



SITE BASED STORMWATER MANAGEMENT PLAN

93 ABBOTSFORD ROAD, BOWEN HILLS PERRY PARK REDEVELOPMENT

PLANS AND DOCUMENTS
referred to in the ULDA
APPROVAL dated 27 / 1 / 11

**Commissioned by
YMCA**

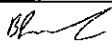
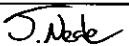
JUNE 2010

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REPORT CONTROL SHEET

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Site:	93 ABBOTSFORD ROAD, BOWEN HILLS
Report Title:	Site Based Stormwater Management Plan
Report Author:	Blake Peacock

REVISION / CHECKING

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1. INTRODUCTION

This report has been prepared to support a development application to be lodged with Brisbane City Council (BCC) for the property at 93 Abbotsford Road, Bowen Hills or Perry Park. The proposed development is for redevelopment works for the existing soccer club which entails the construction of a new sports & recreation building, including an undercover carpark and landscaped areas. The proposed development layout plan is included in Figure 2.

This report also seeks to establish the flooding conditions for the site during a major storm event. The ensuing requirements for the new proposed commercial building floor levels will also be addressed in accordance with Brisbane City Councils Subdivision & Development Guidelines. It will identify requirements of future development, in accordance with Brisbane City Councils Subdivision and Development Guidelines.

In addition, the development will be assessed as to its compliance with the following:

- Flood immunity levels as set out in Table A1.1, Table A1.2 and Table A1.3 of Brisbane City Council's Subdivision and Development Guidelines are achieved.

This report supersedes a previously prepared Site Based Stormwater Management Plan dated February 2010 (i.e. 1463-100215-RPT-SBSMP-REV 1). This updated report revision has development layout amendments attributed to it with respect to the original submission.

2. SITE AND CATCHMENT DESCRIPTION

The site comprises of Lot 136 and 135 on B123430, and Lot 137 and 138 on SL11563, more commonly known as 93 Abbotsford Road, Bowen Hills. The site has total area of 1.801 hectares, however the proposed developable area on site is only 0.654 hectares. Under existing conditions, the site is developed with a two-storey club house building, currently utilised as the Brisbane Strikers Soccer Club Headquarters, which consists of a soccer field, a grandstand facility, bar, food provision services, gym, office and carparking areas. Moreover, the actual proposed developable area is located at the north west corner of the site and is covered by bitumen hardstand area currently utilised as an uncovered car parking area and access driveway. The developable area also has a large portion of grassed areas attributed to it. The site is largely flat (due to the soccer field) with only a slight grade in a easterly direction at approximately 0.8%. The site is bound by Abbotsford Road to the west, Folkstone Street to the south and Edmonstone Road to the north and east.

Contour information obtained indicates that there is an upstream catchment contributing flows onto the site at the corner of Folkstone Street and Abbotsford Road. The contributing catchment has an approximate area of 16.11 hectares and is made up of a mixture of low-medium density residential and commercial/industrial properties. The upstream catchment conveys flows to a sag point at the south west corner of the site, where runoff will pond up until flows weir over Abbotsford Road kerb and channel to continue in a northeast direction. Moreover, BCC's mapping system, eBIMAP indicates that the lower lying regions at the centre of the property (i.e. soccer field) is affected by flooding during major storm events.

Existing stormwater gully infrastructure and subsequent pipe infrastructure is located running through the middle of the site from the sag point at the south west corner to the north east corner of the site.

Existing water reticulation and electrical services are provided in all road frontages to the site. An existing sewer service is provided leaving the site from the north east corner of the property.

The existing site conditions are shown in Figure 1.

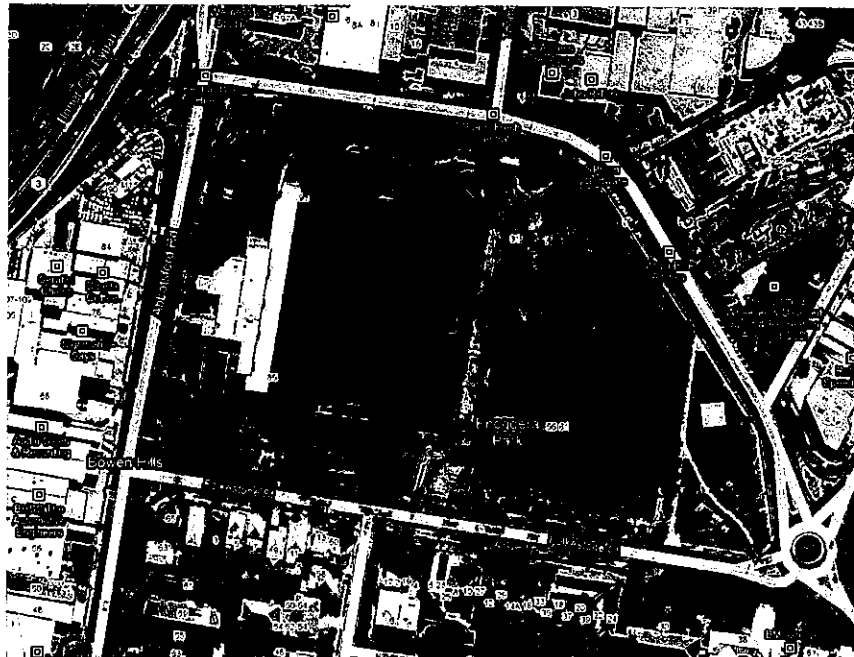


Photo 1: Existing site aerial photo.



