Where lot rules require 1 % AEP infiltration, bioretention basins are paired with soakage trenches or fields to meet this requirement.

6.3 Sizing Basis (Concept Level)

All treatment devices have been sized using the Water Quality Volume (WQV) design storm to establish a consistent basis for concept design and spatial planning across the site.

Two key metrics are used to define treatment requirements:

- **Treatment footprint (m^2/ha):**
  Represents the physical area of bioretention required per hectare of developed catchment.
- **Treatment/storage volume (m^3/ha):**
  Represents the volume of runoff that must be treated and/or stored within the device during the design event.

A treatment requirement of 270 m^2/ha has been derived from a representative 1-hectare HEC-HMS model. This defines the spatial footprint required for treatment devices at concept stage.

Separately, the same modelling indicates that the system is required to manage approximately 205 m^3/ha during the water quality storm event. This volume is accommodated within the bioretention media, drainage layers, and through drawdown over a 24-hour period.

This dual-metric approach allows both:

- spatial allocation of devices within the masterplan (using m^2/ha), and
- confirmation of treatment capacity and performance (using m^3/ha).

Key design assumptions adopted for concept sizing are:

- Media depth = 600 mm engineered bioretention mix
- Transition layer = 100 mm sand
- Base drainage layer = 250 mm clean gravel with perforated underdrain
- Effective porosity = 0.3
- Soakage rate = 50 mm/hr (consistent with GD01 media performance)
- Drawdown ≤ 24 hours
- No network ponding counted towards storage (conservative assumption)

Forebay Allowance:
Each basin includes a forebay sized at 10% of the treatment area (minimum 25 m^2) to provide sediment capture and maintenance access.

Detailed WQV calculations and 1% AEP soakage assessments are provided in Appendix B and Appendix C. Where soakage is required, sizing is based on the 1% AEP to-ground assessment.

Bioretention systems incorporate a permeable base to enable infiltration and groundwater recharge where practicable. Where groundwater clearance is limited, infiltration/soakage is not relied upon for stormwater management performance or exceedance management, and systems are designed to function effectively without infiltration.

This methodology is intended for concept-level sizing and system planning. Detailed hydraulic behaviour, groundwater interaction, and final device configuration will be confirmed at detailed design.

6.4 Application of Catchment-Based Stormwater Approach

The catchment areas shown on Figure 5-1 define how stormwater is managed across the site. Refer to Section 5 for a detailed description of the stormwater management approach.

Catchment extents, device locations, and outlet points are shown on the Stormwater Plans (Sheets 400–499) and summarised in Appendix C.

The treatment and storage requirements defined in this section are implemented through the device types and configurations described in Section 7

7.0 TREATMENT DEVICE FEASIBILITY AND SYSTEM RESPONSE

7.1 Communal Treatment Devices and Feasibility

The public stormwater system comprises communal treatment devices located within road reserves, stormwater reserves, and wetland interface areas. These devices provide the primary public stormwater treatment response for catchments that discharge to the communal network and are sized at concept level using the treatment requirements set out in Section 6.

The communal device response includes:

- **Bioretention basins** for larger catchments and reserve-based treatment areas;
- **Bioretention swales** for linear road-corridor treatment;
- **Bioretention basins with soakage** in selected catchments where infiltration is appropriate; and
- **Proprietary treatment devices or lined systems** where groundwater, depth, or tailwater constraints make conventional soakage-based treatment impracticable.

At resource consent stage, feasibility has been assessed by confirming that each treatment catchment has a viable concept response within the available spatial and vertical envelope. This has been undertaken by combining:

- indicative device footprints shown on the stormwater plans;
- catchment-specific treatment area requirements;
- representative vertical stack requirements;
- piezometer-based groundwater assessment; and
- a treatment-form hierarchy of soakage-capable bioretention, lined bioretention with underdrain, and proprietary treatment where required.

Accordingly, this SMP demonstrates that a feasible public treatment response is available for each communal treatment catchment, while recognising that final dimensions, invert levels, proprietary selections, and detailed layouts will be confirmed at detailed design.

For each communal treatment catchment, the following concept checks were undertaken:

- treatment footprint required versus provided;

- minimum vertical stack availability;
- groundwater clearance relative to the adopted device base;
- suitability of soakage, lined treatment, or proprietary treatment response; and
- receiving environment compatibility, including discharge to downstream wetlands, storage areas, or soakage-based systems where applicable.

Groundwater dataset and concept design basis

Site piezometers provide representative coverage across the development area and have been monitored through summer and winter 2025/2026. This dataset is considered sufficient to assess concept feasibility and identify the likely treatment form for each catchment. Monitoring will continue through detailed design to confirm seasonal high groundwater conditions and refine final device configuration where required.

Minimum vertical stack requirement

A minimum vertical depth is required between adjacent road level and the device base to accommodate the hydraulic and treatment layers of a communal bioretention device. The following concept allowances have been adopted:

- 100 mm – freeboard from road surface to catchpit lid
- 200 mm – hydraulic fall from catchpit lid to bubble-up crest
- 100 mm – cover from bubble-up crest to top of media
- 600 mm – bioretention media depth
- 100 mm – sand transition layer

Total minimum depth (road level to device base) = 1.10 m

Each treatment device has been checked against this concept depth requirement. Where this depth is not achieved, or where the available vertical envelope is otherwise constrained, the concept response assumes either a refined lined configuration or a proprietary treatment device at detailed design.

Groundwater clearance bands and treatment response

Groundwater clearance has been assessed as the difference between adopted device base level and seasonal high groundwater level. For concept design, the following acceptance bands have been adopted to determine the likely device form:

- **≥ 0.50 m clearance** – soakage-capable bioretention feasible, subject to field confirmation;

- **0 m to 0.49 m clearance** – bioretention systems incorporate a permeable base to allow infiltration and groundwater recharge. However, infiltration/soakage is not relied upon for stormwater management performance or exceedance management;
- **< 0 m clearance** – lined treatment response required, with proprietary treatment adopted where vertical or hydraulic constraints make conventional bioretention impracticable.

This approach allows each catchment to be assessed consistently while recognising that final treatment form may change during detailed design as groundwater records are extended and levels are refined.

Response to Ecology Assessment

The stormwater management approach has been developed in response to the outcomes identified through the hydrology and ecology assessments.

From a hydrology perspective, the key requirement is to manage post-development runoff volumes and flow behaviour such that adverse downstream effects are avoided.

From an ecological perspective, stormwater management is required to support the receiving wetland environment by maintaining appropriate hydrological inputs and avoiding detrimental changes to flow regimes.

In response to these requirements, the proposed stormwater strategy adopts a combination of:

- hydraulic neutrality and attenuation for the majority of development areas,
- soakage and infiltration where ground conditions are suitable, and
- controlled discharge to wetland systems in specific areas where this supports ecological outcomes.

The proposed design has therefore been developed to directly respond to the combined hydrological and ecological requirements of the receiving environment.

Hydraulic neutrality has been adopted as the primary design approach across the development, with post-development runoff managed to reflect pre-development conditions where practicable.

In defined western areas, increased discharge to wetland systems is intentional and forms part of the ecological design response. In these locations, strict hydraulic neutrality is not sought, and this approach is supported by the ecological assessment.

Assessment summary

The catchment-by-catchment feasibility assessment is summarised in Table 7-1. For each treatment catchment, the table records the contributing developed area, treatment basin reference, adopted treatment basis, concept vertical stack result, groundwater response, and whether the treatment area requirement is met.

The underlying catchment and device schedule supporting this assessment is provided in Appendix C, together with the basin references and treatment allocations shown on the Stormwater Plans (Sheets 400–499). Groundwater feasibility has been informed by the 2025/2026 piezometer monitoring dataset and the relevant geotechnical and groundwater reporting prepared for the site.

Table 7-1 – Treatment Device Sizing and Checks

Catchment Ref	Treatment Basin Ref	Developed Area (ha)	Soakage Rule	Total Treatment Area incl. Forebay (m^2)	Meets 1.10 m Stack?	Groundwater Approach / Treatment Form	Treatment Area Requirement Met?	Key Comment
1	1_1, 1_2, 1_3, 1_4	8.71	No (270 m^2/ha)	2587.43	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	PASS	Treatment allocation meets requirement; constrained groundwater governs treatment form.
2	2_1	1.78	No (270 m^2/ha)	527.50	FAIL	Proprietary device required at concept stage	PASS	Does not meet depth-stack check; carry forward proprietary treatment response unless refined at detailed design.
3	3_1, 3_2, 3_3	1.39	No (270 m^2/ha)	413.46	PASS	Soakage for groundwater recharge; not relied upon for stormwater	PASS	Marginal clearance; treatment capacity adequate.

						management performance		
4	4_1, 4_2, 4_3, 4_4	2.56	No (270 m²/ha)	759.27	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	PASS	Moderate groundwater constraint; lined treatment appropriate.
5	5_1	3.55	No (270 m²/ha)	1053.00	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	PASS	Borderline depth check; non-soakage treatment form assumed.
7	7_1	1.54	No (270 m²/ha)	457.46	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	PASS	Treatment capacity adequate.
8	8_1	1.81	No (270 m²/ha)	536.72	PASS	Soakage for groundwater recharge; not relied	PASS	Treatment capacity adequate.

						upon for stormwater management performance		
9	9_1, 9_2, 9_3, 9_4	2.88	No (270 m²/ha)	854.54	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	PASS	Marginal clearance governs treatment response.
11	11_1	0.68	Yes (775 m²/ha)	582.62	PASS	Soakage feasible	PASS	Good groundwater clearance.
14	14_1	1.37	No (270 m²/ha)	407.49	PASS	Soakage feasible	PASS	Good depth and clearance.
15	15_1	1.30	No (270 m²/ha)	386.17	PASS	Soakage feasible	PASS	Good depth and clearance.
16	16_1	0.46	No (270 m²/ha)	135.85	PASS	Soakage feasible	PASS	Ample depth and clearance.
18	18_1	0.65	Yes (775 m²/ha)	553.71	PASS	Soakage feasible	PASS	Good groundwater clearance.

98	98_1	2.39	No (270 m²/ha)	708.75	PASS	Soakage feasible	PASS	Adequate clearance for soakage response.
99	99_1	2.74	No (270 m²/ha)	815.18	PASS	Soakage feasible	PASS	Adequate clearance for soakage response.
102	102_1	3.03	No (270 m²/ha)	898.58	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	PASS	Moderate groundwater constraint; lined treatment appropriate.
103	103_1	1.52	No (270 m²/ha)	450.97	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	PASS	Treatment capacity adequate.
105	105_1, 105_2	0.70	No (270 m²/ha)	207.31	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	PASS	Treatment capacity adequate.

108	108_1	0.48	No (270 m²/ha)	143.12	PASS	Soakage feasible	PASS	Good groundwater clearance.
112	112_1	6.37	No (270 m²/ha)	1892.04	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	PASS	Marginal clearance governs treatment response.
120	120_1	0.18	No (270 m²/ha)	53.38	PASS	Soakage feasible	PASS	Good depth and clearance.
121	121_1	0.58	No (270 m²/ha)	170.87	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	PASS	Borderline depth check; non-soakage treatment form assumed.
992	992_1, 992_2, 992_3	8.61	No (270 m²/ha)	2556.74	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	PASS	Treatment allocation meets requirement; marginal clearance governs treatment form.

Notes

1. Table 7-1 summarises catchment-level treatment sizing, vertical feasibility, and treatment-form selection based on the refreshed groundwater and treatment allocation assessment.
2. Minimum required depth stack = 1.10 m.
3. Where groundwater clearance is between 0.00 m and 0.49 m, bioretention systems may incorporate a permeable base; however, infiltration is not relied upon for stormwater management performance or exceedance management.
4. Where groundwater clearance is less than 0.00 m, a lined treatment system or proprietary device may be required. A proprietary treatment device response is assumed unless refined at detailed design.
5. Treatment adequacy has been checked using aggregated provided treatment area against the catchment treatment area required, including forebay allowance where relevant.
6. Where a proprietary treatment response is required, the balance between communal treatment and lot-level controls may be refined at detailed design.

Updated Groundwater Feasibility Summary

- Most catchments are feasible within the available spatial and vertical envelope, although several are constrained by marginal groundwater clearance and are therefore carried forward as lined or proprietary treatment responses rather than soakage devices.
- Catchment 2 is the only location that does not currently satisfy the 1.10 m depth-stack check and is therefore carried forward on the basis of a proprietary treatment response unless refined through detailed design.
- Groundwater monitoring will continue through detailed design to confirm seasonal high groundwater levels and refine final device form where required.

7.2 Lot-Level Attenuation and Soakage Systems

Private lot systems form the second component of the stormwater response and are applied according to the relevant lot rule and catchment type.

For clarity:

- **Attenuation systems** are used where post-development discharge must be controlled before entering the public network;
- **Soakage systems** are used where runoff is required to infiltrate to ground within the lot boundary, without reliance on the public network for routine stormwater disposal; and
- **Rainwater reuse tanks** may be installed for water supply purposes but are not relied upon as stormwater management devices for attenuation or treatment.

Where lot rules require hydraulic neutrality at the network interface, the intended concept response is a private attenuation tank discharging at a controlled rate to the public system, typically via a kerb outlet or equivalent controlled connection. These systems are intended to reduce peak discharge from individual lots such that post-development runoff entering the public network does not exceed the relevant design discharge basis.

Where lot rules require on-site soakage, runoff is managed within the lot boundary via infiltration to ground. In these areas, the lot system is intended to operate without routine connection to the public stormwater network for the design storm response.

Direct-discharge lots are separate again. These lots are intended to discharge to the public network in accordance with the applicable catchment strategy and do not rely on on-lot attenuation for routine stormwater management.

Concept feasibility has been checked using a representative residential lot basis. For lots requiring attenuation and controlled discharge, the representative concept design comprises a 10 kL attenuation tank with controlled outlet to the public network, supported where required by a 5.2 m^3 soak pit to assist in achieving the required discharge response. For lots requiring full soakage, concept sizing has been undertaken in general accordance with E1/VM1 methodology using an adopted factor of safety of 4 on infiltration rates.

A representative infiltration rate of 1000 mm/hr has been adopted for the generic lot-scale assessment, consistent with KCDC requirements and informed by the site soakage testing undertaken for the development area. The concept assessment confirms that both:

- attenuation-only systems for controlled-discharge lots; and

- combined attenuation and soakage systems for soakage-governed lots

can be accommodated within a typical residential lot envelope.

Rainwater tanks installed for water-reuse purposes may provide some incidental detention, but they are not relied upon for stormwater attenuation, treatment, or soakage compliance. For stormwater assessment purposes, roof runoff is conservatively assumed to discharge to the stormwater system unless specifically managed by a compliant stormwater device.

Detailed lot design will be confirmed at subsequent design and consent stages, including verification of final tank size, outlet control, soakage capacity, and compliance with KCDC LDMR (2022) and relevant Building Code requirements. Representative lot-scale calculations are provided in Appendix C, with supporting soakage test information included in Appendix D and the relevant ground investigation reporting.

7.3 Exceedance and System-Level Stormwater Response

An assessment has been undertaken to estimate the additional runoff volume generated during the 1% AEP storm event as a result of development, and to confirm that sufficient spatial provision has been incorporated within the masterplan to accommodate that volume within the downstream receiving environments.

This assessment relates to exceedance volume beyond the local treatment storage provided within the communal devices. Once the water quality storage capacity of those devices is exceeded during larger storm events, the balance of runoff is directed to the adjacent wetlands and storage areas identified within the masterplan.

Based on the representative 1 ha catchment assessment in Appendix B, the additional runoff generated by developed areas relative to greenfield conditions during the 1% AEP event is estimated at approximately 223 m^3/ha. For concept purposes, this rate has been applied to the relevant contributing development areas to estimate the additional storage volume that may require accommodation within the downstream receiving environments.

This is a concept-level storage check intended to confirm spatial provision and likely order of magnitude. It is not a substitute for detailed hydraulic modelling of flow routing, timing, tailwater interaction, or flood level response.

Applying this to the contributing development areas, the additional storage requirements within the receiving environments are estimated as follows:

Eastern Flats
Additional volume = 11,041 m^3
Available storage area = 18.3 ha
→ Equivalent additional depth ≈ 60 mm

Catchment 108 Wetland
Additional volume = 112 m^3

Available storage area = 0.1 ha
→ Equivalent depth ≈ 112 mm

Western HH Wetland
Additional volume = 825 m³
Available storage area = 11 ha
→ Equivalent depth ≈ 8 mm

These volumes represent exceedance flows discharged from the stormwater treatment devices to the downstream wetlands and storage areas during the 1% AEP event.

This assessment is important because the AWA macro-scale flood modelling used to inform site levels does not explicitly incorporate either:

- the increase in impervious area associated with development; or
- the redistribution of flows via the stormwater treatment network.

Accordingly, the above volumes provide an indication of the additional runoff that may contribute to flood levels within the receiving environment.

The equivalent storage depths indicate that the wetland and storage areas incorporated within the masterplan are sufficient to accommodate these additional volumes at a concept level. Based on this review, the additional storage depths identified appear capable of being accommodated within the proposed concept design.

For the Eastern Flats, the additional depth of approximately 60 mm is anticipated to be incorporated within the concept weir and storage arrangement without adverse effects on adjacent land. For the Western Harakeke Wetland, the equivalent depth of approximately 8 mm is minor and is not expected to result in any meaningful change in flood behaviour. Within Catchment 108, the available wetland levels and storage configuration are such that the additional volume can be readily accommodated without adverse effects.

This assessment is intentionally simplified and assumes a uniform distribution of storage across each area. It is intended to confirm spatial provision and indicate potential flood-level effects, rather than represent detailed hydraulic behaviour.

It is also noted that peak runoff from the developed catchments is not expected to coincide with wider Kāpiti Coast District contributing flows represented within the AWA macro-scale model. As a result, the additional volumes identified above are unlikely to align with peak flood conditions in the receiving environment, further reducing the potential impact on flood levels.

The results inform the anticipated exceedance response associated with the stormwater strategy set out in this SMP. Detailed hydraulic behaviour, including downstream flood effects and confirmation of hydraulic neutrality where required, will be addressed through subsequent design stages and supporting modelling.

These conclusions are subject to confirmation through detailed design and modelling. Should this approach not be demonstrated to be appropriate at subsequent design stages, adaptive measures remain available, including selective application of lot-level controls within contributing catchments to reduce developed runoff and more closely replicate greenfield response where required to achieve flood management outcomes.

7.4 Consistency of Modelling Assumptions

Different technical assessments undertaken for the development adopt modelling assumptions that are appropriate to their specific purpose.

For the stormwater design and infrastructure planning presented in this report, a simplified impervious assumption has been adopted for developed areas (i.e. roads and residential or commercial lots), based on a nominal 70 % pervious and 30 % impervious split. This approach is intentionally conservative and is used to confirm that sufficient land area is available within the masterplan to accommodate stormwater management devices, including treatment and attenuation systems.

Other technical assessments, including detailed hydrological modelling, may adopt alternative assumptions to achieve a more refined representation of catchment response and water balance. These differences reflect the varying objectives of each assessment rather than any inconsistency in the overall design approach.

Areas such as open space, stormwater reserves, wetlands, dune reserves, and utility corridors are generally treated as pervious within the stormwater design framework, consistent with their intended function and minimal change from pre-development conditions.

Notwithstanding the variation in modelling inputs across disciplines, the overall stormwater strategy remains consistent: runoff from developed areas is managed through a combination of lot-level controls, communal treatment devices, and downstream receiving environments, with sufficient land allocated within the development to support those functions.

8.0 CONVEYANCE AND EXCEEDANCE

8.1 Primary Network (10 % AEP)

- Concept pipe and outlet locations are indicative only and will be finalised at detailed design to align with vertical road design and service layouts.
- HEC-HMS flows (Section 4.0) have been used to size concept pipes and basin outlets.
- Conveyance infrastructure will adopt either piped or swale-based networks consistent with NZS 4404 and KCDC LDMR (2022).

- Urban typologies anticipate a piped primary network within road carriageways, with kerb outlets (per KCDC standard details) connecting lots to the road network unless designated as Direct-Discharge or Private-Soakage lots.

- Road sag points discharge to adjacent basins via kerb cut-outs. Pipe networks “bubble-up” at catchpits, limited to ≤ 100 mm below road level in the 10 % AEP event.

- Concept sizing confirms all conveyance components can be accommodated within typical road reserves.

- The exceedance/treatment outlet for each basin will be located in the stormwater reserve with the invert set close to the predicted 10 % AEP tailwater. This reduces head drop and jetting risk. Outlets will be stabilised with rock-rip-rap aprons and reinforced planting (sedges, rushes, flaxes) to provide energy dissipation, filtration, and ecological integration. Final invert levels, apron sizing, and planting specifications will be confirmed during detailed design following tailwater sensitivity checks for the 50 %, 10 %, and 1 % AEP events.

Concept methodology and example details are provided in Appendix C – Rip-rap and Outlet Protection.

8.2 Exceedance (1 % AEP)

- Exceedance flows will follow roads, discharging to the site’s wetland and drainage network.

- Treatment devices may be temporarily inundated during extreme events but will remain functional and recoverable post-storm.

- No secondary flow path is assumed across private lots. Where a lot does not have a lawful secondary discharge route to the public system, that lot is required by the applicable lot rule to manage runoff on-lot up to the 1% AEP event, typically by soakage or equivalent private containment / disposal measures. Accordingly, the SMP does not rely on uncontrolled overland flow across adjoining private property to satisfy the 1% AEP design response

- Where no secondary flow path is available, lot rules default to 1 % AEP soakage to ground in accordance with KCDC LDMR (2022).

9.0 OPERATION AND MAINTENANCE

The following key points have been identified in relation to maintenance requirements for the proposed stormwater system:

- Forebays: Minimum 5 × 5 m or at least 10 % of the total treatment area; function as sacrificial sediment capture zones and are designed for machine access.

- Bioretention Basins: Annual vegetation management, with sediment and filter media replaced as required.
- Swales: Routine mowing and debris removal to maintain conveyance and treatment performance.
- Catchpits (with Enviropods): Cartridge replacement every 3–6 months depending on sediment load.
- General: All devices are non-proprietary unless groundwater constraints require the use of proprietary units. Where proprietary devices are installed, the supplier's operation and maintenance manual must be followed.
- Design Standards: Forebays are a minimum of 25 m² or 10 % of the treatment area, with media specifications consistent with Wellington Water GD01.

9.1 Engagement with Kāpiti Coast District Council (KCDC)

Engagement with KCDC through pre-application and concept design identified the following preferences:

- Fewer, larger basins for simpler maintenance.
- Sediment forebays at all basin inlets.
- Robust, passive devices rather than proprietary systems.
- Stormwater functions to integrate with ecological restoration but not double-count as wetlands.

These preferences have been adopted in the SMP through centralised basin design, inclusion of forebays, and alignment of device footprints with open-space corridors.

9.2 Vesting, Ownership and Maintenance Intent

At consent stage, the proposed stormwater system is divided into:

- **public / vested components**: communal basins, swales, public pipework, outlet structures, and associated stormwater reserve access
- **private components**: on-lot attenuation tanks, soakpits, private soakage systems, and any private treatment measures required by lot-specific conditions.

A full O&M manual is not provided at this stage. However, the concept design has been developed to demonstrate:

- that the proposed communal devices are passive and maintainable,
- Treatment device sizing includes an allowance of approximately 10% additional area to accommodate forebays and maintenance access requirements. The

spatial extents shown on plans are indicative but demonstrate that sufficient area is available to support long-term operation and maintenance.

- that reserve extents are larger than the treatment footprint where required to allow inspection and machine access, and
- that private responsibilities can be assigned clearly through lot-specific servicing conditions.

Detailed inspection frequencies, renewal schedules, and asset handover requirements will be confirmed through detailed design and vesting documentation.

10.0 COMPLIANCE AND RECOMMENDATIONS

This SMP follows the recommended process of mapping constraints, overlaying the development framework, and defining treatment trains outside 10 % AEP flood extents. It therefore satisfies the expectations of GWRC Schedule 29 (SMP) and aligns with GD04 Water Sensitive Design principles. Compliance is summarised in the table below.

Table 10-1 – Concept design event compliance table

Topic	Adopted Standard / Event	SMP Response
Water quality treatment	WQV = 1/3 of 50% AEP, 24 h	Communal bioretention / equivalent proprietary treatment
Primary system	10% AEP	Public conveyance via pipe / swale / formal drainage network
Secondary system	1% AEP	Roads, reserves, wetland corridors, or on-lot 1% AEP soakage where no lawful secondary path exists
Hydraulic neutrality	KCDC LDMR concept basis	Achieved by lot-level attenuation / soakage or catchment-level control, depending on catchment type
Groundwater constraint response	Clearance band approach	Soakage / lined bioretention / proprietary hierarchy

Lot controls	SW-401 / SMP lot rules	Direct-discharge, Standard / HN, and Private-Soakage categories

This SMP demonstrates compliance with:

- KCDC LDMR22 – neutrality, treatment, and conveyance.
- GWRC Schedule 29 SIA – constraints mapping, flow modelling, and ecological corridor integration.
- GD04 Water Sensitive Design – source control, bioretention/swales, detention/soakage. The concept also recognises that on-lot attenuation tanks provide incidental treatment through detention and first-flush capture, consistent with GD04's principles of integrated flow and water-quality management.
- TP10 / GD01 – treatment-device design criteria.

Further refinement will occur at detailed design to:

- Confirm device footprints, outlet details, and tailwater levels.
- Integrate ecological outcome principles identified in this report.
- Incorporate KCDC's preference for centralised basins with forebays.
- Final device form is confirmed from verified SHGW and vertical design: '
    - (i) soakage where ≥0.5 m clearance,
    - (ii) bioretention with permeable base, allowing soakage for groundwater recharge but not relied upon for stormwater management performance for 0-0.5m clearance,
    - (iii) proprietary filtration where <0 m or where the 1.10 m depth stack cannot be achieved.

11.0 MATTERS FOR CONSIDERATION IN CONSENT CONDITIONS

The following matters should be reflected in consent conditions. They capture the key commitments, triggers, and controls to be implemented through certified, phase-specific plans.

Governance and Certification

- Detailed design approval is required prior to construction of any public stormwater infrastructure. Material changes to certified designs require re-certification.
- The proposed stormwater strategy adopts an adaptive management approach, whereby design assumptions and performance can be refined at detailed design

stage (EPA) following further input from hydrology and ecology specialists. This allows the system to respond to any updated requirements while maintaining the overall design intent established at resource consent stage.

Treatment Performance

- Devices to be sized to WQV = ⅓ × 50% AEP with ≤24-hour drawdown, GD01-compliant media, and forebays (≥10% of treatment area or 25 m² minimum).
- Where SHGW limits depth, adopt lined bioretention with underdrains; where still constrained, adopt proprietary filtration providing equivalent contaminant removal within the same or smaller footprint.

Hydraulic Neutrality and Flood Effects

- Exceedance (1% AEP) to be routed to wetland and drain corridors with no adverse off-site effects, consistent with macro-modelling.

Groundwater Monitoring and Adaptive Response

- Maintain the piezometer network and record monthly groundwater levels for at least one full year to confirm SHGW prior to detailed design approval. Continue monitoring through construction.
- Detailed design of stormwater devices within groundwater-sensitive and ecologically sensitive areas must be informed by confirmed groundwater levels, vertical design refinement, and receiving environment requirements.
- Where site conditions constrain device configuration, the form of treatment device must be adapted in accordance with the following predefined response hierarchy:
    - soakage-capable bioretention where adequate groundwater clearance is available,
    - lined bioretention with underdrain where soakage is not appropriate,
    - proprietary treatment systems where depth, groundwater, or tailwater constraints preclude bioretention.
- Any adaptation in device form must achieve equivalent hydraulic and treatment performance and remain consistent with the overall stormwater management intent of the SMP.

Lot Controls
Private-lot stormwater management must align with the concept and lot rules in this SMP.

- Direct-Discharge lots: water-reuse only; no attenuation required — peak flows may discharge directly.
- Standard lots: provide on-lot attenuation and/or soakage to achieve hydraulic neutrality at the network interface.

- Private-Soakage lots: infiltrate up to the 1% AEP on-lot with no public network connection.
- A generic concept-lot calculation is provided in the SMP as a reference for demonstrating compliance for Standard and Private-Soakage lots.

Operation and Maintenance

- Submit an O&M manual for certified devices (inspection frequencies, media renewal, forebay clean-out) for vesting approval.

APPENDICES

Appendix A – Rainfall–Runoff Modelling (HEC-HMS v4.12) – Setup & Comparison
The rainfall–runoff modelling compares pre- and post-development responses for the 50 %, 10 %, and 1 % AEP events using a representative 1 ha (0.01 km²) sub-catchment. All simulations apply the same 24-hour temporal pattern and event totals from NIWA HIRDS v4 under RCP 8.5 (conservative future-climate intensities). The only parameter changed between scenarios is imperviousness to isolate development effects.

PARAMETER	PRE-DEVELOPMENT	POST-DEVELOPMENT	NOTES
RAINFALL SOURCE	HIRDS v4 (RCP 8.5)	HIRDS v4 (RCP 8.5)	identical
DESIGN DURATION	24 h	24 h	identical
TEMPORAL PATTERN	Normalised HIRDS 24-h	Normalised HIRDS 24-h	identical
LOSS METHOD	SCS Curve Number	SCS Curve Number	identical
CURVE NUMBER (CN)	69 (pervious)	69 (pervious portion)	identical
INITIAL ABSTRACTION (IA)	5 mm	5 mm	identical
% IMPERVIOUS	0 %	70 %	only change
TIME OF CONCENTRATION (TC)	0.17 h	0.17 h	identical
STORAGE COEFFICIENT (R)	0.07 h	0.07 h	identical

This setup underpins the per-hectare flows used in Section 4 and the treatment/conveyance sizing presented in Appendices A–C.

Project: 2911
Simulation Run: CONCEPT - 1% AEP - POST
Simulation Start: 27 August 2023, 24:00
Simulation End: 28 August 2023, 24:00

HMS Version: 4.12
Executed: 25 September 2025, 08:44

Global Parameter Summary - Subbasin

Area (KM2)

Element Name	Area (KM2)
Development area	0.01

Downstream

Element Name	Downstream
Development area	Natrual basin

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Development area	70	69	5

Transform: Clark

Element Name	Clark Method	Time of Concentration	Storage Coefficient	Time Area Method
Development area	Specified	0.17	0.07	Default

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Development area	0.01	0.35	28Aug2023, 12:10	147.39
Natrual basin	0.01	0.35	28Aug2023, 12:10	147.39

Subbasin: Development area

Area (KM2) : 0.01
Downstream : Natrual basin

Loss Rate: Scs

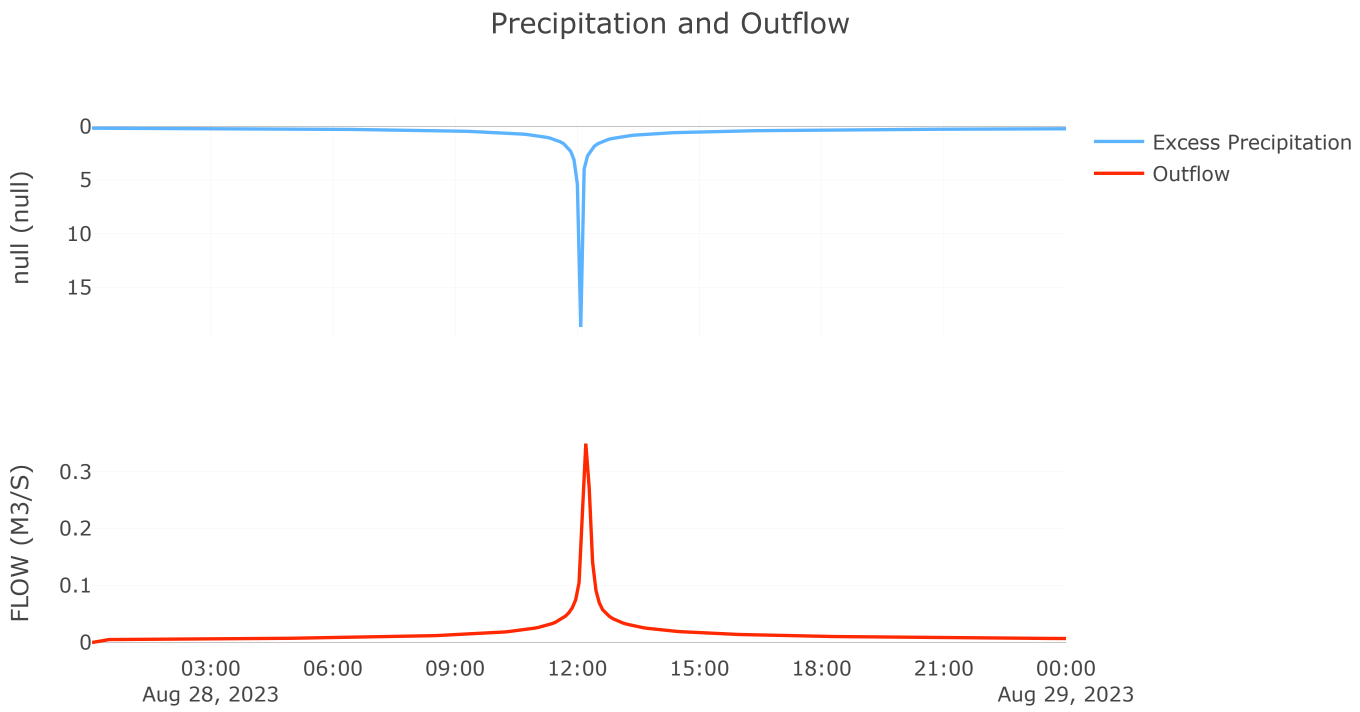
Percent Impervious Area	70
Curve Number	69
Initial Abstraction	5

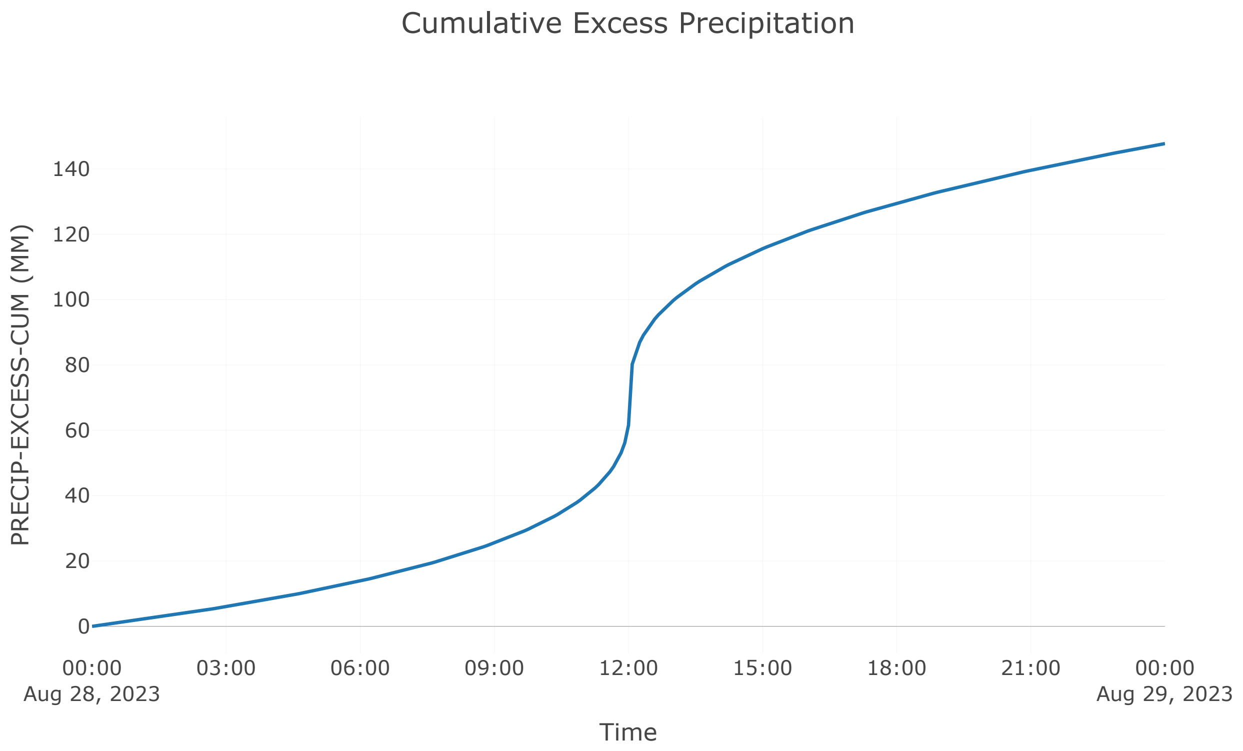
Transform: Clark

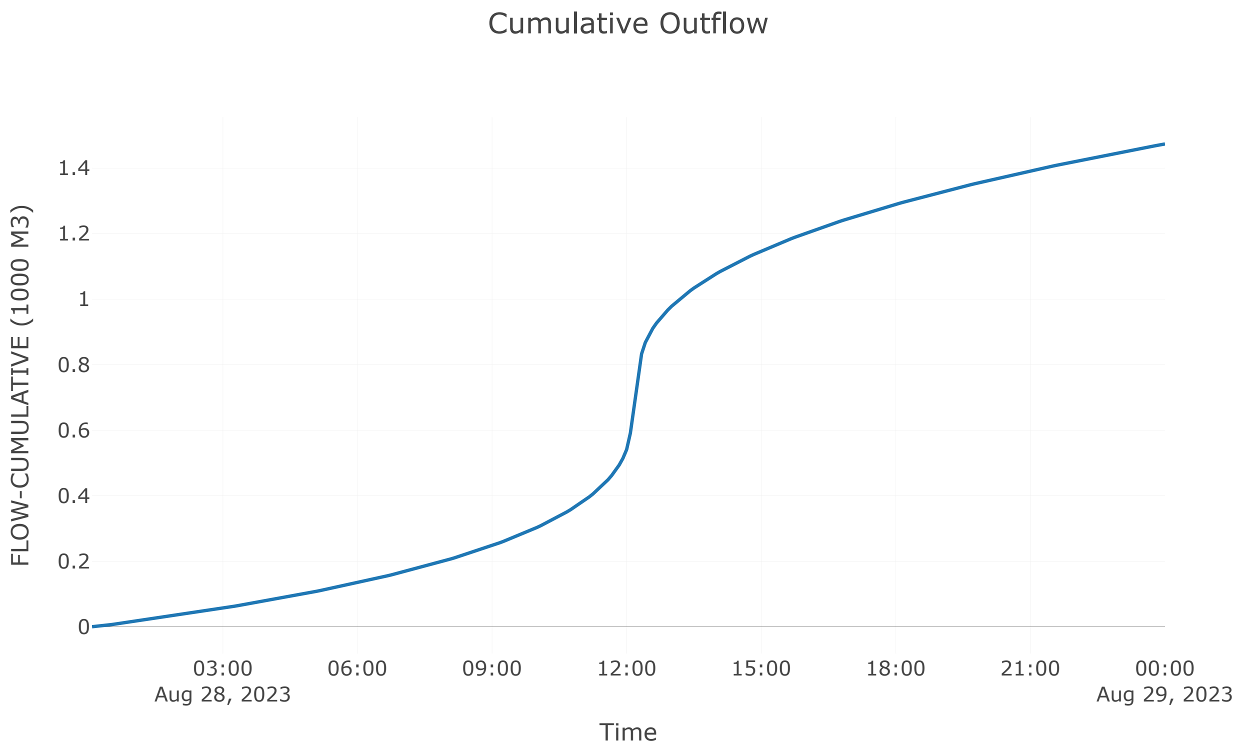
Clark Method	Specified
Time of Concentration	0.17
Storage Coefficient	0.07
Time Area Method	Default

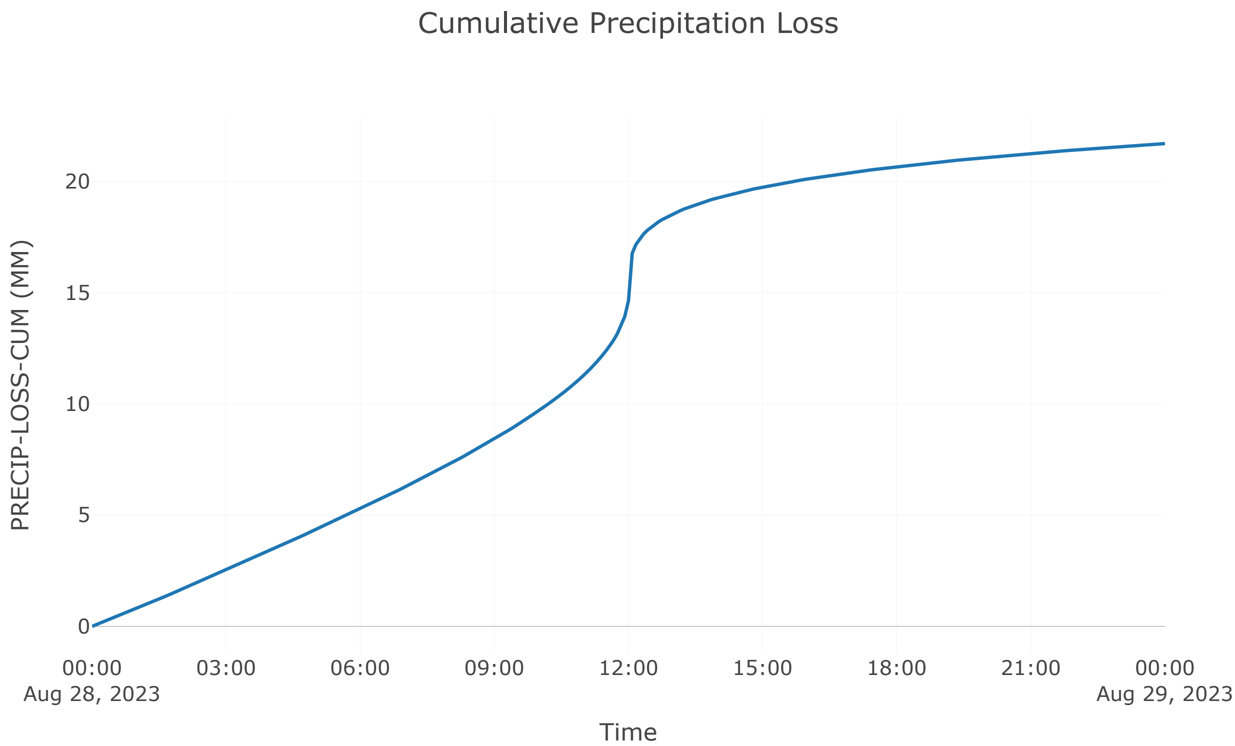
Results: Development area

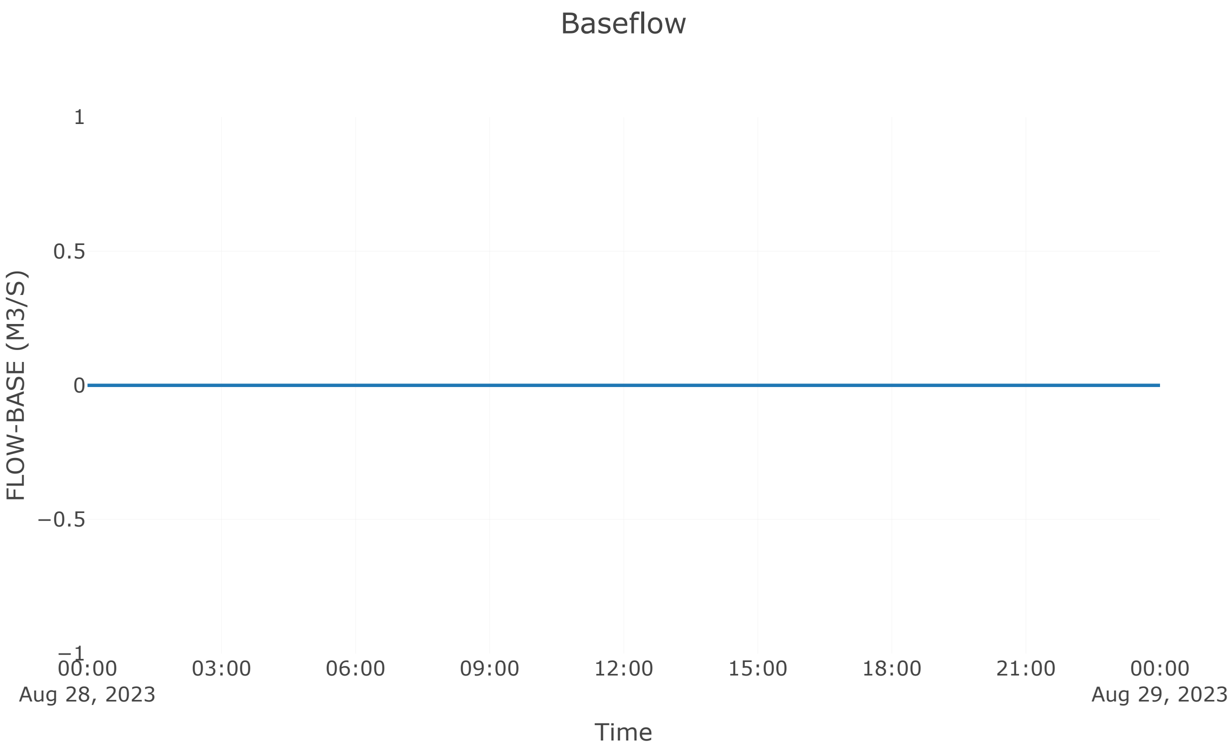
Peak Discharge (M3/S)	0.35
Time of Peak Discharge	28Aug2023, 12:10
Volume (MM)	147.39
Precipitation Volume (M3)	1694.9
Loss Volume (M3)	217.12
Excess Volume (M3)	1477.78
Direct Runoff Volume (M3)	1473.95
Baseflow Volume (M3)	0

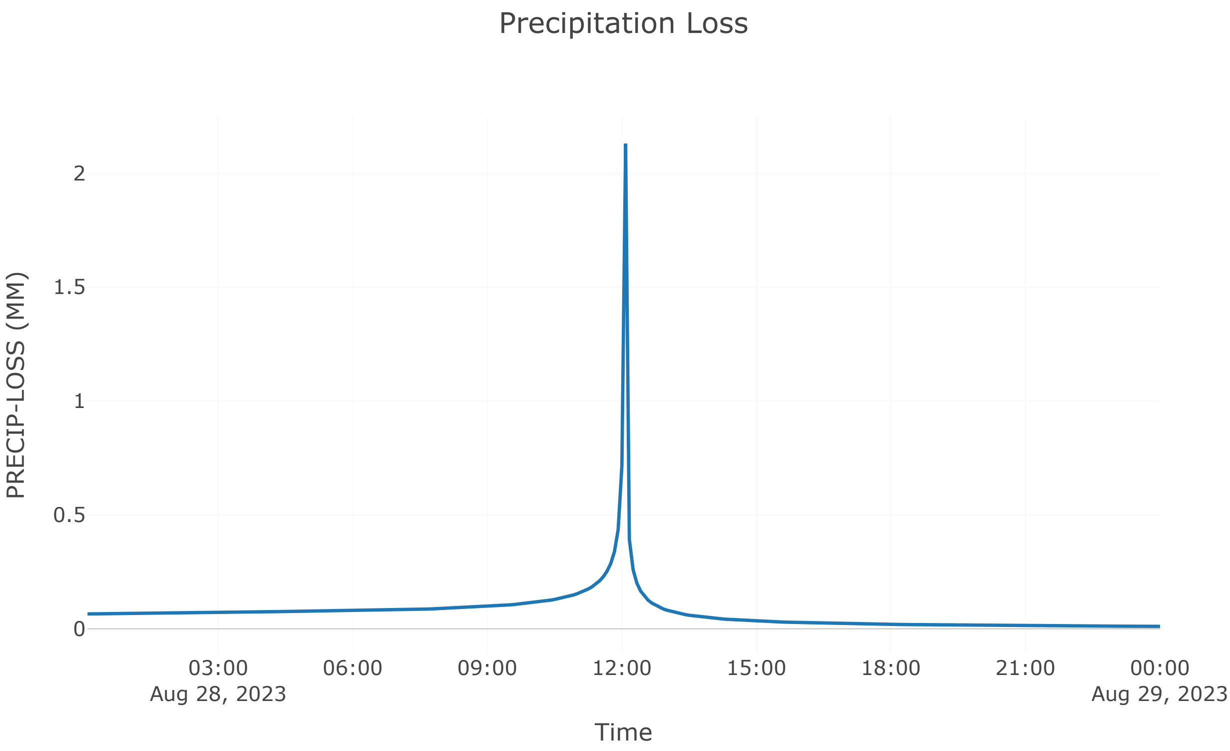

Precipitation and Outflow
Excess Precipitation
Outflow
null (null)
0
5
10
15
FLOW (M3/S)
0.3
0.2
0.1
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023


Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
140
120
100
80
60
40
20
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time


Cumulative Outflow
FLOW-CUMULATIVE (1000 M3)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (MM)
0
5
10
15
20
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time


Baseflow
1
0.5
0
−0.5
−1
FLOW-BASE (M3/S)
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time


Precipitation Loss
2
1.5
1
0.5
0
PRECIP-LOSS (MM)
03:00
Aug 28, 2023
06:00
09:00
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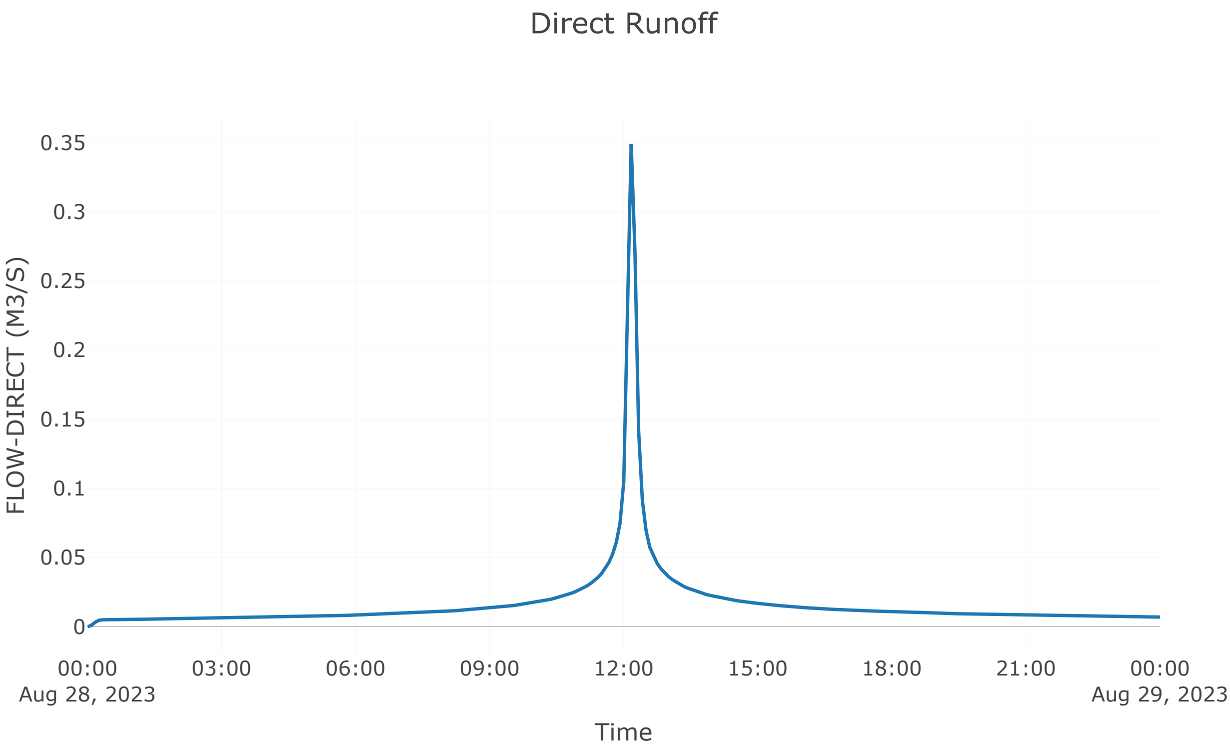
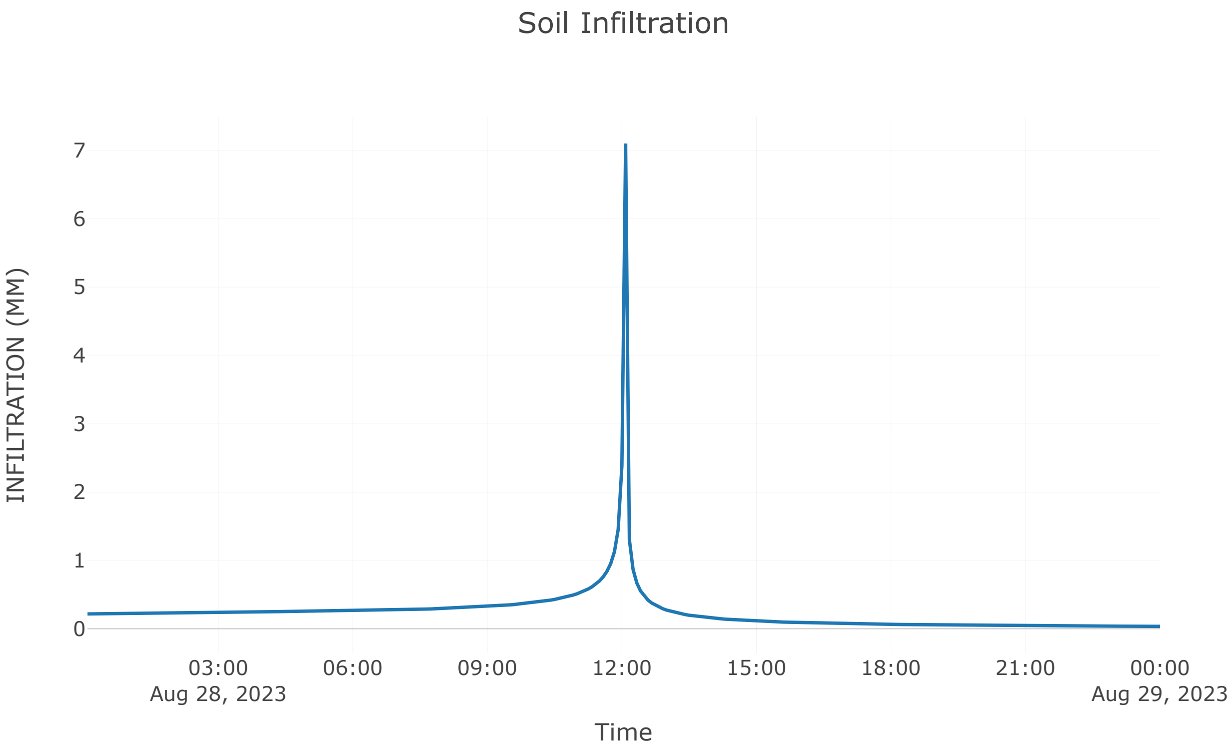
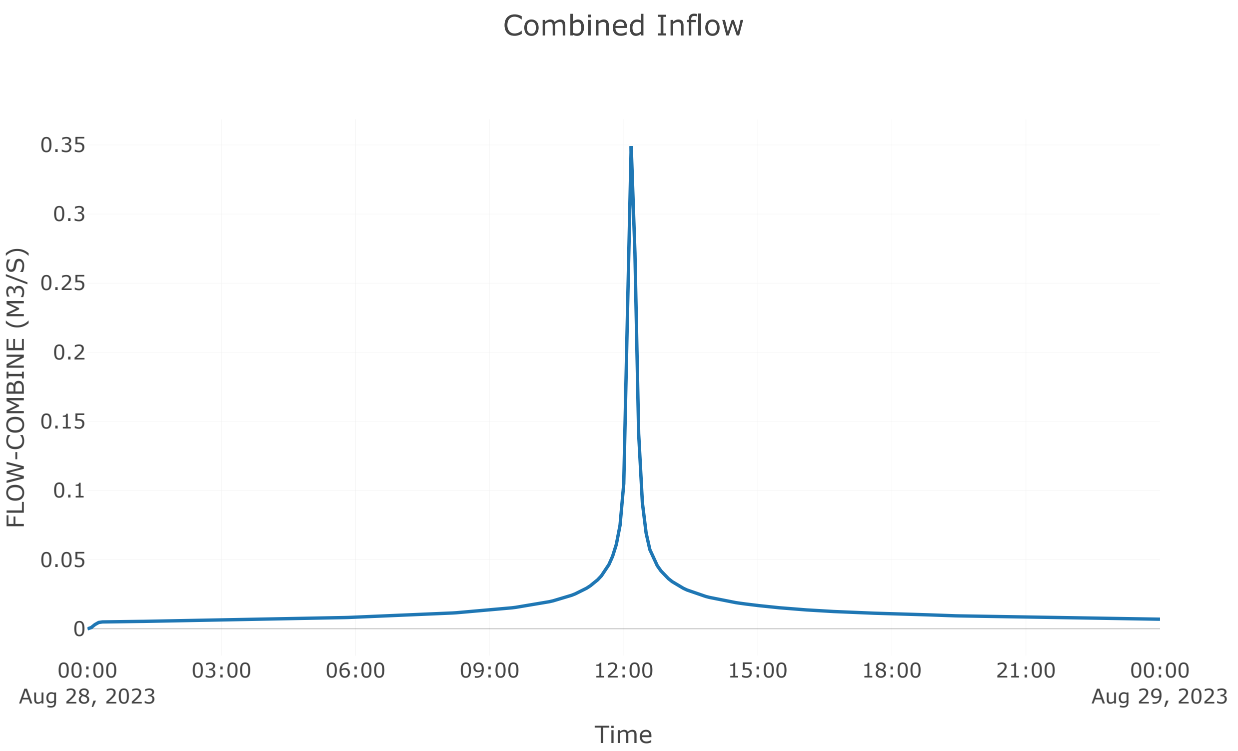
18:00
21:00
00:00
Aug 29, 2023
Time

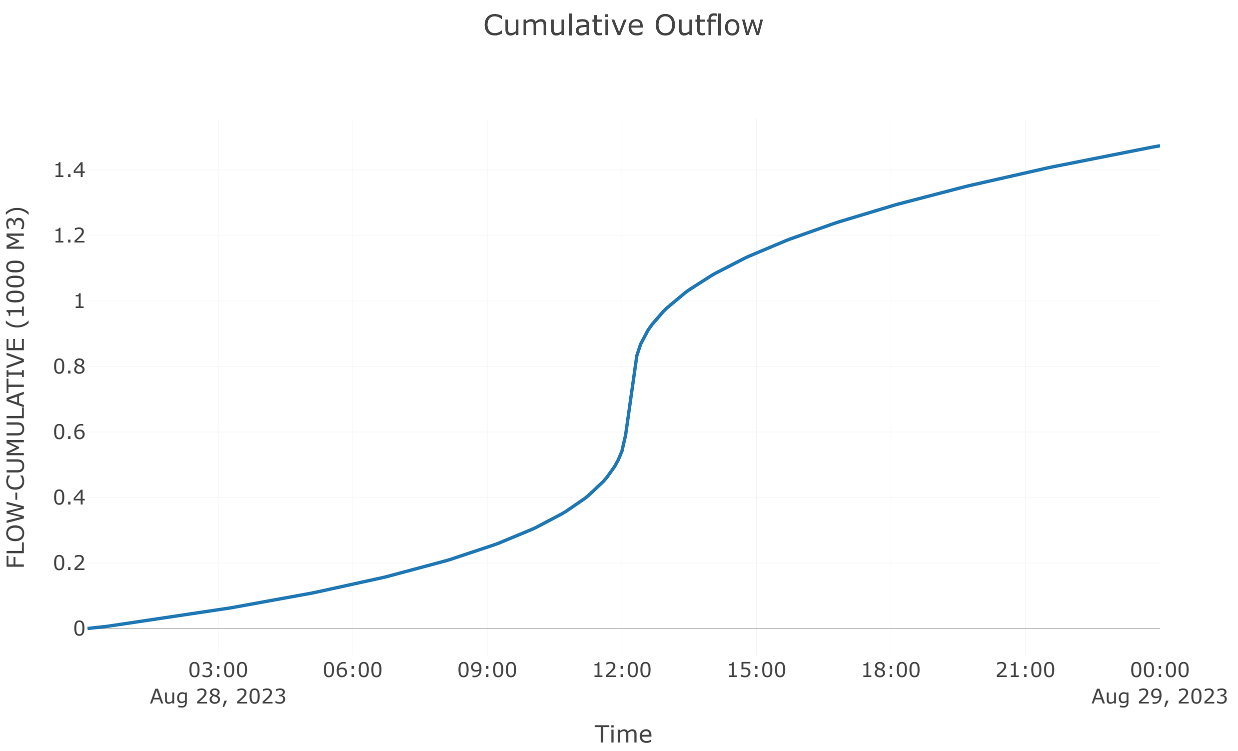

Direct Runoff
FLOW-DIRECT (M3/S)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

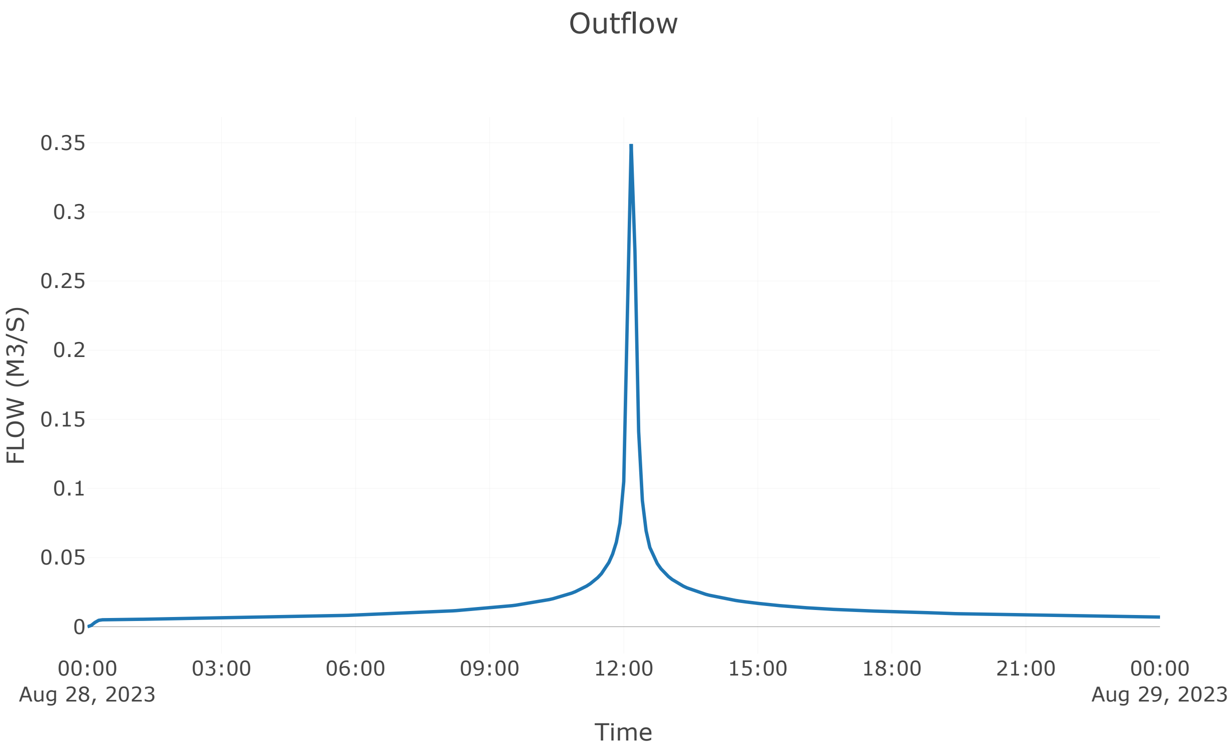

Soil Infiltration
INFILTRATION (MM)
7
6
5
4
3
2
1
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

Junction: Natrual basin

Results: Natrual basin	
Peak Discharge (M3/S)	0.35
Time of Peak Discharge	28Aug2023, 12:10
Volume (MM)	147.39






Outflow
FLOW (M3/S)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

Project: 2911
Simulation Run: CONCEPT - 1% AEP - PRE
Simulation Start: 27 August 2023, 24:00
Simulation End: 28 August 2023, 24:00

HMS Version: 4.12
Executed: 25 September 2025, 08:55

Global Parameter Summary - Subbasin

Area (KM2)

Element Name	Area (KM2)
Development area	0.01

Downstream

Element Name	Downstream
Development area	Natrual basin

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Development area	0	69	5

Transform: Clark

Element Name	Clark Method	Time of Concentration	Storage Coefficient	Time Area Method
Development area	Specified	0.17	0.07	Default

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Development area	0.01	0.25	28Aug2023, 12:10	96.78
Natrual basin	0.01	0.25	28Aug2023, 12:10	96.78

Subbasin: Development area

Area (KM2) : 0.01
Downstream : Natrual basin

Loss Rate: Scs

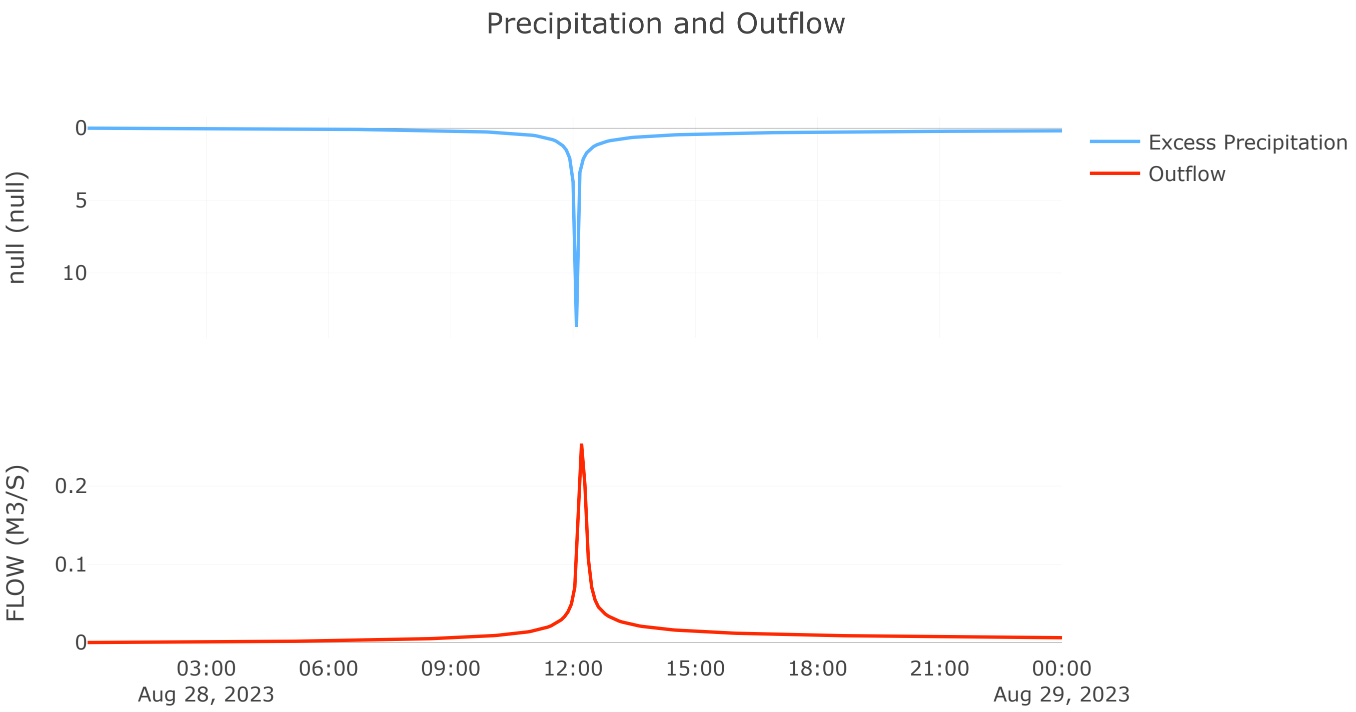
Percent Impervious Area	0
Curve Number	69
Initial Abstraction	5

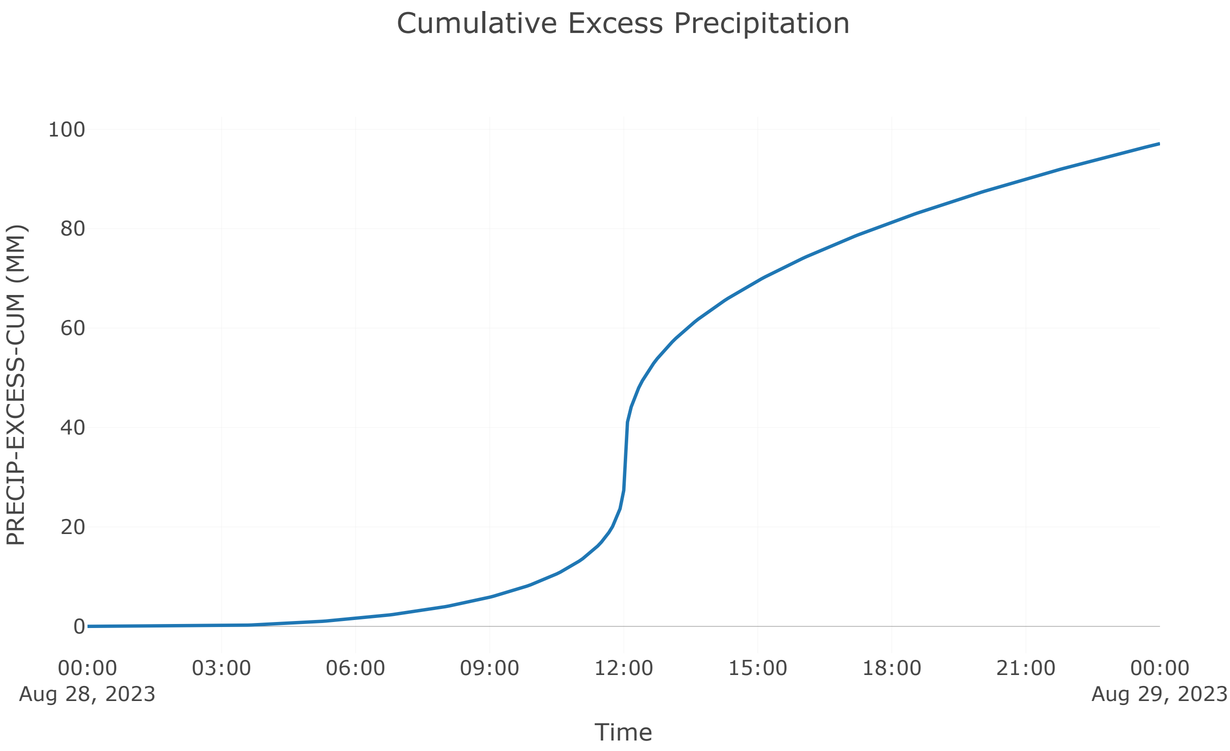
Transform: Clark

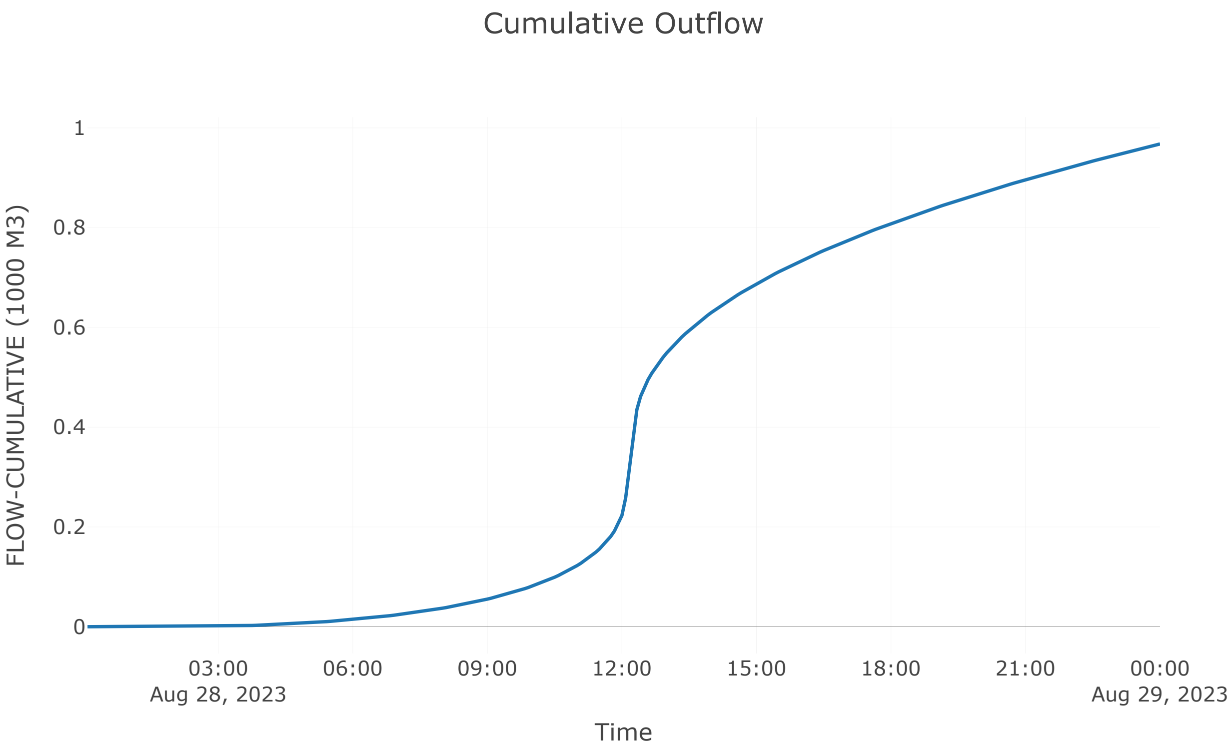
Clark Method	Specified
Time of Concentration	0.17
Storage Coefficient	0.07
Time Area Method	Default

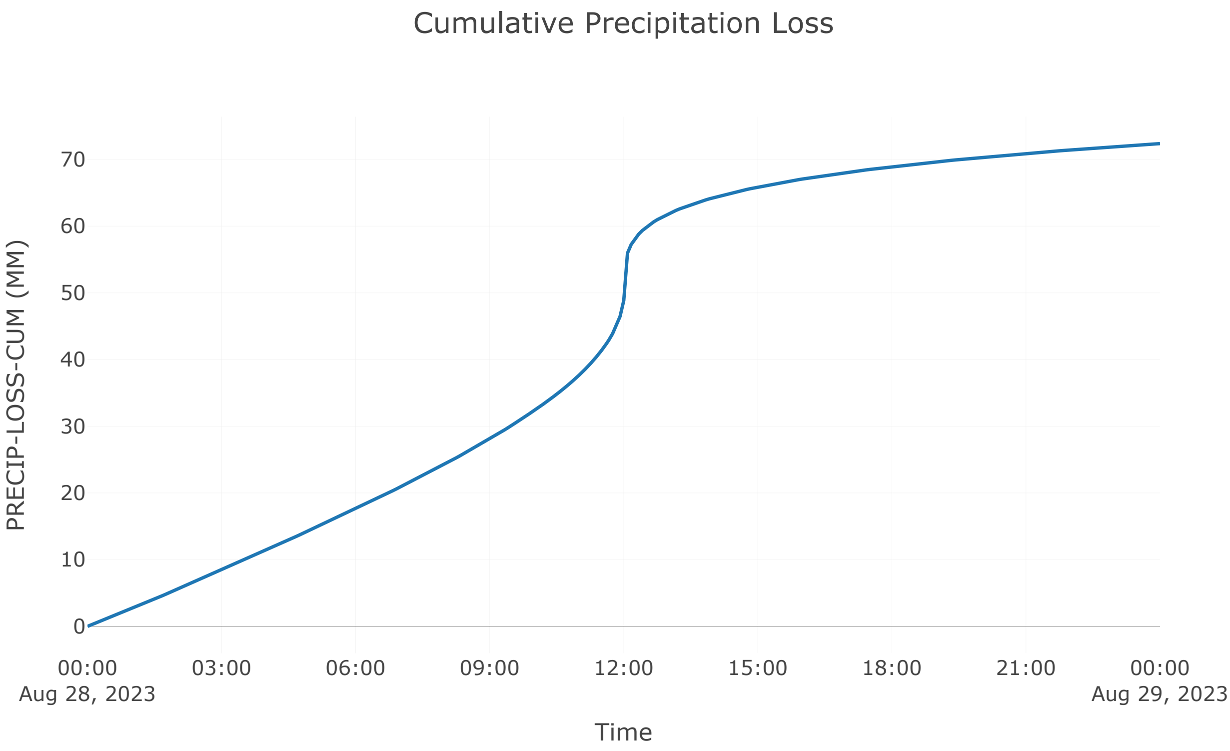
Results: Development area

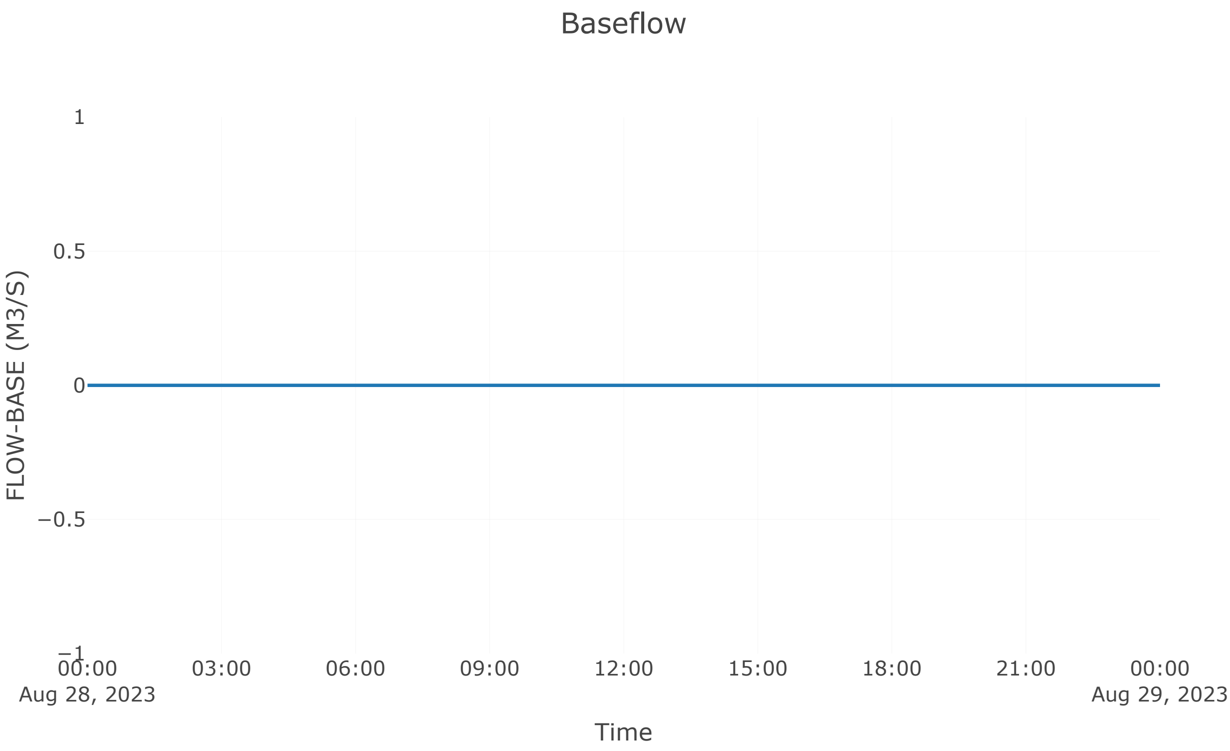
Peak Discharge (M3/S)	0.25
Time of Peak Discharge	28Aug2023, 12:10
Volume (MM)	96.78
Precipitation Volume (M3)	1694.9
Loss Volume (M3)	723.74
Excess Volume (M3)	971.16
Direct Runoff Volume (M3)	967.8
Baseflow Volume (M3)	0

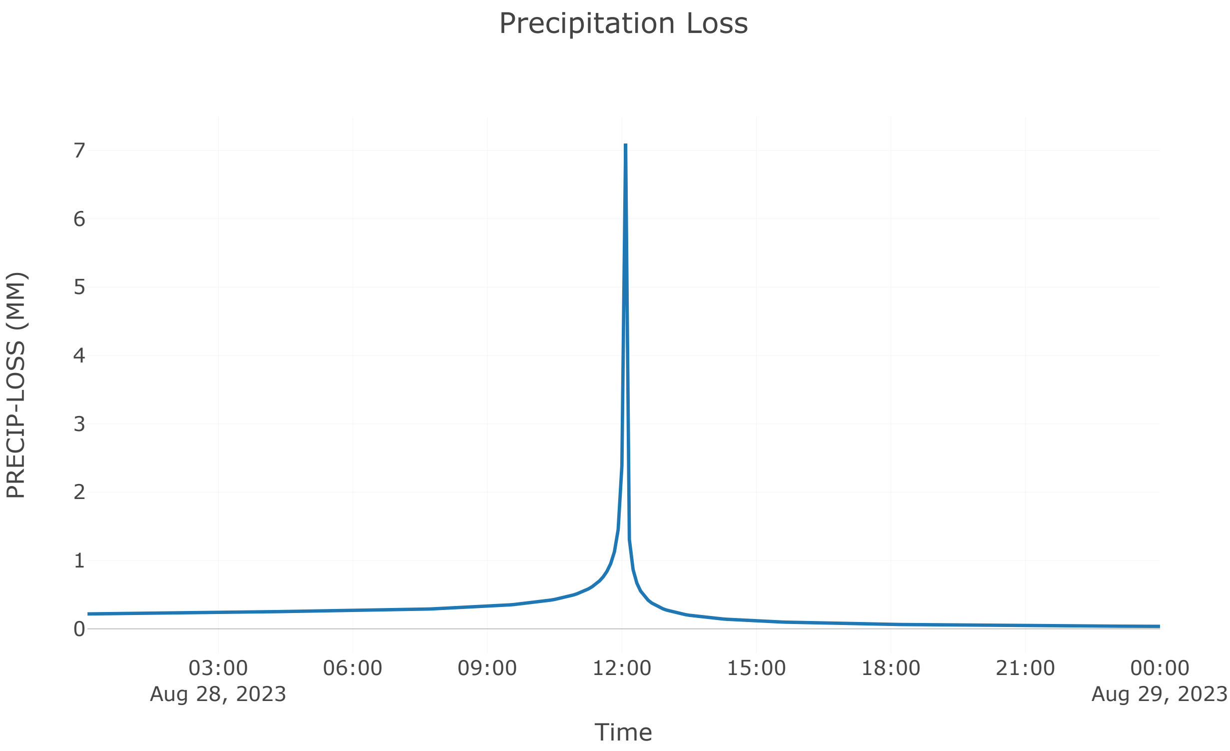

Precipitation and Outflow
Excess Precipitation
Outflow
null (null)
0
5
10
FLOW (M3/S)
0.2
0.1
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023

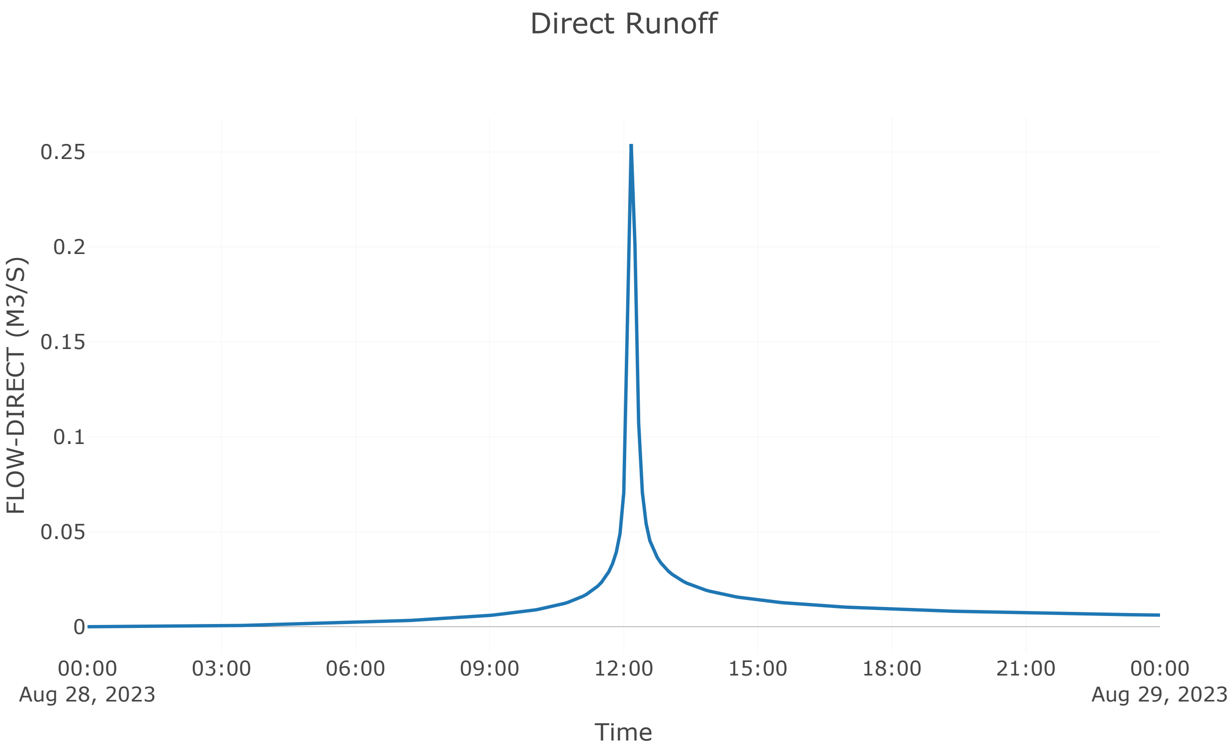

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
100
80
60
40
20
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

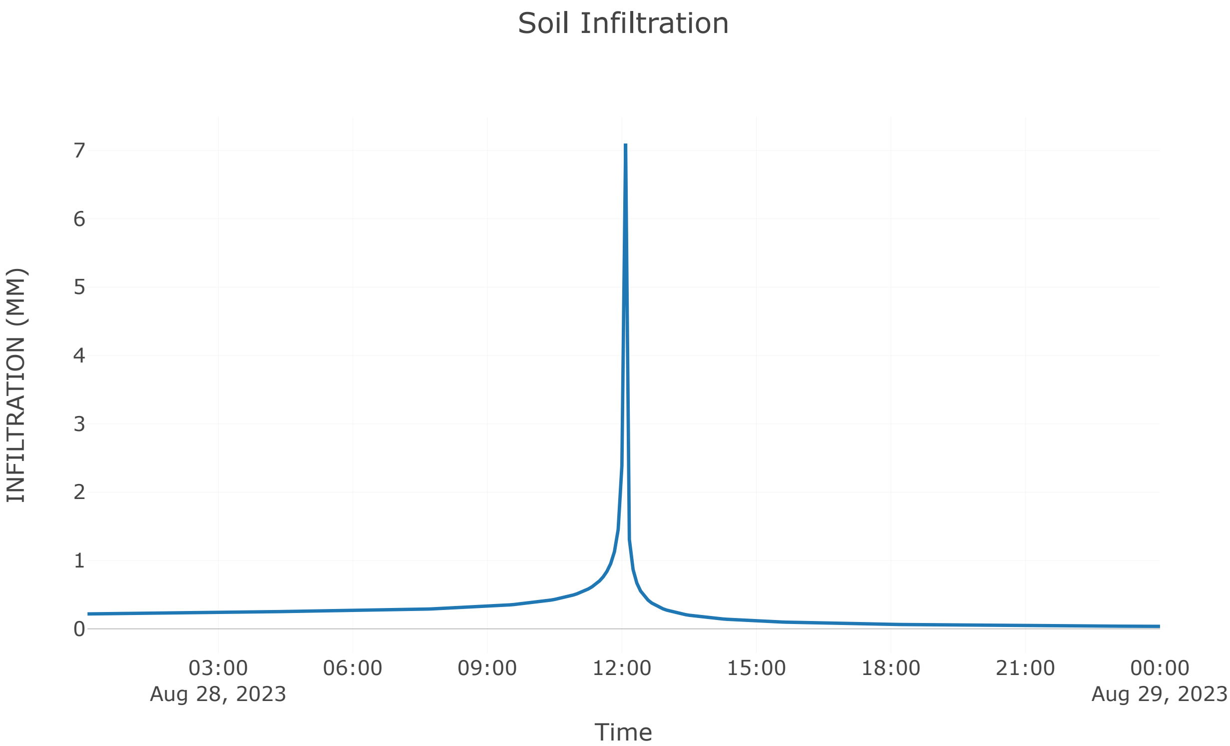

Cumulative Outflow
FLOW-CUMULATIVE (1000 M3)
1
0.8
0.6
0.4
0.2
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (MM)
70
60
50
40
30
20
10
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time


Baseflow
FLOW-BASE (M3/S)
1
0.5
0
−0.5
−1
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time


Precipitation Loss
PRECIP-LOSS (MM)
7
6
5
4
3
2
1
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

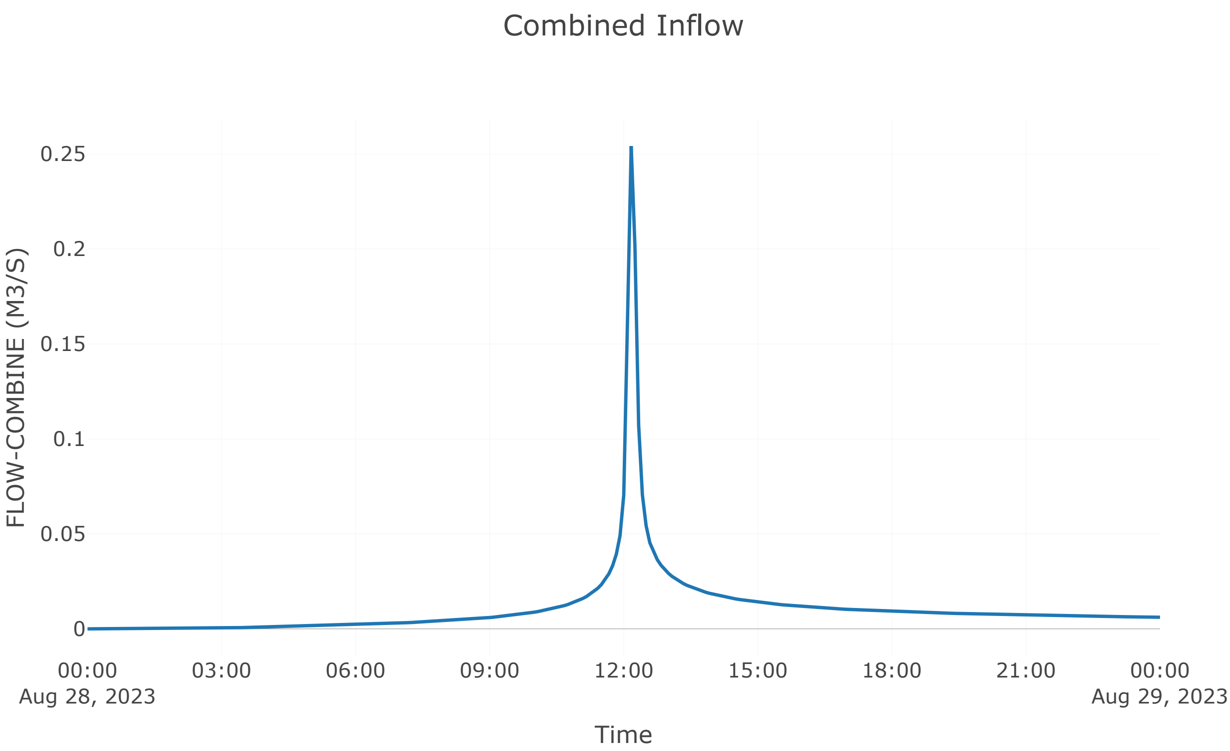

Direct Runoff
FLOW-DIRECT (M3/S)
0.25
0.2
0.15
0.1
0.05
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

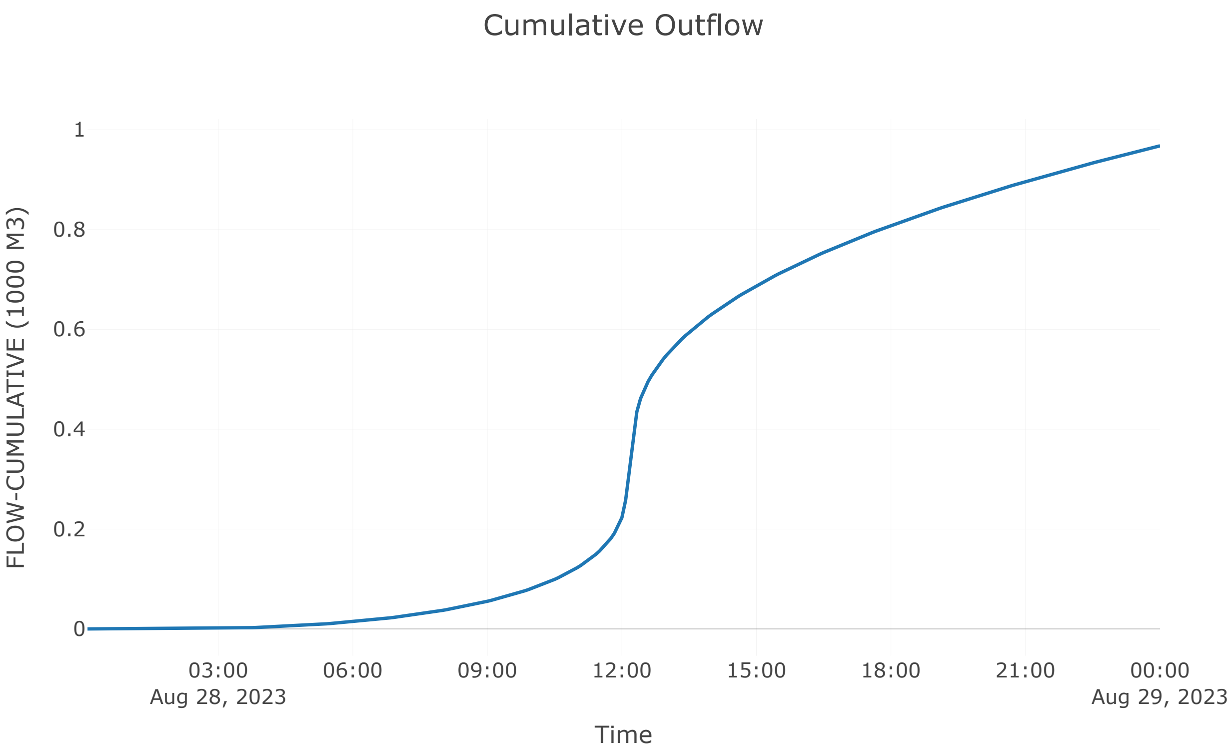

Soil Infiltration
INFILTRATION (MM)
7
6
5
4
3
2
1
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