Photo 2: Existing site looking northeast across site (soccer field).

3. **DATA**

Stormwater quantity and quality objectives were obtained from Brisbane City Council's 'Subdivision and Development Guidelines', and the 'Stormwater Code'. Rainfall IFD data for Brisbane was obtained from Council's 'Subdivision and Development Guidelines'. All XP-RAFTS rainfall input files have been modified to incorporate Brisbane rainfall information.

4. **CONSTRAINTS**

4.1 **Site Constraints**

Due to the developments space restrictions limited space is available to implement large-scale detention and quality mitigation measures.

5.0 WATER QUANTITY MANAGEMENT

This section of the report identifies stormwater quantity management measures that should be incorporated into the development in order to mitigate increased stormwater discharges from the developable areas onsite. The proposed measures will satisfy Brisbane City Council's requirements of a non worsening effect for existing stormwater infrastructure and surrounding properties with respect to stormwater runoff.

5.1 Potential Impacts of Development

The proposed development has increased the proportion of the developable site area that is impervious, therefore increasing the volume of runoff leaving the site. The consequential impacts of conventional development include increased peak flow rates downstream and extended low flow periods. Accordingly, the local authorities require the developer to ensure no worsening of stormwater runoff from the development affecting downstream properties and/or existing drainage infrastructure.

As such it is proposed that an on-site detention system be constructed within the site to mitigate increased peak discharges to pre-development levels, to ensure a no-worsening of peak storm water runoff experienced on the downstream properties and/or existing infrastructure as a result of the development.

5.2 Existing Conditions

Under existing conditions, the proposed developable area onsite is located at the north west corner of the property and is made up of largely grassed areas with a large portion covered with bitumen hardstand area currently utilised for carparking and driveway access to Edmonstone road to the north. The developable site area generally falls in a south-easterly direction to the soccer field centrally located onsite. All runoff is conveyed via the natural land topography as surface flow.

5.2.2 Hydrology

Method: Rational Method (Detailed Calculations in Appendix A)

Total Area: 6539m² (Developable Site Area) N.B. upstream catchment disregarded for detention modeling

Pervious (grassed) Areas: 70.7%

C₁₀: 0.69

Time of Concentration (t_c): 5 minutes.

The Rational Method was initially established to determine the peak discharges from the site. The Rational Method produced a Q₁₀₀ peak discharge of 0.487m³/s.

5.2.3 Hydraulics

XP-RAFTS:

- 2, 10, 20, 50 and 100 year ARI storm events modelled.
- Total catchment area is 0.6539ha

Catchment: E Dev Area

First sub-catchment data

Initial Loss:- 2mm

Continuing Loss:- 0mm/hr

Catchment Area:- 0.1918 ha

Impervious Area:- 100%

Vectored Slope:- 2.5% (altered for Rational Method calibration)

Manning's 'n' :- 0.015

IFD Coefficients:- Brisbane

Second sub-catchment data

Initial Loss:- 10mm

Continuing Loss:- 2mm/hr

Catchment Area:- 0.4621 ha

Impervious Area:- 0%

Vectored Slope:- 2.5% (altered for Rational Method calibration)

Manning's 'n' :- 0.025

IFD Coefficients:- Brisbane

Existing peak discharges estimated by the XP-RAFTS are presented below:

ARI Storm Event (yr)	Peak Discharge (m ³ /s)
2	0.188
10	0.296
20	0.351
50	0.390
100	0.446

Detailed Rational Method calculations are provided in Appendix A. XP-RAFTS summary details are included in Appendix C.

5.3 Proposed Conditions

It is proposed that roof water generated from the majority of the proposed roof areas be conveyed to a detention roofwater tank system located in close proximity to the proposed commercial building extension. It is proposed to implement a 48300L T10500 Bushmans Roof water tank (or equivalent) for retention/reuse and a separate dual tank detention system comprising of two (2) 48300L T10500 Bushmans Roof water tank (or equivalent) in order to detain runoff from majority of the north west roof areas of the proposed building extension. The dimensions for the T10500 tank are 4.60m in diameter by 2.97m in height (apex height = 3.16m).