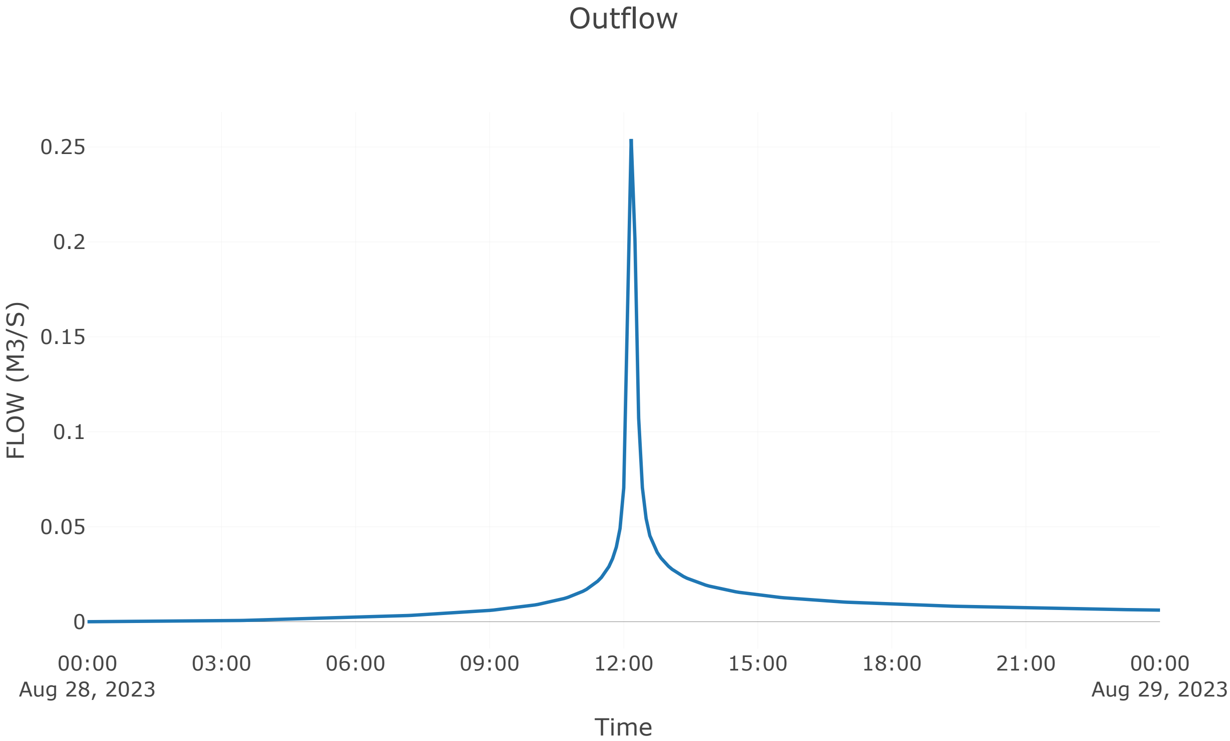
Junction: Natrual basin

Results: Natrual basin

Peak Discharge (M3/S)	0.25
Time of Peak Discharge	28Aug2023, 12:10
Volume (MM)	96.78






Outflow
FLOW (M3/S)
0.25
0.2
0.15
0.1
0.05
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

Project: 2911
Simulation Run: CONCEPT - 10% AEP - POST
Simulation Start: 27 August 2023, 24:00
Simulation End: 28 August 2023, 24:00

HMS Version: 4.12
Executed: 25 September 2025, 01:52

Global Parameter Summary - Subbasin

Area (KM2)

Element Name	Area (KM2)
Development area	0.01

Downstream

Element Name	Downstream
Development area	Natrual basin

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Development area	70	69	5

Transform: Clark

Element Name	Clark Method	Time of Concentration	Storage Coefficient	Time Area Method
Development area	Specified	0.17	0.07	Default

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Development area	0.01	0.23	28Aug2023, 12:10	95.6
Natrual basin	0.01	0.23	28Aug2023, 12:10	95.6

Subbasin: Development area

Area (KM2) : 0.01
Downstream : Natrual basin

Loss Rate: Scs

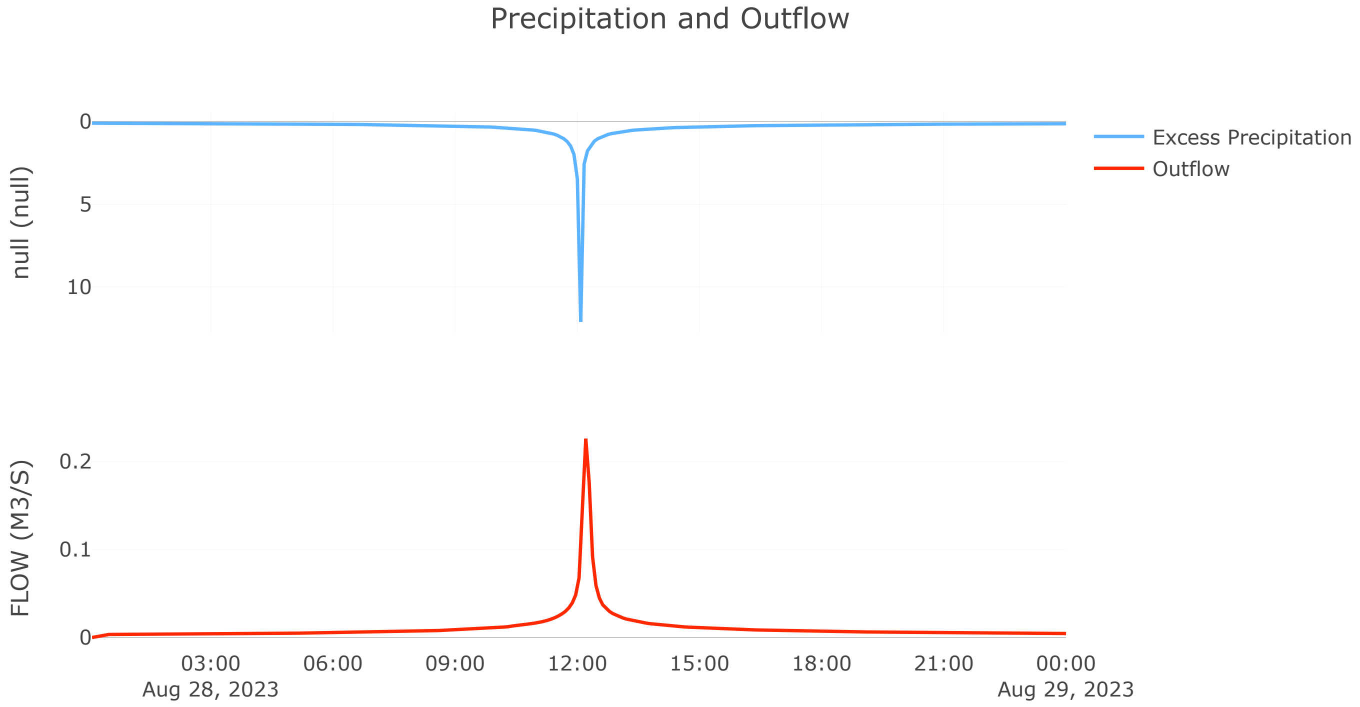
Percent Impervious Area	70
Curve Number	69
Initial Abstraction	5

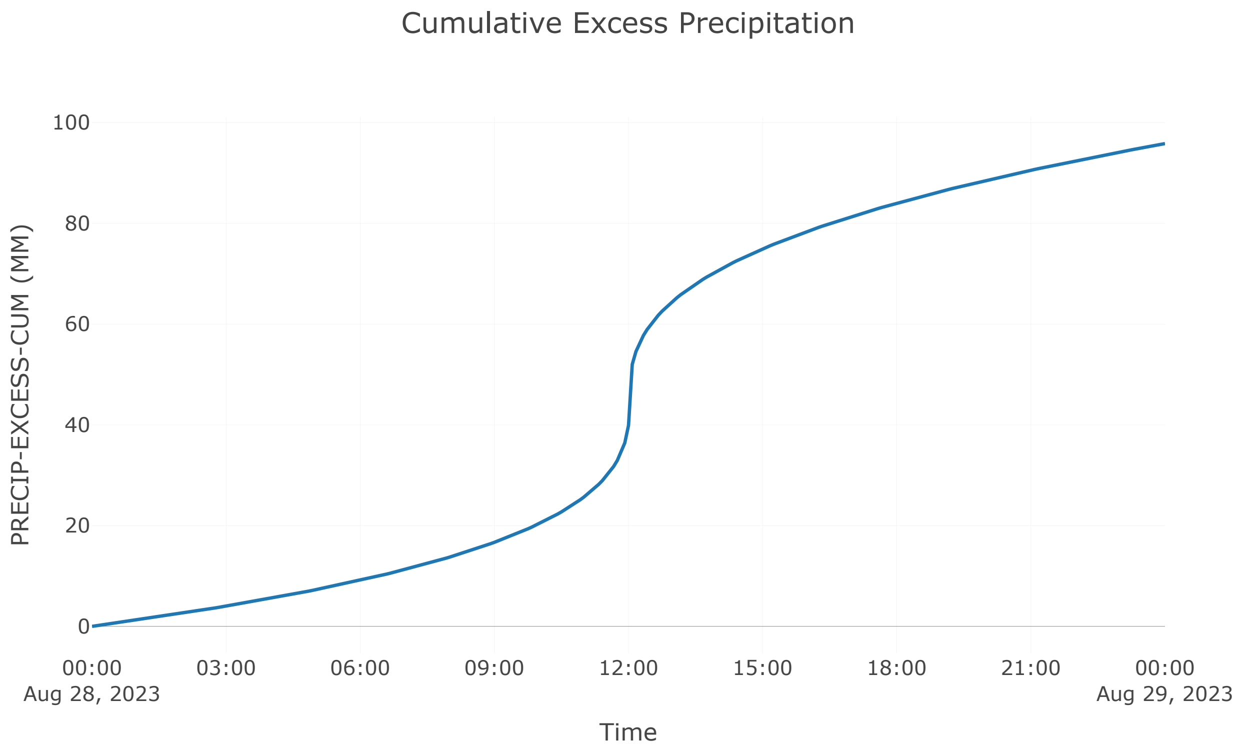
Transform: Clark

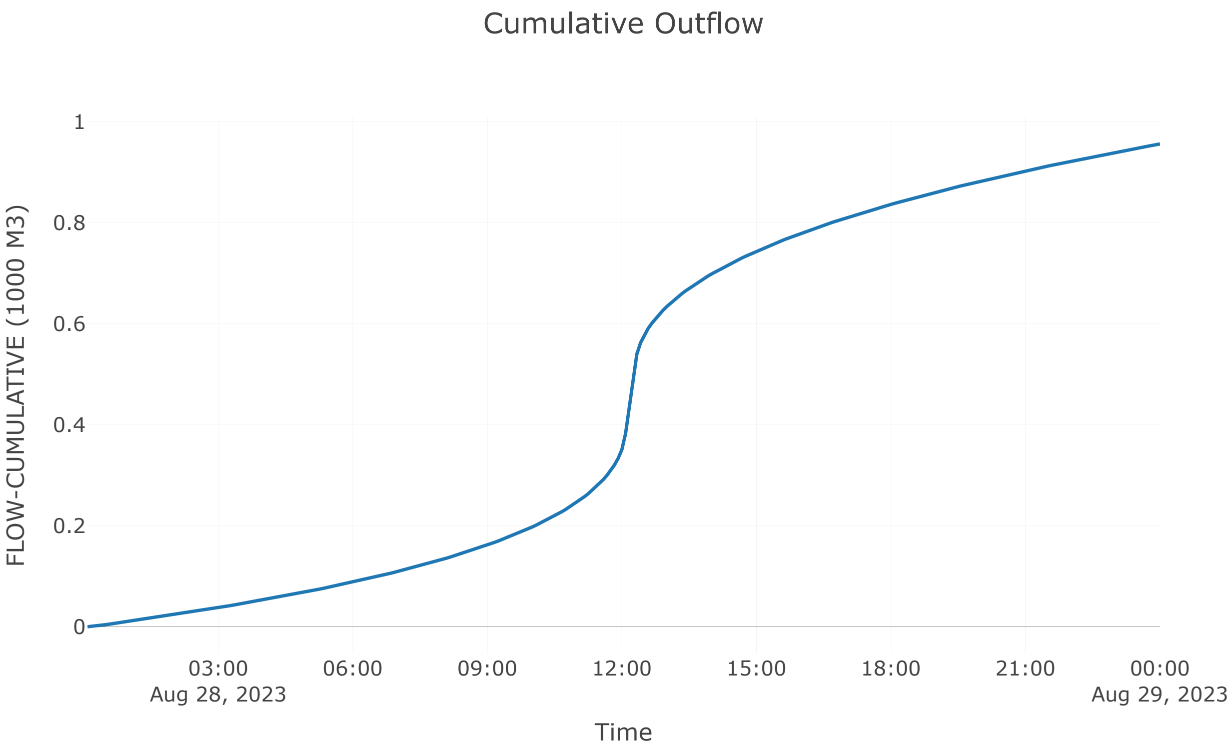
Clark Method	Specified
Time of Concentration	0.17
Storage Coefficient	0.07
Time Area Method	Default

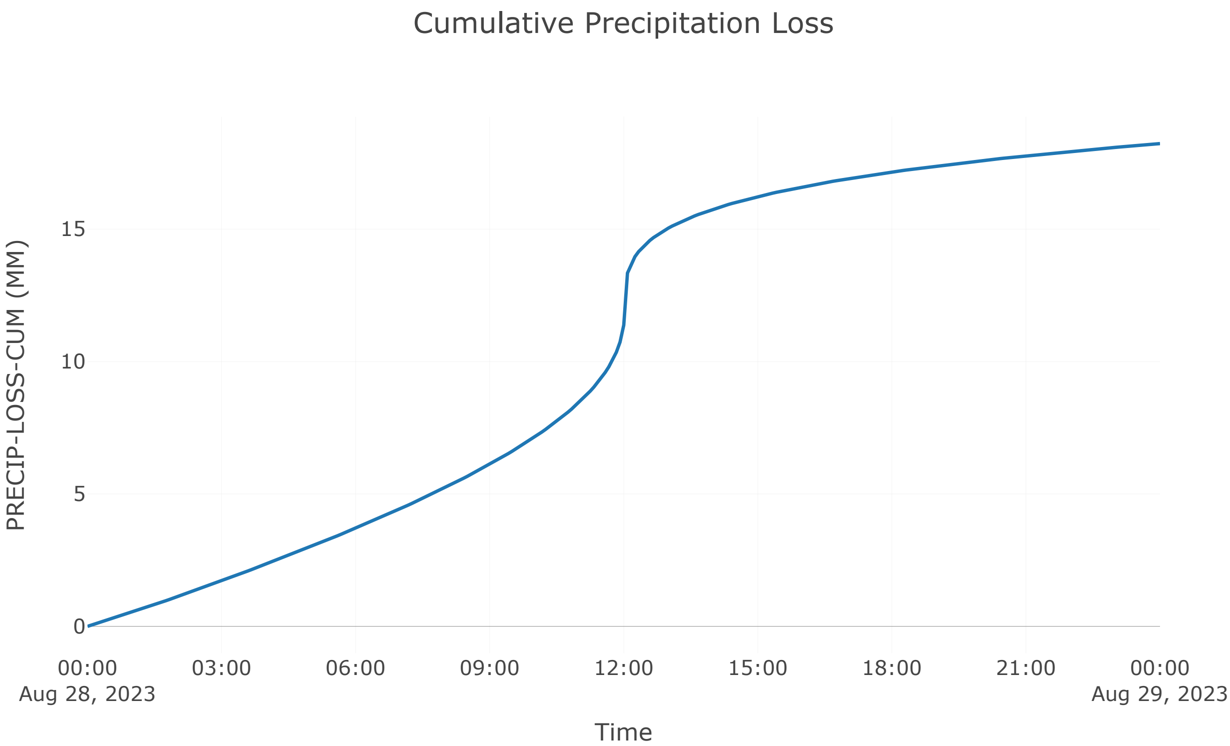
Results: Development area

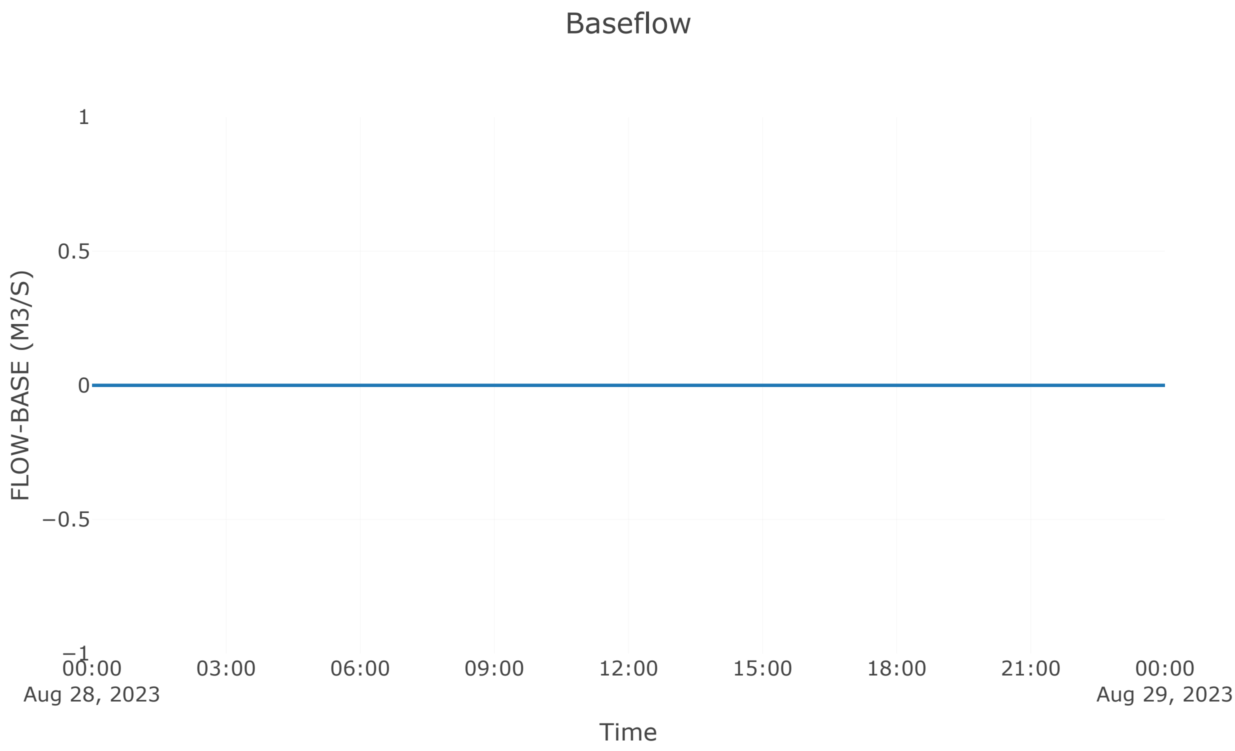
Peak Discharge (M3/S)	0.23
Time of Peak Discharge	28Aug2023, 12:10
Volume (MM)	95.6
Precipitation Volume (M3)	1140.8
Loss Volume (M3)	182.31
Excess Volume (M3)	958.49
Direct Runoff Volume (M3)	956
Baseflow Volume (M3)	0

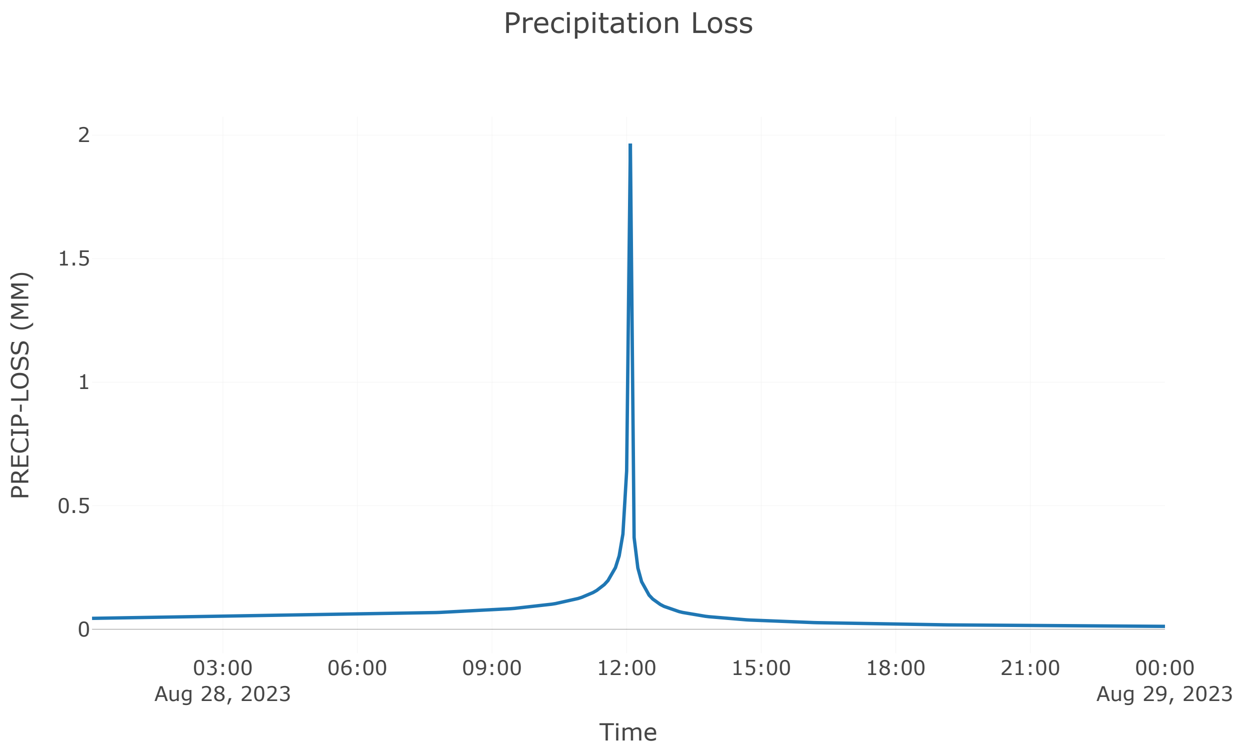

Precipitation and Outflow
null (null)
0
5
10
Excess Precipitation
Outflow
FLOW (M3/S)
0.2
0.1
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023

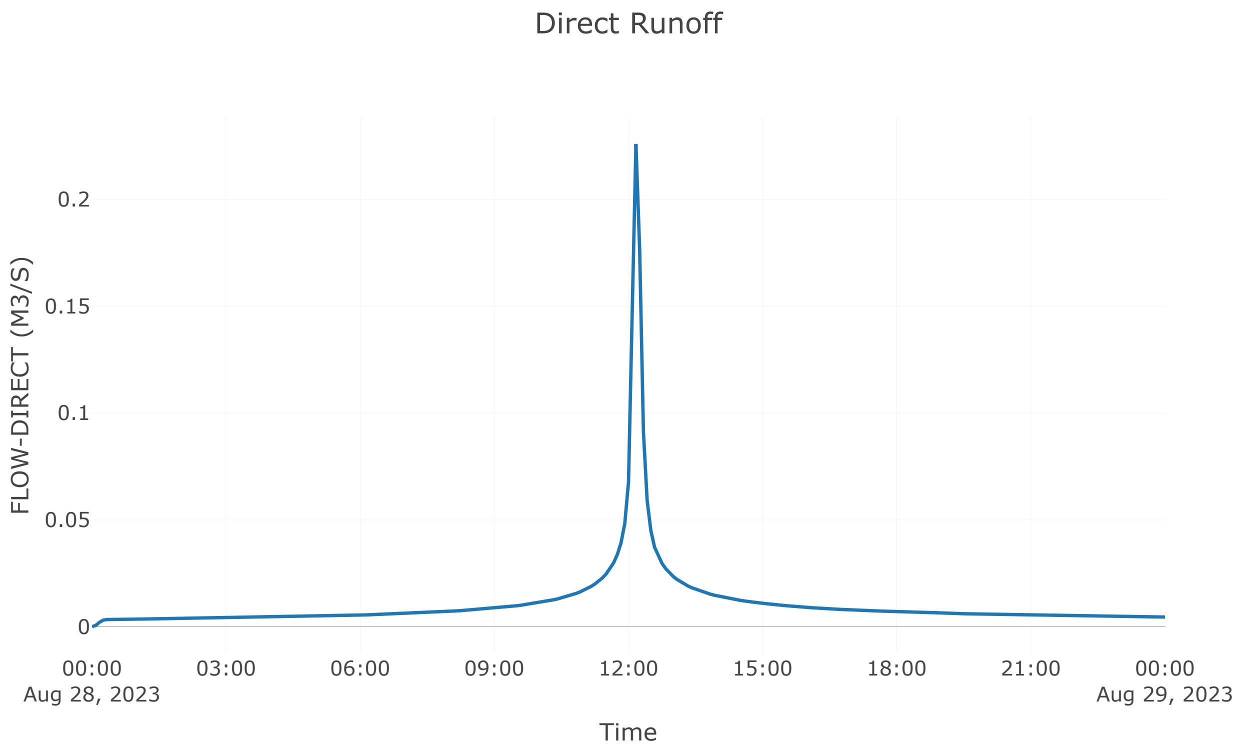

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
100
80
60
40
20
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

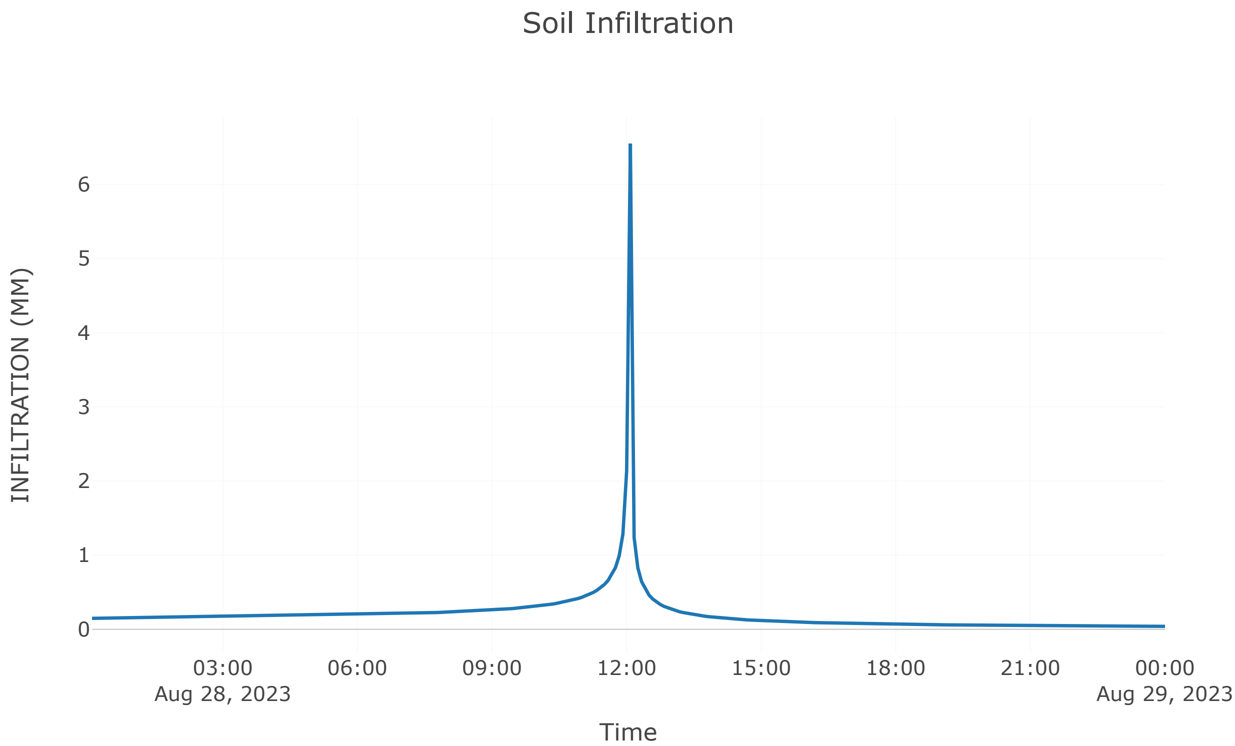

Cumulative Outflow
FLOW-CUMULATIVE (1000 M3)
1
0.8
0.6
0.4
0.2
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (MM)
15
10
5
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time


Baseflow
1
0.5
0
−0.5
−1
FLOW-BASE (M3/S)
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

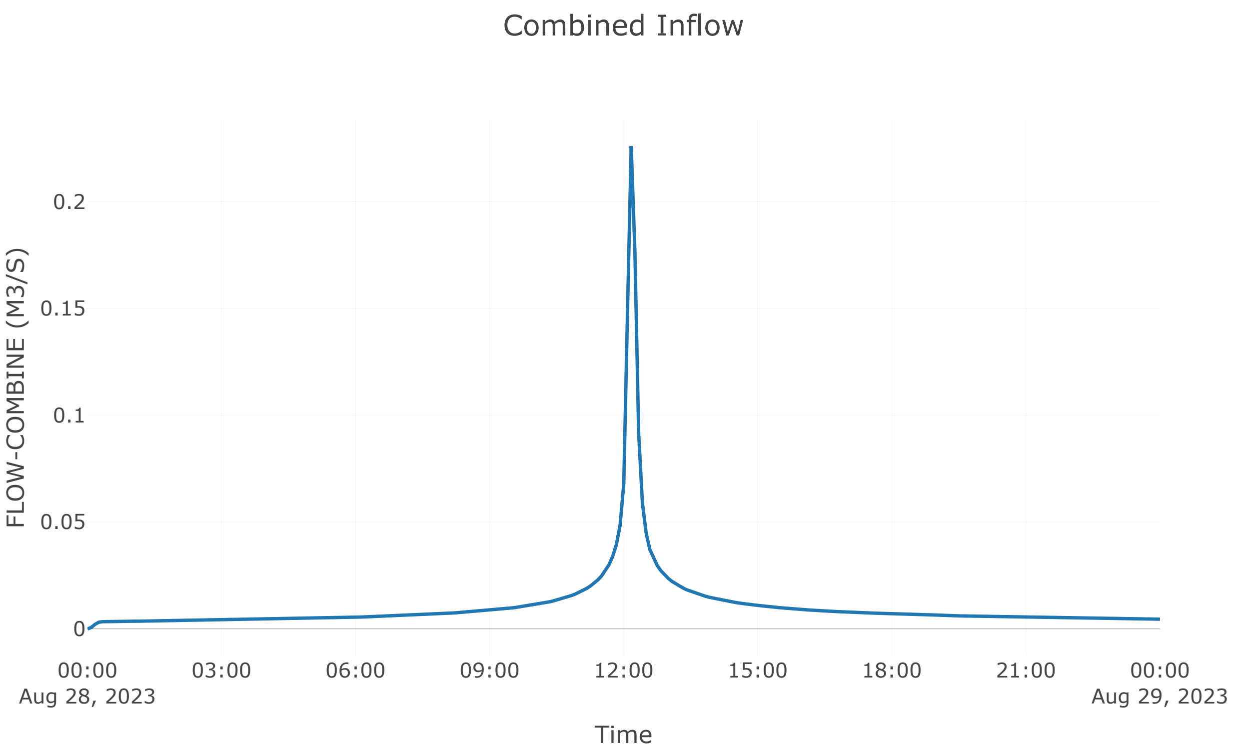

Precipitation Loss
2
1.5
1
0.5
0
PRECIP-LOSS (MM)
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

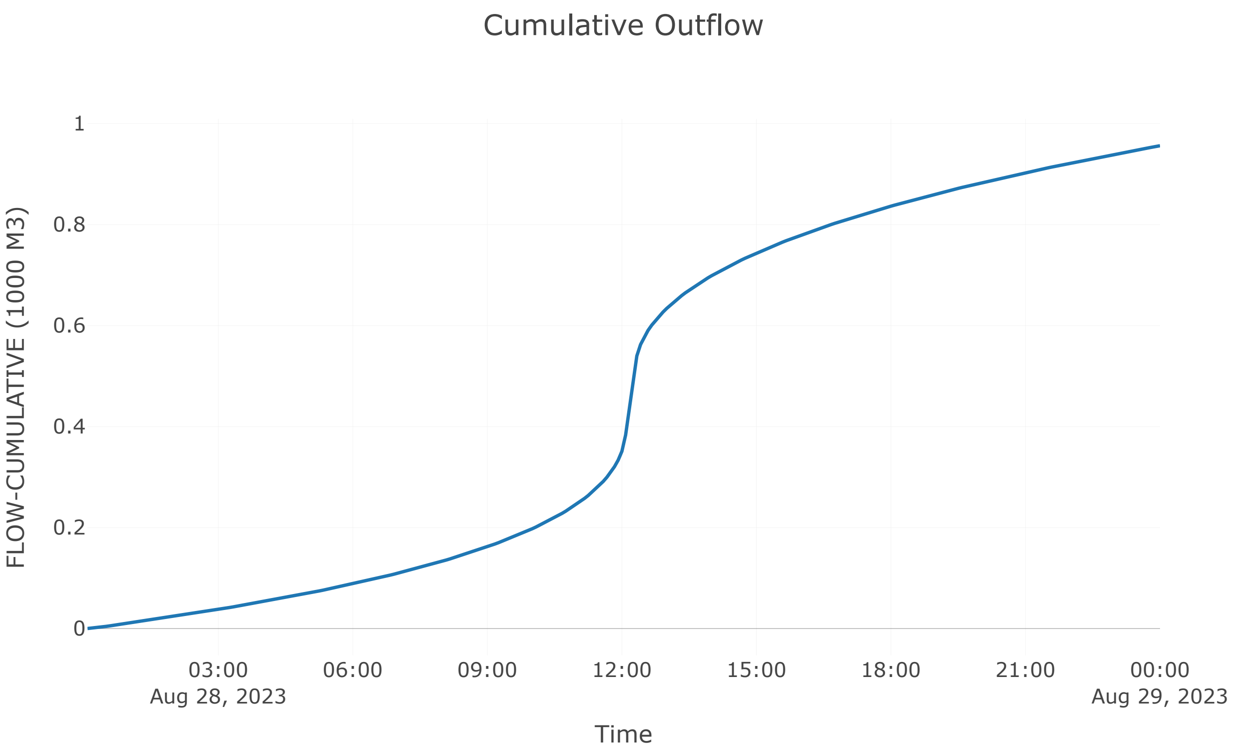

Direct Runoff
FLOW-DIRECT (M3/S)
0.2
0.15
0.1
0.05
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

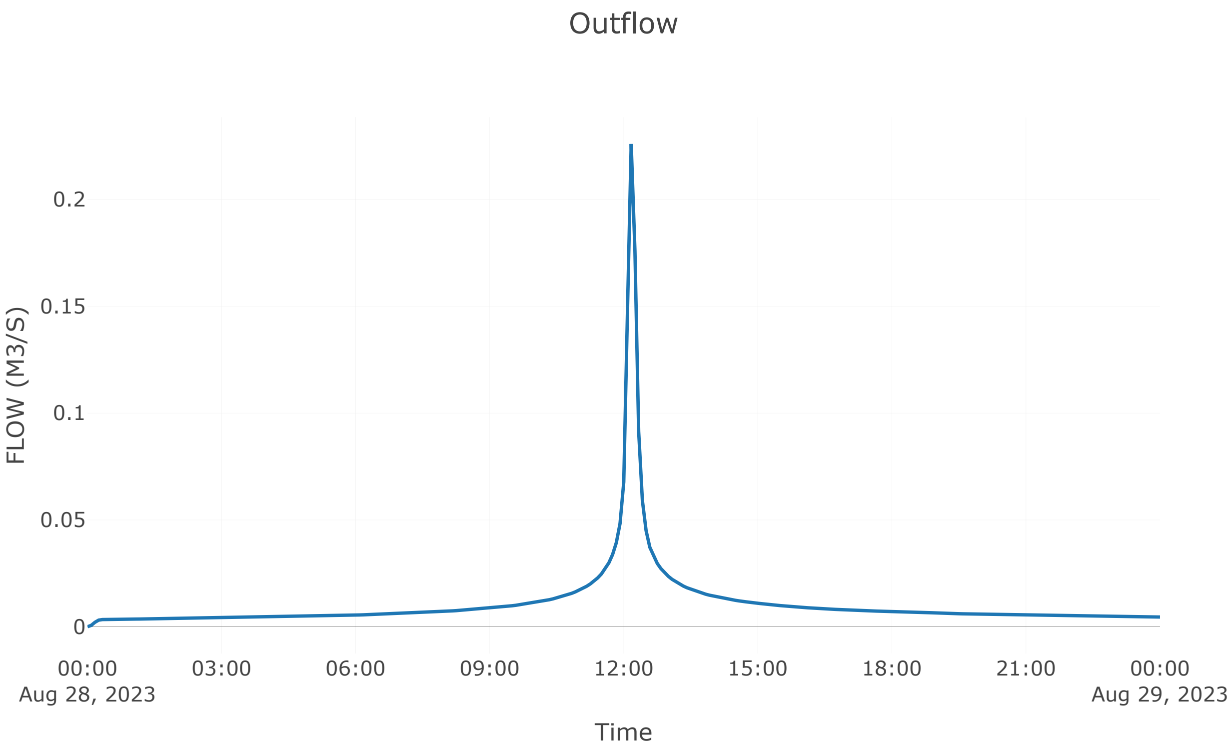

Soil Infiltration
INFILTRATION (MM)
6
5
4
3
2
1
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

Junction: Natrual basin

Results: Natrual basin	
Peak Discharge (M3/S)	0.23
Time of Peak Discharge	28Aug2023, 12:10
Volume (MM)	95.6






Outflow
FLOW (M3/S)
0.2
0.15
0.1
0.05
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

Project: 2911
Simulation Run: CONCEPT - 10% AEP
Simulation Start: 27 August 2023, 24:00
Simulation End: 28 August 2023, 24:00

HMS Version: 4.12
Executed: 25 September 2025, 08:52

Global Parameter Summary - Subbasin

Area (KM2)

Element Name	Area (KM2)
Development area	0.01

Downstream

Element Name	Downstream
Development area	Natrual basin

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Development area	0	69	5

Transform: Clark

Element Name	Clark Method	Time of Concentration	Storage Coefficient	Time Area Method
Development area	Specified	0.17	0.07	Default

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Development area	0.01	0.14	28Aug2023, 12:10	53.11
Natrual basin	0.01	0.14	28Aug2023, 12:10	53.11

Subbasin: Development area

Area (KM2) : 0.01
Downstream : Natrual basin

Loss Rate: Scs

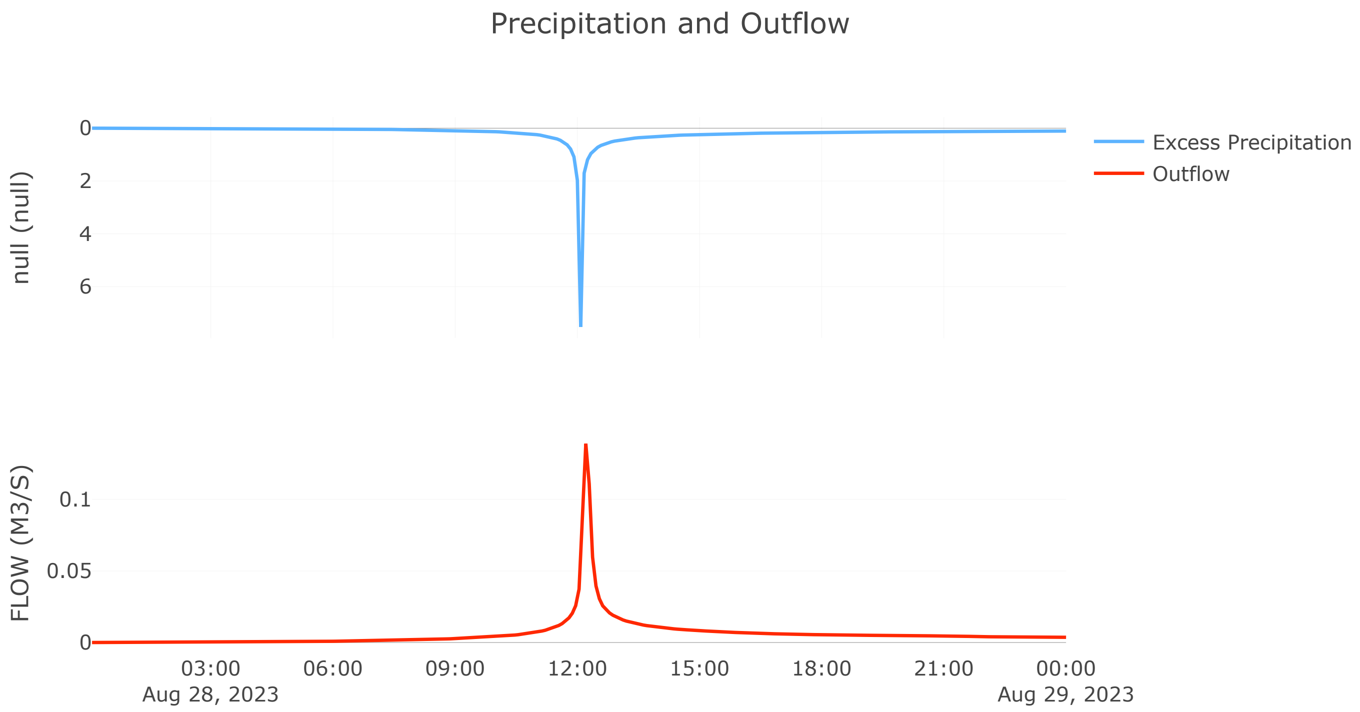
Percent Impervious Area	0
Curve Number	69
Initial Abstraction	5

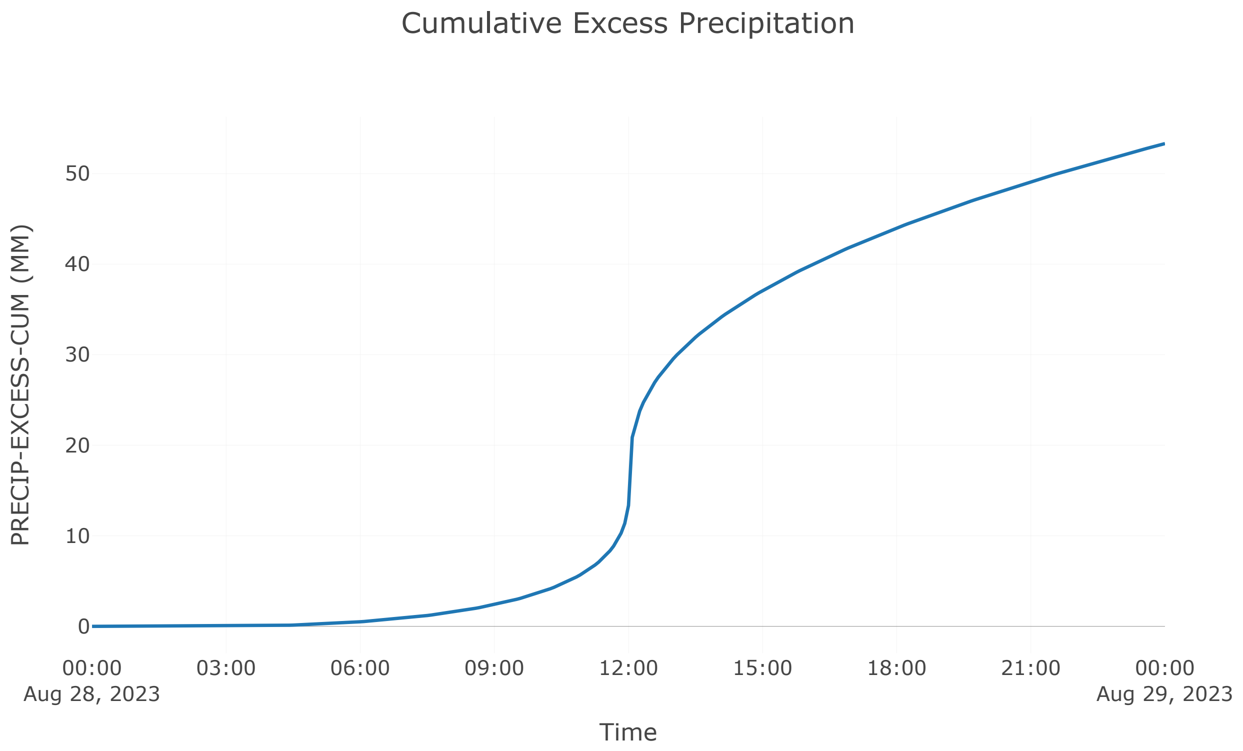
Transform: Clark

Clark Method	Specified
Time of Concentration	0.17
Storage Coefficient	0.07
Time Area Method	Default

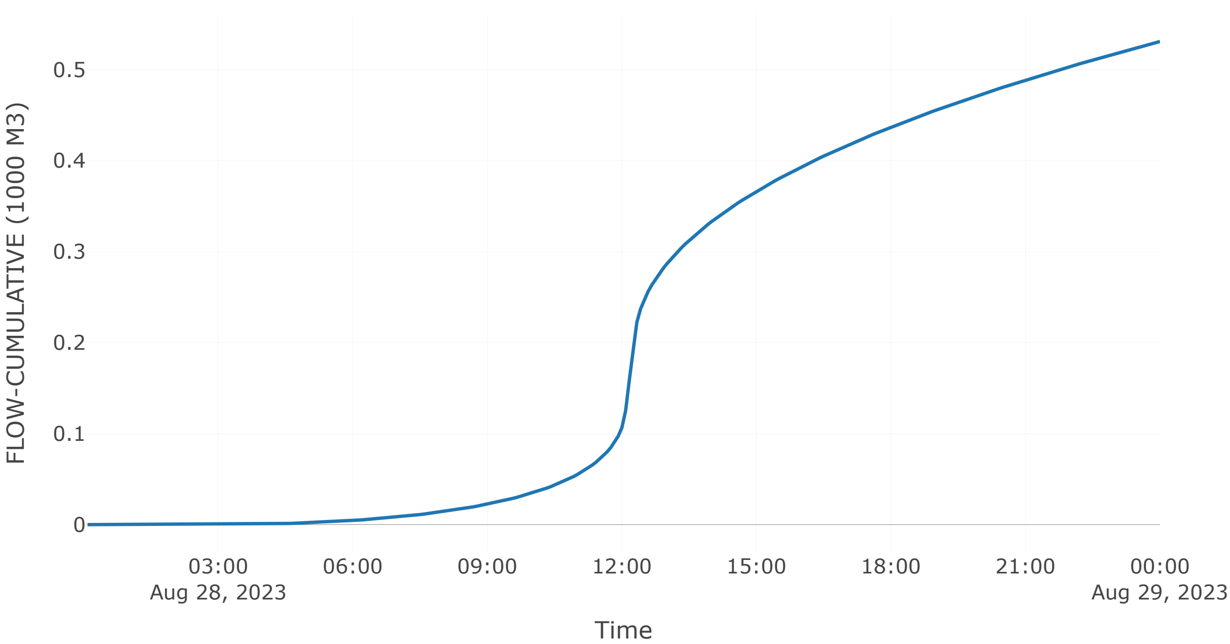
Results: Development area

Peak Discharge (M3/S)	0.14
Time of Peak Discharge	28Aug2023, 12:10
Volume (MM)	53.11
Precipitation Volume (M3)	1140.8
Loss Volume (M3)	607.71
Excess Volume (M3)	533.09
Direct Runoff Volume (M3)	531.1
Baseflow Volume (M3)	0

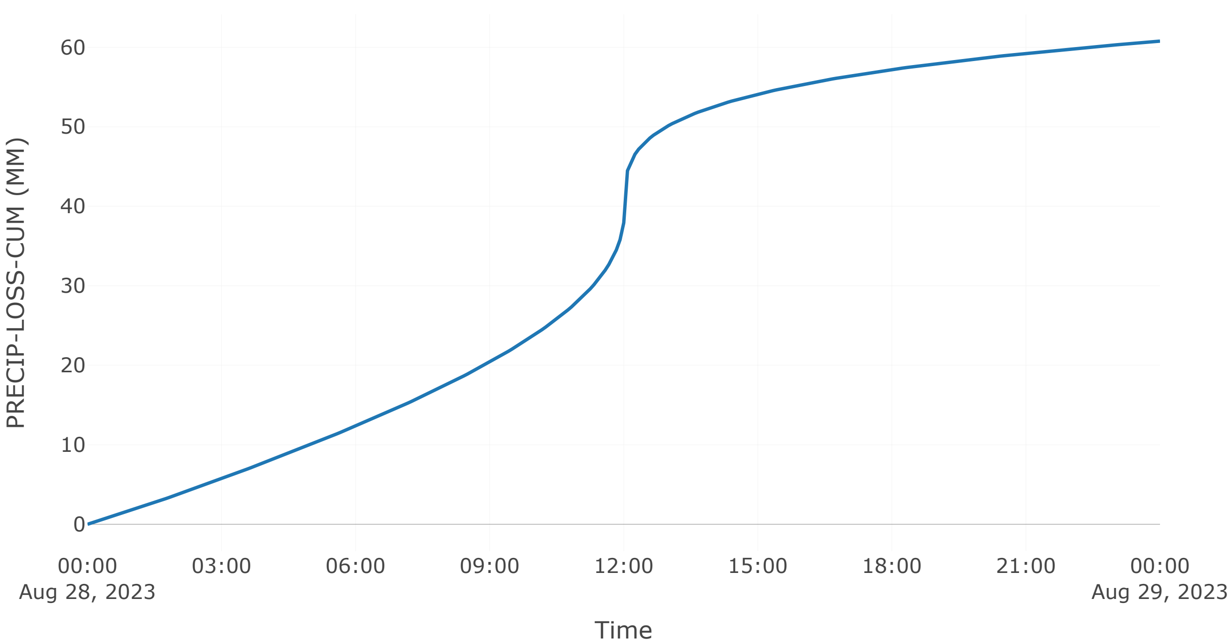

Precipitation and Outflow
null (null)
0
2
4
6
Excess Precipitation
Outflow
FLOW (M3/S)
0.1
0.05
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023


Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
50
40
30
20
10
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

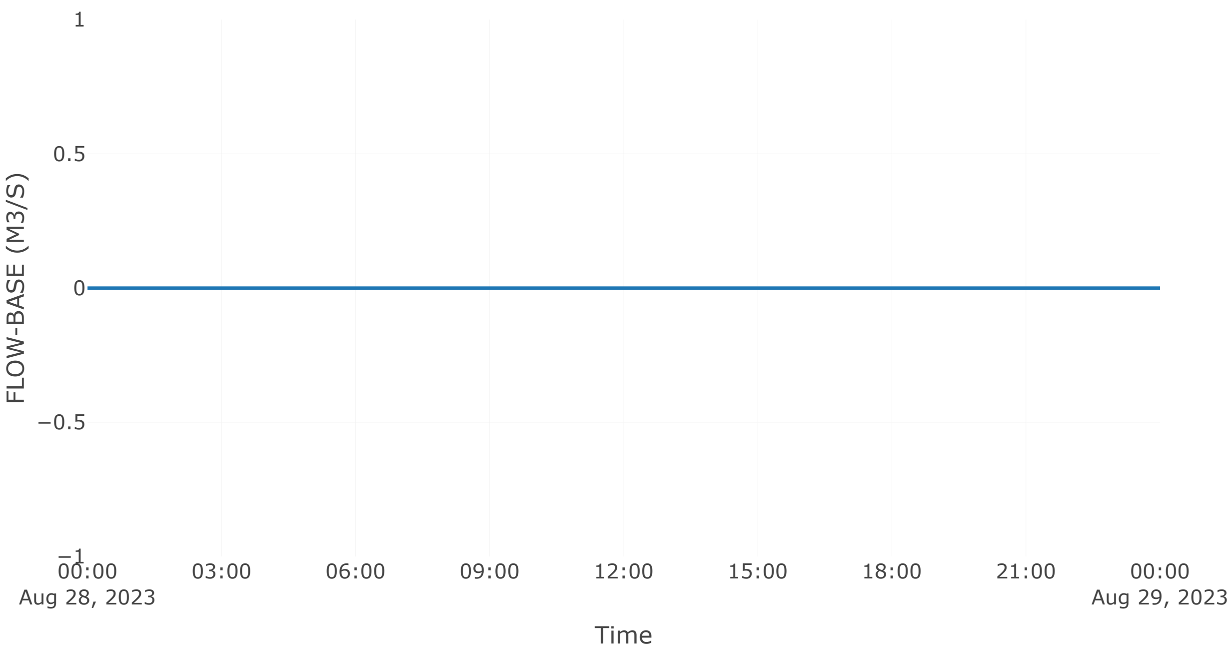
Cumulative Outflow



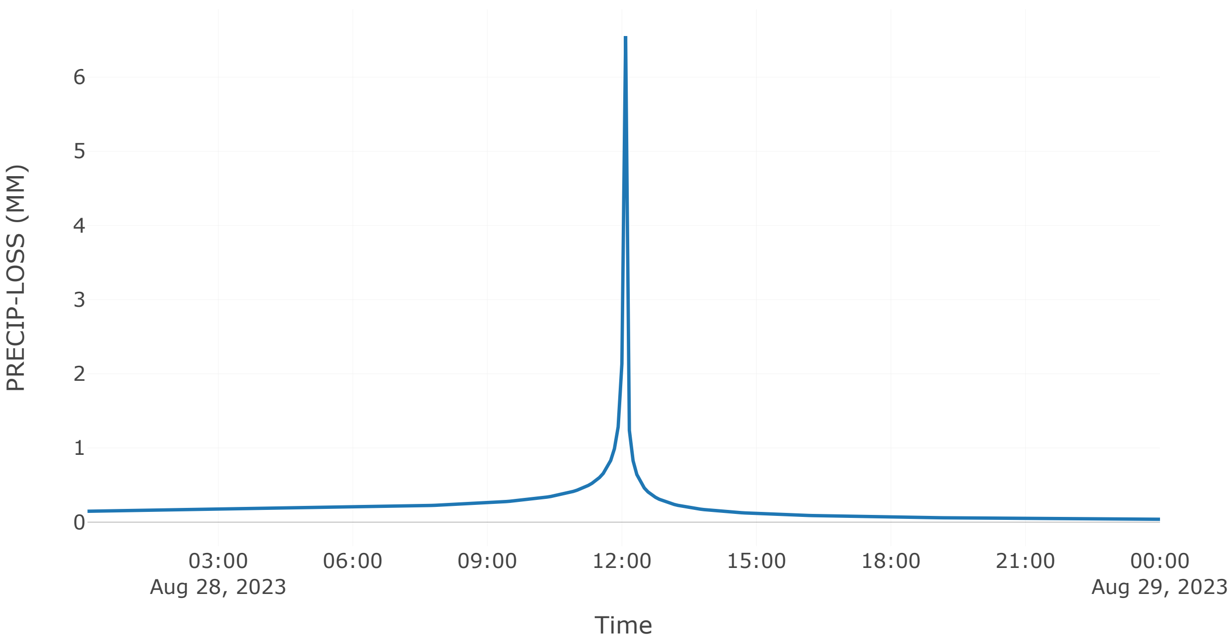
Cumulative Precipitation Loss



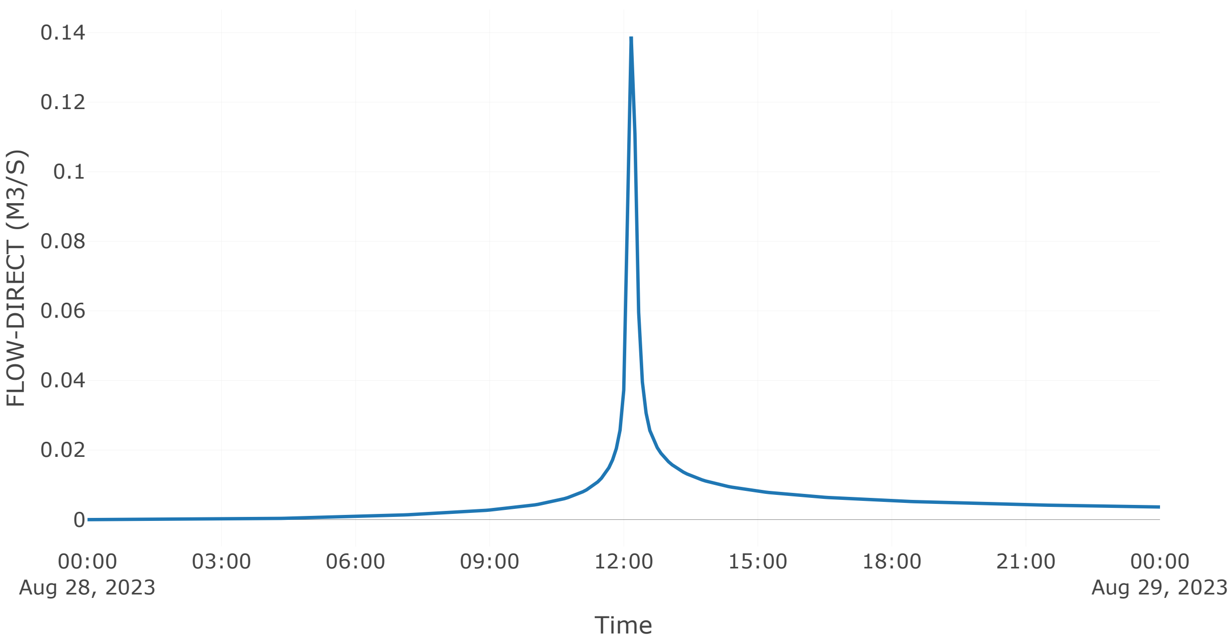
Baseflow



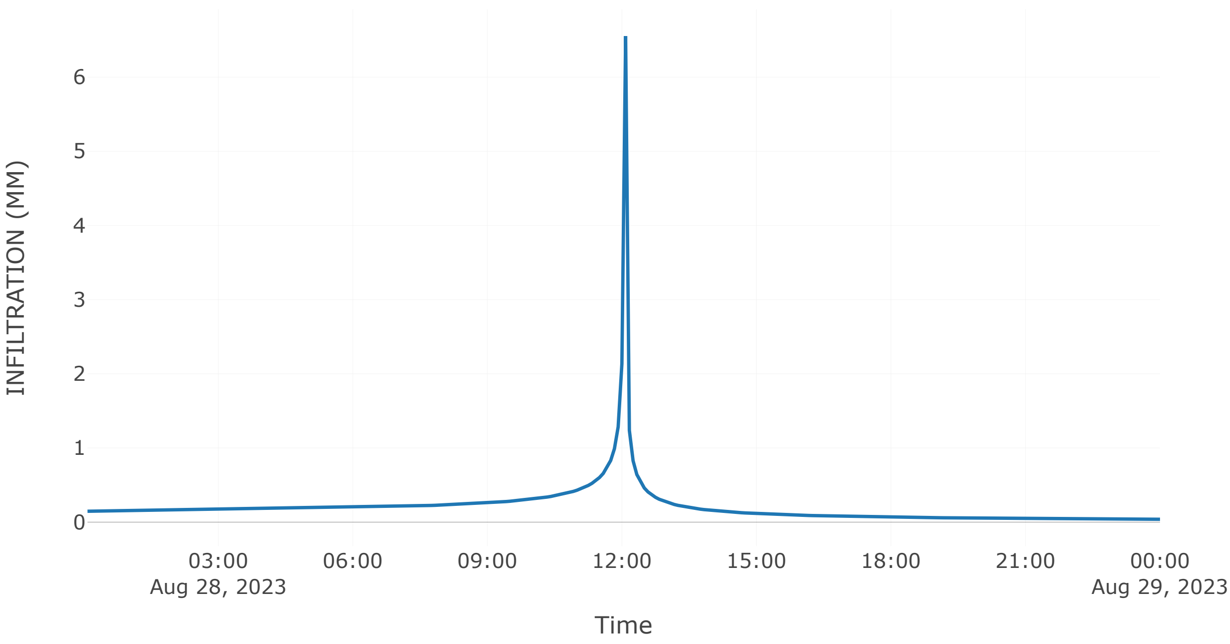
Precipitation Loss



Direct Runoff



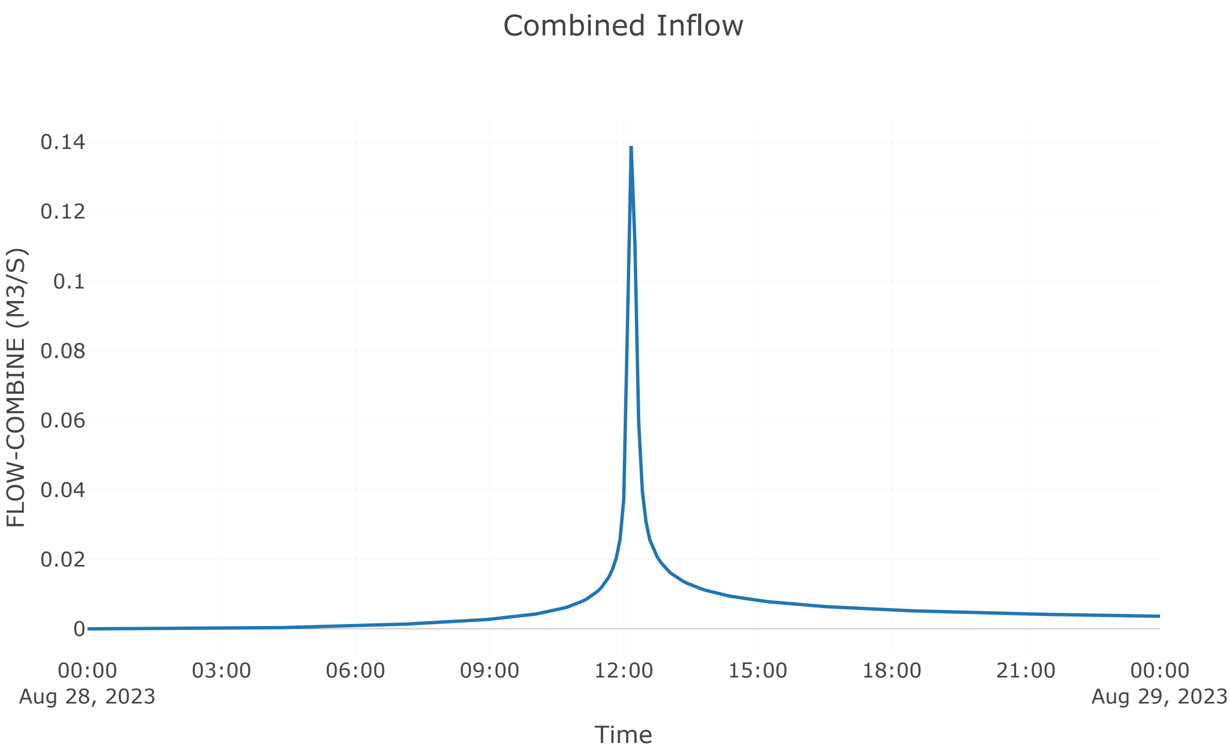
Soil Infiltration

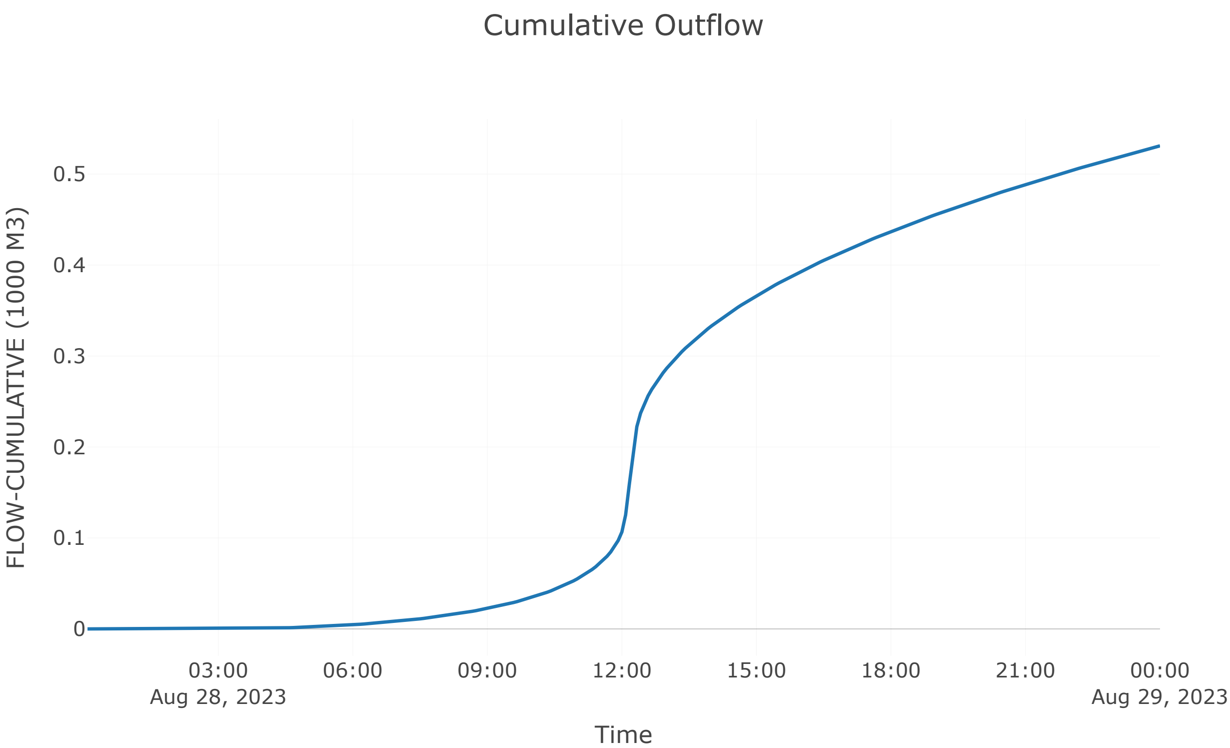


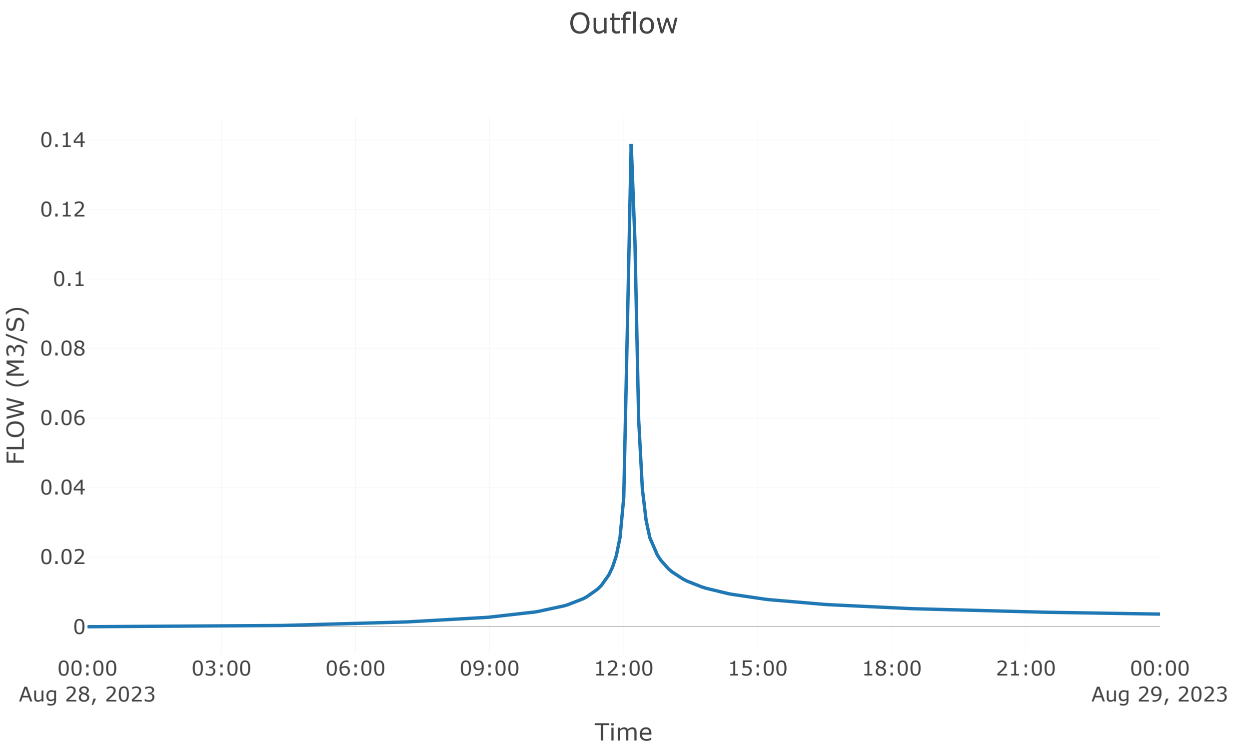
Junction: Natrual basin

Results: Natrual basin

Peak Discharge (M3/S)	0.14
Time of Peak Discharge	28Aug2023, 12:10
Volume (MM)	53.11






Outflow
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
FLOW (M3/S)
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

Project: 2911
Simulation Run: CONCEPT - 50% AEP - POST
Simulation Start: 27 August 2023, 24:00
Simulation End: 28 August 2023, 24:00

HMS Version: 4.12
Executed: 25 September 2025, 08:52

Global Parameter Summary - Subbasin

Area (KM2)

Element Name	Area (KM2)
Development area	0.01

Downstream

Element Name	Downstream
Development area	Natrual basin

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Development area	70	69	5

Transform: Clark

Element Name	Clark Method	Time of Concentration	Storage Coefficient	Time Area Method
Development area	Specified	0.17	0.07	Default

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Development area	0.01	0.14	28Aug2023, 12:10	61.41
Natrual basin	0.01	0.14	28Aug2023, 12:10	61.41

Subbasin: Development area

Area (KM2) : 0.01
Downstream : Natrual basin

Loss Rate: Scs

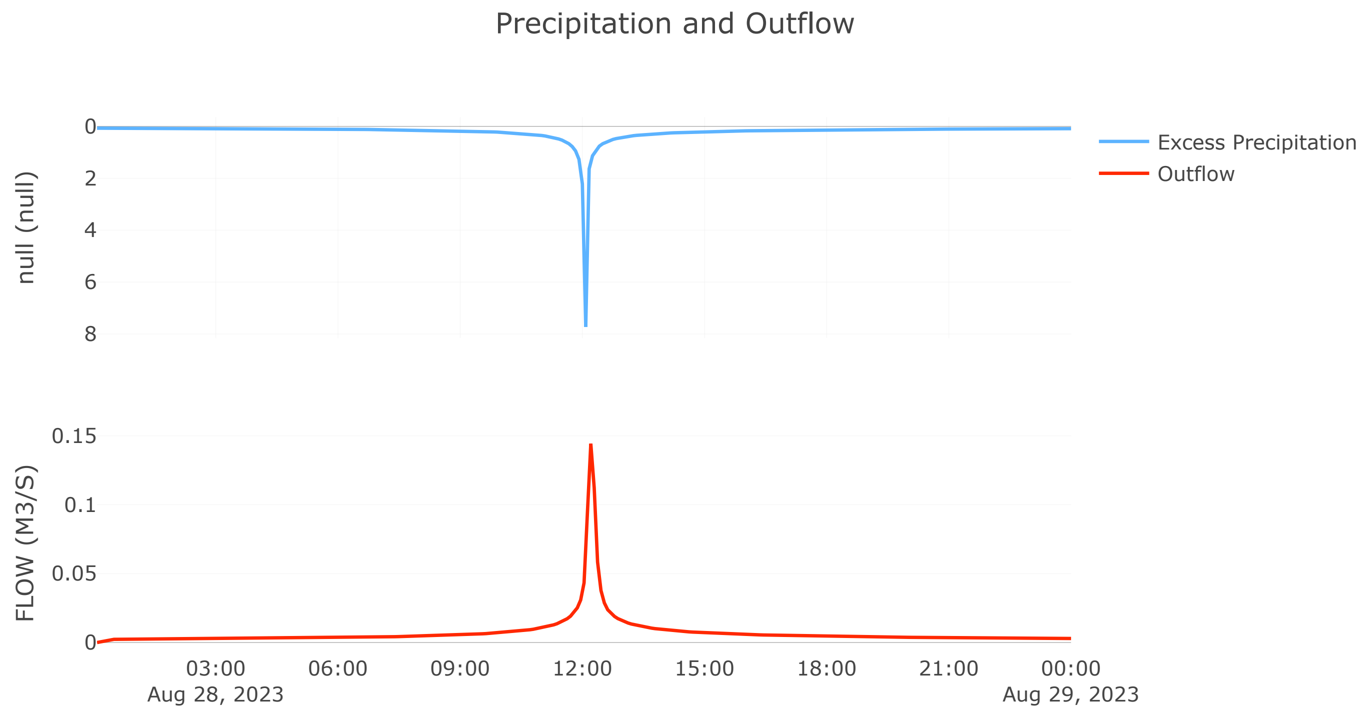
Percent Impervious Area	70
Curve Number	69
Initial Abstraction	5

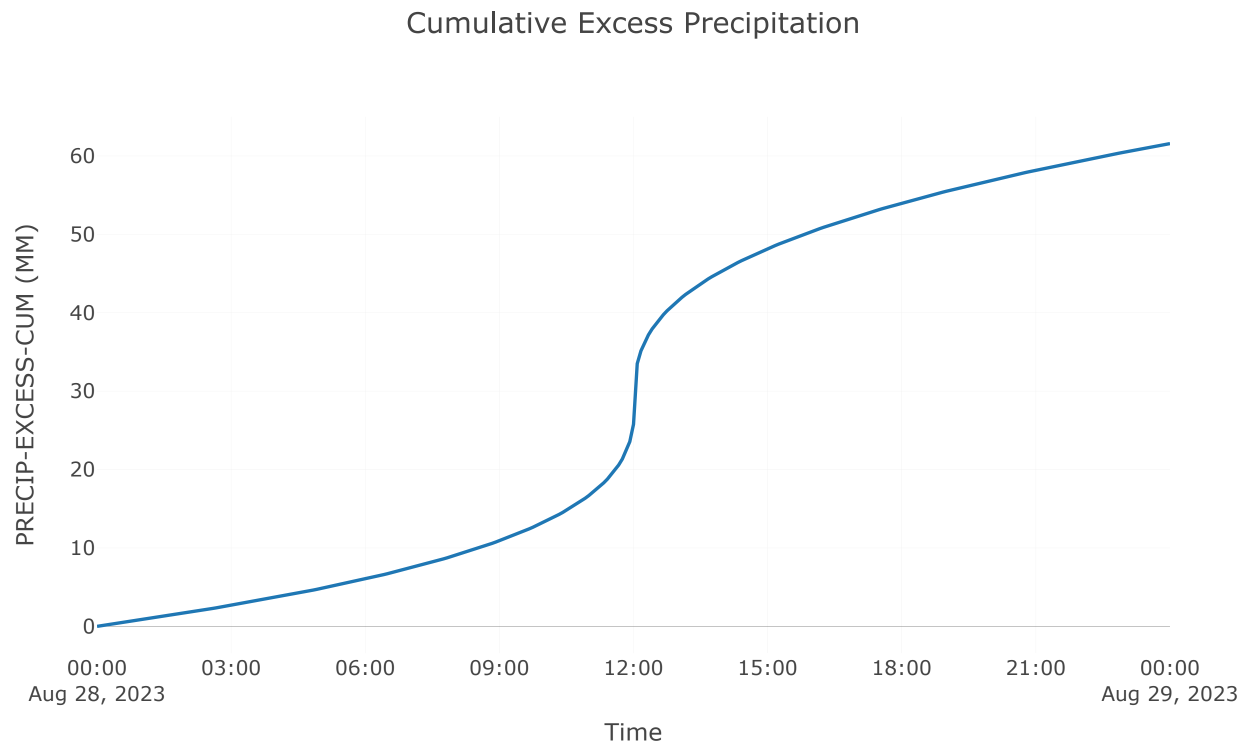
Transform: Clark

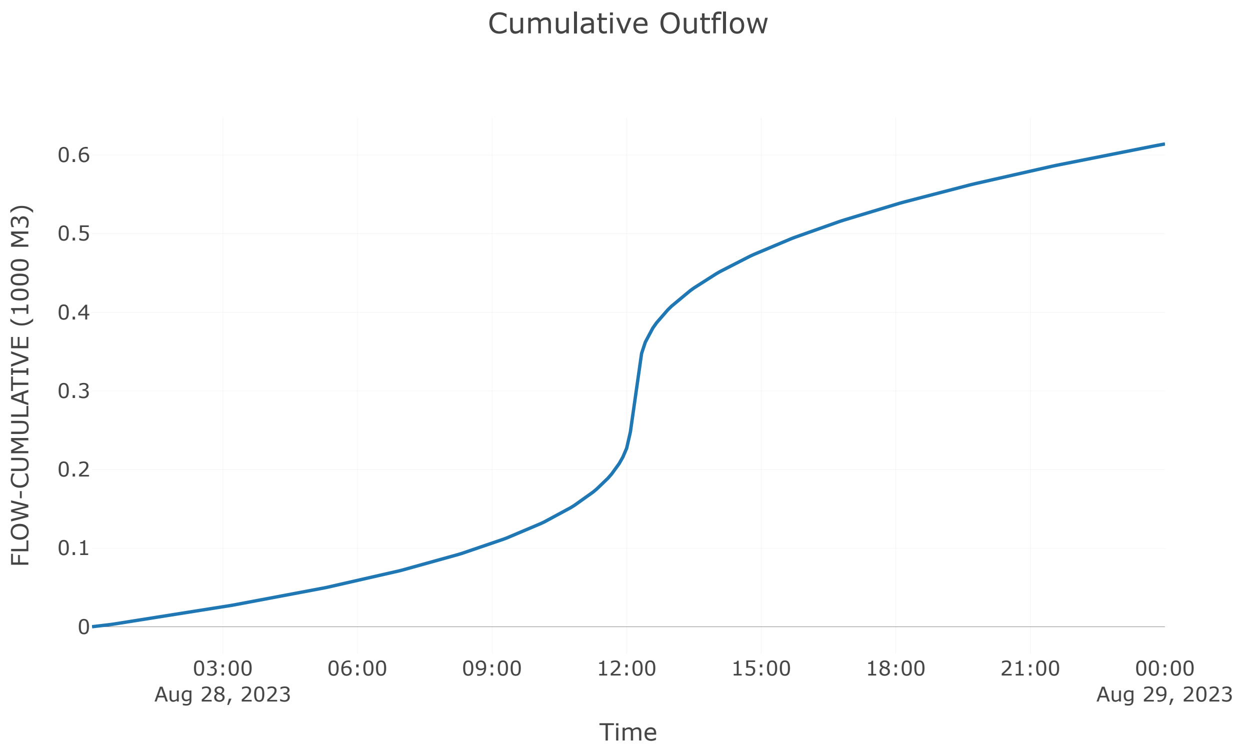
Clark Method	Specified
Time of Concentration	0.17
Storage Coefficient	0.07
Time Area Method	Default

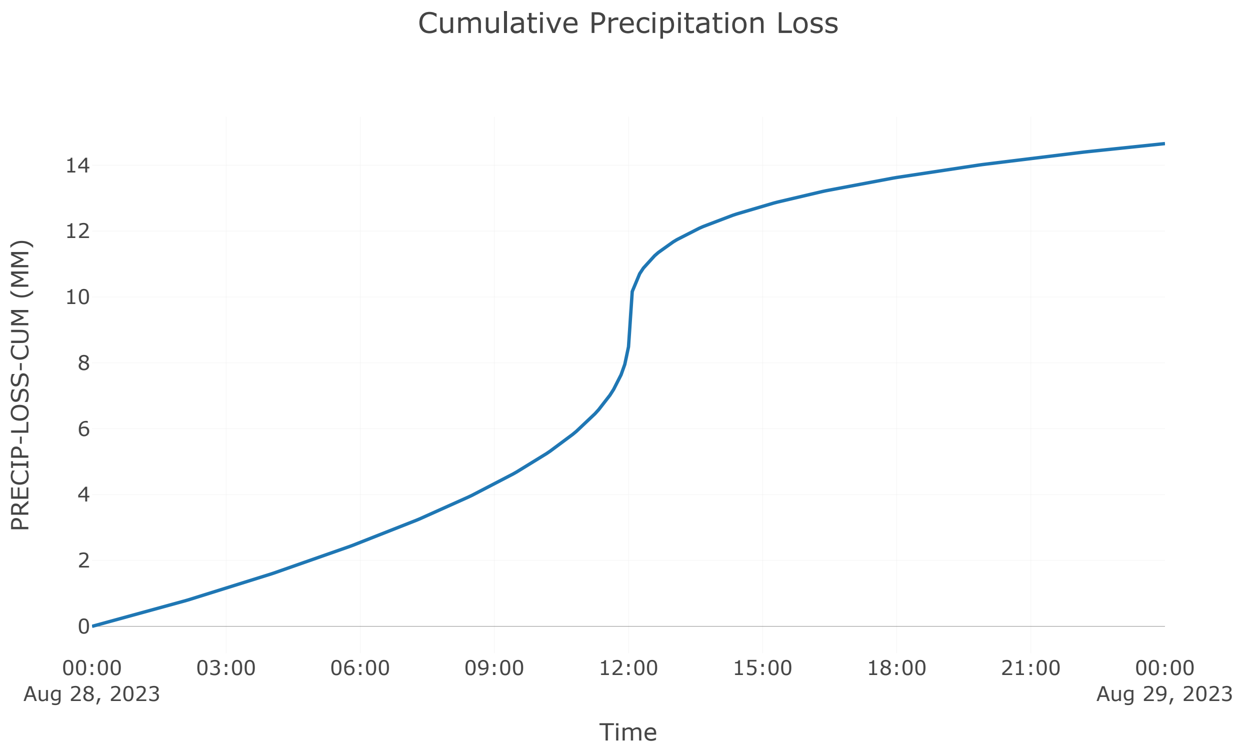
Results: Development area

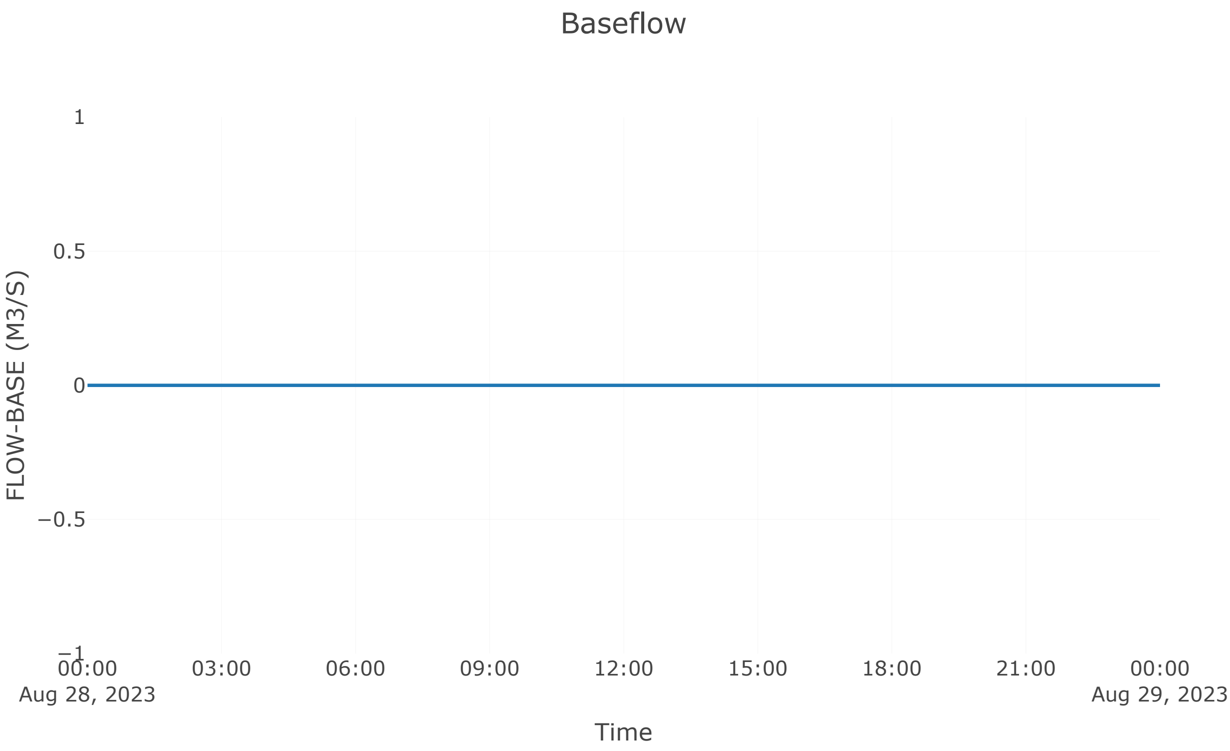
Peak Discharge (M3/S)	0.14
Time of Peak Discharge	28Aug2023, 12:10
Volume (MM)	61.41
Precipitation Volume (M3)	762.3
Loss Volume (M3)	146.57
Excess Volume (M3)	615.73
Direct Runoff Volume (M3)	614.13
Baseflow Volume (M3)	0

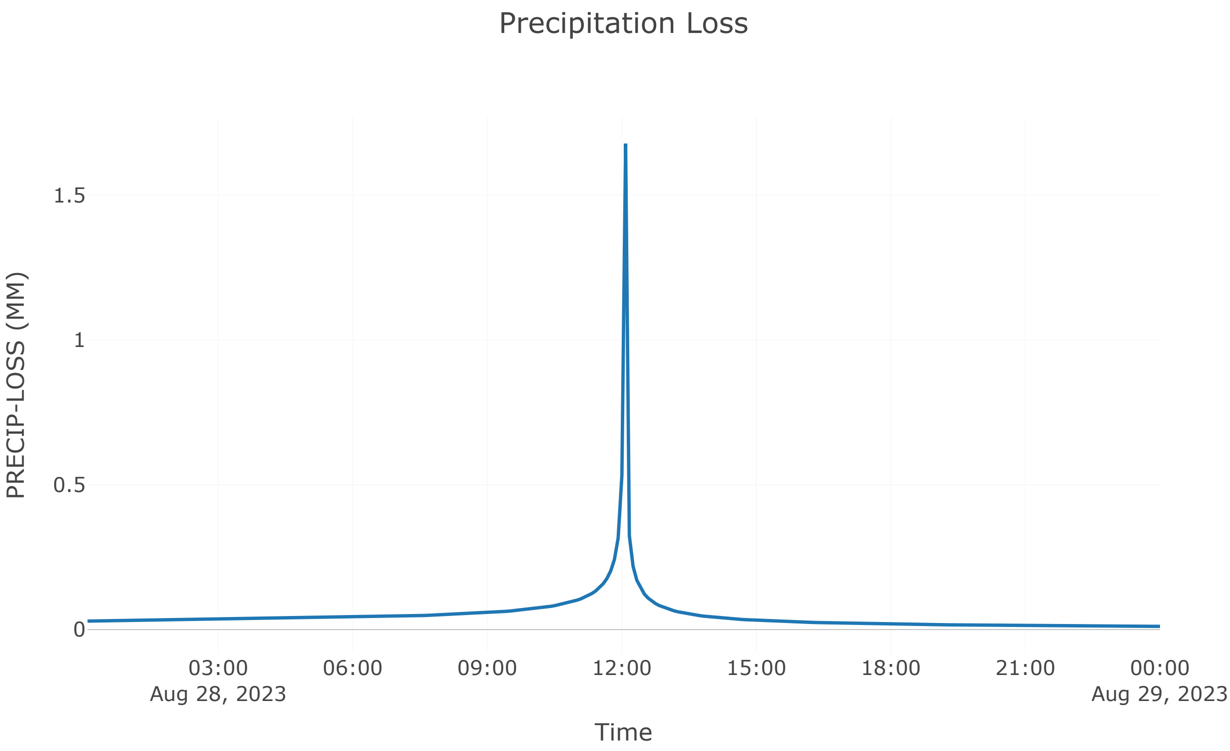

Precipitation and Outflow
null (null)
0
2
4
6
8
Excess Precipitation
Outflow
FLOW (M3/S)
0.15
0.1
0.05
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023

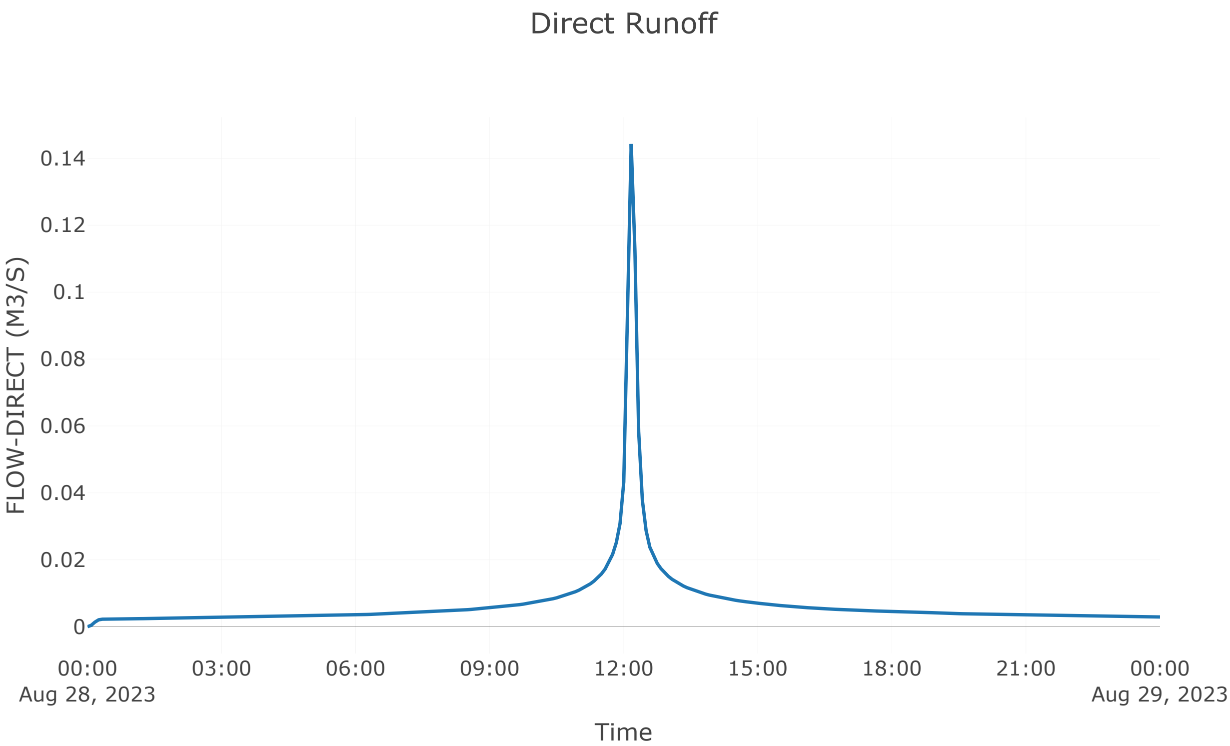

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
60
50
40
30
20
10
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

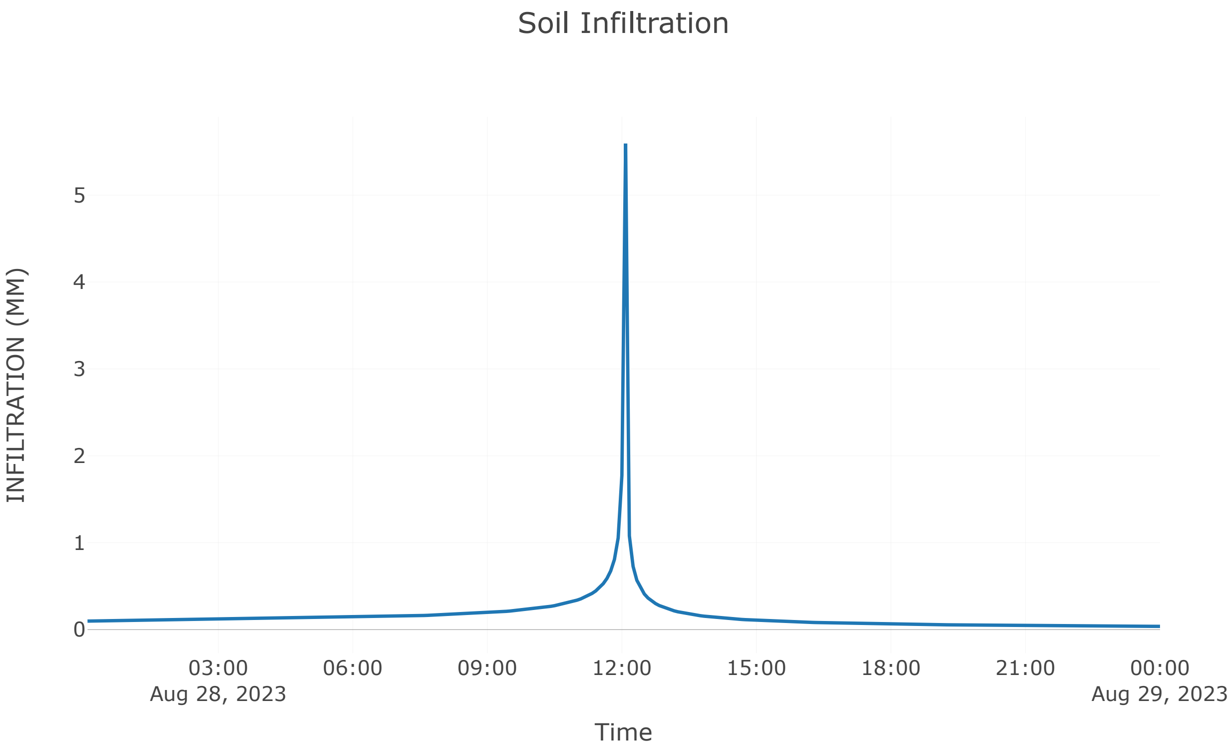

Cumulative Outflow
FLOW-CUMULATIVE (1000 M3)
0.6
0.5
0.4
0.3
0.2
0.1
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (MM)
14
12
10
8
6
4
2
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time


Baseflow
FLOW-BASE (M3/S)
1
0.5
0
−0.5
−1
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

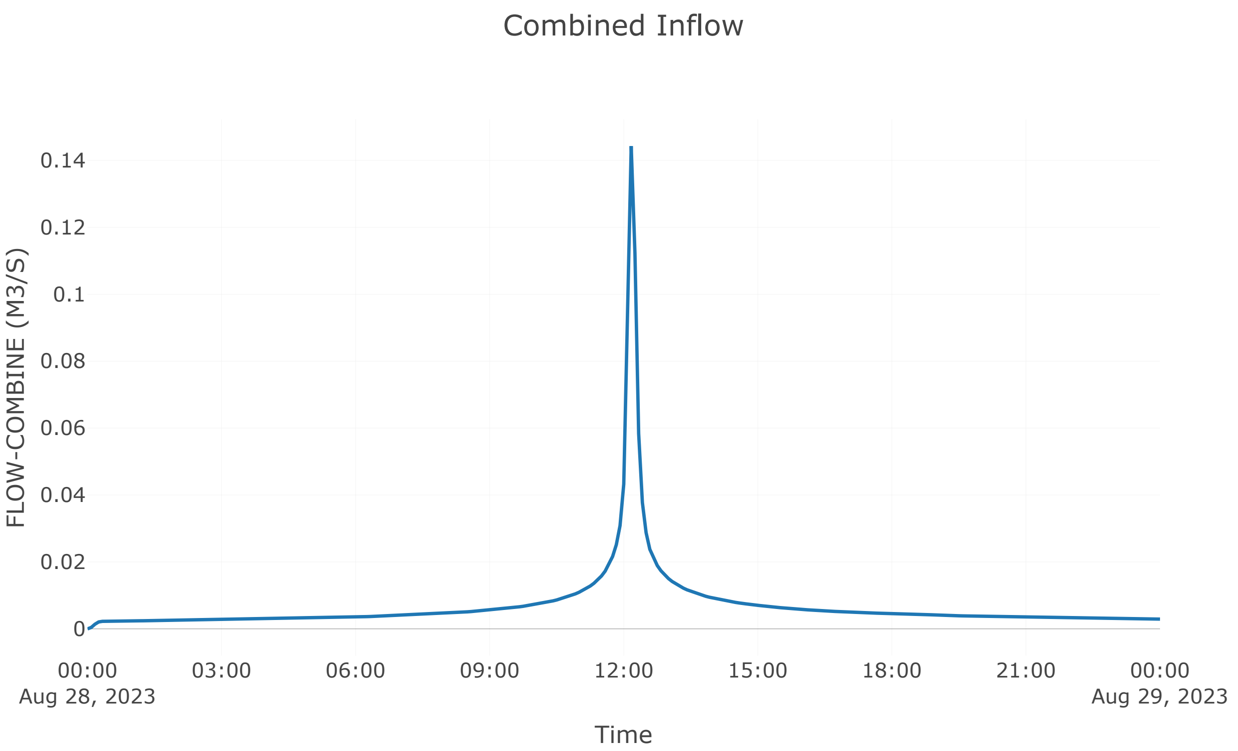

Precipitation Loss
PRECIP-LOSS (MM)
1.5
1
0.5
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