Roof runoff generated from the north eastern roof areas of the proposed building extension shall be conveyed to a 15150L T3300 Bushmans Roofwater tank (or equivalent) for retention/reuse and a separate dual tank detention system comprising

of a 48300L T10500 Bushmans Roof water tank (or equivalent) and a 10000L TS2200 Roofwater Tank (or equivalent). The dimensions for the TS2200 tank are 3.05m in diameter by 1.40m in height (apex height 1.70m). The dimensions for the T3300 tank are 3.05m in diameter by 2.20m in height (apex height = 2.44m). It is proposed to locate both roofwater retention/detention tank systems on ground floor at the north-eastern end of the proposed building extension. The roofwater tanks collectively provide approximately 155m³ of detention storage.

In addition, it is now a requirement for various commercial building developments to provide for water retention/reuse onsite. Section MP4.3 - Alternative Water Sources – Commercial Buildings of the Queensland Development Code (26/11/2009) stipulates that Commercial buildings supplied directly with reticulated town water supply system must have a minimum storage of 1500L of reuse storage volume per required pedestal (i.e. toilet). It is noted that the required number of toilets for the development is 25. The proposal entails the provision of 30 toilets and 5 urinals. Therefore, the total retention/reuse volume required is 52.5m³. It is proposed to provide additional roofwater tanks to account for the retention/reuse storage volume requirements.

Flows discharged from both roofwater tank systems shall be conveyed to the existing stormwater pipe infrastructure running through the middle of the site in a north easterly direction. Runoff generated from the remainder of the developable areas onsite shall also be conveyed to the existing stormwater pipe running through the property. The runoff generated from remaining areas onsite shall be collected via inlet pits within the undercover (ground level) car park underneath the proposed commercial building.

Flows from both roofwater tanks onsite shall discharge to the existing pipe infrastructure onsite.

The remaining ground area/free draining area has been incorporated into the XP-RAFTS modelling and consequently the proposed detention systems have been designed to compensate for the free discharges from these areas. For stormwater management layout details, catchment layout and detention/retention tank details refer to Figure 2, 3, and 4 respectively.

The detention/retention systems have been designed such that peak discharges from the developable areas onsite are mitigated to be at or below pre-development levels (as presented above) for a wide range of ARI storm events.

5.3.1 Hydrology

Method: Rational Method (Detailed Calculations in Appendix A)

Catchment: DEVELOPED - Unmitigated & Mitigated

Catchment Area: 6539m² **N.B.** upstream catchment disregarded for detention modeling; North East Roof Area (Roof 2) = 0.2008ha, North West Roof Area = 0.2389ha (Roof 1), Free Draining Area = 0.2142ha.

C₁₀: North East Roof Area = 0.9; North West Roof Area = 0.9; Free Drain Area = 0.70

Time of concentration (t_c): 5 minutes

The Rational Method was initially established to determine the peak discharges from the developed site. The Rational Method produced a Q₁₀₀ peak discharge of 0.560m³/s.

5.3.2 Hydraulics

XP-RAFTS:

- 2, 10, 20, 50 and 100 year ARI storm events modelled.
- Total catchment area is 0.6539ha

Catchment Name: Roof 2 (North east Sports Centre Roof Area)

First sub-catchment data

Initial Loss:- 2mm

Continuing Loss:- 0mm/hr

Catchment Area:- 0.2008 ha

Impervious Area:- 100%

Vectored Slope:- 2.5% (altered for Rational Method calibration)

Manning's 'n' :- 0.015

IFD Coefficients:- Brisbane, QLD

Second sub-catchment data

Initial Loss:- 10mm

Continuing Loss:- 2mm/hr

Catchment Area:- 0.001 ha

Impervious Area:- 0%

Vectored Slope:- 2.5% (altered for Rational Method calibration)

Manning's 'n' :- 0.025

IFD Coefficients:- Brisbane, QLD

Catchment Name: Roof 1 (North West Sports Centre Roof Area)

First sub-catchment data

Initial Loss:- 2mm

Continuing Loss:- 0mm/hr

Catchment Area:- 0.2389ha

Impervious Area:- 100%

Vectored Slope:- 2.5% (altered for Rational Method calibration)

Manning's 'n' :- 0.015

IFD Coefficients:- Brisbane, QLD

Second sub-catchment data

Initial Loss:- 10mm

Continuing Loss:- 2mm/hr

Catchment Area:- 0.001 ha

Impervious Area:- 0%

Vectored Slope:- 2.5% (altered for Rational Method calibration)

Manning's 'n' :- 0.025

IFD Coefficients:- Brisbane, QLD

Catchment Name: Free Drain (Remaining Free Drain Area)

First sub-catchment data

Initial Loss:- 2mm

Continuing Loss:- 0mm/hr

Catchment Area:- 0.0727 ha

Impervious Area:- 100%

Vectored Slope:- 2.5% (altered for Rational Method calibration)

Manning's 'n' :- 0.015

IFD Coefficients:- Brisbane, QLD

Second sub-catchment data**Initial Loss:-** 10mm**Continuing Loss:-** 2mm/hr**Catchment Area:-** 0.1415 ha**Impervious Area:-** 0%**Vectored Slope:-** 2.5% (altered for Rational Method calibration)**Manning's 'n' :-** 0.025**IFD Coefficients:-** Brisbane, QLD

Developed Unmitigated peak discharges estimated by the XP-RAFTS are presented below:

ARI Storm Event (yr)	Peak Discharge (m ³ /s)
2	0.237
10	0.371
20	0.437
50	0.470
100	0.529

Detailed Rational Method calculations are provided in Appendix A. XP-RAFTS summary details are included in Appendix C.

Catchment: DEVELOPED (Mitigated)

Refer above for XP-Rafts catchment details.

XP-RAFTS: -

- 2, 10, 20, 50 and 100 year ARI storm events modelled.
- On-site storage modelled as two separate detention/retention systems
- Catchment area Details - Refer above for modelled catchment details
- Total detention/retention storage volume:
 - Total Roofwater Tank Storage Volume = 215.8m³
 - Roofwater Tank Detention Storage System - Total – 155.2m³ detention storage
 - Roofwater Tank Detention Volume
 - NE Roofwater Tank System (Roof 2)–Detention Volume – 58.56 m³
 - NW Roofwater Tank System (Roof 1)–Detention Volume – 96.67 m³
 - Roofwater Tank Retention Storage System – Total 60.61m³
 - Retention Volume for contributing roof areas
 - NE Roofwater Tank System (Roof 2)– Retention Volume - 46.0 m³
 - NW Roofwater Tank System (Roof 1)– Retention Volume – 14.6 m³
 - For tank location and outlet details refer to Figure 2 and 4, respectively.

Refer to Appendix C for XP-RAFTS detention tank modelling summary and Figure 4 for rainwater detention tank details.

Peak discharges for existing and developed conditions for a wide range of ARI storm events are given in the table below. Existing conditions (Target) peak discharges are that obtained from XP-RAFTS and indicated below. Refer to Appendix A for detailed Rational Method calculations, Appendix B for storage detention design details and Appendix C for XP-RAFTS calculations/results.

XP-RAFTS Peak Discharges

ARI Storm Event (yr)	Existing Peak Discharge (Rational Method) (m³/s)	Existing Peak Discharge (XP-RAFTS) (m³/s)	Developed Peak Discharge (Rational Method) (m³/s)	Developed Peak Discharge (XP-RAFTS) (m³/s)	Post Developed Target Peak Discharge (m³/s)
2	0.160	0.188	0.195	0.237	0.188
10	0.269	0.296	0.326	0.371	0.296
20	0.325	0.351	0.395	0.437	0.351
50	0.418	0.390	0.495	0.470	0.390
100	0.487	0.446	0.560	0.529	0.446

The resulting peak discharges for mitigated conditions against existing conditions are outlined below.

Peak Discharges for Mitigated Conditions vs. Pre-Development Conditions.

Average Recurrence Interval (years)	Existing Peak Flow Rate (m³/s)	Developed Mitigated Peak Flow Rate (m³/s)	Difference (m³/s)
2	0.188	0.115	- 0.033
10	0.296	0.232	- 0.064
20	0.351	0.273	-0.078
50	0.390	0.339	- 0.051
100	0.446	0.395	- 0.051

The on-site detention systems will mitigate increased peak discharges for developed conditions to or below pre-development levels. Therefore, it is demonstrated that there is no increase in peak discharges for a wide range of storm events up to and including the 100 year ARI event. Moreover, it is considered that there will be no adverse impacts on any existing drainage systems downstream due to the proposed development.

6.0 WATER QUALITY MANAGEMENT

6.1 Risk Category

The proposed development is for the construction of a new sports & recreation building elevated over a ground level carpark. Brisbane City Council's 'Stormwater Management Code' classifies the development as 'Low Risk' as none of the 'High Risk' categories are triggered.

Due to the developments 'Low Risk' classification with respect to water quality, it is proposed to implement best management stormwater treatment measures.

6.2 Pollutants of Concern

6.2.1 Construction Phase

During the construction phase of a development, the pollutants listed in Table 5.2 have been identified by BCC's 'Subdivision and Development Guidelines' as being typically generated. Measures will be put in place during the construction phase to manage each of these pollutants.