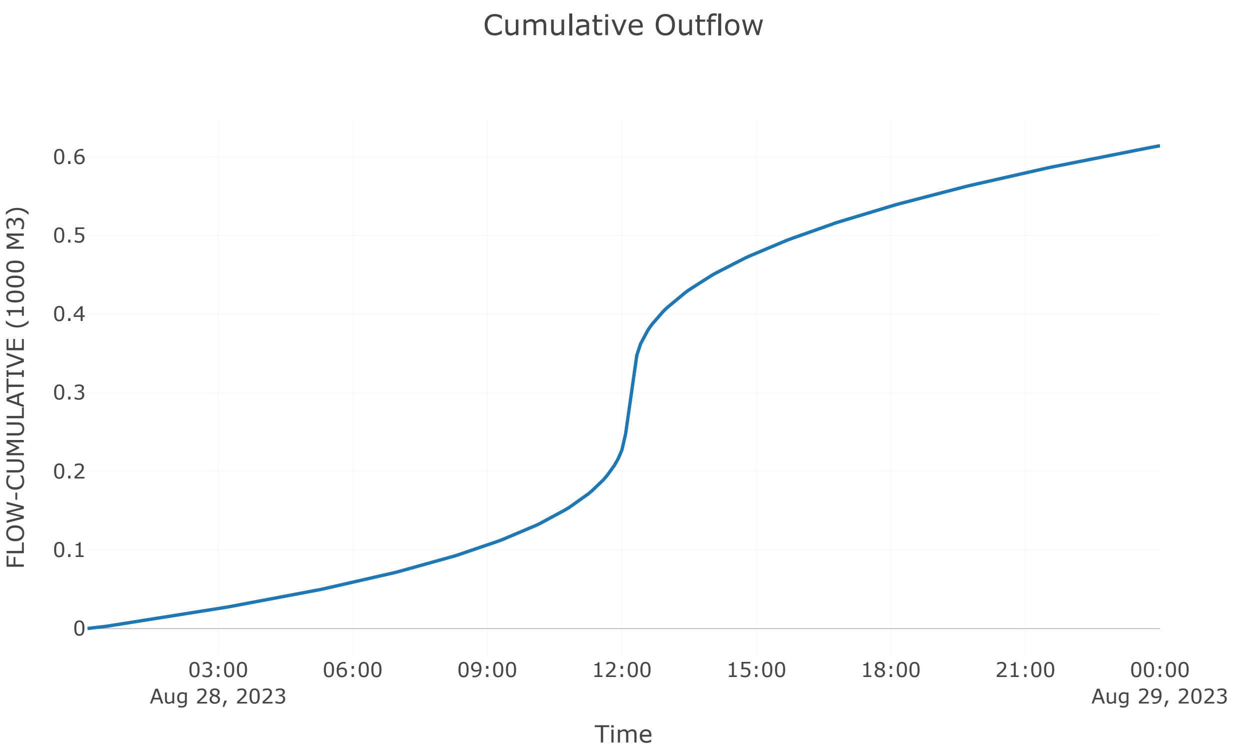

Direct Runoff
FLOW-DIRECT (M3/S)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

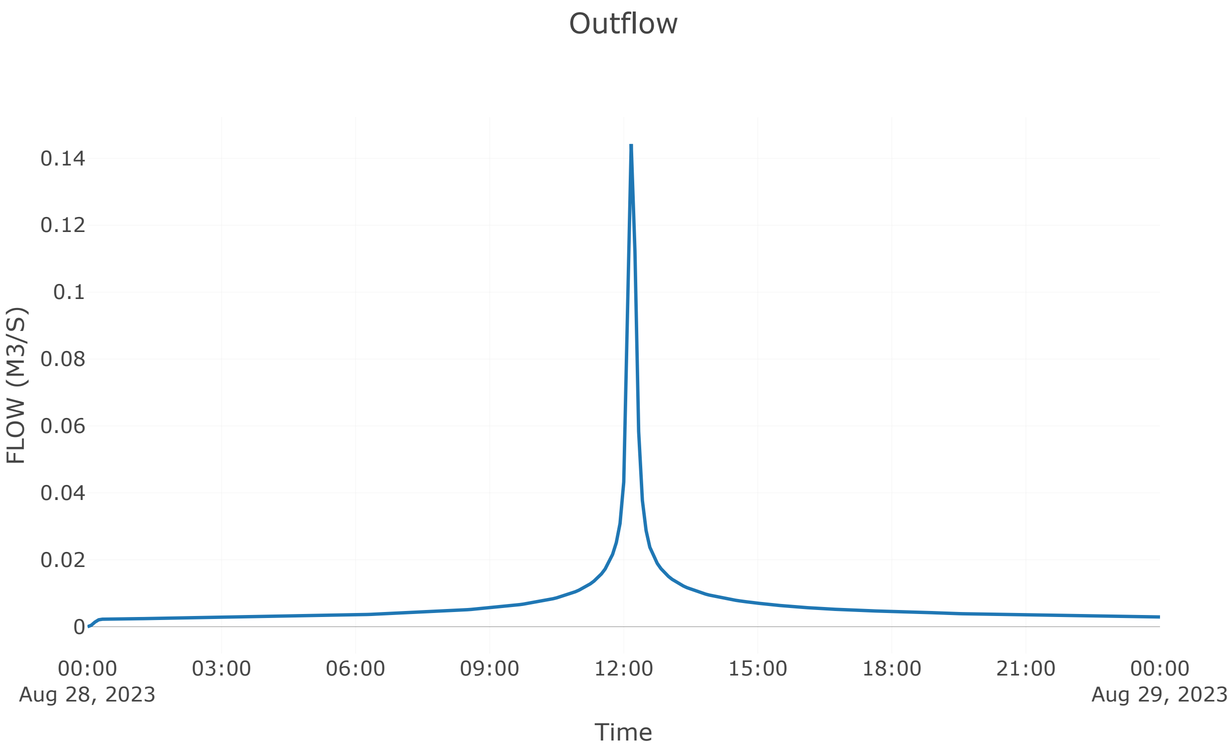

Soil Infiltration
INFILTRATION (MM)
5
4
3
2
1
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

Junction: Natrual basin

Results: Natrual basin	
Peak Discharge (M3/S)	0.14
Time of Peak Discharge	28Aug2023, 12:10
Volume (MM)	61.41






Outflow
FLOW (M3/S)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

Project: 2911
Simulation Run: CONCEPT - 50% AEP - PRE
Simulation Start: 27 August 2023, 24:00
Simulation End: 28 August 2023, 24:00

HMS Version: 4.12
Executed: 20 October 2025, 19:14

Global Parameter Summary - Subbasin

Area (KM2)

Element Name	Area (KM2)
Development area	0.01

Downstream

Element Name	Downstream
Development area	Natrual basin

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Development area	0	69	5

Transform: Clark

Element Name	Clark Method	Time of Concentration	Storage Coefficient	Time Area Method
Development area	Specified	0.17	0.07	Default

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Development area	0.01	0.07	28Aug2023, 12:10	27.26
Natrual basin	0.01	0.07	28Aug2023, 12:10	27.26

Subbasin: Development area

Area (KM2) : 0.01
Downstream : Natrual basin

Loss Rate: Scs

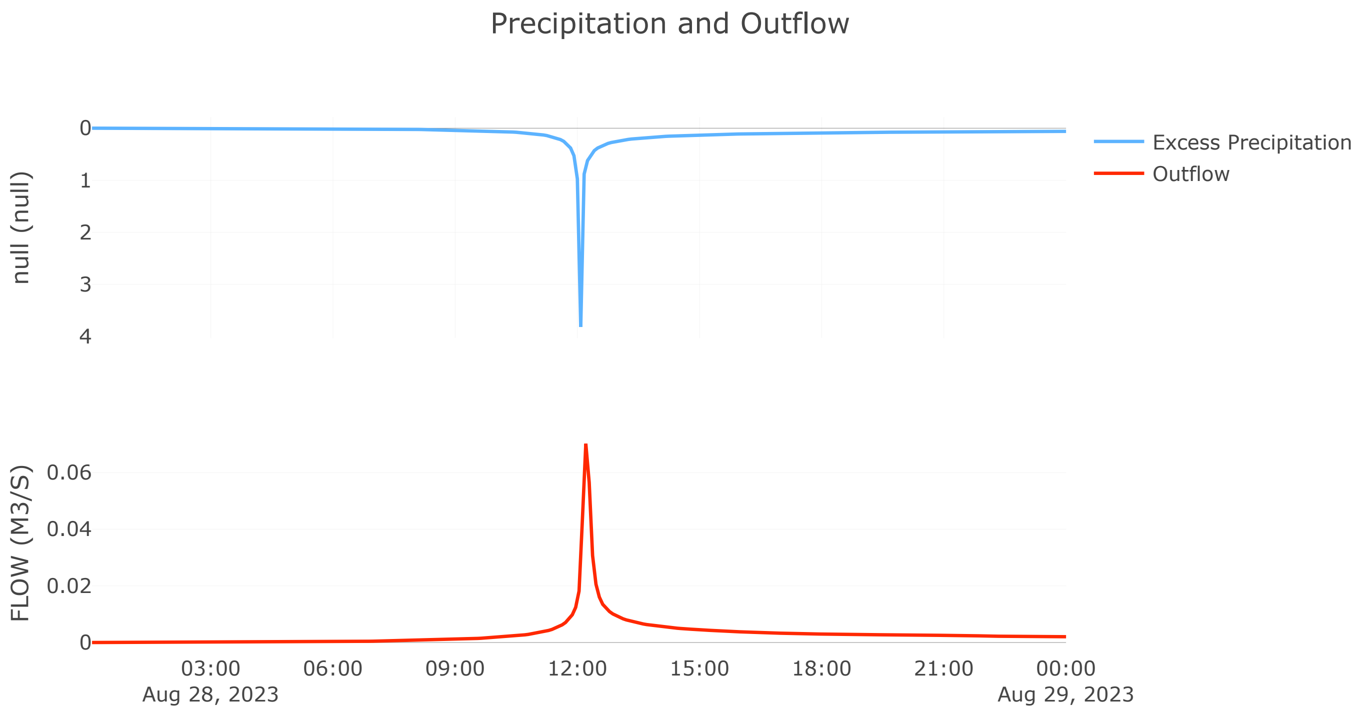
Percent Impervious Area	0
Curve Number	69
Initial Abstraction	5

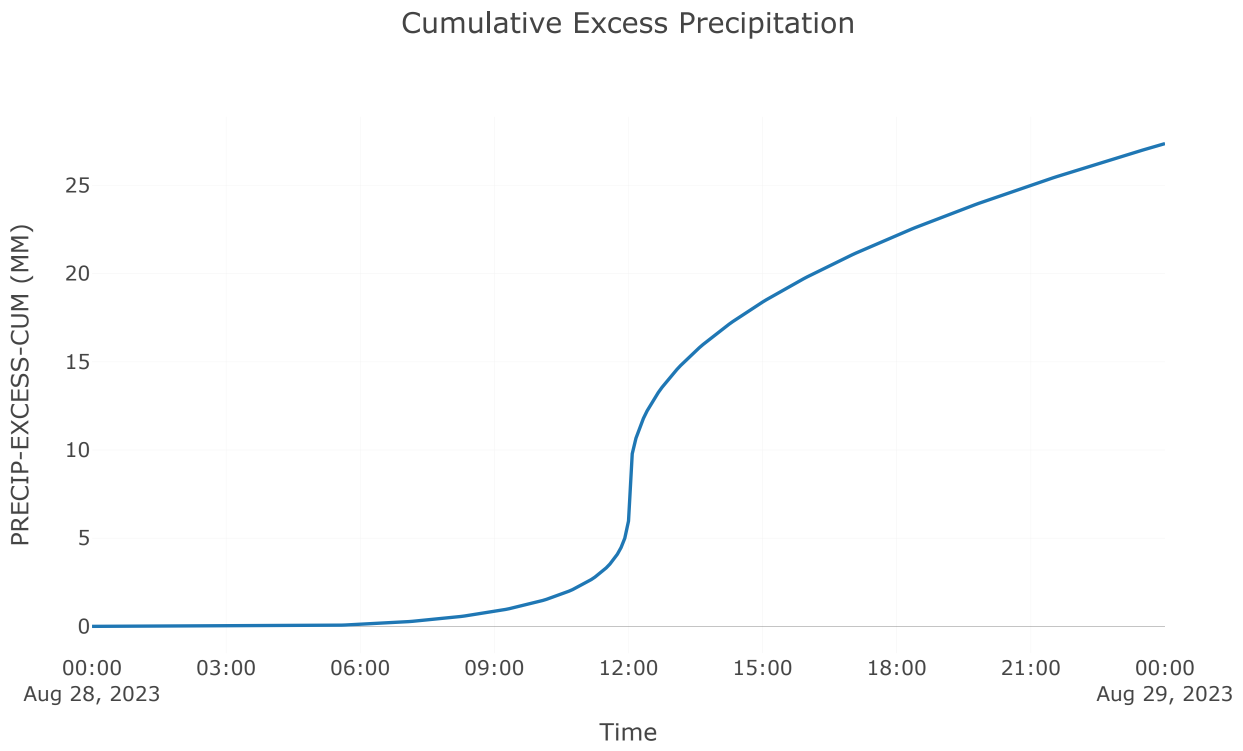
Transform: Clark

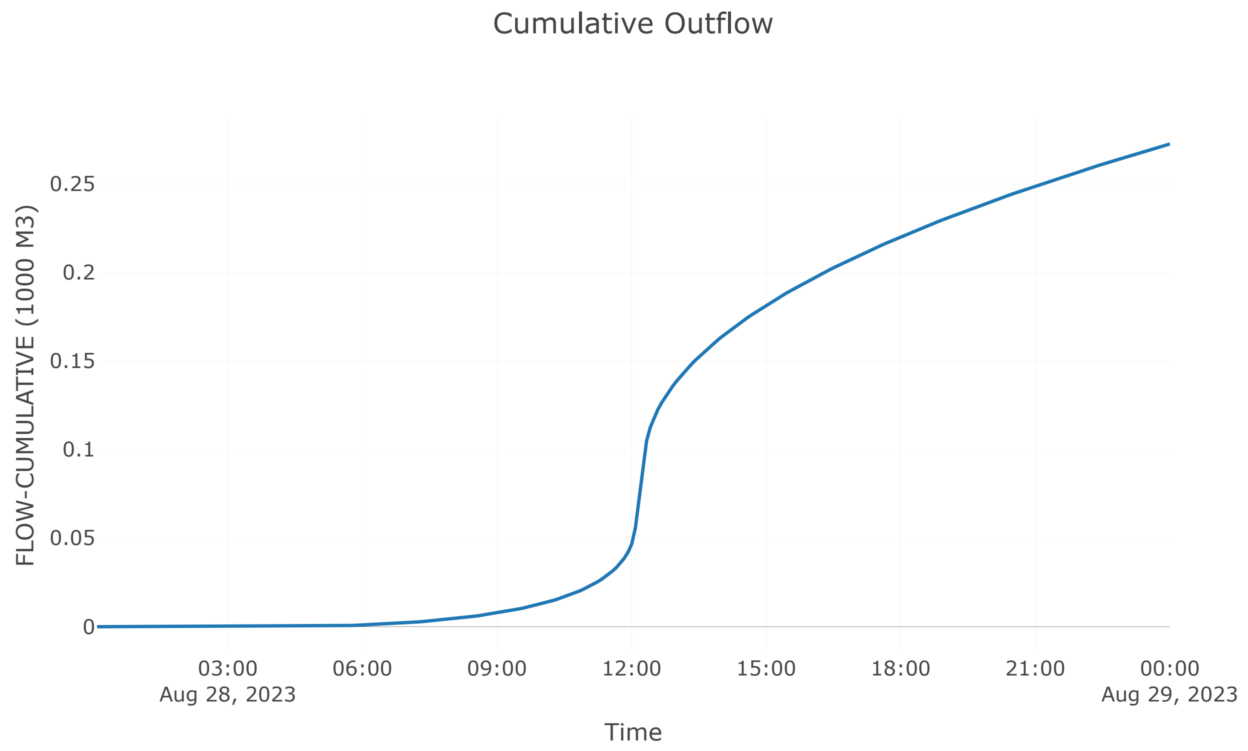
Clark Method	Specified
Time of Concentration	0.17
Storage Coefficient	0.07
Time Area Method	Default

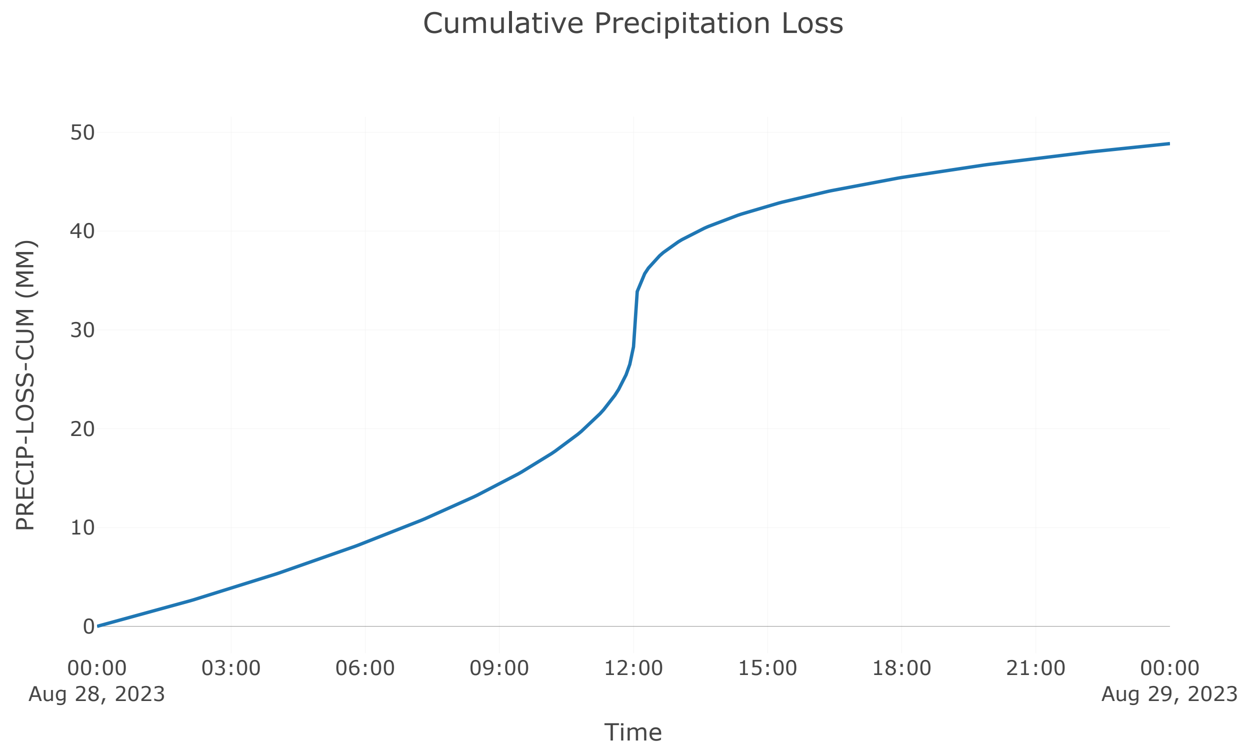
Results: Development area

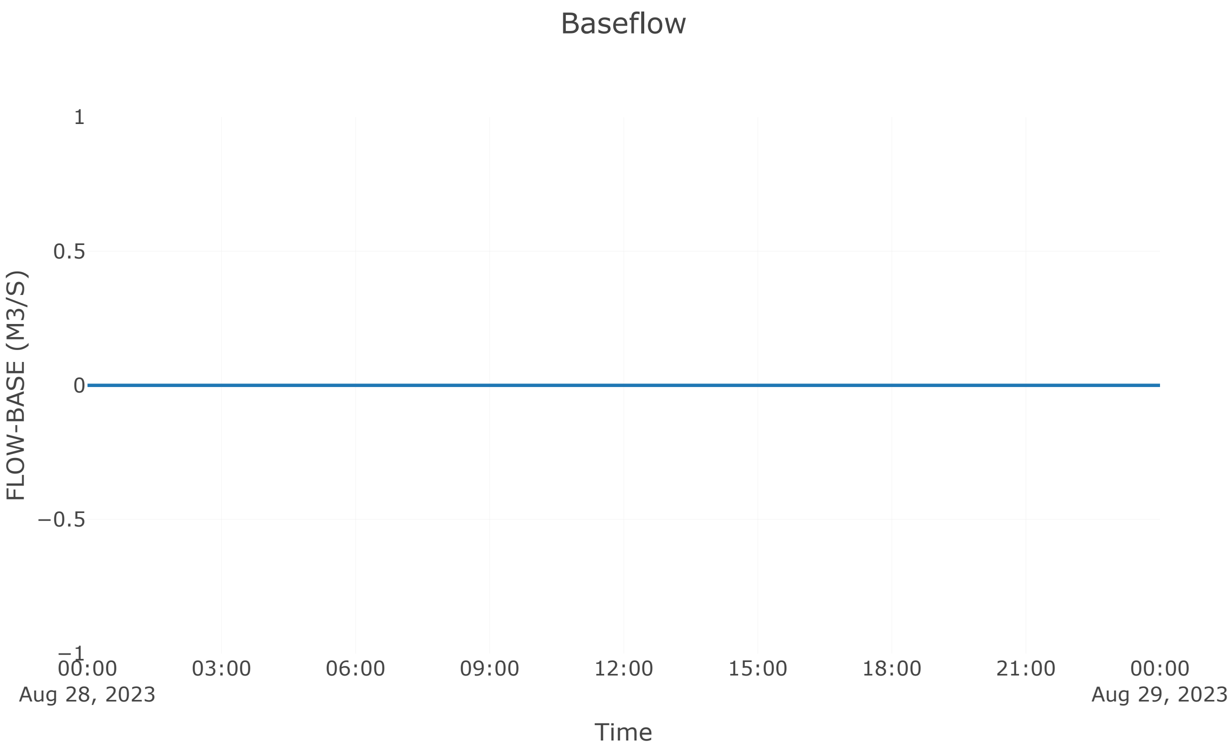
Peak Discharge (M3/S)	0.07
Time of Peak Discharge	28Aug2023, 12:10
Volume (MM)	27.26
Precipitation Volume (M3)	762.3
Loss Volume (M3)	488.56
Excess Volume (M3)	273.74
Direct Runoff Volume (M3)	272.62
Baseflow Volume (M3)	0

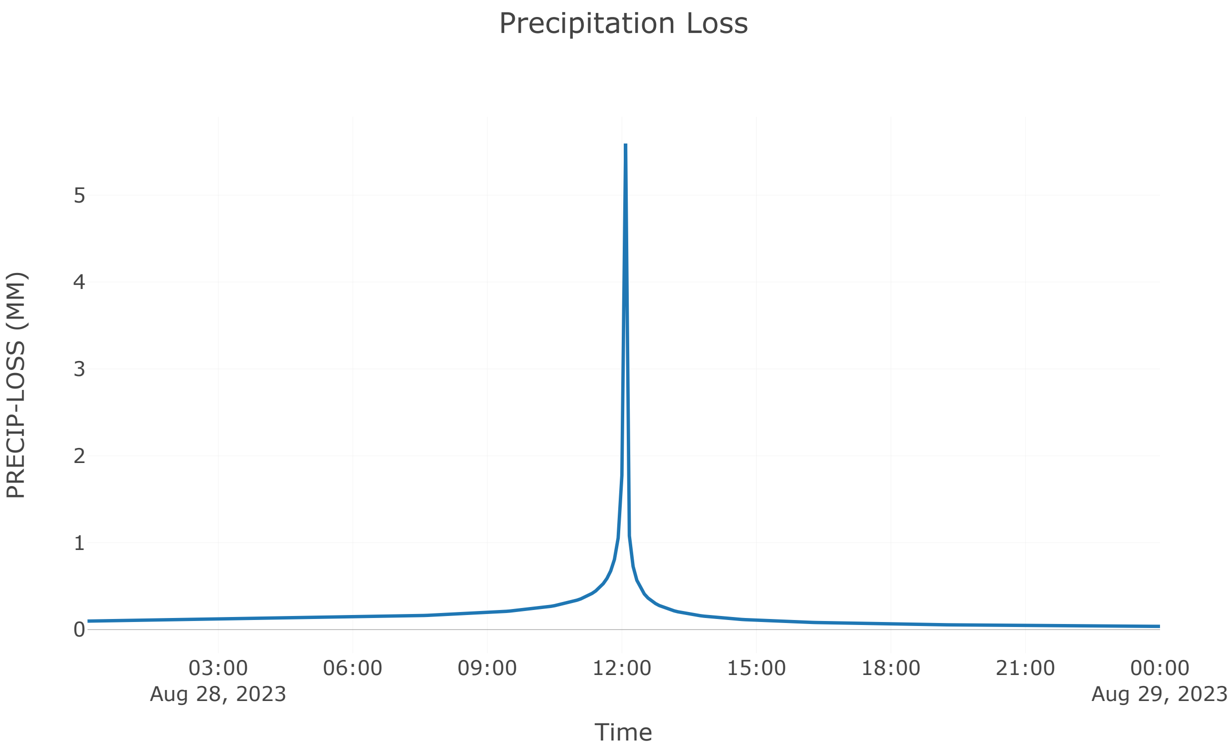

Precipitation and Outflow
null (null)
0
1
2
3
4
Excess Precipitation
Outflow
FLOW (M3/S)
0.06
0.04
0.02
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023

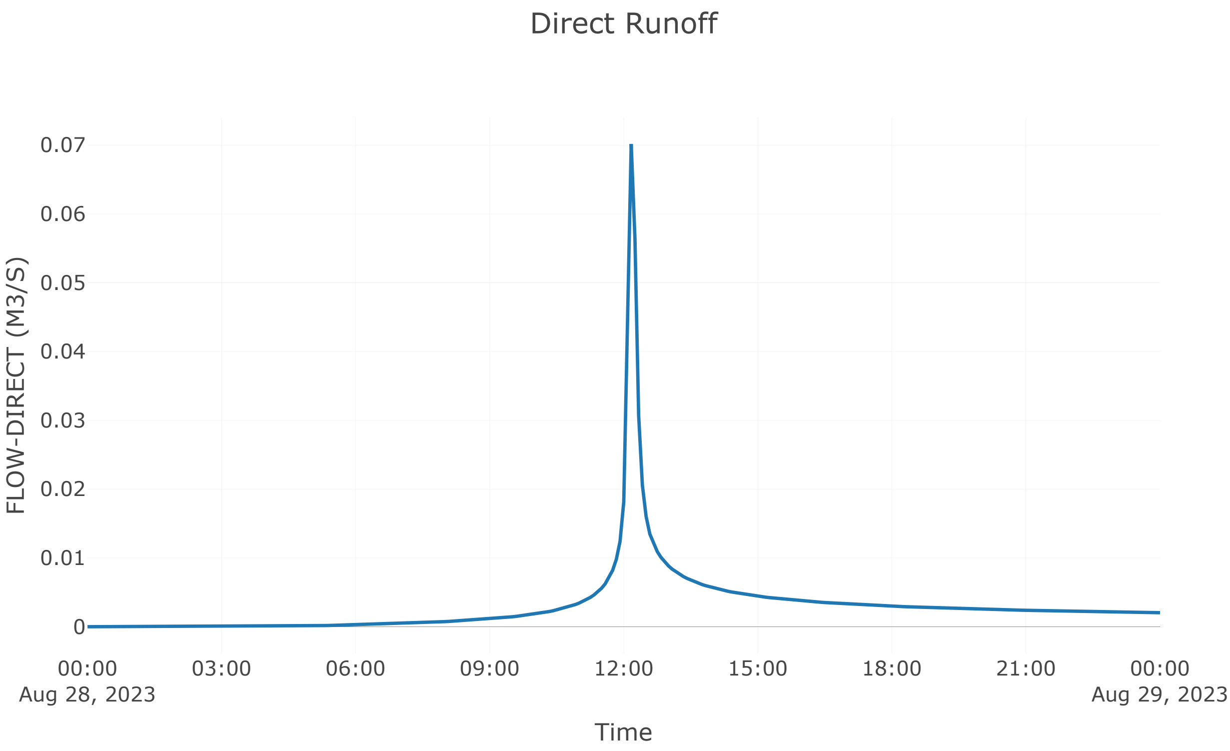

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
25
20
15
10
5
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

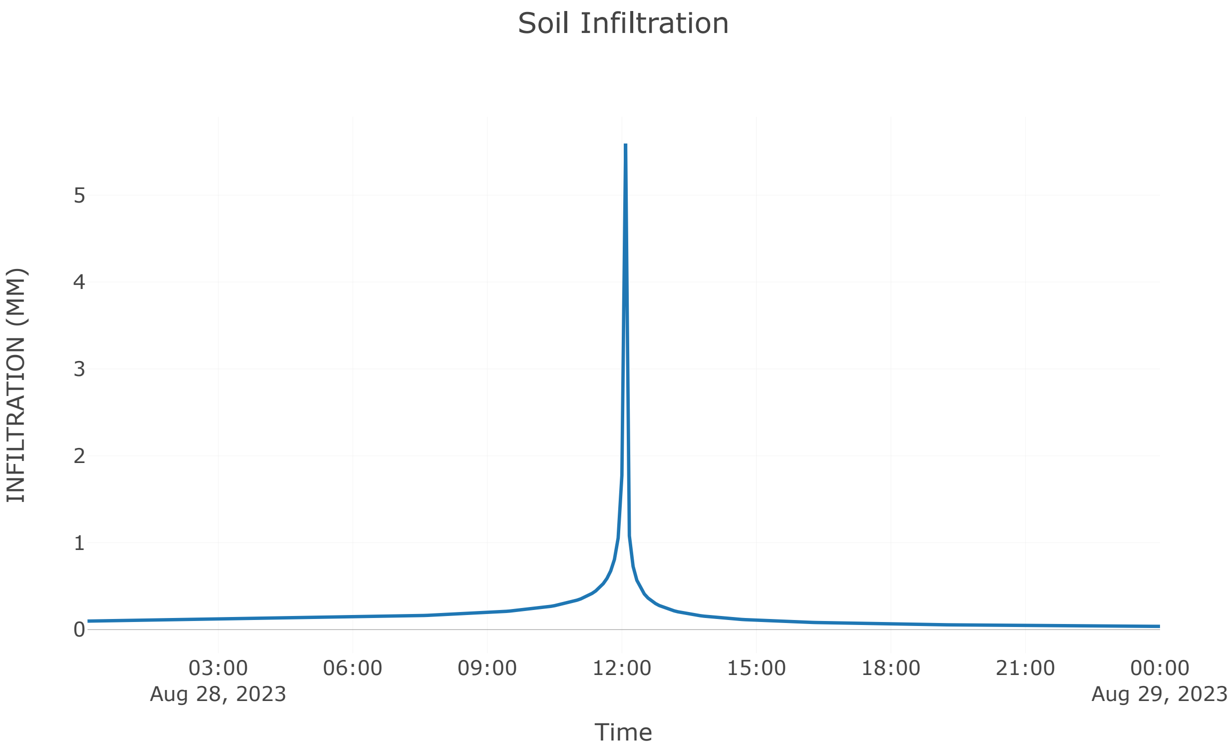

Cumulative Outflow
FLOW-CUMULATIVE (1000 M3)
0.25
0.2
0.15
0.1
0.05
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (MM)
50
40
30
20
10
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time


Baseflow
FLOW-BASE (M3/S)
1
0.5
0
−0.5
−1
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

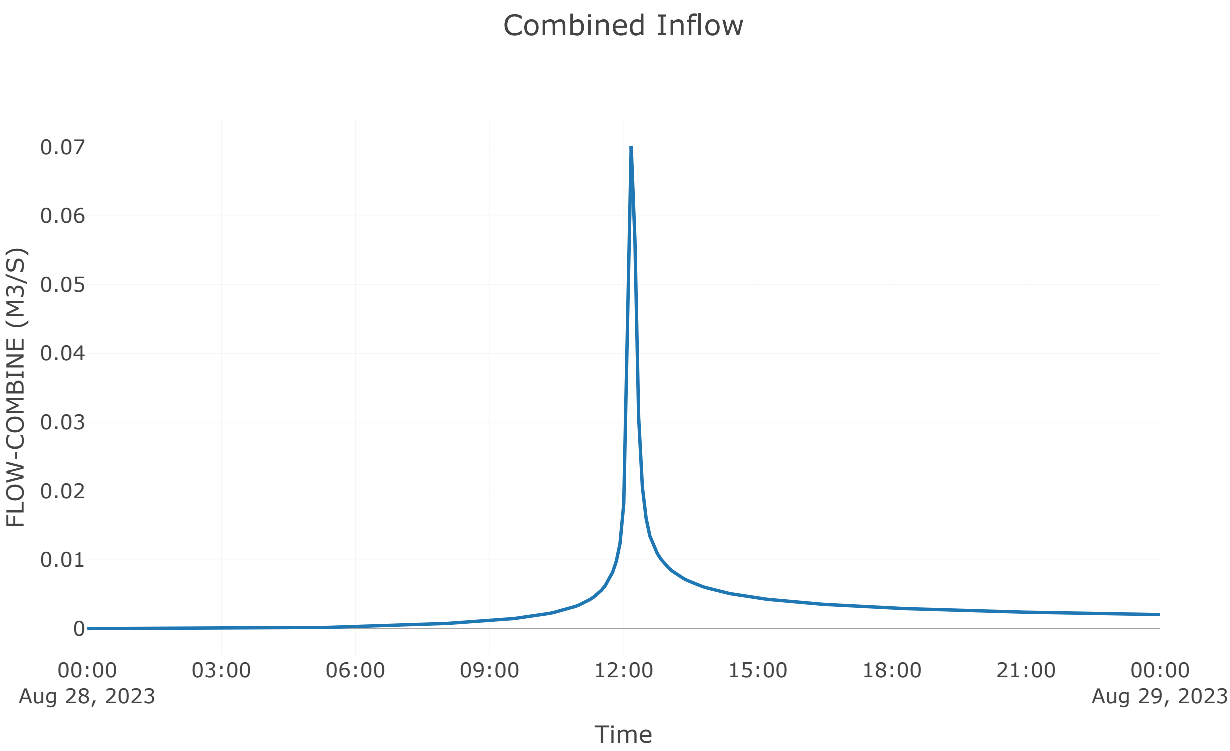

Precipitation Loss
PRECIP-LOSS (MM)
5
4
3
2
1
0
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

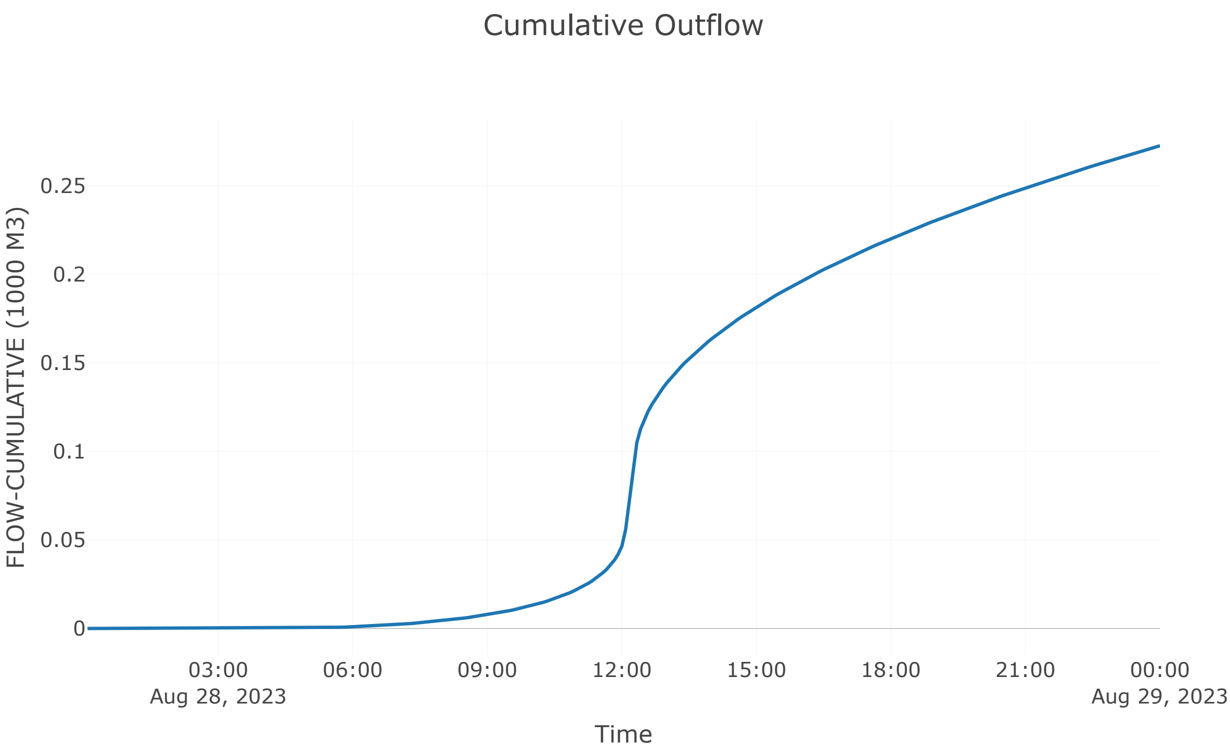

Direct Runoff
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
FLOW-DIRECT (M3/S)
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time


Soil Infiltration
5
4
3
2
1
0
INFILTRATION (MM)
03:00
Aug 28, 2023
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

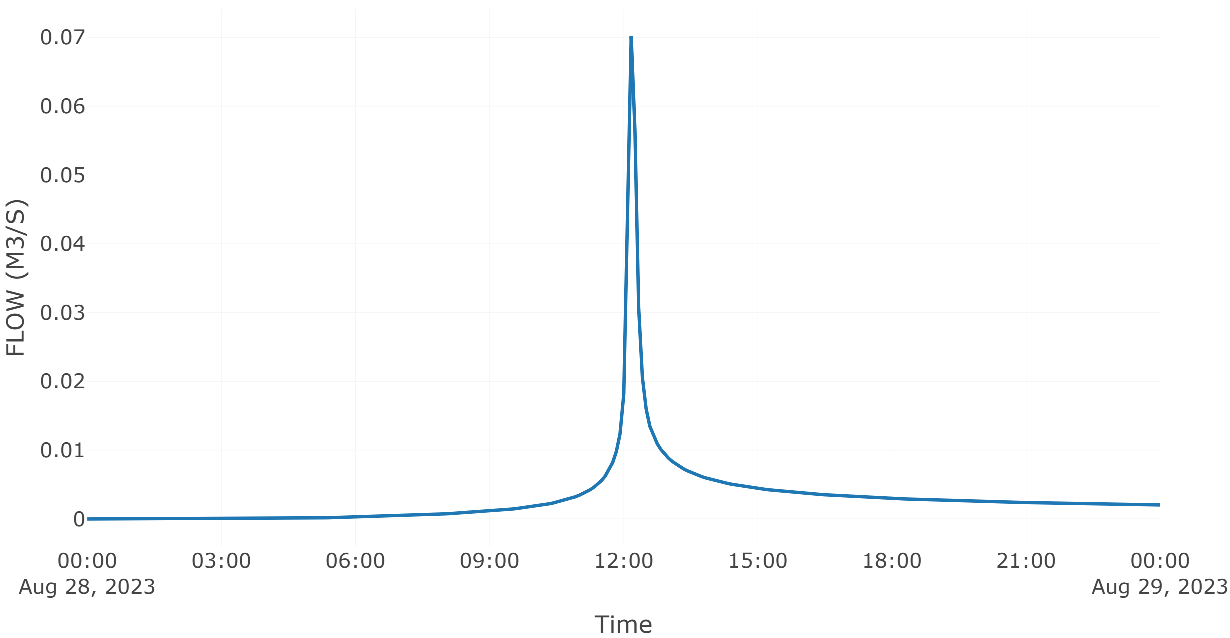
Junction: Natrual basin

Results: Natrual basin	
Peak Discharge (M3/S)	0.07
Time of Peak Discharge	28Aug2023, 12:10
Volume (MM)	27.26





Outflow



FLOW (M3/S)
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
00:00
Aug 28, 2023
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Aug 29, 2023
Time

Appendix B – Treatment Area Calculations
Representative 1 ha calculations supporting concept basin sizing and drawdown confirmation.
Includes:

- *B-1%AEP Treatment Area Calculations 1 Ha.pdf* – 1 % AEP to-ground sizing check
- *B-50%AEP WQV Treatment Area Calculations 1 Ha.pdf* – WQV treatment footprint and storage confirmation
- B–1% AEP Treatment Area Overflow Volume Assessment

These establish the per-hectare treatment requirement of 270 m² / ha adopted in Section 6.3, exceedance volumes in Section 7.3 and the 1 % AEP soakage sizing reference in Section 7.

WQV (1% AEP) – Overflow Volume Check (1 ha Catchment) – 270 m² Treatment Area Provided

To estimate the additional runoff volume generated by a 1 ha developed catchment (70% impervious) relative to greenfield conditions during the 24-hour 1% AEP storm event. This additional volume is used to estimate the extra storage required within the site-wide storage areas.

Typical 1ha Development Area									
Time (h:mm)	1% AEP (m^3/s)	Inflow (m^3/5 min)	Infiltration capacity (m^3/5 min)	Net surplus (m^3)	Running storage (m^3)	Available storage (m^3)	Overflow (m^3)	Cumulative inflow (m^3)	Cumulative infiltration (m^3)
0:00	0	0	1.125	-1.125	0	56.7	0.0	0	0
0:05	0.001	0.3	1.125	-0.825	0	56.7	0.0	0.3	0.3
0:10	0.003	0.9	1.125	-0.225	0	56.7	0.0	1.2	1.2
0:15	0.005	1.5	1.125	0.375	0.375	56.7	0.0	2.7	2.325
0:20	0.005	1.5	1.125	0.375	0.75	56.7	0.0	4.2	3.45
0:25	0.005	1.5	1.125	0.375	1.125	56.7	0.0	5.7	4.575
0:30	0.005	1.5	1.125	0.375	1.5	56.7	0.0	7.2	5.700
0:35	0.005	1.5	1.125	0.375	1.875	56.7	0.0	8.7	6.825
0:40	0.005	1.5	1.125	0.375	2.25	56.7	0.0	10.2	7.95
0:45	0.005	1.5	1.125	0.375	2.625	56.7	0.0	11.7	9.075
0:50	0.005	1.5	1.125	0.375	3	56.7	0.0	13.2	10.2
0:55	0.005	1.5	1.125	0.375	3.375	56.7	0.0	14.7	11.325
1:00	0.005	1.5	1.125	0.375	3.75	56.7	0.0	16.2	12.45
1:05	0.005	1.5	1.125	0.375	4.125	56.7	0.0	17.7	13.575
1:10	0.005	1.5	1.125	0.375	4.5	56.7	0.0	19.2	14.7
1:15	0.005	1.5	1.125	0.375	4.875	56.7	0.0	20.7	15.825
1:20	0.005	1.5	1.125	0.375	5.25	56.7	0.0	22.2	16.95
1:25	0.005	1.5	1.125	0.375	5.625	56.7	0.0	23.7	18.075
1:30	0.005	1.5	1.125	0.375	6	56.7	0.0	25.2	19.2
1:35	0.006	1.8	1.125	0.675	6.675	56.7	0.0	27	20.325
1:40	0.006	1.8	1.125	0.675	7.35	56.7	0.0	28.8	21.45
1:45	0.006	1.8	1.125	0.675	8.025	56.7	0.0	30.6	22.575
1:50	0.006	1.8	1.125	0.675	8.7	56.7	0.0	32.4	23.7
1:55	0.006	1.8	1.125	0.675	9.375	56.7	0.0	34.2	24.825
2:00	0.006	1.8	1.125	0.675	10.05	56.7	0.0	36	25.95
2:05	0.006	1.8	1.125	0.675	10.725	56.7	0.0	37.8	27.075
2:10	0.006	1.8	1.125	0.675	11.4	56.7	0.0	39.6	28.2
2:15	0.006	1.8	1.125	0.675	12.075	56.7	0.0	41.4	29.325
2:20	0.006	1.8	1.125	0.675	12.75	56.7	0.0	43.2	30.45
2:25	0.006	1.8	1.125	0.675	13.425	56.7	0.0	45	31.575
2:30	0.006	1.8	1.125	0.675	14.1	56.7	0.0	46.8	32.7
2:35	0.006	1.8	1.125	0.675	14.775	56.7	0.0	48.6	33.825
2:40	0.006	1.8	1.125	0.675	15.45	56.7	0.0	50.4	34.95
2:45	0.006	1.8	1.125	0.675	16.125	56.7	0.0	52.2	36.075
2:50	0.006	1.8	1.125	0.675	16.8	56.7	0.0	54	37.2
2:55	0.006	1.8	1.125	0.675	17.475	56.7	0.0	55.8	38.325
3:00	0.006	1.8	1.125	0.675	18.15	56.7	0.0	57.6	39.45
3:05	0.006	1.8	1.125	0.675	18.825	56.7	0.0	59.4	40.575
3:10	0.006	1.8	1.125	0.675	19.5	56.7	0.0	61.2	41.7
3:15	0.007	2.1	1.125	0.975	20.475	56.7	0.0	63.3	42.825
3:20	0.007	2.1	1.125	0.975	21.45	56.7	0.0	65.4	43.95
3:25	0.007	2.1	1.125	0.975	22.425	56.7	0.0	67.5	45.075
3:30	0.007	2.1	1.125	0.975	23.4	56.7	0.0	69.6	46.2
3:35	0.007	2.1	1.125	0.975	24.375	56.7	0.0	71.7	47.325
3:40	0.007	2.1	1.125	0.975	25.35	56.7	0.0	73.8	48.45
3:45	0.007	2.1	1.125	0.975	26.325	56.7	0.0	75.9	49.575
3:50	0.007	2.1	1.125	0.975	27.3	56.7	0.0	78	50.7
3:55	0.007	2.1	1.125	0.975	28.275	56.7	0.0	80.1	51.825
4:00	0.007	2.1	1.125	0.975	29.25	56.7	0.0	82.2	52.95
4:05	0.007	2.1	1.125	0.975	30.225	56.7	0.0	84.3	54.075
4:10	0.007	2.1	1.125	0.975	31.2	56.7	0.0	86.4	55.2
4:15	0.007	2.1	1.125	0.975	32.175	56.7	0.0	88.5	56.325
4:20	0.007	2.1	1.125	0.975	33.15	56.7	0.0	90.6	57.45
4:25	0.007	2.1	1.125	0.975	34.125	56.7	0.0	92.7	58.575
4:30	0.008	2.4	1.125	1.275	35.4	56.7	0.0	95.1	59.7
4:35	0.008	2.4	1.125	1.275	36.675	56.7	0.0	97.5	60.825
4:40	0.008	2.4	1.125	1.275	37.95	56.7	0.0	99.9	61.95
4:45	0.008	2.4	1.125	1.275	39.225	56.7	0.0	102.3	63.075
4:50	0.008	2.4	1.125	1.275	40.5	56.7	0.0	104.7	64.2
4:55	0.008	2.4	1.125	1.275	41.775	56.7	0.0	107.1	65.325
5:00	0.008	2.4	1.125	1.275	43.05	56.7	0.0	109.5	66.45
5:05	0.008	2.4	1.125	1.275	44.325	56.7	0.0	111.9	67.575
5:10	0.008	2.4	1.125	1.275	45.6	56.7	0.0	114.3	68.7
5:15	0.008	2.4	1.125	1.275	46.875	56.7	0.0	116.7	69.825
5:20	0.008	2.4	1.125	1.275	48.15	56.7	0.0	119.1	70.95
5:25	0.008	2.4	1.125	1.275	49.425	56.7	0.0	121.5	72.075
5:30	0.009	2.7	1.125	1.575	51	56.7	0.0	124.2	73.2
5:35	0.009	2.7	1.125	1.575	52.575	56.7	0.0	126.9	74.325
5:40	0.009	2.7	1.125	1.575	54.15	56.7	0.0	129.6	75.45
5:45	0.009	2.7	1.125	1.575	55.725	56.7	0.0	132.3	76.575
5:50	0.009	2.7	1.125	1.575	57.3	56.7	0.6	135	77.7
5:55	0.009	2.7	1.125	1.575	58.875	56.7	2.2	137.7	78.825
6:00	0.009	2.7	1.125	1.575	60.45	56.7	3.8	140.4	79.95
6:05	0.009	2.7	1.125	1.575	62.025	56.7	5.3	143.1	81.075
6:10	0.009	2.7	1.125	1.575	63.6	56.7	6.9	145.8	82.2
6:15	0.009	2.7	1.125	1.575	65.175	56.7	8.5	148.5	83.325
6:20	0.009	2.7	1.125	1.575	66.75	56.7	10.1	151.2	84.45
6:25	0 01	3	1.125	1.875	68.625	56.7	11.9	154.2	85.575
6:30	0 01	3	1.125	1.875	70.5	56.7	13.8	157.2	86.7
6:35	0 01	3	1.125	1.875	72.375	56.7	15.7	160.2	87.825
6:40	0 01	3	1.125	1.875	74.25	56.7	17.6	163.2	88.95
6:45	0 01	3	1.125	1.875	76.125	56.7	19.4	166.2	90.075
6:50	0 01	3	1.125	1.875	78	56.7	21.3	169.2	91.2
6:55	0 01	3	1.125	1.875	79.875	56.7	23.2	172.2	92.325
7:00	0 01	3	1.125	1.875	81.75	56.7	25.1	175.2	93.45
7:05	0.011	3.3	1.125	2.175	83.925	56.7	27.2	178.5	94.575
7:10	0.011	3.3	1.125	2.175	86.1	56.7	29.4	181.8	95.7
7:15	0.011	3.3	1.125	2.175	88.275	56.7	31.6	185.1	96.825
7:20	0.011	3.3	1.125	2.175	90.45	56.7	33.8	188.4	97.95
7:25	0.011	3.3	1.125	2.175	92.625	56.7	35.9	191.7	99.075
7:30	0.011	3.3	1.125	2.175	94.8	56.7	38.1	195	100.2
7:35	0.011	3.3	1.125	2.175	96.975	56.7	40.3	198.3	101.325
7:40	0.012	3.6	1.125	2.475	99.45	56.7	42.8	201.9	102.45
7:45	0.012	3.6	1.125	2.475	101.925	56.7	45.2	205.5	103.575
7:50	0.012	3.6	1.125	2.475	104.4	56.7	47.7	209.1	104.7
7:55	0.012	3.6	1.125	2.475	106.875	56.7	50.2	212.7	105.825
8:00	0.012	3.6	1.125	2.475	109.35	56.7	52.7	216.3	106.95
8:05	0.012	3.6	1.125	2.475	111.825	56.7	55.1	219.9	108.075
8:10	0.013	3.9	1.125	2.775	114.6	56.7	57.9	223.8	109.2
8:15	0.013	3.9	1.125	2.775	117.375	56.7	60.7	227.7	110.325
8:20	0.013	3.9	1.125	2.775	120.15	56.7	63.5	231.6	111.45
8:25	0.013	3.9	1.125	2.775	122.925	56.7	66.2	235.5	112.575
8:30	0.013	3.9	1.125	2.775	125.7	56.7	69.0	239.4	113.7
8:35	0.014	4.2	1.125	3.075	128.775	56.7	72.1	243.6	114.825
8:40	0.014	4.2	1.125	3.075	131.85	56.7	75.2	247.8	115.95
8:45	0.014	4.2	1.125	3.075	134.925	56.7	78.2	252	117.075
8:50	0.014	4.2	1.125	3.075	138	56.7	81.3	256.2	118.2
8:55	0.015	4.5	1.125	3.375	141.375	56.7	84.7	260.7	119.325
9:00	0.015	4.5	1.125	3.375	144.75	56.7	88.1	265.2	120.45
9:05	0.015	4.5	1.125	3.375	148.125	56.7	91.4	269.7	121.575
9:10	0.015	4.5	1.125	3.375	151.5	56.7	94.8	274.2	122.7
9:15	0.016	4.8	1.125	3.675	155.175	56.7	98.5	279	123.825
9:20	0.016	4.8	1.125	3.675	158.85	56.7	102.2	283.8	124.95
9:25	0.016	4.8	1.125	3.675	162.525	56.7	105.8	288.6	126.075
9:30	0.017	5.1	1.125	3.975	166.5	56.7	109.8	293.7	127.2
9:35	0.017	5.1	1.125	3.975	170.475	56.7	113.8	298.8	128.325
9:40	0.017	5.1	1.125	3.975	174.45	56.7	117.8	303.9	129.45
9:45	0.018	5.4	1.125	4.275	178.725	56.7	122.0	309.3	130.575
9:50	0.018	5.4	1.125	4.275	183	56.7	126.3	314.7	131.7
9:55	0.019	5.7	1.125	4.575	187.575	56.7	130.9	320.4	132.825
10:00	0.019	5.7	1.125	4.575	192.15	56.7	135.5	326.1	133.95
10:05	0.02	6	1.125	4.875	197.025	56.7	140.3	332.1	135.075

Parameter	Value	Unit
Ponding storage depth assumed	0	m
Treatment media depth	0.6	m
Sand transition layer depth	0.1	m
Infiltration area provided	270.0	m2
Water quality storage capacity (media + sand @ n = 0.30)	56.7	m3
Infiltration rate (hydraulic conductivity)	50.0	mm/hr
Estimated infiltration via treatment basin and subsoil dispersal during 24-hour 1% AEP storm event	322.95	m³ from representative 1 ha catchment
Estimated developed catchment direct runoff (bypass)	1190.85	m³ from representative 1 ha catchment
Estimated greenfield direct runoff scenario based on representative 1 ha HEC-HMS model catchment (refer Appendix A)	967.8	m³ from representative 1 ha catchment
Estimated additional volume requiring storage to mitigate developed area runoff	223.05	m³ per ha

Eastern Flats Storage Adjustment

Development area contributing to Eastern Flats storage area	49.5	ha
Additional storage required	11041	m³
Available storage area	18.3	ha
Equivalent average additional storage depth required	60	mm

Catchment 108 Storage Adjustment

Development area contributing to Catchment 108 storage area	0.5	ha
Additional storage required	112	m³
Available storage area within Catchment 108 wetland	0.1	ha
Equivalent average additional storage depth required	112	mm

Western HH wetland adjusment

Development area contributing to Catchment 108 storage area	3.7	ha
Additional storage required	825	m³
Available storage area within HH Wetland	11	ha
Equivalent average additional storage depth required	8	mm

WQV (1% AEP) – Overflow Volume Check (1 ha Catchment) – 270 m² Treatment Area Provided

To estimate the additional runoff volume generated by a 1 ha developed catchment (70% impervious) relative to greenfield conditions during the 24-hour 1% AEP storm event. This additional volume is used to estimate the extra storage required within the site-wide storage areas.

Typical 1ha Development Area									
Time (h:mm)	1% AEP (m^3/s)	Inflow (m^3/5 min)	Infiltration capacity (m^3/5 min)	Net surplus (m^3)	Running storage (m^3)	Available storage (m^3)	Overflow (m^3)	Cumulative inflow (m^3)	Cumulative infiltration (m^3)
10:10	0.02	6	1.125	4.875	201.9	56.7	145.2	338.1	136.2
10:15	0.021	6.3	1.125	5.175	207.075	56.7	150.4	344.4	137.325
10:20	0.022	6.6	1.125	5.475	212.55	56.7	155.9	351	138.45
10:25	0.022	6.6	1.125	5.475	218.025	56.7	161.3	357.6	139.575
10:30	0.023	6.9	1.125	5.775	223.8	56.7	167.1	364.5	140.7
10:35	0.024	7.2	1.125	6.075	229.875	56.7	173.2	371.7	141.825
10:40	0.025	7.5	1.125	6.375	236.25	56.7	179.6	379.2	142.95
10:45	0.026	7.8	1.125	6.675	242.925	56.7	186.2	387	144.075
10:50	0.027	8.1	1.125	6.975	249.9	56.7	193.2	395.1	145.2
10:55	0.028	8.4	1.125	7.275	257.175	56.7	200.5	403.5	146.325
11:00	0.029	8.7	1.125	7.575	264.75	56.7	208.1	412.2	147.45
11:05	0.03	9	1.125	7.875	272.625	56.7	215.9	421.2	148.575
11:10	0.032	9.6	1.125	8.475	281.1	56.7	224.4	430.8	149.7
11:15	0.034	10.2	1.125	9.075	290.175	56.7	233.5	441	150.825
11:20	0.036	10.8	1.125	9.675	299.85	56.7	243.2	451.8	151.95
11:25	0.039	11.7	1.125	10.575	310.425	56.7	253.7	463.5	153.075
11:30	0.042	12.6	1.125	11.475	321.9	56.7	265.2	476.1	154.2
11:35	0.046	13.8	1.125	12.675	334.575	56.7	277.9	489.9	155.325
11:40	0.051	15.3	1.125	14.175	348.75	56.7	292.1	505.2	156.45
11:45	0.057	17.1	1.125	15.975	364.725	56.7	308.0	522.3	157.575
11:50	0.066	19.8	1.125	18.675	383.4	56.7	326.7	542.1	158.7
11:55	0.081	24.3	1.125	23.175	406.575	56.7	349.9	566.4	159.825
12:00	0.114	34.2	1.125	33.075	439.65	56.7	383.0	600.6	160.95
12:05	0.246	73.8	1.125	72.675	512.325	56.7	455.6	674.4	162.075
12:10	0.375	112.5	1.125	111.375	623.7	56.7	567.0	786.9	163.2
12:15	0.291	87.3	1.125	86.175	709.875	56.7	653.2	874.2	164.325
12:20	0.151	45.3	1.125	44.175	754.05	56.7	697.4	919.5	165.45
12:25	0.097	29.1	1.125	27.975	782.025	56.7	725.3	948.6	166.575
12:30	0.074	22.2	1.125	21.075	803.1	56.7	746.4	970.8	167.7
12:35	0.061	18.3	1.125	17.175	820.275	56.7	763.6	989.1	168.825
12:40	0.054	16.2	1.125	15.075	835.35	56.7	778.7	1005.3	169.95
12:45	0.048	14.4	1.125	13.275	848.625	56.7	791.9	1019.7	171.075
12:50	0.044	13.2	1.125	12.075	860.7	56.7	804.0	1032.9	172.2
12:55	0.041	12.3	1.125	11.175	871.875	56.7	815.2	1045.2	173.325
13:00	0.038	11.4	1.125	10.275	882.15	56.7	825.5	1056.6	174.45
13:05	0.036	10.8	1.125	9.675	891.825	56.7	835.1	1067.4	175.575
13:10	0.034	10.2	1.125	9.075	900.9	56.7	844.2	1077.6	176.7
13:15	0.032	9.6	1.125	8.475	909.375	56.7	852.7	1087.2	177.825
13:20	0.031	9.3	1.125	8.175	917.55	56.7	860.9	1096.5	178.95
13:25	0.03	9	1.125	7.875	925.425	56.7	868.7	1105.5	180.075
13:30	0.028	8.4	1.125	7.275	932.7	56.7	876.0	1113.9	181.2
13:35	0.027	8.1	1.125	6.975	939.675	56.7	883.0	1122	182.325
13:40	0.026	7.8	1.125	6.675	946.35	56.7	889.7	1129.8	183.45
13:45	0.026	7.8	1.125	6.675	953.025	56.7	896.3	1137.6	184.575
13:50	0.025	7.5	1.125	6.375	959.4	56.7	902.7	1145.1	185.7
13:55	0.024	7.2	1.125	6.075	965.475	56.7	908.8	1152.3	186.825
14:00	0.023	6.9	1.125	5.775	971.25	56.7	914.6	1159.2	187.95
14:05	0.023	6.9	1.125	5.775	977.025	56.7	920.3	1166.1	189.075
14:10	0.022	6.6	1.125	5.475	982.5	56.7	925.8	1172.7	190.2
14:15	0.021	6.3	1.125	5.175	987.675	56.7	931.0	1179	191.325
14:20	0.021	6.3	1.125	5.175	992.85	56.7	936.2	1185.3	192.45
14:25	0.02	6	1.125	4.875	997.725	56.7	941.0	1191.3	193.575
14:30	0.02	6	1.125	4.875	1002.6	56.7	945.9	1197.3	194.7
14:35	0.02	6	1.125	4.875	1007.475	56.7	950.8	1203.3	195.825
14:40	0.019	5.7	1.125	4.575	1012.05	56.7	955.4	1209	196.95
14:45	0.019	5.7	1.125	4.575	1016.625	56.7	959.9	1214.7	198.075
14:50	0.018	5.4	1.125	4.275	1020.9	56.7	964.2	1220.1	199.2
14:55	0.018	5.4	1.125	4.275	1025.175	56.7	968.5	1225.5	200.325
15:00	0.018	5.4	1.125	4.275	1029.45	56.7	972.8	1230.9	201.45
15:05	0.017	5.1	1.125	3.975	1033.425	56.7	976.7	1236	202.575
15:10	0.017	5.1	1.125	3.975	1037.4	56.7	980.7	1241.1	203.7
15:15	0.017	5.1	1.125	3.975	1041.375	56.7	984.7	1246.2	204.825
15:20	0.016	4.8	1.125	3.675	1045.05	56.7	988.4	1251	205.95
15:25	0.016	4.8	1.125	3.675	1048.725	56.7	992.0	1255.8	207.075
15:30	0.016	4.8	1.125	3.675	1052.4	56.7	995.7	1260.6	208.2
15:35	0.016	4.8	1.125	3.675	1056.075	56.7	999.4	1265.4	209.325
15:40	0.015	4.5	1.125	3.375	1059.45	56.7	1002.8	1269.9	210.45
15:45	0.015	4.5	1.125	3.375	1062.825	56.7	1006.1	1274.4	211.575
15:50	0.015	4.5	1.125	3.375	1066.2	56.7	1009.5	1278.9	212.7
15:55	0.015	4.5	1.125	3.375	1069.575	56.7	1012.9	1283.4	213.825
16:00	0.015	4.5	1.125	3.375	1072.95	56.7	1016.3	1287.9	214.95
16:05	0.014	4.2	1.125	3.075	1076.025	56.7	1019.3	1292.1	216.075
16:10	0.014	4.2	1.125	3.075	1079.1	56.7	1022.4	1296.3	217.2
16:15	0.014	4.2	1.125	3.075	1082.175	56.7	1025.5	1300.5	218.325
16:20	0.014	4.2	1.125	3.075	1085.25	56.7	1028.6	1304.7	219.45
16:25	0.014	4.2	1.125	3.075	1088.325	56.7	1031.6	1308.9	220.575
16:30	0.014	4.2	1.125	3.075	1091.4	56.7	1034.7	1313.1	221.7
16:35	0.013	3.9	1.125	2.775	1094.175	56.7	1037.5	1317	222.825
16:40	0.013	3.9	1.125	2.775	1096.95	56.7	1040.3	1320.9	223.95
16:45	0.013	3.9	1.125	2.775	1099.725	56.7	1043.0	1324.8	225.075
16:50	0.013	3.9	1.125	2.775	1102.5	56.7	1045.8	1328.7	226.2
16:55	0.013	3.9	1.125	2.775	1105.275	56.7	1048.6	1332.6	227.325
17:00	0.013	3.9	1.125	2.775	1108.05	56.7	1051.4	1336.5	228.45
17:05	0.013	3.9	1.125	2.775	1110.825	56.7	1054.1	1340.4	229.575
17:10	0.012	3.6	1.125	2.475	1113.3	56.7	1056.6	1344	230.7
17:15	0.012	3.6	1.125	2.475	1115.775	56.7	1059.1	1347.6	231.825
17:20	0.012	3.6	1.125	2.475	1118.25	56.7	1061.6	1351.2	232.95
17:25	0.012	3.6	1.125	2.475	1120.725	56.7	1064.0	1354.8	234.075
17:30	0.012	3.6	1.125	2.475	1123.2	56.7	1066.5	1358.4	235.2
17:35	0.012	3.6	1.125	2.475	1125.675	56.7	1069.0	1362	236.325
17:40	0.012	3.6	1.125	2.475	1128.15	56.7	1071.5	1365.6	237.45
17:45	0.012	3.6	1.125	2.475	1130.625	56.7	1073.9	1369.2	238.575
17:50	0.011	3.3	1.125	2.175	1132.8	56.7	1076.1	1372.5	239.7
17:55	0.011	3.3	1.125	2.175	1134.975	56.7	1078.3	1375.8	240.825
18:00	0.011	3.3	1.125	2.175	1137.15	56.7	1080.5	1379.1	241.95
18:05	0.011	3.3	1.125	2.175	1139.325	56.7	1082.6	1382.4	243.075
18:10	0.011	3.3	1.125	2.175	1141.5	56.7	1084.8	1385.7	244.2
18:15	0.011	3.3	1.125	2.175	1143.675	56.7	1087.0	1389	245.325
18:20	0.011	3.3	1.125	2.175	1145.85	56.7	1089.2	1392.3	246.45
18:25	0.011	3.3	1.125	2.175	1148.025	56.7	1091.3	1395.6	247.575
18:30	0.011	3.3	1.125	2.175	1150.2	56.7	1093.5	1398.9	248.7
18:35	0.011	3.3	1.125	2.175	1152.375	56.7	1095.7	1402.2	249.825
18:40	0.011	3.3	1.125	2.175	1154.55	56.7	1097.9	1405.5	250.95
18:45	0.01	3	1.125	1.875	1156.425	56.7	1099.7	1408.5	252.075
18:50	0.01	3	1.125	1.875	1158.3	56.7	1101.6	1411.5	253.2
18:55	0.01	3	1.125	1.875	1160.175	56.7	1103.5	1414.5	254.325
19:00	0.01	3	1.125	1.875	1162.05	56.7	1105.4	1417.5	255.45
19:05	0.01	3	1.125	1.875	1163.925	56.7	1107.2	1420.5	256.575
19:10	0.01	3	1.125	1.875	1165.8	56.7	1109.1	1423.5	257.7
19:15	0.01	3	1.125	1.875	1167.675	56.7	1111.0	1426.5	258.825
19:20	0.01	3	1.125	1.875	1169.55	56.7	1112.9	1429.5	259.95
19:25	0.01	3	1.125	1.875	1171.425	56.7	1114.7	1432.5	261.075
19:30	0.01	3	1.125	1.875	1173.3	56.7	1116.6	1435.5	262.2
19:35	0.01	3	1.125	1.875	1175.175	56.7	1118.5	1438.5	263.325
19:40	0.01	3	1.125	1.875	1177.05	56.7	1120.4	1441.5	264.45
19:45	0.01	3	1.125	1.875	1178.925	56.7	1122.2	1444.5	265.575
19:50	0.01	3	1.125	1.875	1180.8	56.7	1124.1	1447.5	266.7
19:55	0.009	2.7	1.125	1.575	1182.375	56.7	1125.7	1450.2	267.825
20:00	0.009	2.7	1.125	1.575	1183.95	56.7	1127.3	1452.9	268.95
20:05	0.009	2.7	1.125	1.575	1185.525	56.7	1128.8	1455.6	270.075
20:10	0.009	2.7	1.125	1.575	1187.1	56.7	1130.4	1458.3	271.2
20:15	0.009	2.7	1.125	1.575	1188.675	56.7	1132.0	1461	272.325
20:20	0.009	2.7	1.125	1.575	1190.25	56.7	1133.6	1463.7	273.45
20:25	0.009	2.7	1.125	1.575	1191.825	56.7	1135.1	1466.4	274.575
20:30	0.009	2.7	1.125	1.575	1193.4	56.7	1136.7	1469.1	275.7
20:35	0.009	2.7	1.125	1.575	1194.975	56.7	1138.3	1471.8	276.825
20:40	0.009	2.7	1.125	1.575	1196.55	56.7	1139.9	1474.5	277.95
20:45	0.009	2.7	1.125	1.575	1198.125	56.7	1141.4	1477.2	279.075
20:50	0.009	2.7	1.125	1.575	1199.7	56.7	1143.0	1479.9	280.2
20:55	0.009	2.7	1.125	1.575	1201.275	56.7	1144.6	1482.6	281.325
21:00	0.009	2.7	1.125	1.575	1202.85	56.7	1146.2	1485.3	282.45
21:05	0.009	2.7	1.125	1.575	1204.425	56.7	1147.7	1488	283.575
21:10	0.009	2.7	1.125	1.575	1206	56.7	1149.3	1490.7	284.7
21:15	0.009	2.7	1.125	1.575	1207.575	56.7	1150.9	1493.4	285.825
21:20	0.009	2.7	1.125	1.575	1209.15	56.7	1152.5	1496.1	286.95
21:25	0.008	2.4	1.125	1.275	1210.425	56.7	1153.7	1498.5	288.075
21:30	0.008	2.4	1.125	1.275	1211.7	56.7	1155.0	1500.9	289.2
21:35	0.008	2.4	1.125	1.275	1212.975	56.7	1156.3	1503.3	290.325
21:40	0.008	2.4	1.125	1.275	1214.25	56.7	1157.6	1505.7	291.45
21:45	0.008	2.4	1.125	1.275	1215.525	56.7	1158.8	1508.1	292.575
21:50	0.008	2.4	1.125	1.275	1216.8	56.7	1160.1	1510.5	293.7
21:55	0.008	2.4	1.125	1.275	1218.075	56.7	1161.4	1512.9	294.825
22:00	0.008	2.4	1.125	1.275	1219.35	56.7	1162.7	1515.3	295.95
22:05	0.008	2.4	1.125	1.275	1220.625	56.7	1163.9	1517.7	297.075
22:10	0.008	2.4	1.125	1.275	1221.9	56.7	1165.2	1520.1	298.2

WQV (1% AEP) – Overflow Volume Check (1 ha Catchment) – 270 m² Treatment Area Provided

To estimate the additional runoff volume generated by a 1 ha developed catchment (70% impervious) relative to greenfield conditions during the 24-hour 1% AEP storm event. This additional volume is used to estimate the extra storage required within the site-wide storage areas.

Typical 1ha Development Area									
Time (h:mm)	1% AEP (m^3/s)	Inflow (m^3/5 min)	Infiltration capacity (m^3/5 min)	Net surplus (m^3)	Running storage (m^3)	Available storage (m^3)	Overflow (m^3)	Cumulative inflow (m^3)	Cumulative infiltration (m^3)
22:15	0.008	2.4	1.125	1.275	1223.175	56.7	1166.5	1522.5	299.325
22:20	0.008	2.4	1.125	1.275	1224.45	56.7	1167.8	1524.9	300.45
22:25	0.008	2.4	1.125	1.275	1225.725	56.7	1169.0	1527.3	301.575
22:30	0.008	2.4	1.125	1.275	1227	56.7	1170.3	1529.7	302.7
22:35	0.008	2.4	1.125	1.275	1228.275	56.7	1171.6	1532.1	303.825
22:40	0.008	2.4	1.125	1.275	1229.55	56.7	1172.9	1534.5	304.95
22:45	0.008	2.4	1.125	1.275	1230.825	56.7	1174.1	1536.9	306.075
22:50	0.008	2.4	1.125	1.275	1232.1	56.7	1175.4	1539.3	307.2
22:55	0.008	2.4	1.125	1.275	1233.375	56.7	1176.7	1541.7	308.325
23:00	0.008	2.4	1.125	1.275	1234.65	56.7	1178.0	1544.1	309.45
23:05	0.008	2.4	1.125	1.275	1235.925	56.7	1179.2	1546.5	310.575
23:10	0.008	2.4	1.125	1.275	1237.2	56.7	1180.5	1548.9	311.7
23:15	0.008	2.4	1.125	1.275	1238.475	56.7	1181.8	1551.3	312.825
23:20	0.008	2.4	1.125	1.275	1239.75	56.7	1183.1	1553.7	313.95
23:25	0.007	2.1	1.125	0.975	1240.725	56.7	1184.0	1555.8	315.075
23:30	0.007	2.1	1.125	0.975	1241.7	56.7	1185.0	1557.9	316.2
23:35	0.007	2.1	1.125	0.975	1242.675	56.7	1186.0	1560	317.325
23:40	0.007	2.1	1.125	0.975	1243.65	56.7	1187.0	1562.1	318.45
23:45	0.007	2.1	1.125	0.975	1244.625	56.7	1187.9	1564.2	319.575
23:50	0.007	2.1	1.125	0.975	1245.6	56.7	1188.9	1566.3	320.7
23:55	0.007	2.1	1.125	0.975	1246.575	56.7	1189.9	1568.4	321.825
End	0.007	2.1	1.125	0.975	1247.55	56.7	1190.9	1570.5	322.95

1% AEP – Volume Check (1 ha Catchment)

Purpose: To assess the additional footprint required for 1% AEP catchments by modelling full 1% AEP flows (HIRDS rainfall, 1 ha development area, 70% impervious). The calculation estimates soakage capacity and identifies the extra bioretention area needed beyond WQV treatment to accommodate the full 1% AEP event.

Typical 1ha Development Area									
Time (h:mm)	1% AEP (m^3/s)	Inflow (m^3/5 min)	Infiltration capacity (m^3/5 min)	Net surplus (m^3)	Running storage (m^3)	Available storage (m^3)	Storage (m^3)	Cumulative inflow (m^3)	Cumulative infiltration (m^3)
0:00	0	0	3.229	-3.229166667	0	782.8	0.0	0	0
0:05	0.001	0.3	3.229	-2.929	0	782.8	0.0	0.3	0.3
0:10	0.003	0.9	3.229	-2.329166667	0	782.8	0.0	1.2	1.2
0:15	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	2.7	2.7
0:20	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	4.2	4.2
0:25	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	5.7	5.7
0:30	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	7.2	7.2
0:35	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	8.7	8.7
0:40	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	10.2	10.2
0:45	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	11.7	11.7
0:50	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	13.2	13.2
0:55	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	14.7	14.7
1:00	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	16.2	16.2
1:05	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	17.7	17.7
1:10	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	19.2	19.2
1:15	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	20.7	20.7
1:20	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	22.2	22.2
1:25	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	23.7	23.7
1:30	0.005	1.5	3.229	-1.729166667	0	782.8	0.0	25.2	25.2
1:35	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	27	27
1:40	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	28.8	28.8
1:45	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	30.6	30.6
1:50	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	32.4	32.4
1:55	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	34.2	34.2
2:00	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	36	36
2:05	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	37.8	37.8
2:10	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	39.6	39.6
2:15	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	41.4	41.4
2:20	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	43.2	43.2
2:25	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	45	45
2:30	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	46.8	46.8
2:35	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	48.6	48.6
2:40	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	50.4	50.4
2:45	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	52.2	52.2
2:50	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	54	54
2:55	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	55.8	55.8
3:00	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	57.6	57.6
3:05	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	59.4	59.4
3:10	0.006	1.8	3.229	-1.429166667	0	782.8	0.0	61.2	61.2
3:15	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	63.3	63.3
3:20	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	65.4	65.4
3:25	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	67.5	67.5
3:30	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	69.6	69.6
3:35	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	71.7	71.7
3:40	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	73.8	73.8
3:45	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	75.9	75.9
3:50	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	78	78
3:55	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	80.1	80.1
4:00	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	82.2	82.2
4:05	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	84.3	84.3
4:10	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	86.4	86.4
4:15	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	88.5	88.5
4:20	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	90.6	90.6
4:25	0.007	2.1	3.229	-1.129166667	0	782.8	0.0	92.7	92.7
4:30	0.008	2.4	3.229	-0.829166667	0	782.8	0.0	95.1	95.1
4:35	0.008	2.4	3.229	-0.829166667	0	782.8	0.0	97.5	97.5
4:40	0.008	2.4	3.229	-0.829166667	0	782.8	0.0	99.9	99.9
4:45	0.008	2.4	3.229	-0.829166667	0	782.8	0.0	102.3	102.3
4:50	0.008	2.4	3.229	-0.829166667	0	782.8	0.0	104.7	104.7
4:55	0.008	2.4	3.229	-0.829166667	0	782.8	0.0	107.1	107.1
5:00	0.008	2.4	3.229	-0.829166667	0	782.8	0.0	109.5	109.5
5:05	0.008	2.4	3.229	-0.829166667	0	782.8	0.0	111.9	111.9
5:10	0.008	2.4	3.229	-0.829166667	0	782.8	0.0	114.3	114.3
5:15	0.008	2.4	3.229	-0.829166667	0	782.8	0.0	116.7	116.7
5:20	0.008	2.4	3.229	-0.829166667	0	782.8	0.0	119.1	119.1
5:25	0.008	2.4	3.229	-0.829166667	0	782.8	0.0	121.5	121.5
5:30	0.009	2.7	3.229	-0.529166667	0	782.8	0.0	124.2	124.2
5:35	0.009	2.7	3.229	-0.529166667	0	782.8	0.0	126.9	126.9
5:40	0.009	2.7	3.229	-0.529166667	0	782.8	0.0	129.6	129.6
5:45	0.009	2.7	3.229	-0.529166667	0	782.8	0.0	132.3	132.3
5:50	0.009	2.7	3.229	-0.529166667	0	782.8	0.0	135	135
5:55	0.009	2.7	3.229	-0.529166667	0	782.8	0.0	137.7	137.7
6:00	0.009	2.7	3.229	-0.529166667	0	782.8	0.0	140.4	140.4
6:05	0.009	2.7	3.229	-0.529166667	0	782.8	0.0	143.1	143.1
6:10	0.009	2.7	3.229	-0.529166667	0	782.8	0.0	145.8	145.8
6:15	0.009	2.7	3.229	-0.529166667	0	782.8	0.0	148.5	148.5
6:20	0.009	2.7	3.229	-0.529166667	0	782.8	0.0	151.2	151.2
6:25	0.01	3	3.229	-0.229166667	0	782.8	0.0	154.2	154.2
6:30	0.01	3	3.229	-0.229166667	0	782.8	0.0	157.2	157.2
6:35	0.01	3	3.229	-0.229166667	0	782.8	0.0	160.2	160.2
6:40	0.01	3	3.229	-0.229166667	0	782.8	0.0	163.2	163.2
6:45	0.01	3	3.229	-0.229166667	0	782.8	0.0	166.2	166.2
6:50	0.01	3	3.229	-0.229166667	0	782.8	0.0	169.2	169.2
6:55	0.01	3	3.229	-0.229166667	0	782.8	0.0	172.2	172.2
7:00	0.01	3	3.229	-0.229166667	0	782.8	0.0	175.2	175.2
7:05	0.011	3.3	3.229	0.070833333	0.070833333	782.8	0.0	178.5	178.4291667
7:10	0.011	3.3	3.229	0.070833333	0.141666667	782.8	0.0	181.8	181.6583333
7:15	0.011	3.3	3.229	0.070833333	0.2125	782.8	0.0	185.1	184.8875
7:20	0.011	3.3	3.229	0.070833333	0.283333333	782.8	0.0	188.4	188.1166667
7:25	0.011	3.3	3.229	0.070833333	0.354166667	782.8	0.0	191.7	191.3458333
7:30	0.011	3.3	3.229	0.070833333	0.425	782.8	0.0	195	194.575
7:35	0.011	3.3	3.229	0.070833333	0.495833333	782.8	0.0	198.3	197.8041667
7:40	0.012	3.6	3.229	0.370833333	0.866666667	782.8	0.0	201.9	201.0333333
7:45	0.012	3.6	3.229	0.370833333	1.2375	782.8	0.0	205.5	204.2625
7:50	0.012	3.6	3.229	0.370833333	1.608333333	782.8	0.0	209.1	207.4916667
7:55	0.012	3.6	3.229	0.370833333	1.979166667	782.8	0.0	212.7	210.7208333
8:00	0.012	3.6	3.229	0.370833333	2.35	782.8	0.0	216.3	213.95
8:05	0.012	3.6	3.229	0.370833333	2.720833333	782.8	0.0	219.9	217.1791667
8:10	0.013	3.9	3.229	0.670833333	3.391666667	782.8	0.0	223.8	220.4083333
8:15	0.013	3.9	3.229	0.670833333	4.0625	782.8	0.0	227.7	223.6375
8:20	0.013	3.9	3.229	0.670833333	4.733333333	782.8	0.0	231.6	226.8666667
8:25	0.013	3.9	3.229	0.670833333	5.404166667	782.8	0.0	235.5	230.0958333
8:30	0.013	3.9	3.229	0.670833333	6.075	782.8	0.0	239.4	233.325
8:35	0.014	4.2	3.229	0.970833333	7.045833333	782.8	0.0	243.6	236.5541667
8:40	0.014	4.2	3.229	0.970833333	8.016666667	782.8	0.0	247.8	239.7833333
8:45	0.014	4.2	3.229	0.970833333	8.9875	782.8	0.0	252	243.0125
8:50	0.014	4.2	3.229	0.970833333	9.958333333	782.8	0.0	256.2	246.2416667
8:55	0.015	4.5	3.229	1.270833333	11.22916667	782.8	0.0	260.7	249.4708333
9:00	0.015	4.5	3.229	1.270833333	12.5	782.8	0.0	265.2	252.7
9:05	0.015	4.5	3.229	1.270833333	13.77083333	782.8	0.0	269.7	255.9291667
9:10	0.015	4.5	3.229	1.270833333	15.04166667	782.8	0.0	274.2	259.1583333
9:15	0.016	4.8	3.229	1.570833333	16.6125	782.8	0.0	279	262.3875
9:20	0.016	4.8	3.229	1.570833333	18.18333333	782.8	0.0	283.8	265.6166667
9:25	0.016	4.8	3.229	1.570833333	19.75416667	782.8	0.0	288.6	268.8458333
9:30	0.017	5.1	3.229	1.870833333	21.625	782.8	0.0	293.7	272.075
9:35	0.017	5.1	3.229	1.870833333	23.49583333	782.8	0.0	298.8	275.3041667
9:40	0.017	5.1	3.229	1.870833333	25.36666667	782.8	0.0	303.9	278.5333333
9:45	0.018	5.4	3.229	2.170833333	27.5375	782.8	0.0	309.3	281.7625
9:50	0.018	5.4	3.229	2.170833333	29.70833333	782.8	0.0	314.7	284.9916667
9:55	0.019	5.7	3.229	2.470833333	32.17916667	782.8	0.0	320.4	288.2208333
10:00	0.019	5.7	3.229	2.470833333	34.65	782.8	0.0	326.1	291.45
10:05	0.02	6	3.229	2.770833333	37.42083333	782.8	0.0	332.1	294.6791667
10:10	0.02	6	3.229	2.770833333	40.19166667	782.8	0.0	338.1	297.9083333
10:15	0.021	6.3	3.229	3.070833333	43.2625	782.8	0.0	344.4	301.1375
10:20	0.022	6.6	3.229	3.370833333	46.63333333	782.8	0.0	351	304.3666667
10:25	0.022	6.6	3.229	3.370833333	50.00416667	782.8	0.0	357.6	307.5958333
10:30	0.023	6.9	3.229	3.670833333	53.675	782.8	0.0	364.5	310.825
10:35	0.024	7.2	3.229	3.970833333	57.64583333	782.8	0.0	371.7	314.0541667
10:40	0.025	7.5	3.229	4.270833333	61.91666667	782.8	0.0	379.2	317.2833333
10:45	0.026	7.8	3.229	4.570833333	66.4875	782.8	0.0	387	320.5125
10:50	0.027	8.1	3.229	4.870833333	71.35833333	782.8	0.0	395.1	323.7416667
10:55	0.028	8.4	3.229	5.170833333	76.52916667	782.8	0.0	403.5	326.9708333
11:00	0.029	8.7	3.229	5.470833333	82	782.8	0.0	412.2	330.2

Parameter	Value	Unit
Ponding storage depth assumed	0.8	m
Treatment media depth	0.6	m
Sand transition layer depth	0.1	m
Infiltration area provided	775.0	m2
Water quality storage capacity (media + sand @ n = 0.30)	782.8	m3
Infiltration rate (hydraulic conductivity)	50.0	mm/hr
Treatment overflow	0.0	OK (no overflow expected)

1% AEP – Volume Check (1 ha Catchment)

Purpose: To assess the additional footprint required for 1% AEP catchments by modelling full 1% AEP flows (HIRDS rainfall, 1 ha development area, 70% impervious). The calculation estimates soakage capacity and identifies the extra bioretention area needed beyond WQV treatment to accommodate the full 1% AEP event.

Typical 1ha Development Area									
Time (h:mm)	1% AEP (m^3/s)	Inflow (m^3/5 min)	Infiltration capacity (m^3/5 min)	Net surplus (m^3)	Running storage (m^3)	Available storage (m^3)	Storage (m^3)	Cumulative inflow (m^3)	Cumulative infiltration (m^3)
11:05	0.03	9	3.229	5.770833333	87.77083333	782.8	0.0	421.2	333.4291667
11:10	0.032	9.6	3.229	6.370833333	94.14166667	782.8	0.0	430.8	336.6583333
11:15	0.034	10.2	3.229	6.970833333	101.1125	782.8	0.0	441	339.8875
11:20	0.036	10.8	3.229	7.570833333	108.6833333	782.8	0.0	451.8	343.1166667
11:25	0.039	11.7	3.229	8.470833333	117.1541667	782.8	0.0	463.5	346.3458333
11:30	0.042	12.6	3.229	9.370833333	126.525	782.8	0.0	476.1	349.575
11:35	0.046	13.8	3.229	10.57083333	137.0958333	782.8	0.0	489.9	352.8041667
11:40	0.051	15.3	3.229	12.07083333	149.1666667	782.8	0.0	505.2	356.0333333
11:45	0.057	17.1	3.229	13.87083333	163.0375	782.8	0.0	522.3	359.2625
11:50	0.066	19.8	3.229	16.57083333	179.6083333	782.8	0.0	542.1	362.4916667
11:55	0.081	24.3	3.229	21.07083333	200.6791667	782.8	0.0	566.4	365.7208333
12:00	0.114	34.2	3.229	30.97083333	231.65	782.8	0.0	600.6	368.95
12:05	0.246	73.8	3.229	70.57083333	302.2208333	782.8	0.0	674.4	372.1791667
12:10	0.375	112.5	3.229	109.2708333	411.4916667	782.8	0.0	786.9	375.4083333
12:15	0.291	87.3	3.229	84.07083333	495.5625	782.8	0.0	874.2	378.6375
12:20	0.151	45.3	3.229	42.07083333	537.6333333	782.8	0.0	919.5	381.8666667
12:25	0.097	29.1	3.229	25.87083333	563.5041667	782.8	0.0	948.6	385.0958333
12:30	0.074	22.2	3.229	18.97083333	582.475	782.8	0.0	970.8	388.325
12:35	0.061	18.3	3.229	15.07083333	597.5458333	782.8	0.0	989.1	391.5541667
12:40	0.054	16.2	3.229	12.97083333	610.5166667	782.8	0.0	1005.3	394.7833333
12:45	0.048	14.4	3.229	11.17083333	621 6875	782.8	0.0	1019.7	398.0125
12:50	0.044	13.2	3.229	9.970833333	631.6583333	782.8	0.0	1032.9	401.2416667
12:55	0.041	12.3	3.229	9.070833333	640.7291667	782.8	0.0	1045.2	404.4708333
13:00	0.038	11.4	3.229	8.170833333	648.9	782.8	0.0	1056.6	407.7
13:05	0.036	10.8	3.229	7.570833333	656.4708333	782.8	0.0	1067.4	410.9291667
13:10	0.034	10.2	3.229	6.970833333	663.4416667	782.8	0.0	1077.6	414.1583333
13:15	0.032	9.6	3.229	6.370833333	669 8125	782.8	0.0	1087.2	417.3875
13:20	0.031	9.3	3.229	6.070833333	675.8833333	782.8	0.0	1096.5	420.6166667
13:25	0.03	9	3.229	5.770833333	681.6541667	782.8	0.0	1105.5	423.8458333
13:30	0.028	8.4	3.229	5.170833333	686.825	782.8	0.0	1113.9	427.075
13:35	0.027	8.1	3.229	4.870833333	691.6958333	782.8	0.0	1122	430.3041667
13:40	0.026	7.8	3.229	4.570833333	696.2666667	782.8	0.0	1129.8	433.5333333
13:45	0.026	7.8	3.229	4.570833333	700 8375	782.8	0.0	1137.6	436.7625
13:50	0.025	7.5	3.229	4.270833333	705.1083333	782.8	0.0	1145.1	439.9916667
13:55	0.024	7.2	3.229	3.970833333	709.0791667	782.8	0.0	1152.3	443.2208333
14:00	0.023	6.9	3.229	3.670833333	712.75	782.8	0.0	1159.2	446.45
14:05	0.023	6.9	3.229	3.670833333	716.4208333	782.8	0.0	1166.1	449.6791667
14:10	0.022	6.6	3.229	3.370833333	719.7916667	782.8	0.0	1172.7	452.9083333
14:15	0.021	6.3	3.229	3.070833333	722 8625	782.8	0.0	1179	456.1375
14:20	0.021	6.3	3.229	3.070833333	725.9333333	782.8	0.0	1185.3	459.3666667
14:25	0.02	6	3.229	2.770833333	728.7041667	782.8	0.0	1191.3	462.5958333
14:30	0.02	6	3.229	2.770833333	731.475	782.8	0.0	1197.3	465.825
14:35	0.02	6	3.229	2.770833333	734.2458333	782.8	0.0	1203.3	469.0541667
14:40	0.019	5.7	3.229	2.470833333	736.7166667	782.8	0.0	1209	472.2833333
14:45	0.019	5.7	3.229	2.470833333	739.1875	782.8	0.0	1214.7	475.5125
14:50	0.018	5.4	3.229	2.170833333	741.3583333	782.8	0.0	1220.1	478.7416667
14:55	0.018	5.4	3.229	2.170833333	743.5291667	782.8	0.0	1225.5	481.9708333
15:00	0.018	5.4	3.229	2.170833333	745.7	782.8	0.0	1230.9	485.2
15:05	0.017	5.1	3.229	1.870833333	747.5708333	782.8	0.0	1236	488.4291667
15:10	0.017	5.1	3.229	1.870833333	749.4416667	782.8	0.0	1241.1	491.6583333
15:15	0.017	5.1	3.229	1.870833333	751 3125	782.8	0.0	1246.2	494.8875
15:20	0.016	4.8	3.229	1.570833333	752.8833333	782.8	0.0	1251	498.1166667
15:25	0.016	4.8	3.229	1.570833333	754.4541667	782.8	0.0	1255.8	501.3458333
15:30	0.016	4.8	3.229	1.570833333	756.025	782.8	0.0	1260.6	504.575
15:35	0.016	4.8	3.229	1.570833333	757.5958333	782.8	0.0	1265.4	507.8041667
15:40	0.015	4.5	3.229	1.270833333	758.8666667	782.8	0.0	1269.9	511.0333333
15:45	0.015	4.5	3.229	1.270833333	760.1375	782.8	0.0	1274.4	514.2625
15:50	0.015	4.5	3.229	1.270833333	761.4083333	782.8	0.0	1278.9	517.4916667
15:55	0.015	4.5	3.229	1.270833333	762.6791667	782.8	0.0	1283.4	520.7208333
16:00	0.015	4.5	3.229	1.270833333	763.95	782.8	0.0	1287.9	523.95
16:05	0.014	4.2	3.229	0.970833333	764.9208333	782.8	0.0	1292.1	527.1791667
16:10	0.014	4.2	3.229	0 971	765.8916667	782.8	0.0	1296.3	530.4083333
16:15	0.014	4.2	3.229	0.970833333	766 8625	782.8	0.0	1300.5	533.6375
16:20	0.014	4.2	3.229	0.970833333	767.8333333	782.8	0.0	1304.7	536.8666667
16:25	0.014	4.2	3.229	0.970833333	768.8041667	782.8	0.0	1308.9	540.0958333
16:30	0.014	4.2	3.229	0.970833333	769.775	782.8	0.0	1313.1	543.325
16:35	0.013	3.9	3.229	0.670833333	770.4458333	782.8	0.0	1317	546.5541667
16:40	0.013	3.9	3.229	0.670833333	771.1166667	782.8	0.0	1320.9	549.7833333
16:45	0.013	3.9	3.229	0.670833333	771.7875	782.8	0.0	1324.8	553.0125
16:50	0.013	3.9	3.229	0.670833333	772.4583333	782.8	0.0	1328.7	556.2416667
16:55	0.013	3.9	3.229	0.670833333	773.1291667	782.8	0.0	1332.6	559.4708333
17:00	0.013	3.9	3.229	0.670833333	773.8	782.8	0.0	1336.5	562.7
17:05	0.013	3.9	3.229	0.670833333	774.4708333	782.8	0.0	1340.4	565.9291667
17:10	0.012	3.6	3.229	0.370833333	774.8416667	782.8	0.0	1344	569.1583333
17:15	0.012	3.6	3.229	0.370833333	775 2125	782.8	0.0	1347.6	572.3875
17:20	0.012	3.6	3.229	0.370833333	775.5833333	782.8	0.0	1351.2	575.6166667
17:25	0.012	3.6	3.229	0.370833333	775.9541667	782.8	0.0	1354.8	578.8458333
17:30	0.012	3.6	3.229	0.370833333	776.325	782.8	0.0	1358.4	582.075
17:35	0.012	3.6	3.229	0.370833333	776.6958333	782.8	0.0	1362	585.3041667
17:40	0.012	3.6	3.229	0.370833333	777.0666667	782.8	0.0	1365.6	588.5333333
17:45	0.012	3.6	3.229	0.370833333	777.4375	782.8	0.0	1369.2	591.7625
17:50	0.011	3.3	3.229	0.070833333	777.5083333	782.8	0.0	1372.5	594.9916667
17:55	0.011	3.3	3.229	0.070833333	777.5791667	782.8	0.0	1375.8	598.2208333
18:00	0.011	3.3	3.229	0.070833333	777.65	782.8	0.0	1379.1	601.45
18:05	0.011	3.3	3.229	0.070833333	777.7208333	782.8	0.0	1382.4	604.6791667
18:10	0.011	3.3	3.229	0.070833333	777.7916667	782.8	0.0	1385.7	607.9083333
18:15	0.011	3.3	3.229	0.070833333	777 8625	782.8	0.0	1389	611.1375
18:20	0.011	3.3	3.229	0.070833333	777.9333333	782.8	0.0	1392.3	614.3666667
18:25	0.011	3.3	3.229	0.070833333	778.0041667	782.8	0.0	1395.6	617.5958333
18:30	0.011	3.3	3.229	0.070833333	778.075	782.8	0.0	1398.9	620.825
18:35	0.011	3.3	3.229	0.070833333	778.1458333	782.8	0.0	1402.2	624.0541667
18:40	0.011	3.3	3.229	0.070833333	778.2166667	782.8	0.0	1405.5	627.2833333
18:45	0.01	3	3.229	-0.229166667	777 9875	782.8	0.0	1408.5	630.2833333
18:50	0.01	3	3.229	-0.229166667	777.7583333	782.8	0.0	1411.5	633.2833333
18:55	0.01	3	3.229	-0.229166667	777.5291667	782.8	0.0	1414.5	636.2833333
19:00	0.01	3	3.229	-0.229166667	777.3	782.8	0.0	1417.5	639.2833333
19:05	0.01	3	3.229	-0.229166667	777.0708333	782.8	0.0	1420.5	642.2833333
19:10	0.01	3	3.229	-0.229166667	776.8416667	782.8	0.0	1423.5	645.2833333
19:15	0.01	3	3.229	-0.229166667	776 6125	782.8	0.0	1426.5	648.2833333
19:20	0.01	3	3.229	-0.229166667	776.3833333	782.8	0.0	1429.5	651.2833333
19:25	0.01	3	3.229	-0.229166667	776.1541667	782.8	0.0	1432.5	654.2833333
19:30	0.01	3	3.229	-0.229166667	775.925	782.8	0.0	1435.5	657.2833333
19:35	0.01	3	3.229	-0.229166667	775.6958333	782.8	0.0	1438.5	660.2833333
19:40	0.01	3	3.229	-0.229166667	775.4666667	782.8	0.0	1441.5	663.2833333
19:45	0.01	3	3.229	-0.229166667	775 2375	782.8	0.0	1444.5	666.2833333
19:50	0.01	3	3.229	-0.229166667	775.0083333	782.8	0.0	1447.5	669.2833333
19:55	0.009	2.7	3.229	-0.529166667	774.4791667	782.8	0.0	1450.2	671.9833333
20:00	0.009	2.7	3.229	-0.529166667	773.95	782.8	0.0	1452.9	674.6833333
20:05	0.009	2.7	3.229	-0.529166667	773.4208333	782.8	0.0	1455.6	677.3833333
20:10	0.009	2.7	3.229	-0.529166667	772.8916667	782.8	0.0	1458.3	680.0833333
20:15	0.009	2.7	3.229	-0.529166667	772 3625	782.8	0.0	1461	682.7833333
20:20	0.009	2.7	3.229	-0.529166667	771.8333333	782.8	0.0	1463.7	685.4833333
20:25	0.009	2.7	3.229	-0.529166667	771.3041667	782.8	0.0	1466.4	688.1833333
20:30	0.009	2.7	3.229	-0.529166667	770.775	782.8	0.0	1469.1	690.8833333
20:35	0.009	2.7	3.229	-0.529166667	770.2458333	782.8	0.0	1471.8	693.5833333
20:40	0.009	2.7	3.229	-0.529166667	769.7166667	782.8	0.0	1474.5	696.2833333
20:45	0.009	2.7	3.229	-0.529166667	769.1875	782.8	0.0	1477.2	698.9833333
20:50	0.009	2.7	3.229	-0.529166667	768.6583333	782.8	0.0	1479.9	701.6833333
20:55	0.009	2.7	3.229	-0.529166667	768.1291667	782.8	0.0	1482.6	704.3833333
21:00	0.009	2.7	3.229	-0.529166667	767.6	782.8	0.0	1485.3	707.0833333
21:05	0.009	2.7	3.229	-0.529166667	767.0708333	782.8	0.0	1488	709.7833333
21:10	0.009	2.7	3.229	-0.529166667	766.5416667	782.8	0.0	1490.7	712.4833333
21:15	0.009	2.7	3.229	-0.529166667	766.0125	782.8	0.0	1493.4	715.1833333
21:20	0.009	2.7	3.229	-0.529166667	765.4833333	782.8	0.0	1496.1	717.8833333
21:25	0.008	2.4	3.229	-0.829166667	764.6541667	782.8	0.0	1498.5	720.2833333
21:30	0.008	2.4	3.229	-0.829166667	763.825	782.8	0.0	1500.9	722.6833333
21:35	0.008	2.4	3.229	-0.829166667	762.9958333	782.8	0.0	1503.3	725.0833333
21:40	0.008	2.4	3.229	-0.829166667	762.1666667	782.8	0.0	1505.7	727.4833333
21:45	0.008	2.4	3.229	-0.829166667	761 3375	782.8	0.0	1508.1	729.8833333
21:50	0.008	2.4	3.229	-0.829166667	760.5083333	782.8	0.0	1510.5	732.2833333
21:55	0.008	2.4	3.229	-0.829166667	759.6791667	782.8	0.0	1512.9	734.6833333
22:00	0.008	2.4	3.229	-0.829166667	758.85	782.8	0.0	1515.3	737.0833333
22:05	0.008	2.4	3.229	-0.829166667	758.0208333	782.8	0.0	1517.7	739.4833333
22:10	0.008	2.4	3.229	-0.829166667	757.1916667	782.8	0.0	1520.1	741.8833333
22:15	0.008	2.4	3.229	-0.829166667	756 3625	782.8	0.0	1522.5	744.2833333
22:20	0.008	2.4	3.229	-0.829166667	755.5333333	782.8	0.0	1524.9	746.6833333

1% AEP – Volume Check (1 ha Catchment)

Purpose: To assess the additional footprint required for 1% AEP catchments by modelling full 1% AEP flows (HIRDS rainfall, 1 ha development area, 70% impervious). The calculation estimates soakage capacity and identifies the extra bioretention area needed beyond WQV treatment to accommodate the full 1% AEP event.