**Table 6.2 - Pollutants Typically Generated During the Construction Phase
(Brisbane City Council's 'Subdivision and Development Guidelines')**

Pollutant	Source
Litter	Paper, construction packaging, food packaging, cement bags, off-cuts
Sediment	Unprotected exposed soils and stockpiles during earthworks and building
Hydrocarbons	Fuel and oil spills, leaks from construction equipment
Toxic Materials	Cement slurry, asphalt prime, solvents, cleaning agents, washwaters (eg. from tile works)
pH Altering Substances	Acid sulfate soils, cement slurry and washwaters

6.2.2 Operational Phase

The key pollutants generated by various developments during the operational (post-construction) phase of residential developments are outlined below. Those presented in bold text are identified as the key pollutants to be targeted for treatment, and have been selected with consideration of the proposed operational activities and processes to be undertaken on the site.

- **Litter**
- **Sediment**
- Oxygen demanding substances (possibly present)
- **Nutrients (nitrogen & phosphorus)**
- Pathogens / Faecal coliforms (possibly present)
- **Hydrocarbons**
- **Heavy Metals (often associated with fine sediment)**
- **Surfactants**
- Organochlorines & organophosphates (unlikely to be present)
- Thermal pollution
- pH altering substances (possibly present)

During the operational phase, no major sources of oxygen demanding substances, pathogens/faecal coliforms, organochlorines & organophosphates have been identified within the site; therefore it is believed that no further consideration of these pollutants is required.

6.3 Environmental Values and Water Quality Objectives

The level of stormwater quality assessment has been determined in accordance with Council's Stormwater Management Code. As the site has been identified as 'Low Risk' it is considered appropriate to apply best management measures to capture and treat target pollutants.

6.4 Water Quality Treatment

6.4.1 Construction Phase

An Erosion Hazard Assessment (EHA) has been completed based on the information currently available. The assessment indicates that the site may be considered 'High Risk' with respect to erosion and sediment control. The EHA score is 13, which is less than the trigger score of 17. Moreover the trigger score value for Emerson Class was obtained.

The EHA is based on assumed soil characteristics as outlined in Brisbane City Council's 'Erosion Hazard Assessment Supporting Technical Notes'. It is noted that the EHA score may be reduced if soil testing was undertaken for the site. Soil testing may indicate that the soils are of lower erosion potential than currently adopted for the EHA.

It is envisaged that, in order to gain approval, appropriate erosion and sediment control measures will be prepared and implemented on site during construction activities.

Refer to Appendix D for the Erosion Hazard Assessment.

6.4.2 Operational Phase

Consideration has been given to a variety of stormwater quality treatment measures and the opportunity has been taken to implement water sensitive urban design into the development. Due to the nature of the proposed development being classified as 'low risk' with respect to stormwater quality impacts, and the type of pollutants that are expected to be generated on the site it proposed to implement Best Management measures for stormwater treatment.

Council's 'Water Sensitive Urban Design Engineering Guidelines' dated August 2005 state that roof runoff can contain a range of stormwater pollutants including nitrogen washed from the atmosphere during rainfall events and that all roofwater for a Q_3 Month storm event will drain to the stormwater quality treatment devices prior to discharge from the site.

Key elements of the proposed stormwater quality management plan are as follows:

- i) Capture of all roofwater runoff for onsite retention/reuse is proposed via two (2) retention roofwater tank systems. Proposed Retention/reuse Volume = 60.6m³.
- ii) Capture and treatment of runoff generated from the uncovered/covered carpark and driveway area via at-source solid pollutant filters (installed in grated inlet pits) before being discharged offsite.

It is proposed that a rainwater tank system be utilised to capture roof water for onsite retention/detention purposes for the development. The overflow from the retention component will be conveyed to the detention roofwater tank component of the system to then be detained and gradually discharged via roofwater pipe drainage infrastructure to the existing pipe infrastructure running through the centre of the property.

Treatment of all roofwater shall be achieved by the sedimentation and settling process within the proposed rainwater retention/detention tank. The rainwater tank shall facilitate the polishing of roofwater and removal of target pollutants, including litter, sediments and hydrocarbons that may be associated with roofwater runoff.

Treatment of runoff from the uncovered driveway areas (ground level) and basement level areas shall be achieved via an at-source solid pollutant filter (gross pollutant trap).

The Gross Pollutant Trap shall treat for gross pollutants, suspended solids, and some nutrients. As such, pollutant concentrations and loads from the stormwater discharge to existing infrastructure will be reduced accordingly.

The proposed stormwater management plan is shown in Figure 2.

6.5 Water Quality Monitoring

No monitoring of water quality of the runoff from the site is proposed. Untrialled stormwater quality management measures are not proposed. Additionally, the level of treatment proposed is considered best practice and appropriate for the site.

7.0 FLOOD MANAGEMENT

As noted earlier, the property maybe subject to a number of flooding sources, including storm tide and river flooding, as well as flooding due to overland flow.

A BCC Floodwise Property Report was acquired for the development site, which indicated the highest defined flood level (or 100 year ARI Flood Level)(due to stormtide flooding) of 2.5m AHD and a 50 year ARI Flood Level of 2.2m AHD.