Typical 1ha Development Area									
Time (h:mm)	1% AEP (m^3/s)	Inflow (m^3/5 min)	Infiltration capacity (m^3/5 min)	Net surplus (m^3)	Running storage (m^3)	Available storage (m^3)	Storage (m^3)	Cumulative inflow (m^3)	Cumulative infiltration (m^3)
22:25	0.008	2.4	3.229	-0.829166667	754.7041667	782.8	0.0	1527.3	749.0833333
22:30	0.008	2.4	3.229	-0.829166667	753.875	782.8	0.0	1529.7	751.4833333
22:35	0.008	2.4	3.229	-0.829166667	753.0458333	782.8	0.0	1532.1	753.8833333
22:40	0.008	2.4	3.229	-0.829166667	752.2166667	782.8	0.0	1534.5	756.2833333
22:45	0.008	2.4	3.229	-0.829166667	751 3875	782.8	0.0	1536.9	758.6833333
22:50	0.008	2.4	3.229	-0.829166667	750.5583333	782.8	0.0	1539.3	761.0833333
22:55	0.008	2.4	3.229	-0.829166667	749.7291667	782.8	0.0	1541.7	763.4833333
23:00	0.008	2.4	3.229	-0.829166667	748.9	782.8	0.0	1544.1	765.8833333
23:05	0.008	2.4	3.229	-0.829166667	748.0708333	782.8	0.0	1546.5	768.2833333
23:10	0.008	2.4	3.229	-0.829166667	747.2416667	782.8	0.0	1548.9	770.6833333
23:15	0.008	2.4	3.229	-0.829166667	746.4125	782.8	0.0	1551.3	773.0833333
23:20	0.008	2.4	3.229	-0.829166667	745.5833333	782.8	0.0	1553.7	775.4833333
23:25	0.007	2.1	3.229	-1.129166667	744.4541667	782.8	0.0	1555.8	777.5833333
23:30	0.007	2.1	3.229	-1.129166667	743.325	782.8	0.0	1557.9	779.6833333
23:35	0.007	2.1	3.229	-1.129166667	742.1958333	782.8	0.0	1560	781.7833333
23:40	0.007	2.1	3.229	-1.129166667	741.0666667	782.8	0.0	1562.1	783.8833333
23:45	0.007	2.1	3.229	-1.129166667	739 9375	782.8	0.0	1564.2	785.9833333
23:50	0.007	2.1	3.229	-1.129166667	738.8083333	782.8	0.0	1566.3	788.0833333
23:55	0.007	2.1	3.229	-1.129166667	737.6791667	782.8	0.0	1568.4	790.1833333
End	0.007	2.1	3.229	-1.129166667	736.55	782.8	0.0	1570.5	792.2833333

WQV (1/3 of 50% AEP) – Treatment Volume Check (1 ha Catchment)

Purpose: To assess the footprint required for a 1 ha development area (70% impervious). The calculation estimates the water quality volume (WQV) treatment area required to accommodate the water quality event.

Typical 1ha Development Area									
Time (h:mm)	1/3 of 50% (m^3/s)	Inflow (m^3/5 min)	Infiltration capacity (m^3/5 min)	Net surplus (m^3)	Running storage (m^3)	Available storage (m^3)	Overflow (m^3)	Cumulative inflow (m^3)	Cumulative infiltration (m^3)
0:00	0	0	1.125	-1.125	0	56.7	0.0	0	0
0:05	0.000133333	0.04	1.125	-1.085	0	56.7	0.0	0.04	0.04
0:10	0.000466667	0.14	1.125	-0.985	0	56.7	0.0	0.18	0.18
0:15	0.0007	0.21	1.125	-0.915	0	56.7	0.0	0.39	0.39
0:20	0.000733333	0.22	1.125	-0.905	0	56.7	0.0	0.61	0.61
0:25	0.000766667	0.23	1.125	-0.895	0	56.7	0.0	0.84	0.84
0:30	0.000766667	0.23	1.125	-0.895	0	56.7	0.0	1.07	1.07
0:35	0.000766667	0.23	1.125	-0.895	0	56.7	0.0	1.3	1.3
0:40	0.000766667	0.23	1.125	-0.895	0	56.7	0.0	1.53	1.53
0:45	0.0008	0.24	1.125	-0.885	0	56.7	0.0	1.77	1.77
0:50	0.0008	0.24	1.125	-0.885	0	56.7	0.0	2.01	2.01
0:55	0.0008	0.24	1.125	-0.885	0	56.7	0.0	2.25	2.25
1:00	0.0008	0.24	1.125	-0.885	0	56.7	0.0	2.49	2.49
1:05	0.0008	0.24	1.125	-0.885	0	56.7	0.0	2.73	2.73
1:10	0.0008	0.24	1.125	-0.885	0	56.7	0.0	2.97	2.97
1:15	0.0008	0.24	1.125	-0.885	0	56.7	0.0	3.21	3.21
1:20	0.0008	0.24	1.125	-0.885	0	56.7	0.0	3.45	3.45
1:25	0.0008	0.24	1.125	-0.885	0	56.7	0.0	3.69	3.69
1:30	0.000833333	0.25	1.125	-0.875	0	56.7	0.0	3.94	3.94
1:35	0.000833333	0.25	1.125	-0.875	0	56.7	0.0	4.19	4.19
1:40	0.000833333	0.25	1.125	-0.875	0	56.7	0.0	4.44	4.44
1:45	0.000833333	0.25	1.125	-0.875	0	56.7	0.0	4.69	4.69
1:50	0.000833333	0.25	1.125	-0.875	0	56.7	0.0	4.94	4.94
1:55	0.000833333	0.25	1.125	-0.875	0	56.7	0.0	5.19	5.19
2:00	0.000833333	0.25	1.125	-0.875	0	56.7	0.0	5.44	5.44
2:05	0.000833333	0.25	1.125	-0.875	0	56.7	0.0	5.69	5.69
2:10	0.000866667	0.26	1.125	-0.865	0	56.7	0.0	5.95	5.95
2:15	0.000866667	0.26	1.125	-0.865	0	56.7	0.0	6.21	6.21
2:20	0.000866667	0.26	1.125	-0.865	0	56.7	0.0	6.47	6.47
2:25	0.000866667	0.26	1.125	-0.865	0	56.7	0.0	6.73	6.73
2:30	0.000866667	0.26	1.125	-0.865	0	56.7	0.0	6.99	6.99
2:35	0.000866667	0.26	1.125	-0.865	0	56.7	0.0	7.25	7.25
2:40	0.000866667	0.26	1.125	-0.865	0	56.7	0.0	7.51	7.51
2:45	0.0009	0.27	1.125	-0.855	0	56.7	0.0	7.78	7.78
2:50	0.0009	0.27	1.125	-0.855	0	56.7	0.0	8.05	8.05
2:55	0.0009	0.27	1.125	-0.855	0	56.7	0.0	8.32	8.32
3:00	0.0009	0.27	1.125	-0.855	0	56.7	0.0	8.59	8.59
3:05	0.0009	0.27	1.125	-0.855	0	56.7	0.0	8.86	8.86
3:10	0.0009	0.27	1.125	-0.855	0	56.7	0.0	9.13	9.13
3:15	0.000933333	0.28	1.125	-0.845	0	56.7	0.0	9.41	9.41
3:20	0.000933333	0.28	1.125	-0.845	0	56.7	0.0	9.69	9.69
3:25	0.000933333	0.28	1.125	-0.845	0	56.7	0.0	9.97	9.97
3:30	0.000933333	0.28	1.125	-0.845	0	56.7	0.0	10.25	10.25
3:35	0.000933333	0.28	1.125	-0.845	0	56.7	0.0	10.53	10.53
3:40	0.000933333	0.28	1.125	-0.845	0	56.7	0.0	10.81	10.81
3:45	0.000966667	0.29	1.125	-0.835	0	56.7	0.0	11.1	11.1
3:50	0.000966667	0.29	1.125	-0.835	0	56.7	0.0	11.39	11.39
3:55	0.000966667	0.29	1.125	-0.835	0	56.7	0.0	11.68	11.68
4:00	0.000966667	0.29	1.125	-0.835	0	56.7	0.0	11.97	11.97
4:05	0.000966667	0.29	1.125	-0.835	0	56.7	0.0	12.26	12.26
4:10	0.001	0.3	1.125	-0.825	0	56.7	0.0	12.56	12.56
4:15	0.001	0.3	1.125	-0.825	0	56.7	0.0	12.86	12.86
4:20	0.001	0.3	1.125	-0.825	0	56.7	0.0	13.16	13.16
4:25	0.001	0.3	1.125	-0.825	0	56.7	0.0	13.46	13.46
4:30	0.001	0.3	1.125	-0.825	0	56.7	0.0	13.76	13.76
4:35	0.001033333	0.31	1.125	-0.815	0	56.7	0.0	14.07	14.07
4:40	0.001033333	0.31	1.125	-0.815	0	56.7	0.0	14.38	14.38
4:45	0.001033333	0.31	1.125	-0.815	0	56.7	0.0	14.69	14.69
4:50	0.001033333	0.31	1.125	-0.815	0	56.7	0.0	15	15
4:55	0.001066667	0.32	1.125	-0.805	0	56.7	0.0	15.32	15.32
5:00	0.001066667	0.32	1.125	-0.805	0	56.7	0.0	15.64	15.64
5:05	0.001066667	0.32	1.125	-0.805	0	56.7	0.0	15.96	15.96
5:10	0.001066667	0.32	1.125	-0.805	0	56.7	0.0	16.28	16.28
5:15	0.0011	0.33	1.125	-0.795	0	56.7	0.0	16.61	16.61
5:20	0.0011	0.33	1.125	-0.795	0	56.7	0.0	16.94	16.94
5:25	0.0011	0.33	1.125	-0.795	0	56.7	0.0	17.27	17.27
5:30	0.001133333	0.34	1.125	-0.785	0	56.7	0.0	17.61	17.61
5:35	0.001133333	0.34	1.125	-0.785	0	56.7	0.0	17.95	17.95
5:40	0.001133333	0.34	1.125	-0.785	0	56.7	0.0	18.29	18.29
5:45	0.001166667	0.35	1.125	-0.775	0	56.7	0.0	18.64	18.64
5:50	0.001166667	0.35	1.125	-0.775	0	56.7	0.0	18.99	18.99
5:55	0.001166667	0.35	1.125	-0.775	0	56.7	0.0	19.34	19.34
6:00	0.0012	0.36	1.125	-0.765	0	56.7	0.0	19.7	19.7
6:05	0.0012	0.36	1.125	-0.765	0	56.7	0.0	20.06	20.06
6:10	0.0012	0.36	1.125	-0.765	0	56.7	0.0	20.42	20.42
6:15	0.001233333	0.37	1.125	-0.755	0	56.7	0.0	20.79	20.79
6:20	0.001233333	0.37	1.125	-0.755	0	56.7	0.0	21.16	21.16
6:25	0.001233333	0.37	1.125	-0.755	0	56.7	0.0	21.53	21.53
6:30	0.001266667	0.38	1.125	-0.745	0	56.7	0.0	21.91	21.91
6:35	0.001266667	0.38	1.125	-0.745	0	56.7	0.0	22.29	22.29
6:40	0.001266667	0.38	1.125	-0.745	0	56.7	0.0	22.67	22.67
6:45	0.0013	0.39	1.125	-0.735	0	56.7	0.0	23.06	23.06
6:50	0.0013	0.39	1.125	-0.735	0	56.7	0.0	23.45	23.45
6:55	0.001333333	0.4	1.125	-0.725	0	56.7	0.0	23.85	23.85
7:00	0.001333333	0.4	1.125	-0.725	0	56.7	0.0	24.25	24.25
7:05	0.001366667	0.41	1.125	-0.715	0	56.7	0.0	24.66	24.66
7:10	0.001366667	0.41	1.125	-0.715	0	56.7	0.0	25.07	25.07
7:15	0.0014	0.42	1.125	-0.705	0	56.7	0.0	25.49	25.49
7:20	0.0014	0.42	1.125	-0.705	0	56.7	0.0	25.91	25.91
7:25	0.001433333	0.43	1.125	-0.695	0	56.7	0.0	26.34	26.34
7:30	0.001433333	0.43	1.125	-0.695	0	56.7	0.0	26.77	26.77
7:35	0.001466667	0.44	1.125	-0.685	0	56.7	0.0	27.21	27.21
7:40	0.001466667	0.44	1.125	-0.685	0	56.7	0.0	27.65	27.65
7:45	0.0015	0.45	1.125	-0.675	0	56.7	0.0	28.1	28.1
7:50	0.0015	0.45	1.125	-0.675	0	56.7	0.0	28.55	28.55
7:55	0.001533333	0.46	1.125	-0.665	0	56.7	0.0	29.01	29.01
8:00	0.001566667	0.47	1.125	-0.655	0	56.7	0.0	29.48	29.48
8:05	0.001566667	0.47	1.125	-0.655	0	56.7	0.0	29.95	29.95
8:10	0.0016	0.48	1.125	-0.645	0	56.7	0.0	30.43	30.43
8:15	0.001633333	0.49	1.125	-0.635	0	56.7	0.0	30.92	30.92
8:20	0.001633333	0.49	1.125	-0.635	0	56.7	0.0	31.41	31.41
8:25	0.001666667	0.5	1.125	-0.625	0	56.7	0.0	31.91	31.91
8:30	0.0017	0.51	1.125	-0.615	0	56.7	0.0	32.42	32.42
8:35	0.001733333	0.52	1.125	-0.605	0	56.7	0.0	32.94	32.94
8:40	0.001766667	0.53	1.125	-0.595	0	56.7	0.0	33.47	33.47
8:45	0.001766667	0.53	1.125	-0.595	0	56.7	0.0	34	34
8:50	0.0018	0.54	1.125	-0.585	0	56.7	0.0	34.54	34.54
8:55	0.001833333	0.55	1.125	-0.575	0	56.7	0.0	35.09	35.09
9:00	0.001866667	0.56	1.125	-0.565	0	56.7	0.0	35.65	35.65
9:05	0.0019	0.57	1.125	-0.555	0	56.7	0.0	36.22	36.22
9:10	0.001933333	0.58	1.125	-0.545	0	56.7	0.0	36.8	36.8
9:15	0.001966667	0.59	1.125	-0.535	0	56.7	0.0	37.39	37.39
9:20	0.002033333	0.61	1.125	-0.515	0	56.7	0.0	38	38
9:25	0.002066667	0.62	1.125	-0.505	0	56.7	0.0	38.62	38.62
9:30	0.0021	0.63	1.125	-0.495	0	56.7	0.0	39.25	39.25
9:35	0.002166667	0.65	1.125	-0.475	0	56.7	0.0	39.9	39.9
9:40	0.0022	0.66	1.125	-0.465	0	56.7	0.0	40.56	40.56
9:45	0.002233333	0.67	1.125	-0.455	0	56.7	0.0	41.23	41.23
9:50	0.0023	0.69	1.125	-0.435	0	56.7	0.0	41.92	41.92
9:55	0.002366667	0.71	1.125	-0.415	0	56.7	0.0	42.63	42.63
10:00	0.002433333	0.73	1.125	-0.395	0	56.7	0.0	43.36	43.36
10:05	0.0025	0.75	1.125	-0.375	0	56.7	0.0	44.11	44.11
10:10	0.002566667	0.77	1.125	-0.355	0	56.7	0.0	44.88	44.88
10:15	0.002633333	0.79	1.125	-0.335	0	56.7	0.0	45.67	45.67
10:20	0.0027	0.81	1.125	-0.315	0	56.7	0.0	46.48	46.48
10:25	0.0028	0.84	1.125	-0.285	0	56.7	0.0	47.32	47.32
10:30	0.002866667	0.86	1.125	-0.265	0	56.7	0.0	48.18	48.18
10:35	0.002966667	0.89	1.125	-0.235	0	56.7	0.0	49.07	49.07
10:40	0.0031	0.93	1.125	-0.195	0	56.7	0.0	50	50
10:45	0.0032	0.96	1.125	-0.165	0	56.7	0.0	50.96	50.96
10:50	0.003333333	1	1.125	-0.125	0	56.7	0.0	51.96	51.96
10:55	0.0035	1.05	1.125	-0.075	0	56.7	0.0	53.01	53.01
11:00	0.003633333	1.09	1.125	-0.035	0	56.7	0.0	54.1	54.1
11:05	0.003833333	1.15	1.125	0.025	0.025	56.7	0.0	55.25	55.225
11:10	0.004033333	1.21	1.125	0.085	0.11	56.7	0.0	56.46	56.35
11:15	0.004266667	1.28	1.125	0.155	0.265	56.7	0.0	57.74	57.475
11:20	0.004533333	1.36	1.125	0.235	0.5	56.7	0.0	59.1	58.6
11:25	0.004866667	1.46	1.125	0.335	0.835	56.7	0.0	60.56	59.725

Parameter	Value	Unit
Ponding storage depth assumed	0	m
Treatment media depth	0.6	m
Sand transition layer depth	0.1	m
Infiltration area provided	270.0	m2
Water quality storage capacity (media + sand @ n = 0.30)	56.7	m3
Infiltration rate (hydraulic conductivity)	50.0	mm/hr
Treatment overflow	0.0	OK (no overflow expected)

WQV (1/3 of 50% AEP) – Treatment Volume Check (1 ha Catchment)

Purpose: To assess the footprint required for a 1 ha development area (70% impervious). The calculation estimates the water quality volume (WQV) treatment area required to accommodate the water quality event.

Typical 1ha Development Area									
Time (h:mm)	1/3 of 50% (m^3/s)	Inflow ($m^3/5$ min)	Infiltration capacity ($m^3/5$ min)	Net surplus (m^3)	Running storage (m^3)	Available storage (m^3)	Overflow (m^3)	Cumulative inflow (m^3)	Cumulative infiltration (m^3)
11:30	0.005266667	1.58	1.125	0.455	1.29	56.7	0.0	62.14	60.85
11:35	0.005733333	1.72	1.125	0.595	1.885	56.7	0.0	63.86	61.975
11:40	0.006366667	1.91	1.125	0.785	2.67	56.7	0.0	65.77	63.1
11:45	0.0072	2.16	1.125	1.035	3.705	56.7	0.0	67.93	64.225
11:50	0.0084	2.52	1.125	1.395	5.1	56.7	0.0	70.45	65.35
11:55	0.0103	3.09	1.125	1.965	7.065	56.7	0.0	73.54	66.475
12:00	0.014433333	4.33	1.125	3.205	10.27	56.7	0.0	77.87	67.6
12:05	0.0315	9.45	1.125	8.325	18.595	56.7	0.0	87.32	68.725
12:10	0.0481	14.43	1.125	13.305	31.9	56.7	0.0	101.75	69.85
12:15	0.037433333	11.23	1.125	10.105	42.005	56.7	0.0	112.98	70.975
12:20	0.019466667	5.84	1.125	4.715	46.72	56.7	0.0	118.82	72.1
12:25	0.0126	3.78	1.125	2.655	49.375	56.7	0.0	122.6	73.225
12:30	0.009566667	2.87	1.125	1.745	51.12	56.7	0.0	125.47	74.35
12:35	0.007933333	2.38	1.125	1.255	52.375	56.7	0.0	127.85	75.475
12:40	0.007	2.1	1.125	0.975	53.35	56.7	0.0	129.95	76.6
12:45	0.0063	1.89	1.125	0.765	54.115	56.7	0.0	131.84	77.725
12:50	0.005766667	1.73	1.125	0.605	54.72	56.7	0.0	133.57	78.85
12:55	0.005366667	1.61	1.125	0.485	55.205	56.7	0.0	135.18	79.975
13:00	0.005	1.5	1.125	0.375	55.58	56.7	0.0	136.68	81.1
13:05	0.004733333	1.42	1.125	0.295	55.875	56.7	0.0	138.1	82.225
13:10	0.004466667	1.34	1.125	0.215	56.09	56.7	0.0	139.44	83.35
13:15	0.004266667	1.28	1.125	0.155	56.245	56.7	0.0	140.72	84.475
13:20	0.004066667	1.22	1.125	0.095	56.34	56.7	0.0	141.94	85.6
13:25	0.0039	1.17	1.125	0.045	56.385	56.7	0.0	143.11	86.725
13:30	0.003733333	1.12	1.125	-0.005	56.38	56.7	0.0	144.23	87.845
13:35	0.0036	1.08	1.125	-0.045	56.335	56.7	0.0	145.31	88.925
13:40	0.003466667	1.04	1.125	-0.085	56.25	56.7	0.0	146.35	89.965
13:45	0.003366667	1.01	1.125	-0.115	56.135	56.7	0.0	147.36	90.975
13:50	0.003233333	0.97	1.125	-0.155	55.98	56.7	0.0	148.33	91.945
13:55	0.003166667	0.95	1.125	-0.175	55.805	56.7	0.0	149.28	92.895
14:00	0.003066667	0.92	1.125	-0.205	55.6	56.7	0.0	150.2	93.815
14:05	0.002966667	0.89	1.125	-0.235	55.365	56.7	0.0	151.09	94.705
14:10	0.0029	0.87	1.125	-0.255	55.11	56.7	0.0	151.96	95.575
14:15	0.002833333	0.85	1.125	-0.275	54.835	56.7	0.0	152.81	96.425
14:20	0.002766667	0.83	1.125	-0.295	54.54	56.7	0.0	153.64	97.255
14:25	0.0027	0.81	1.125	-0.315	54.225	56.7	0.0	154.45	98.065
14:30	0.002633333	0.79	1.125	-0.335	53.89	56.7	0.0	155.24	98.855
14:35	0.002566667	0.77	1.125	-0.355	53.535	56.7	0.0	156.01	99.625
14:40	0.002533333	0.76	1.125	-0.365	53.17	56.7	0.0	156.77	100.385
14:45	0.002466667	0.74	1.125	-0.385	52.785	56.7	0.0	157.51	101.125
14:50	0.002433333	0.73	1.125	-0.395	52.39	56.7	0.0	158.24	101.855
14:55	0.002366667	0.71	1.125	-0.415	51.975	56.7	0.0	158.95	102.565
15:00	0.002333333	0.7	1.125	-0.425	51.55	56.7	0.0	159.65	103.265
15:05	0.0023	0.69	1.125	-0.435	51.115	56.7	0.0	160.34	103.955
15:10	0.002266667	0.68	1.125	-0.445	50.67	56.7	0.0	161.02	104.635
15:15	0.002233333	0.67	1.125	-0.455	50.215	56.7	0.0	161.69	105.305
15:20	0.002166667	0.65	1.125	-0.475	49.74	56.7	0.0	162.34	105.955
15:25	0.002133333	0.64	1.125	-0.485	49.255	56.7	0.0	162.98	106.595
15:30	0.0021	0.63	1.125	-0.495	48.76	56.7	0.0	163.61	107.225
15:35	0.002066667	0.62	1.125	-0.505	48.255	56.7	0.0	164.23	107.845
15:40	0.002066667	0.62	1.125	-0.505	47.75	56.7	0.0	164.85	108.465
15:45	0.002033333	0.61	1.125	-0.515	47.235	56.7	0.0	165.46	109.075
15:50	0.002	0.6	1.125	-0.525	46.71	56.7	0.0	166.06	109.675
15:55	0.001966667	0.59	1.125	-0.535	46.175	56.7	0.0	166.65	110.265
16:00	0.001933333	0.58	1.125	-0.545	45.63	56.7	0.0	167.23	110.845
16:05	0.0019	0.57	1.125	-0.555	45.075	56.7	0.0	167.8	111.415
16:10	0.0019	0.57	1.125	-0.555	44.52	56.7	0.0	168.37	111.985
16:15	0.001866667	0.56	1.125	-0.565	43.955	56.7	0.0	168.93	112.545
16:20	0.001833333	0.55	1.125	-0.575	43.38	56.7	0.0	169.48	113.095
16:25	0.001833333	0.55	1.125	-0.575	42.805	56.7	0.0	170.03	113.645
16:30	0.0018	0.54	1.125	-0.585	42.22	56.7	0.0	170.57	114.185
16:35	0.001766667	0.53	1.125	-0.595	41.625	56.7	0.0	171.1	114.715
16:40	0.001766667	0.53	1.125	-0.595	41.03	56.7	0.0	171.63	115.245
16:45	0.001733333	0.52	1.125	-0.605	40.425	56.7	0.0	172.15	115.765
16:50	0.001733333	0.52	1.125	-0.605	39.82	56.7	0.0	172.67	116.285
16:55	0.0017	0.51	1.125	-0.615	39.205	56.7	0.0	173.18	116.795
17:00	0.001666667	0.5	1.125	-0.625	38.58	56.7	0.0	173.68	117.295
17:05	0.001666667	0.5	1.125	-0.625	37.955	56.7	0.0	174.18	117.795
17:10	0.001633333	0.49	1.125	-0.635	37.32	56.7	0.0	174.67	118.285
17:15	0.001633333	0.49	1.125	-0.635	36.685	56.7	0.0	175.16	118.775
17:20	0.0016	0.48	1.125	-0.645	36.04	56.7	0.0	175.64	119.255
17:25	0.0016	0.48	1.125	-0.645	35.395	56.7	0.0	176.12	119.735
17:30	0.001566667	0.47	1.125	-0.655	34.74	56.7	0.0	176.59	120.205
17:35	0.001566667	0.47	1.125	-0.655	34.085	56.7	0.0	177.06	120.675
17:40	0.001566667	0.47	1.125	-0.655	33.43	56.7	0.0	177.53	121.145
17:45	0.001533333	0.46	1.125	-0.665	32.765	56.7	0.0	177.99	121.605
17:50	0.001533333	0.46	1.125	-0.665	32.1	56.7	0.0	178.45	122.065
17:55	0.0015	0.45	1.125	-0.675	31.425	56.7	0.0	178.9	122.515
18:00	0.0015	0.45	1.125	-0.675	30.75	56.7	0.0	179.35	122.965
18:05	0.0015	0.45	1.125	-0.675	30.075	56.7	0.0	179.8	123.415
18:10	0.001466667	0.44	1.125	-0.685	29.39	56.7	0.0	180.24	123.855
18:15	0.001466667	0.44	1.125	-0.685	28.705	56.7	0.0	180.68	124.295
18:20	0.001433333	0.43	1.125	-0.695	28.01	56.7	0.0	181.11	124.725
18:25	0.001433333	0.43	1.125	-0.695	27.315	56.7	0.0	181.54	125.155
18:30	0.001433333	0.43	1.125	-0.695	26.62	56.7	0.0	181.97	125.585
18:35	0.0014	0.42	1.125	-0.705	25.915	56.7	0.0	182.39	126.005
18:40	0.0014	0.42	1.125	-0.705	25.21	56.7	0.0	182.81	126.425
18:45	0.0014	0.42	1.125	-0.705	24.505	56.7	0.0	183.23	126.845
18:50	0.001366667	0.41	1.125	-0.715	23.79	56.7	0.0	183.64	127.255
18:55	0.001366667	0.41	1.125	-0.715	23.075	56.7	0.0	184.05	127.665
19:00	0.001366667	0.41	1.125	-0.715	22.36	56.7	0.0	184.46	128.075
19:05	0.001333333	0.4	1.125	-0.725	21.635	56.7	0.0	184.86	128.475
19:10	0.001333333	0.4	1.125	-0.725	20.91	56.7	0.0	185.26	128.875
19:15	0.001333333	0.4	1.125	-0.725	20.185	56.7	0.0	185.66	129.275
19:20	0.001333333	0.4	1.125	-0.725	19.46	56.7	0.0	186.06	129.675
19:25	0.0013	0.39	1.125	-0.735	18.725	56.7	0.0	186.45	130.065
19:30	0.0013	0.39	1.125	-0.735	17.99	56.7	0.0	186.84	130.455
19:35	0.0013	0.39	1.125	-0.735	17.255	56.7	0.0	187.23	130.845
19:40	0.0013	0.39	1.125	-0.735	16.52	56.7	0.0	187.62	131.235
19:45	0.001266667	0.38	1.125	-0.745	15.775	56.7	0.0	188	131.615
19:50	0.001266667	0.38	1.125	-0.745	15.03	56.7	0.0	188.38	131.995
19:55	0.001266667	0.38	1.125	-0.745	14.285	56.7	0.0	188.76	132.375
20:00	0.001266667	0.38	1.125	-0.745	13.54	56.7	0.0	189.14	132.755
20:05	0.001233333	0.37	1.125	-0.755	12.785	56.7	0.0	189.51	133.125
20:10	0.001233333	0.37	1.125	-0.755	12.03	56.7	0.0	189.88	133.495
20:15	0.001233333	0.37	1.125	-0.755	11.275	56.7	0.0	190.25	133.865
20:20	0.001233333	0.37	1.125	-0.755	10.52	56.7	0.0	190.62	134.235
20:25	0.0012	0.36	1.125	-0.765	9.755	56.7	0.0	190.98	134.595
20:30	0.0012	0.36	1.125	-0.765	8.99	56.7	0.0	191.34	134.955
20:35	0.0012	0.36	1.125	-0.765	8.225	56.7	0.0	191.7	135.315
20:40	0.0012	0.36	1.125	-0.765	7.46	56.7	0.0	192.06	135.675
20:45	0.001166667	0.35	1.125	-0.775	6.685	56.7	0.0	192.41	136.025
20:50	0.001166667	0.35	1.125	-0.775	5.91	56.7	0.0	192.76	136.375
20:55	0.001166667	0.35	1.125	-0.775	5.135	56.7	0.0	193.11	136.725
21:00	0.001166667	0.35	1.125	-0.775	4.36	56.7	0.0	193.46	137.075
21:05	0.001166667	0.35	1.125	-0.775	3.585	56.7	0.0	193.81	137.425
21:10	0.001133333	0.34	1.125	-0.785	2.8	56.7	0.0	194.15	137.765
21:15	0.001133333	0.34	1.125	-0.785	2.015	56.7	0.0	194.49	138.105
21:20	0.001133333	0.34	1.125	-0.785	1.23	56.7	0.0	194.83	138.445
21:25	0.001133333	0.34	1.125	-0.785	0.445	56.7	0.0	195.17	138.785
21:30	0.001133333	0.34	1.125	-0.785	0	56.7	0.0	195.51	139.125
21:35	0.001133333	0.34	1.125	-0.785	0	56.7	0.0	195.85	139.465
21:40	0.0011	0.33	1.125	-0.795	0	56.7	0.0	196.18	139.795
21:45	0.0011	0.33	1.125	-0.795	0	56.7	0.0	196.51	140.125
21:50	0.0011	0.33	1.125	-0.795	0	56.7	0.0	196.84	140.455
21:55	0.0011	0.33	1.125	-0.795	0	56.7	0.0	197.17	140.785
22:00	0.0011	0.33	1.125	-0.795	0	56.7	0.0	197.5	141.115
22:05	0.001066667	0.32	1.125	-0.805	0	56.7	0.0	197.82	141.435
22:10	0.001066667	0.32	1.125	-0.805	0	56.7	0.0	198.14	141.755
22:15	0.001066667	0.32	1.125	-0.805	0	56.7	0.0	198.46	142.075
22:20	0.001066667	0.32	1.125	-0.805	0	56.7	0.0	198.78	142.395
22:25	0.001066667	0.32	1.125	-0.805	0	56.7	0.0	199.1	142.715
22:30	0.001066667	0.32	1.125	-0.805	0	56.7	0.0	199.42	143.035
22:35	0.001066667	0.32	1.125	-0.805	0	56.7	0.0	199.74	143.355
22:40	0.001033333	0.31	1.125	-0.815	0	56.7	0.0	200.05	143.665
22:45	0.001033333	0.31	1.125	-0.815	0	56.7	0.0	200.36	143.975
22:50	0.001033333	0.31	1.125	-0.815	0	56.7	0.0	200.67	144.285
22:55	0.001033333	0.31	1.125	-0.815	0	56.7	0.0	200.98	144.595
23:00	0.001033333	0.31	1.125	-0.815	0	56.7	0.0	201.29	144.905
23:05	0.001033333	0.31	1.125	-0.815	0	56.7	0.0	201.6	145.215
23:10	0.001	0.3	1.125	-0.825	0	56.7	0.0	201.9	145.515

WQV (1/3 of 50% AEP) – Treatment Volume Check (1 ha Catchment)

Purpose: To assess the footprint required for a 1 ha development area (70% impervious). The calculation estimates the water quality volume (WQV) treatment area required to accommodate the water quality event.

Typical 1ha Development Area									
Time (h:mm)	1/3 of 50% (m^3/s)	Inflow (m^3/5 min)	Infiltration capacity (m^3/5 min)	Net surplus (m^3)	Running storage (m^3)	Available storage (m^3)	Overflow (m^3)	Cumulative inflow (m^3)	Cumulative infiltration (m^3)
23:15	0.001	0.3	1.125	-0.825	0	56.7	0.0	202.2	145.815
23:20	0.001	0.3	1.125	-0.825	0	56.7	0.0	202.5	146.115
23:25	0.001	0.3	1.125	-0.825	0	56.7	0.0	202.8	146.415
23:30	0.001	0.3	1.125	-0.825	0	56.7	0.0	203.1	146.715
23:35	0.001	0.3	1.125	-0.825	0	56.7	0.0	203.4	147.015
23:40	0.001	0.3	1.125	-0.825	0	56.7	0.0	203.7	147.315
23:45	0.001	0.3	1.125	-0.825	0	56.7	0.0	204	147.615
23:50	0.000966667	0.29	1.125	-0.835	0	56.7	0.0	204.29	147.905
23:55	0.000966667	0.29	1.125	-0.835	0	56.7	0.0	204.58	148.195
End	0.000966667	0.29	1.125	-0.835	0	56.7	0.0	204.87	148.485

Appendix C – Treatment Sizing and Groundwater Checks
Catchment-specific sizing, groundwater verification, and private-lot feasibility calculations.
Includes:

- *C-Treatment Sizing and Groundwater Check.pdf* – Catchment summary tables and groundwater clearance checks (refer Section 7.0)
- *C-Typical Private Attenuated Lot Calculations and Soakage.pdf* – Representative 550 m^2 lot assessment demonstrating feasibility of a 10 kL attenuation tank and 5.2 m^3 soak pit achieving 1 % AEP neutrality
- *C-Rip Rap.pdf* – Outlet protection and energy-dissipation rip rap sizing for stormwater discharges. To verify spatial allowance of Stormwater Reserves.

These confirm treatment and soakage feasibility at concept stage, with ongoing groundwater monitoring to inform detailed design.

Table C-1 – Basin-Level Groundwater and Depth Feasibility Check

This table summarises the basin-level groundwater and vertical clearance checks for all proposed treatment catchments, together with updated treatment capacity adequacy based on the current catchment allocation schedule Piezometer groundwater levels are based on summer-winter 2025/2026 monitoring data Developed areas exclude lots with on-lot attenuation or soakage that are hydraulically neutral to the communal treatment network Each basin has been assessed against a 1 10 m minimum depth stack between the adjacent road level and the base of the bioretention system, comprising 100 mm road-to-lid, 200 mm hydraulic fall, 100 mm lid-to-media, 600 mm media, and 100 mm sand For catchments with multiple basin components, the groundwater and depth check adopts the most constrained sub-basin condition within that catchment

Catchment ID	Treatment Basin Ref	Total catchment area (ha)	Developed area (ha)	Soakage requirement / rule	Total treatment area incl. forebay (m^2)	Road level (mRL)	Governing piezometer	Max observed GW level (mRL)	Check depth = avail – req (m)	Meets 1.10 m stack?	Groundwater approach / treatment form	Concept Design Treatment area Provided (m^2)	Treatment area surplus / deficit (m^2)	Meets treatment area requirement?	Estimated 10% AEP Peak Flow (m^3/s)	Estimated 1% AEP Peak Flow (m^3/s)
1	1_1, 1_2, 1_3, 1_4	18 07	8 71	no Use 270m^2/ha	2587 43	6 6	P03	5 41	0 09	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	2820 47	233 04	PASS	3 214	5 21
2	2_1	1 93	1 78	no Use 270m^2/ha	527 5	7 5	P07	6 76	-0 36	FAIL	Proprietary device required at concept stage	637 28	109 77	PASS	0 429	0 659
3	3_1, 3_2, 3_3	1 68	1 39	no Use 270m^2/ha	413 46	7 6	P01	6 41	0 09	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	434 95	21 49	PASS	0 324	0 494
4	4_1, 4_2, 4_3, 4_4	2 71	2 56	no Use 270m^2/ha	759 27	6 8	P06	5 53	0 17	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	1180 74	421 46	PASS	0 592	0 902
5	5_1	3 83	3 55	no Use 270m^2/ha	1053	7 5	P01	6 41	0	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	1179 11	126 1	PASS	0 856	1 313
7	7_1	1 66	1 54	no Use 270m^2/ha	457 46	6 9	P08	5 49	0 31	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	488 6	31 14	PASS	0 354	0 539
8	8_1	2 01	1 81	no Use 270m^2/ha	536 72	6 7	P09	5 31	0 29	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	616 29	79 58	PASS	0 416	0 632
9	9_1, 9_2, 9_3, 9_4	3 13	2 88	no Use 270m^2/ha	854 54	6 7	P06	5 53	0 07	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	1247 67	393 13	PASS	0 663	1 009
11	11_1	2 84	0 68	yes Use 775m^2/ha	582 62	8 8	P13	5 02	2 68	PASS	Soakage feasible	793 58	210 96	PASS	0 423	0 713
14	14_1	8 73	1 37	no Use 270m^2/ha	407 49	5	P16	2 9	1	PASS	Soakage feasible	1081 63	674 14	PASS	1 324	2 281
15	15_1	8 13	1 3	no Use 270m^2/ha	386 17	5 1	P16	2 9	1 1	PASS	Soakage feasible	766	379 83	PASS	1 239	2 133
16	16_1	3 04	0 46	no Use 270m^2/ha	135 85	10 1	P15	2 82	6 18	PASS	Soakage feasible	257 83	121 98	PASS	0 461	0 795
18	18_1	1 89	0 65	yes Use 775m^2/ha	553 71	5 9	P16	2 9	1 9	PASS	Soakage feasible	916 97	363 27	PASS	0 286	0 472
98	98_1	9 57	2 39	no Use 270m^2/ha	708 75	6 5	P11	4 69	0 71	PASS	Soakage feasible	974 91	266 16	PASS	1 536	2 599
99	99_1	8 92	2 74	no Use 270m^2/ha	815 18	6 5	P04	4 53	0 87	PASS	Soakage feasible	1492 53	677 35	PASS	1 443	2 41
102	102_1	3 39	3 03	no Use 270m^2/ha	898 58	6 5	P02	5 17	0 23	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	1564 84	666 27	PASS	0 696	1 059
103	103_1	1 73	1 52	no Use 270m^2/ha	450 97	6 6	P09	5 31	0 19	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	745 52	294 54	PASS	0 349	0 531
105	105_1, 105_2	0 73	0 7	no Use 270m^2/ha	207 31	6 6	P09	5 31	0 19	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	282 29	74 98	PASS	0 161	0 244
108	108_1	2 87	0 48	no Use 270m^2/ha	143 12	6 8	P17	3 65	2 05	PASS	Soakage feasible	507 52	364 4	PASS	0 445	0 765
112	112_1	7 92	6 37	no Use 270m^2/ha	1892 04	6 6	P03	5 41	0 09	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	2423 01	530 96	PASS	1 465	2 23
120	120_1	0 19	0 18	no Use 270m^2/ha	53 38	5	P16	2 9	1	PASS	Soakage feasible	143 4	90 02	PASS	0 041	0 063
121	121_1	1 44	0 58	no Use 270m^2/ha	170 87	4	P16	2 9	0	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	215 31	44 45	PASS	0 216	0 351
992	992_1, 992_2, 992_3	9 14	8 61	no Use 270m^2/ha	2556 74	6 7	P06	5 53	0 07	PASS	Soakage for groundwater recharge; not relied upon for stormwater management performance	2985 63	428 88	PASS	1 98	3 013

Notes:

1. Groundwater levels are derived from site piezometers monitored through summer–winter 2025/2026. Monitoring will continue through detailed design to confirm seasonal peak groundwater levels.

2. Check depth = available depth – 1.10 m. Positive values indicate the concept-stage depth stack is achieved. Negative values indicate constrained geometry requiring refinement or an alternative treatment response.

3. Groundwater approach / treatment form categories adopted in this table are:
≥ 0.50 m clearance: Soakage feasible
0.00 m to 0.49 m clearance: Bioretention with permeable base allowing groundwater recharge; infiltration/soakage not relied upon for stormwater management performance
< 0.00 m clearance: Proprietary device required

4. Where groundwater clearance is less than 0.50 m, treatment devices may incorporate a permeable base to allow groundwater recharge; however, infiltration/soakage is not relied upon for stormwater management performance and systems are designed to function effectively without infiltration.

5. Catchment treatment capacity has been checked using aggregated provided treatment area against the catchment treatment area required, including forebay allowance where relevant.

6. Basin 2 does not meet the 1.10 m stack check on the refreshed dataset and should be carried forward on the basis of a proprietary treatment response unless refined through detailed design and updated groundwater review.

7. Departure from the 0.5 m KCDC LDMR groundwater clearance criterion may be acceptable for non-soakage treatment devices where infiltration is not relied upon.

8. Where a proprietary treatment response is required (e.g. Basin 2), the treatment strategy may be adjusted at detailed design, including redistribution between communal treatment and on-lot controls. This may result in revised lot-level control requirements to achieve the required water quality and hydraulic performance.

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Stormwater Design Calculations - Private Lot

Client:	Waikanae North Developments Ltd		Job Number:	2911	
Job Name:	Generic Lot claculations		Date:	12/11/2025	
Catchment:	Private Lot				
	Design Parameters		**Runoff Coefficient**	**Coefficient x Area**	
	Design Storm Event:	Q100			
	Catchment Area	550 m²	C= 0.35	192.5	Pre-Development
	Roof Area	335 m²	C= 0.9	301.5	Attenuated
	Hardstand Area	50 m²	C= 0.85	42.5	Direct to kerb or soak pit; assumed attenuated for neutrality
	Additional Impermeable:	0 m²	C= 0.85	0.0	
	Permeable Balance:	165 m²	C= 0.35	57.8	
	Impermeable Percentage:	70%		401.8	Post-Development
	Design Limitations:	The design calculations attached rely on scheme plans. Any alterations to the design and assumed configurations will need to be assessed for compliance with this design. These calculations are for a hypothetical design for this subdivision, to demonstrate its suitability for development. These are not intended for any other use.			
AttenuationTankDesign					
	Assumed Tank:	10,000 litres			
	Manufacturer:				
	Tank Height*:	2.47	*Clear internal dimension to top of design storage level		
	Base Thickness:	100mm			
	Attenuation Orifice Diameter:	40 mm			
	Design Max Attenuation Storage:	7,088 litres			
	Max Orifice Height above Base:	0.20 m			
	Note: Orifice controlled outlet to be discharged to a suitable location.				
	Preferred Disposal System:	Outfall (eg Kerb Outlet)			
	Other Design Requirements:	Final tank sizing to be confirmed at the building consent stage once the building layout is finalised. Current sizing is indicative and demonstrates that the lot achieves hydraulic neutrality, even though a 50 m² hardstand area is not expected to be connected. The tank is intended for attenuation only and is not to be counted towards water reuse. In later design stages, the system may comprise attenuation only (as per these calculations), a combination of attenuation and soakage, or a soak pit alone, provided compliance with KCDC LDMR requirements for either attenuation or soakage is demonstrated. On page 3 of this calculation sheet, a soak pit is shown sized to accommodate attenuated flows up to the 1 % AEP event. This provides an example for lots without a kerb outlet or available secondary flow path.			
	Calculations By:	Joseph Harris			
	Approved by:	Sushil Timsina			

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STORMWATER ON-SITE DETENTION TANK (OSD) DESIGN — 12 November 2025
100 YEAR ARI STORM with 2 YEAR ARI STORM OUTLET

550 m² of development with 60.9% site coverage.

ADDRESS	Generic Lot claculations	Calcs By	0 0
NAME	Waikanae North Developments Ltd		
PHONE		Date	12-Nov-25

NOTE:
Only fill in the blue (unprotected) cells

NOTE A "#DIV/0!" message appearing in a cell means that data has been entered incorrectly

DATA	Calculated Height	Assumed Height			
Depth of Water to orifice invert	2.27	1	m	Tank Diameter	2.16
2 Year Isohyet Value		71.5	mm		
100 Year Isohyet Value		158	mm		
Time of Concentration		10	min. (10,15,20,30,60)		

	Area (m²)	'C'	CA (m²)
Site Area	550		
1. EXISTING SITE COVERAGE			
Existing Roof	0	0.9	0.0
Existing Paved	0	0.85	0.0
Existing Garden	550	0.35	192.5
TOTAL Existing Area	550		192.5
2. PROPOSED DEVELOPMENT			
Additional/Reduced Roof	335	0.9	301.5
Additional/Reduced Paved	50	0.85	42.5
Additional/Reduced Lawn/Garden	-385	0.35	-134.8
TOTAL Addition Area (should be zero)	0		209.3
3. REMAINING UNDRAINED AREA	(Not routed thru detention tank after development)		
Undrained Roof Area (Normally Zero)	0	0.9	0.0
Undrained Paved Area (Normally Zero)	0	0.85	0.0
Undrained Lawn/Garden Area	165	0.35	57.8
TOTAL Extg Not to Tank Area	165		57.8

NOTE The sum of the existing areas must equal the 'Site Area'

* NOTE If pre-development lawn areas are reduced a negative number is required to be entered.

CONTROL DATA			
Existing 'C'	0.35		('CA'extg/Site Area)
Developed 'CA' to OSD tank	344	(m²)	('CA'extg+'CA'adds-'CA'undr)
Additional Area	0	(m²)	('A'add)
	0.00	0	0

RUNOFF DATA	for 2 year		for 100 year	
Intensity I	67.6	mm/hr	149.3	mm/hr
Allowable Qmax whole site	3.62		7.99	
Lost Flows	1.08		2.40	
Allowable Qmax from tanks =	2.5	l/s	5.59	l/s
Allowable Qave from tanks =	1.6	l/s	3.6	l/s (Qmax * 0.65)

Rainfall Intensities (mm)

MIN	Normalised Rainfall Depth(I/I24)	2 Yr (mm/hr)	100 yr (mm/hr)
10	0.16	67.6	149.3
15	0.18	52.4	115.7
20	0.20	43.7	96.6
30	0.24	33.9	74.9
60	0.31	21.9	48.5
120	0.40	14.2	31.4
180	0.46	11.0	24.3
240	0.51	9.2	20.3
300	0.56	8.0	17.6
360	0.60	7.1	15.7
420	0.63	6.5	14.3
480	0.66	5.9	13.1
540	0.69	5.5	12.2
600	0.72	5.2	11.4
660	0.75	4.9	10.7
720	0.77	4.6	10.2
1440	1.00	2.98	6.58

Orifice Calculation - PROTECTED DO NOT ENTER ANY FIGURES

d=	41.6 mm		
Q10 outflow=	3.763545938 for h=	1	
Q10 ave	2.446		
Q=	2.5	h(Q2)=	0.452531646
Qave	1.6 Q2		

STORAGE (2 year)

time (min)	(mm)	depth	inflow (l)	outflow (l)	storage (l)
10		11.3	3874	987	2887
15		13.1	4505	1481	3024
20		14.6	5013	1974	3039
30		16.9	5829	2962	2868
60		21.9	7543	5923	1620
120		28.4	9762	11846	0
180		33.0	11350	17769	0
240		36.7	12632	23693	0
300		39.9	13725	29616	0
360		42.7	14688	35539	0
420		45.2	15554	41462	0
480		47.5	16346	47385	0
540		49.6	17078	53308	0
600		51.6	17761	59231	0
660		53.5	18402	65154	0
720		55.3	19007	71078	0
				Max=	3039

*inflow='CA'dev*depth*
*outflow=Qave*time*
diff=inflow-outflow

STORAGE (100 year)

time (min)	depth (mm)	inflow (l)	100 yr outflow (l)	Storage (100 yr) (l)
10	24.9	8561	1468	7093
15	28.9	9954	2202	7753
20	32.2	11078	2936	8143
30	37.4	12881	4403	8478
60	48.5	16669	8807	7863
120	62.7	21571	17613	3957
180	72.9	25082	26420	0
240	81.1	27914	35227	0
300	88.2	30329	44033	0
360	94.4	32457	52840	0
420	99.9	34372	61647	0
480	105.0	36122	70454	0
540	109.7	37740	79260	0
600	114.1	39248	88067	0
660	118.2	40664	96874	0
720	122.1	42001	105680	0
1440	158.0	54352	211361	0
			Max=	8478

SUMMARY

Tank Volume	8480.0	litres
100 year Max Discharge	3.8	l/s
2 Year Max Discharge	2.5	l/s
Orifice Diameter	42	mm

Adjust to Design "h" and selected Orifice Size:

Tank Volume	10000.00	L	
Tank Height =	2.47	m	Clear internal dimension to top of design storage level
Diameter =	2.16	m	
Storage rate	4049	L/m	
Set Orifice Diameter to	40	mm	Less than Calculated Orifice Diameter

B) 'Adjust "h" in accordance with storage volume

For Q100, Set h=	2.17	m	Adjust until it meets calculated "Storage Height H" below		
Q100 outflow	5.1	L/s	Ave Flow	3.3	L/s
Q2 Outflow	2.3	L/s	Ave Flow	1.5	L/s
Allow Freeboard=	0.1	mm			
Min height to overflow=	2.3	m			
Max Storage (100 year)	7088	L			
Calculated Storage Height H =	2.17	m	OK		
Freeboard	0.1	m			
Set Outlet height from (100mm) base of tank	0.20	m			

time (min)	(mm)	depth	inflow (l)	2 yr outflow (l)	Storage (2 yr) (l)
10		11.3	3874	911	2963
15		13.1	4505	1367	3138
20		14.6	5013	1822	3191
30		16.9	5829	2733	3096
60		21.9	7543	5466	2077
120		28.4	9762	10933	0
180		33.0	11350	16399	0
240		36.7	12632	21866	0
300		39.9	13725	27332	0
360		42.7	14688	32799	0
420		45.2	15554	38265	0
480		47.5	16346	43732	0
540		49.6	17078	49198	0
600		51.6	17761	54665	0
660		53.5	18402	60131	0
720		55.3	19007	65597	0
0		0.0	0	0	0
0				Max=	3191

time (min)	(mm)	depth	inflow (l)	100 yr outflow (l)	Outflow Rate (L/s)	Storage (100 yr) (l)
10		24.9	8561	1995	3.33	6566
15		28.9	9954	2993	3.33	6962
20		32.2	11078	3990	3.33	7088
30		37.4	12881	5985	3.33	6896
60		48.5	16669	11970	3.33	4699
120		62.7	21571	23941	3.00	0
180		72.9	25082	35911	2.32	0
240		81.1	27914	47882	1.94	0
300		88.2	30329	59852	1.68	0
360		94.4	32457	71823	1.50	0
420		99.9	34372	83793	1.36	0
480		105.0	36122	95764	1.25	0
540		109.7	37740	107734	1.16	0
600		114.1	39248	119705	1.09	0
660		118.2	40664	131675	1.03	0
720		122.1	42001	143646	0.97	0
1440		0.0	0	287291	0.00	0
					Max=	7088

Attenuated Q100 Soakpit Size

Job:	2911									
Name:	Generic Lot claculations									
Event:	Q100									
	Soakage Rate SR=	225	mm/hr	Rainsmart Pit		Non-Trafficable				
	Length L=	7.15	m	10	Units			Storage available:	11.31	m³
	Width, W=	1.20	m	3	Units	0	at 30.00%		(Based on Porosity)	
	Effective Depth, D=	1.32	m	3	Units			Max. outflow:	0.0000	m³
	Cover =	0.4	m		allow	0	at 30.00%			
	Initial Water Depth=	0.00	m					Max soakage rate:	0.000100661	m³/s
	Porosity, n=	0.95	(Volume voids/Total Volume)							
	Central Riser, Dia=	0.45	m	2.00	Number of manholes					
	Central Riser Area =	0.32	m2							

Time	Runoff	Volume In	Base Soakage	Surplus	Storage Depth	Wall Soakage	Total Input	Total Soakage	Accumulated Storage	Trench outflow
s	m³/s	m³	m³	m³	m³	m³	m³	m³	m³	m³
10	0.00333	2.00	0.32	1.67	0.21	0.11	2.00	0.43	1.56	0.00
15	0.00333	2.99	0.48	2.51	0.31	0.25	2.99	0.73	2.26	0.00
20	0.00333	3.99	0.64	3.35	0.41	0.44	3.99	1.08	2.91	0.00
30	0.00333	5.99	0.97	5.02	0.62	0.99	5.99	1.96	4.03	0.00
60	0.00333	11.97	1.93	10.04	1.23	3.96	11.97	5.89	6.08	0.00
120	0.00300	21.57	3.86	17.71	1.32	8.49	21.57	12.36	9.22	0.00
180	0.00232	25.08	5.79	19.29	1.32	12.74	25.08	18.53	6.55	0.00
240	0.00194	27.91	7.72	20.19	1.32	16.99	27.91	24.71	3.20	0.00
300	0.00168	30.33	9.65	20.68	1.32	21.24	30.33	30.89	0.00	0.00
360	0.00150	32.46	11.58	20.87	1.32	25.48	32.46	37.07	0.00	0.00
420	0.00136	34.37	13.51	20.86	1.32	29.73	34.37	43.24	0.00	0.00
480	0.00125	36.12	15.44	20.68	1.32	33.98	36.12	49.42	0.00	0.00
540	0.00116	37.74	17.37	20.37	1.32	38.22	37.74	55.60	0.00	0.00
600	0.00109	39.25	19.31	19.94	1.32	42.47	39.25	61.78	0.00	0.00
660	0.00103	40.66	21.24	19.43	1.32	46.72	40.66	67.95	0.00	0.00
720	0.00097	42.00	23.17	18.84	1.32	50.97	42.00	74.13	0.00	0.00
1440	0.00000	0.00	46.33	0.00	0.00	0.00	0.00	46.33	0.00	0.00

Job:	2911
Name:	Generic Lot claculations

Rainfall depths (mm) :: RCP8.5 for the period 2081-2100

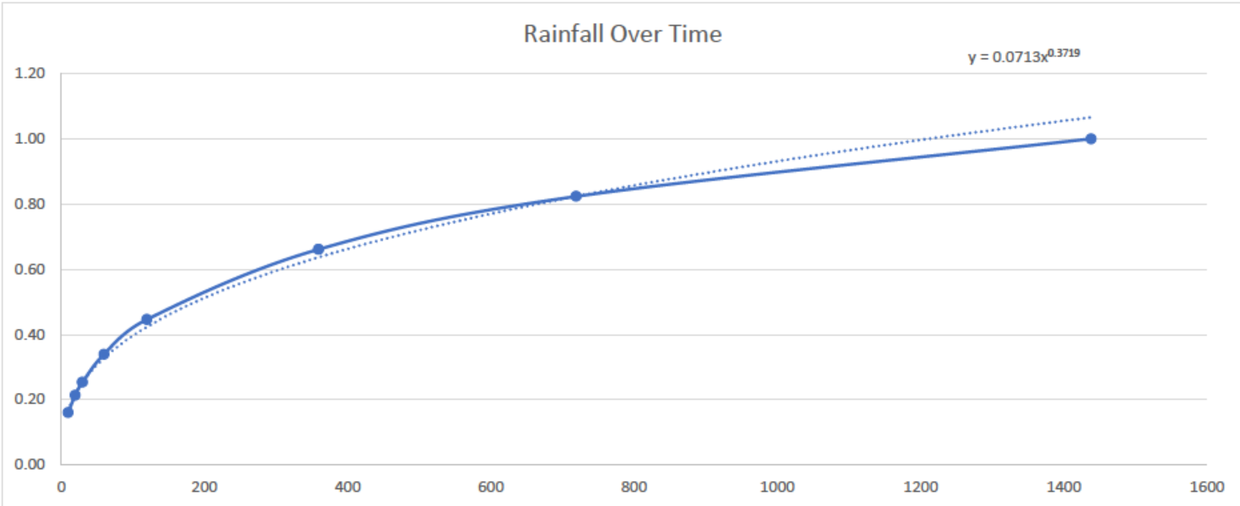
ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	9.9	13.3	15.8	21.4	28.3	42.4	53.2	65.6	78.2	85.3	90.3	94.1
2	0.5	10.9	14.7	17.4	23.5	31.1	46.5	58.4	71.5	85.4	93.3	98.6	102
5	0.2	14.4	19.3	22.9	30.7	40.5	60.3	75.4	91.8	109	119	125	130
10	0.1	17.1	22.8	27	36.1	47.6	70.5	87.8	107	126	138	145	150
20	0.05	20	26.5	31.4	41.8	54.9	81	101	121	144	156	165	170
30	0.033	21.7	28.8	34	45.2	59.3	87.3	108	131	154	168	176	182
40	0.025	22.9	30.4	35.9	47.6	62.4	91.9	114	137	162	176	184	191
50	0.02	23.9	31.7	37.4	49.7	65	95.4	118	142	168	182	191	197
60	0.017	24.8	32.7	38.6	51.2	67	98.5	122	146	172	187	196	203
80	0.013	26.1	34.5	40.7	53.9	70.4	103	127	153	180	195	205	212
100	0.01	27.1	35.8	42.2	55.9	72.9	107	132	158	186	201	211	218
250	0.004	31.5	41.4	48.7	64.3	83.5	122	150	179	210	226	237	245

Rainfall Over Time

	10	20	30	60	120	360	720	1440	2880
Q2	0.15	0.21	0.24	0.33	0.43	0.65	0.82	1.00	1.19
Q5	0.16	0.21	0.25	0.33	0.44	0.66	0.82	1.00	1.19
Q10	0.16	0.21	0.25	0.34	0.44	0.66	0.82	1.00	1.18
Q100	0.17	0.23	0.27	0.35	0.46	0.68	0.84	1.00	1.18
Average	0.16	0.21	0.25	0.34	0.45	0.66	0.82	1.00	1.18

y = Ax^n	
A	0.0713
n	0.3719

Time	Calculated Depth	Normalised Depth
10	0.17	0.158
15	0.20	0.183
20	0.22	0.204
30	0.25	0.237
60	0.33	0.307
120	0.42	0.397
180	0.49	0.461
240	0.55	0.514
300	0.59	0.558
360	0.64	0.597
420	0.67	0.632
480	0.71	0.665
540	0.74	0.694
600	0.77	0.722
660	0.80	0.748
720	0.82	0.773
1440	1.07	1.000



HIRDS V4 Depth-Duration-Frequency Results
Sitename: Peka Peka Peka Peka
Coordinate system: WGS84
Longitude: 175.0648
Latitude: -40.8393

DDF Mode Parameter:	c	d	e	f	g	h	i
Values:	-0.00564	0.428403	-0.00517	-0.00266	0.243409	-0.00904	2.794195
Example:	Duration (h	ARI (yrs)	x	y	Rainfall Depth (mm)		
	24	100	3.178054	4.600149	129.5321		

Rainfall depths (mm) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	7.57	10.2	12.1	16.3	21.9	34.1	44.1	55.6	68	75.4	80.5	84.3
2	0.5	8.31	11.1	13.3	17.9	23.9	37.1	47.9	60.3	73.8	81.7	87.1	91.2
5	0.2	10.9	14.5	17.2	23.1	30.8	47.4	60.9	76.4	93	103	109	114
10	0.1	12.8	17.1	20.2	27	35.9	55.1	70.6	88.2	107	118	126	131
20	0.05	14.9	19.7	23.3	31.1	41.2	63	80.4	100	121	134	142	148
30	0.033	16.1	21.4	25.3	33.6	44.5	67.8	86.4	108	130	143	152	158
40	0.025	17	22.6	26.6	35.4	46.8	71.2	90.7	113	136	150	159	165
50	0.02	17.8	23.5	27.7	36.8	48.6	73.9	94	117	141	155	164	171
60	0.017	18.4	24.3	28.7	38	50.2	76.1	96.8	120	145	159	169	176
80	0.013	19.3	25.5	30.1	39.9	52.6	79.7	101	125	151	166	176	183
100	0.01	20.1	26.5	31.3	41.4	54.5	82.4	105	130	156	171	181	188
250	0.004	23.3	30.7	36.1	47.6	62.4	93.9	119	147	176	192	203	211

Depth standard error (mm) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	0.99	1.2	1.3	2	2.7	5.1	7.1	12	15	17	17	19
2	0.5	1.1	1.3	1.5	2.1	2.9	5.6	7.7	13	17	18	19	21
5	0.2	1.5	1.8	2.1	2.9	3.9	7.2	9.9	16	21	24	24	27
10	0.1	2	2.5	2.9	3.7	4.8	8.4	12	19	25	27	28	31
20	0.05	2.6	3.3	3.9	4.7	6.1	9.9	14	22	29	31	32	36
30	0.033	3.1	3.9	4.6	5.5	7.1	11	15	24	31	34	35	39
40	0.025	3.5	4.5	5.2	6.1	7.8	12	16	25	33	36	37	41
50	0.02	3.8	4.9	5.8	6.7	8.5	13	17	26	34	37	39	43
60	0.017	4.1	5.3	6.2	7.2	9.1	13	18	27	35	39	40	45
80	0.013	4.6	6	7	8	10	14	19	28	37	41	42	47
100	0.01	5.1	6.5	7.7	8.7	11	15	20	30	39	42	44	49
250	0.004	7.4	9.5	11	13	16	19	26	36	46	50	53	59

Rainfall depths (mm) :: RCP2.6 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	8.11	10.9	13	17.5	23.4	36	46.1	57.9	70.4	77.7	82.7	86.5
2	0.5	8.9	11.9	14.2	19.1	25.6	39.3	50.3	62.9	76.4	84.3	89.7	93.7
5	0.2	11.7	15.6	18.5	24.8	33	50.4	64.2	79.9	96.7	106	113	118
10	0.1	13.8	18.4	21.8	29.1	38.6	58.6	74.5	92.4	111	123	130	135
20	0.05	16	21.3	25.2	33.5	44.4	67.1	85	105	127	139	147	153
30	0.033	17.4	23.1	27.3	36.3	47.9	72.2	91.4	113	136	149	157	164
40	0.025	18.4	24.3	28.8	38.2	50.4	75.9	96	118	142	156	165	171
50	0.02	19.2	25.4	30	39.8	52.4	78.8	99.5	123	147	161	170	177
60	0.017	19.8	26.2	30.9	41	54	81.2	102	126	151	165	175	182
80	0.013	20.9	27.6	32.5	43.1	56.7	85	107	132	158	172	182	189
100	0.01	21.7	28.6	33.8	44.7	58.7	88	111	136	163	178	188	195
250	0.004	25.2	33.1	39	51.4	67.3	100	126	154	183	200	211	219

Rainfall depths (mm) :: RCP2.6 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	8.11	10.9	13	17.5	23.4	36	46.1	57.9	70.4	77.7	82.7	86.5
2	0.5	8.9	11.9	14.2	19.1	25.6	39.3	50.3	62.9	76.4	84.3	89.7	93.7
5	0.2	11.7	15.6	18.5	24.8	33	50.4	64.2	79.9	96.7	106	113	118
10	0.1	13.8	18.4	21.8	29.1	38.6	58.6	74.5	92.4	111	123	130	135
20	0.05	16	21.3	25.2	33.5	44.4	67.1	85	105	127	139	147	153
30	0.033	17.4	23.1	27.3	36.3	47.9	72.2	91.4	113	136	149	157	164
40	0.025	18.4	24.3	28.8	38.2	50.4	75.9	96	118	142	156	165	171
50	0.02	19.2	25.4	30	39.8	52.4	78.8	99.5	123	147	161	170	177
60	0.017	19.8	26.2	30.9	41	54	81.2	102	126	151	165	175	182
80	0.013	20.9	27.6	32.5	43.1	56.7	85	107	132	158	172	182	189
100	0.01	21.7	28.6	33.8	44.7	58.7	88	111	136	163	178	188	195
250	0.004	25.2	33.1	39	51.4	67.3	100	126	154	183	200	211	219

Rainfall depths (mm) :: RCP4.5 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	8.24	11.1	13.2	17.8	23.7	36.5	46.7	58.4	71	78.3	83.3	87.1
2	0.5	9.06	12.2	14.5	19.5	26	39.8	50.9	63.5	77.1	85	90.4	94.4
5	0.2	11.9	15.9	18.9	25.3	33.6	51.1	65.1	80.8	97.6	107	114	119
10	0.1	14	18.7	22.2	29.6	39.3	59.5	75.5	93.5	113	124	131	137
20	0.05	16.3	21.7	25.6	34.2	45.1	68.2	86.2	106	128	140	148	154
30	0.033	17.7	23.5	27.8	36.9	48.7	73.4	92.6	114	137	150	159	165
40	0.025	18.7	24.8	29.3	38.9	51.3	77.1	97.3	120	143	157	166	173
50	0.02	19.5	25.9	30.5	40.5	53.3	80.1	101	124	149	162	172	179
60	0.017	20.2	26.7	31.5	41.8	55	82.5	104	128	153	167	177	183
80	0.013	21.3	28.1	33.1	43.9	57.7	86.4	109	133	159	174	184	191
100	0.01	22.1	29.2	34.4	45.5	59.8	89.4	112	138	164	180	190	197
250	0.004	25.7	33.8	39.7	52.4	68.5	102	128	156	185	202	213	221

Rainfall depths (mm) :: RCP4.5 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	8.67	11.6	13.9	18.7	24.9	38	48.3	60.3	72.8	80.1	85.1	88.9
2	0.5	9.53	12.8	15.2	20.5	27.3	41.5	52.8	65.6	79.2	87.1	92.5	96.5
5	0.2	12.5	16.8	19.9	26.7	35.4	53.5	67.7	83.6	101	110	117	122
10	0.1	14.8	19.8	23.4	31.3	41.4	62.3	78.7	96.8	116	127	135	140
20	0.05	17.3	22.9	27.1	36.1	47.6	71.5	89.9	110	132	144	153	158
30	0.033	18.7	24.8	29.4	39	51.4	76.9	96.6	118	141	154	163	169
40	0.025	19.8	26.2	31	41.1	54.1	80.9	102	124	148	162	171	177
50	0.02	20.7	27.3	32.3	42.8	56.3	84	105	129	153	167	177	183
60	0.017	21.4	28.3	33.3	44.2	58.1	86.6	108	132	158	172	182	188
80	0.013	22.5	29.7	35.1	46.5	60.9	90.6	113	138	165	179	189	196
100	0.01	23.4	30.9	36.4	48.2	63.1	93.9	117	143	170	185	195	202
250	0.004	27.2	35.7	42	55.4	72.3	107	133	162	192	208	219	227

Rainfall depths (mm) :: RCP6.0 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	8.19	11	13.1	17.7	23.6	36.3	46.5	58.2	70.7	78	83.1	86.9
2	0.5	9	12.1	14.4	19.3	25.8	39.6	50.7	63.3	76.8	84.7	90.1	94.1
5	0.2	11.8	15.8	18.7	25.1	33.3	50.8	64.7	80.4	97.2	107	114	118
10	0.1	13.9	18.6	22	29.4	39	59.1	75.1	93.1	112	123	131	136
20	0.05	16.2	21.5	25.5	33.9	44.8	67.8	85.7	106	127	140	148	154
30	0.033	17.6	23.3	27.6	36.7	48.4	72.9	92.1	114	136	149	158	164
40	0.025	18.6	24.6	29.1	38.6	50.9	76.7	96.8	119	143	156	165	172
50	0.02	19.4	25.7	30.3	40.2	53	79.6	100	123	148	162	171	178
60	0.017	20	26.5	31.3	41.5	54.6	82	103	127	152	166	176	183
80	0.013	21.1	27.9	32.9	43.6	57.3	85.8	108	133	159	173	183	190
100	0.01	21.9	29	34.1	45.2	59.4	88.9	112	137	164	179	189	196
250	0.004	25.5	33.5	39.4	52	68	101	127	155	185	201	212	220

Rainfall depths (mm) :: RCP6.0 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	9.04	12.2	14.5	19.5	25.9	39.3	49.8	61.9	74.5	81.7	86.7	90.5
2	0.5	9.96	13.4	15.9	21.4	28.5	43.1	54.5	67.4	81.1	89	94.4	98.3
5	0.2	13.1	17.5	20.8	27.9	36.9	55.6	70.1	86.1	103	113	120	124
10	0.1	15.5	20.7	24.5	32.8	43.3	64.8	81.5	99.8	119	131	138	143
20	0.05	18.1	24	28.4	37.9	49.8	74.4	93.2	114	136	148	156	162
30	0.033	19.6	26	30.8	40.9	53.8	80.1	100	122	145	158	167	173
40	0.025	20.8	27.5	32.5	43.1	56.7	84.3	105	128	152	166	175	181
50	0.02	21.7	28.7	33.9	44.9	59	87.5	109	133	158	172	181	188
60	0.017	22.4	29.6	35	46.4	60.8	90.3	113	137	162	177	186	193
80	0.013	23.6	31.2	36.8	48.7	63.8	94.5	118	143	169	184	194	201
100	0.01	24.5	32.4	38.2	50.5	66.1	97.9	122	148	175	190	200	207
250	0.004	28.5	37.5	44.1	58.1	75.8	111	138	167	197	214	225	232

Rainfall depths (mm) :: RCP8.5 for the period 2031-2050

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	8.34	11.2	13.3	18	24	36.8	47.1	58.9	71.4	78.7	83.7	87.5
2	0.5	9.17	12.3	14.6	19.7	26.3	40.2	51.3	64	77.6	85.5	90.9	94.9
5	0.2	12	16.1	19.1	25.6	34	51.7	65.7	81.5	98.3	108	115	120
10	0.1	14.2	19	22.5	30	39.8	60.2	76.3	94.3	113	125	132	137
20	0.05	16.5	22	26	34.6	45.7	68.9	87.1	107	129	141	149	155
30	0.033	18	23.8	28.1	37.4	49.3	74.2	93.6	115	138	151	160	166
40	0.025	19	25.1	29.7	39.4	51.9	78	98.3	121	144	158	167	174
50	0.02	19.8	26.2	30.9	41.1	54	81	102	125	150	164	173	180
60	0.017	20.5	27.1	31.9	42.4	55.7	83.5	105	129	154	168	178	184
80	0.013	21.6	28.5	33.6	44.5	58.5	87.4	110	134	161	175	185	192
100	0.01	22.4	29.6	34.9	46.2	60.6	90.5	114	139	166	181	191	198
250	0.004	26	34.2	40.2	53.1	69.4	103	129	157	187	203	215	222

Rainfall depths (mm) :: RCP8.5 for the period 2081-2100

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	9.9	13.3	15.8	21.4	28.3	42.4	53.2	65.6	78.2	85.3	90.3	94.1
2	0.5	10.9	14.7	17.4	23.5	31.1	46.5	58.4	71.5	85.4	93.3	98.6	102
5	0.2	14.4	19.3	22.9	30.7	40.5	60.3	75.4	91.8	109	119	125	130
10	0.1	17.1	22.8	27	36.1	47.6	70.5	87.8	107	126	138	145	150
20	0.05	20	26.5	31.4	41.8	54.9	81	101	121	144	156	165	170
30	0.033	21.7	28.8	34	45.2	59.3	87.3	108	131	154	168	176	182
40	0.025	22.9	30.4	35.9	47.6	62.4	91.9	114	137	162	176	184	191
50	0.02	23.9	31.7	37.4	49.7	65	95.4	118	142	168	182	191	197
60	0.017	24.8	32.7	38.6	51.2	67	98.5	122	146	172	187	196	203
80	0.013	26.1	34.5	40.7	53.9	70.4	103	127	153	180	195	205	212
100	0.01	27.1	35.8	42.2	55.9	72.9	107	132	158	186	201	211	218
250	0.004	31.5	41.4	48.7	64.3	83.5	122	150	179	210	226	237	245

RIP Rap sizing

Purpose: To understand indicative rip rap sizing required to accommodate maximum 1% and 10% AEP flows prior to discharge to identified outlet locaitons in drain and wetland.

Outlet Pipe			
Estimated Flow	2827	L/s	
Pipe Size	1200	mm	
Pipe Roughness	0.0015	k	
Grade	2.00%		
Velocity	2.50	m/s	
Capacity Flow	2827.43	L/s	Assumes full flow
Froude Number			
Depth of flow in pipe	1.200	m	Assumes full flow
	0.73		
RipRap Median Size			
Diameter	219.00	mm	TP10 Rip Rap Apron calculation
Apron Size			
Length	6.81	m	TP10 Rip Rap Apron calculation
Width	3.60	m	TP10 Rip Rap Apron calculation
Designer	JH		

Appendix D – Supporting Details and Soakage Tests

- *D-21512-CAL-C-001 – Soakage Tests.pdf* – Field soakage test results (CGW, 2025)

Job Number	21512	**Prepared**	SC
Job Name	Waikanae North Subdivision	**Reviewed**	CG
Calc Purpose	Subdivision	**Date**	14/05/2025

Falling Head (Variable Head) Percolation Test - ST01

This calculator is based on NZBC E/1 VM1. Note that sizing a soakage device using this percolation rate should be use base soakage only per NZBC E1/VM1 (i.e. no side soakage).

Result

Based on the testing carried out the percolation rate is assesed as 3000mm/hr

Testing Data

Test hole diameter	0.10m	Test hole depth (D)	1.00m

Table 1 - Test Log

Time	Water Level	Water depth	Time steps		Interval	Depth steps		Water Drop Over interval	Interval Gradient		%age Empty
T	d	D-d	t0	t1	x = t1-t0	h0	h1	y = h1 - h0	y/x		
min	mBGL	m	min	min	min	m	m	m - m	m/min	mm/hr	
0	0.250	0.750	-	-		-	-	- - -			25%
1	0.400	0.600	0	1	1	0.750	0.600	0.150	0.150	9000	40%
2	0.490	0.510	1	2	1	0.600	0.510	0.090	0.090	5400	49%
3	0.610	0.390	2	3	1	0.510	0.390	0.120	0.120	7200	61%
4	0.700	0.300	3	4	1	0.390	0.300	0.090	0.090	5400	70%
5	0.790	0.210	4	5	1	0.300	0.210	0.090	0.090	5400	79%
6	0.860	0.140	5	6	1	0.210	0.140	0.070	0.070	4200	86%
7	0.910	0.090	6	7	1	0.140	0.090	0.050	0.050	3000	91%
				0							

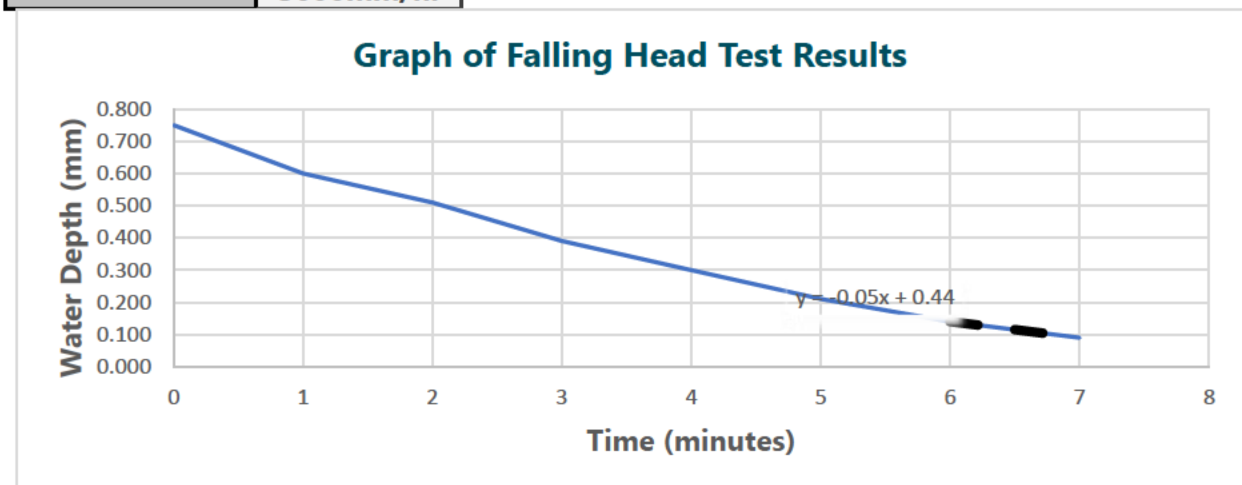
6		0.140	Selected points for minimum gradient
7		0.090	

Minimum Gradient - assesssed from graph below

y	0.050m	x	1min	Gradient	y/x	0.050

Percolation Rate

Percolation Rate =	3000mm/hr



Job Number	21512	**Prepared**	SC
Job Name	Waikanae North Subdivision	**Reviewed**	CG
Calc Purpose	Subdivision	**Date**	14/05/2025

Falling Head (Variable Head) Percolation Test - ST02

This calculator is based on NZBC E/1 VM1. Note that sizing a soakage device using this percolation rate should be use base soakage only per NZBC E1/VM1 (i.e. no side soakage).

Result

Based on the testing carried out the percolation rate is assesed as 1800mm/hr

Testing Data

Test hole diameter	0.10m	**Test hole depth (D)**	0.60m

Table 1 - Test Log

Time	Water Level	Water depth	Time steps		Interval	Depth steps		Water Drop Over interval	Interval Gradient		%age Empty
T	d	D-d	t0	t1	x = t1-t0	h0	h1	y = h1 - h0	y/x		
min	mBGL	m	min	min	min	m	m	m - m	m/min	mm/hr	
0	0.000	0.600	-	-		-	-	- - -			0%
1	0.200	0.400	0	1	1	0.600	0.400	0.200	0.200	12000	33%
2	0.310	0.290	1	2	1	0.400	0.290	0.110	0.110	6600	52%
3	0.380	0.220	2	3	1	0.290	0.220	0.070	0.070	4200	63%
4	0.450	0.150	3	4	1	0.220	0.150	0.070	0.070	4200	75%
5	0.480	0.120	4	5	1	0.150	0.120	0.030	0.030	1800	80%
6	0.530	0.070	5	6	1	0.120	0.070	0.050	0.050	3000	88%

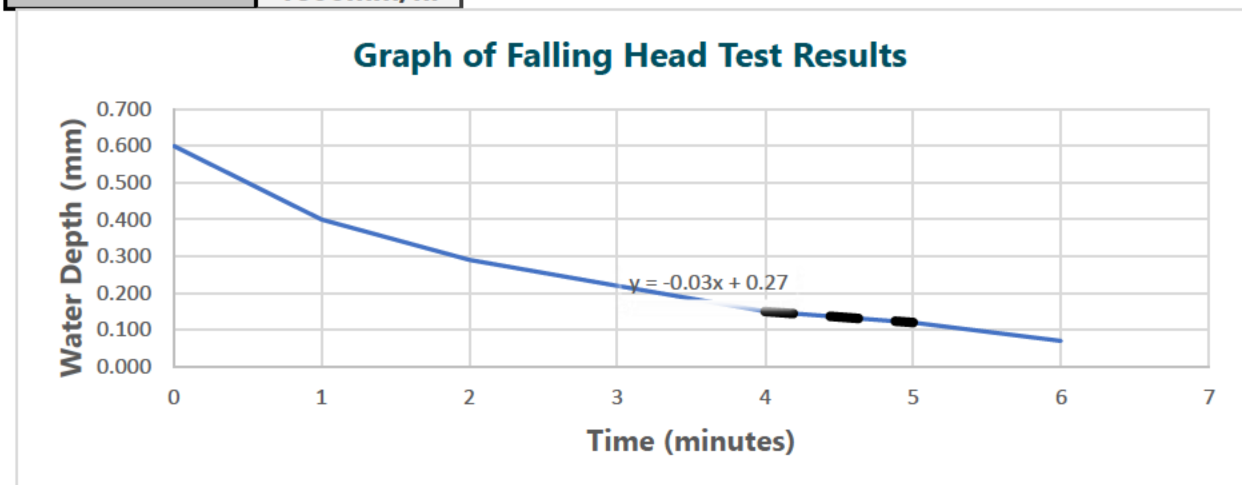
4		0.150	Selected points for minimum gradient
5		0.120	

Minimum Gradient - assesssed from graph below

y	0.030m	x	1min	Gradient	y/x	0.030

Percolation Rate

Percolation Rate =	1800mm/hr



Job Number	21512	**Prepared**	SC
Job Name	Waikanae North Subdivision	**Reviewed**	CG
Calc Purpose	Subdivision	**Date**	14/05/2025

Falling Head (Variable Head) Percolation Test - ST03

This calculator is based on NZBC E/1 VM1. Note that sizing a soakage device using this percolation rate should be use base soakage only per NZBC E1/VM1 (i.e. no side soakage).

Result

Based on the testing carried out the percolation rate is assesed as 2700mm/hr

Testing Data

Test hole diameter	0.10m	Test hole depth (D)	1.00m

Table 1 - Test Log

Time	Water Level	Water depth	Time steps		Interval	Depth steps		Water Drop Over interval	Interval Gradient		%age Empty
T	d	D-d	t0	t1	x = t1-t0	h0	h1	y = h1 - h0	y/x		
min	mBGL	m	min	min	min	m	m	m - m	m/min	mm/hr	
0	0.150	0.850	-	-		-	-	- - -			15%
1	0.380	0.620	0	1	1	0.850	0.620	0.230	0.230	13800	38%
2	0.490	0.510	1	2	1	0.620	0.510	0.110	0.110	6600	49%
3	0.560	0.440	2	3	1	0.510	0.440	0.070	0.070	4200	56%
4	0.640	0.360	3	4	1	0.440	0.360	0.080	0.080	4800	64%
5	0.700	0.300	4	5	1	0.360	0.300	0.060	0.060	3600	70%
6	0.750	0.250	5	6	1	0.300	0.250	0.050	0.050	3000	75%
7	0.800	0.200	6	7	1	0.250	0.200	0.050	0.050	3000	80%
8	0.840	0.160	7	8	1	0.200	0.160	0.040	0.040	2400	84%
9	0.890	0.110	8	9	1	0.160	0.110	0.050	0.050	3000	89%
10	0.930	0.070	9	10	1	0.110	0.070	0.040	0.040	2400	93%

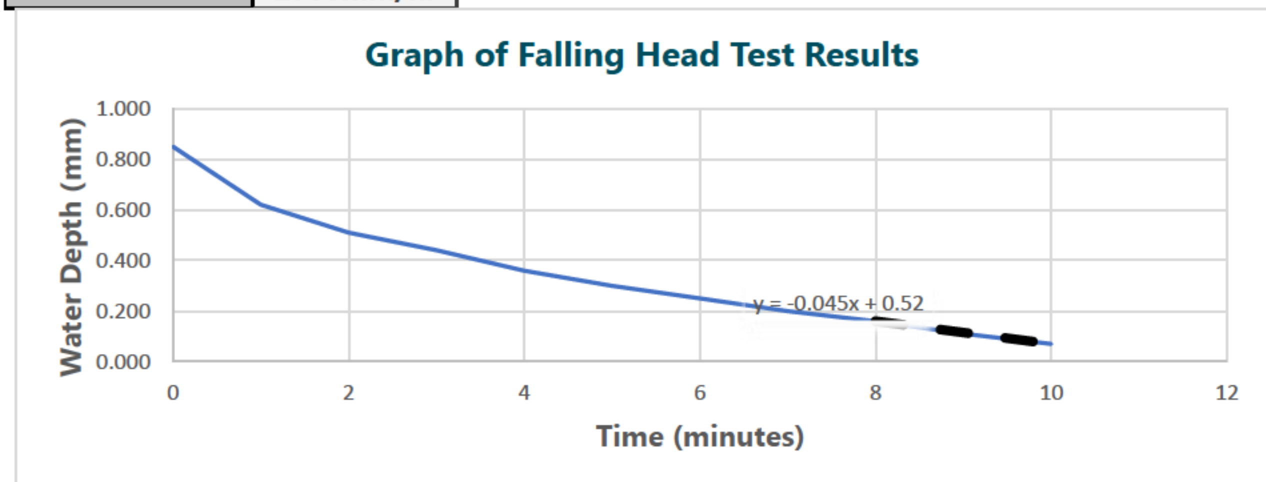
8		0.160	Selected points for minimum gradient
10		0.070	

Minimum Gradient - assesssed from graph below

y	0.090m	x	2min	Gradient	y/x	0.045

Percolation Rate

Percolation Rate =	2700mm/hr



Job Number	21512	**Prepared**	SC
Job Name	Waikanae North Subdivision	**Reviewed**	CG
Calc Purpose	Subdivision	**Date**	14/05/2025

Falling Head (Variable Head) Percolation Test - ST04

This calculator is based on NZBC E/1 VM1. Note that sizing a soakage device using this percolation rate should be use base soakage only per NZBC E1/VM1 (i.e. no side soakage).

Result

Based on the testing carried out the percolation rate is assesed as 1200mm/hr

Testing Data

Test hole diameter	0.10m	Test hole depth (D)	1.00m

Table 1 - Test Log

Time	Water Level	Water depth	Time steps		Interval	Depth steps		Water Drop Over interval	Interval Gradient		%age Empty
T	d	D-d	t0	t1	x = t1-t0	h0	h1	y = h1 - h0	y/x		
min	mBGL	m	min	min	min	m	m	m - m	m/min	mm/hr	
0	0.100	0.900	-	-		-	-	- - -			10%
1	0.420	0.580	0	1	1	0.900	0.580	0.320	0.320	19200	42%
2	0.540	0.460	1	2	1	0.580	0.460	0.120	0.120	7200	54%
3	0.640	0.360	2	3	1	0.460	0.360	0.100	0.100	6000	64%
4	0.700	0.300	3	4	1	0.360	0.300	0.060	0.060	3600	70%
5	0.730	0.270	4	5	1	0.300	0.270	0.030	0.030	1800	73%
6	0.850	0.150	5	6	1	0.270	0.150	0.120	0.120	7200	85%
7	0.890	0.110	6	7	1	0.150	0.110	0.040	0.040	2400	89%
8	0.910	0.090	7	8	1	0.110	0.090	0.020	0.020	1200	91%
9	0.930	0.070	8	9	1	0.090	0.070	0.020	0.020	1200	93%

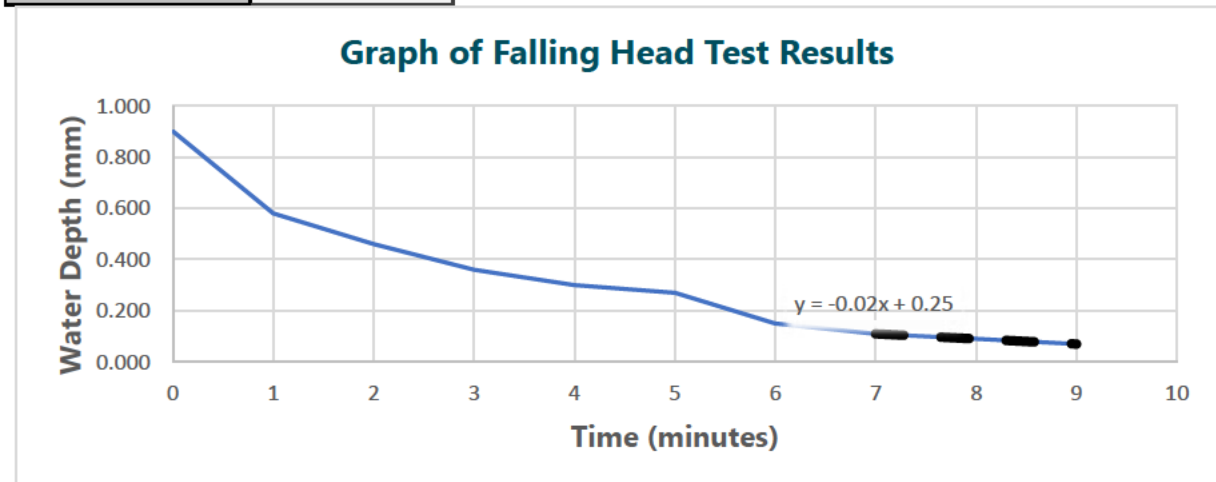
7		0.110	Selected points for minimum gradient
9		0.070	

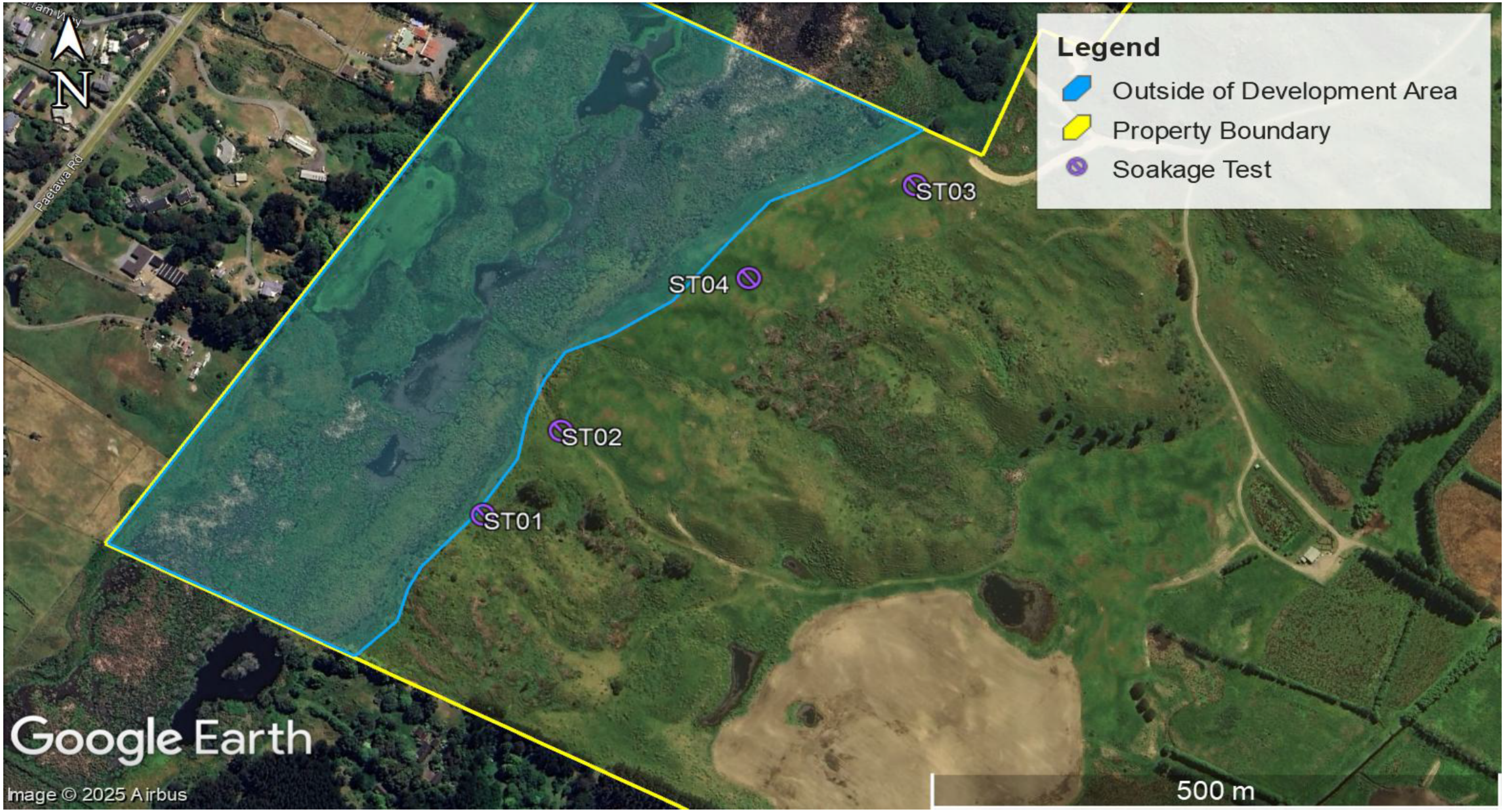
Minimum Gradient - assesssed from graph below

y	0.040m	x	2min	Gradient	y/x	0.020

Percolation Rate

Percolation Rate =	1200mm/hr





CGW CONSULTING ENGINEERS AUCKLAND • WELLINGTON • NELSON • WESTPORT • CHRISTCHURCH • WANAKA www.cgwl.co.nz • office@cgwl.co.nz • Tel: +64 3 548 8259	CLIENT WAIKANAE NORTH DEVELOPMENTS C/- LANDLINK (PAUL TURNER)	JOB TITLE WAIKANAE NORTH SUBDIVISION WAIKANAE, KAPITI COAST	DRAWING TITLE TEST LOCATION PLAN SOAKAGE TESTING	DESIGNED BY: CLEM GIBBENS DRAFTED BY: CLEM GIBBENS	REV A, DATE 16/05/25, REVISION TEST LOCATION PLAN - SOAKAGE, CHD -, APD RS	NOT FOR CONSTRUCTION SCALE N.T.S. PROJECT NO 21512, TYPE -TLP-, SHEET G-Soakage	SIZE A3 REV A