However, Council's Floodwise Property Report indicates that the property maybe affected by overland stormwater flow from the sag point at the southwest corner of the property. The upstream catchment contributing flows to the sag point in Abbotsford Road, has an area of approximately 16.12 hectares. During a Q_{50} storm event, approximately 0.98m³/s of runoff will be generated to the Abbotsford Road sag point, before ponding up and weiring over the kerb and channel to continue onto the property and subsequently the soccer field in a north easterly direction. Despite there being some concern as to how adverse of an affect this flooding source may have on the development site, it is noted that the proposed developable area is approximately 90 metres away from the centre of the flow path which runs through the middle of the site. In addition, the levels at which the developable areas onsite are located are somewhat higher than the lower lying areas within the flowpath (soccer field). Moreover, no developable areas are proposed within the lower lying southwestern areas onsite and thus it is envisaged that the stormtide flood levels will be the flooding source from which floor levels should be set.

As specified in Table A1.2 - Categories of Flood Immunity Levels and A1.3 - Assigned Flood Immunity Levels, of Brisbane City Council's Subdivision and Development Guidelines, for Class 5 building type, the minimum 'building' design floor level is the Q_{100} flood level. For 'Garage/carpark' areas located in the building undercroft, the design floor level is the Q_{100} flood level also. For minimum design levels for a carport or unroofed carpark is the Q_{50} flood level.

The minimum design levels for developed areas onsite are based on the stormtide flood levels and are tabulated below.

Table 3. Required Minimum Finished Floor Levels for Proposed Sports Centre

Flood Source Location	Defined Flood Level	Building Floor Level (RL)	Garage/Carpark (undercroft of building)	Carport/Unroofed Carpark Level (RL)
Stormtide	2.50	2.50	2.50	2.20

8. CONCLUSIONS

The proposed development has increased the proportion of the developable site area that is impervious, therefore increasing the volume of runoff leaving the developed area onsite. The consequential impacts of conventional development include increased peak flow rates downstream and extended low flow periods. Accordingly, the local authorities require the developer to ensure no worsening of stormwater runoff from the development affecting downstream properties and/or existing drainage infrastructure. As such it is proposed that an on-site detention system be constructed within the site.

The proposed on-site detention system will provide detention to mitigate increased peak discharges for developed conditions to below existing levels. Therefore, it is demonstrating no increase in peak discharges for a wide range of storm events up to and including the 100 year ARI event. As such there will be no peak flow increases leaving developed areas onsite.

Figures 2 and 3 illustrate the proposed stormwater management layout and on-site detention device locations. Figure 4 shows the rainwater tank detention/retention device preliminary design detail.

Consideration has been given to a variety of stormwater quality treatment measures and the opportunity has been taken to implement water sensitive urban design into the development design.

Key elements of the proposed stormwater quality management plan are as follows:

- i) Capture of all roofwater runoff for onsite detention/retention is proposed via a retention/detention roofwater tank system.
- ii) Capture and treatment of runoff generated from the uncovered/covered carpark and driveway area via at-source solid pollutant filters (installed in grated inlet pits) before being discharged offsite.

Appropriate erosion and sediment control measures will be prepared and implemented on site during construction activities to minimise water quality impacts during the construction phase.

As noted earlier, the property maybe subject to a number of flooding sources, including storm tide and river flooding, as well as flooding due to overland flow. It is envisaged that flooding due to the stormtide is the governing source of flooding with regards to the development site and setting floor levels.

As specified in Table A1.2 - Categories of Flood Immunity Levels and A1.3 - Assigned Flood Immunity Levels, of Brisbane City Council's Subdivision and Development Guidelines, for Class 5 building type, the minimum 'building' design floor level is the Q_{100} flood level. For 'Garage/carpark' areas located in the building undercroft, the design floor level is the Q_{100} flood level also. For minimum design levels for a carport or unroofed carpark is the Q_{50} flood level.

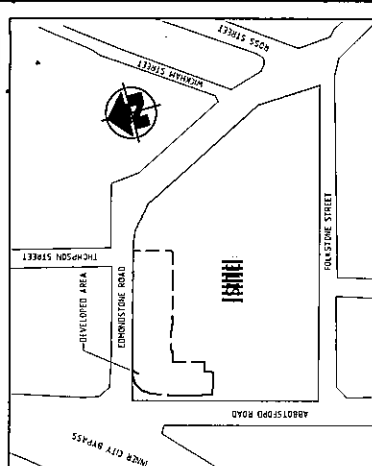
The minimum design levels for developed areas onsite are based on the stormtide flood levels and are tabulated below.

Required Minimum Finished Floor Levels for Proposed Sports Centre

Flood Source Location	Defined Flood Level	Building Floor Level (RL)	Garage/Carpark (undercroft of building)	Carpport/Unroofed Carpark Level (RL)
Stormtide	2.50	2.50	2.50	2.20

In summary, the proposed development allows for management and conveyance of runoff through/from the site with no adverse impact on existing stormwater infrastructure and neighbouring properties provided:

1. The detention/retention roof water tank system specified in this report is provided.
2. The proposed floor levels are constructed to the minimum floor levels specified in the Table above.



UBO MAP REF. MAP C19, 140
GRID REFERENCE K15
LOCALITY PLAN
SCALE 1:2500

LEGEND

- T — EXISTING TELECOMMUNICATIONS
- SWD — EXISTING STOPWATER
- M — EXISTING WATER MAIN
- S — EXISTING SEWER
- E — EXISTING ELECTRICAL
- EXISTING CONTIGURS

ISSUE	AMENDMENT	DATE
A	ISSUED WITH SET	27.10.07
B	ISSUED WITH SET	27.10.07
C	ISSUED WITH SET	27.10.07
D	ISSUED WITH SET	27.10.07

PROJECT
93 ABBOTSFORD ROAD
BOWEN HILLS

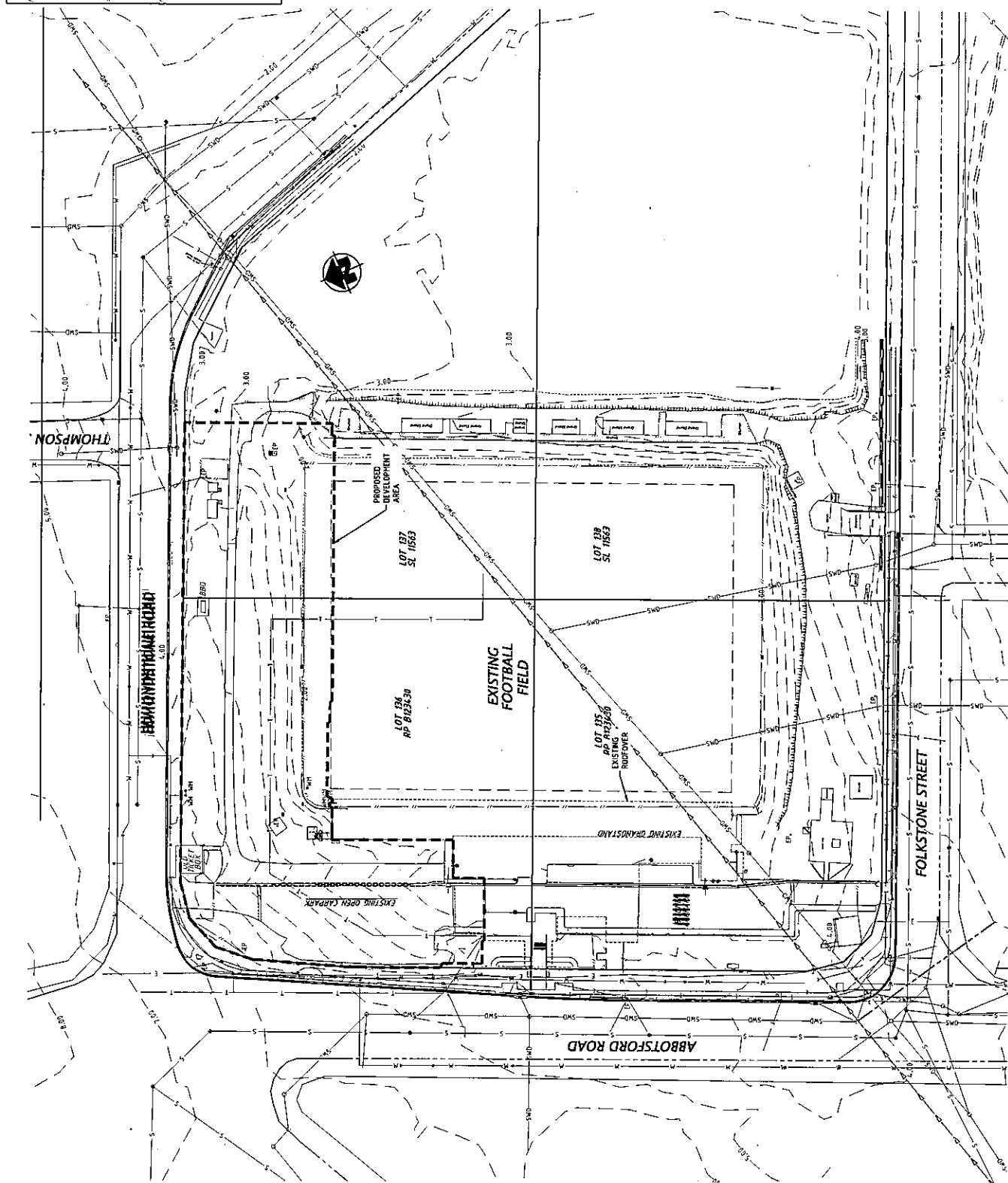
CLIENT
YMCA

TITLE
FIGURE 1
EXISTING
SITE

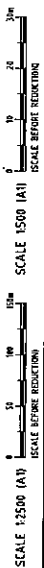
TERPANE ENGINEERING

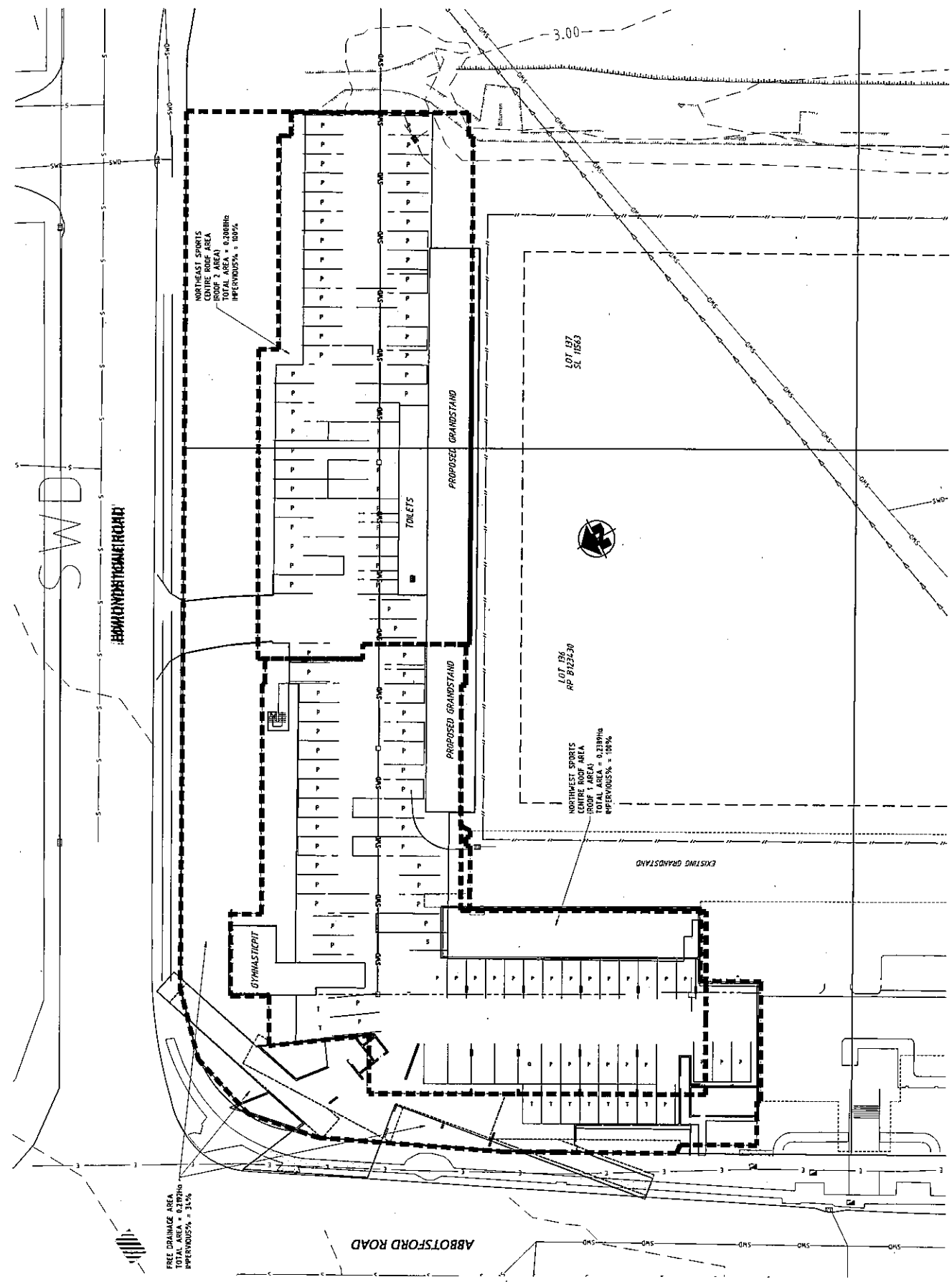
 180 ROSS STREET, SUITE 101
 BOWEN HILLS, QLD 4006
 Phone: (07) 3281 6822
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 Email: info@terpaneengineering.com.au
 140N 71 752 103 428

Drawn By:	CL	Rev:	24.11.09
Checked By:		Scale:	1:2500
Project No:	1463-SK01	Page:	C



PLAN
SCALE 1:500





- LEGEND**
- T — EXISTING TELECOMMUNICATIONS
 - SW — EXISTING STORMWATER
 - M — EXISTING WATER MAIN
 - S — EXISTING SEWER
 - E — EXISTING ELECTRICAL
 - — EXISTING CONDUITS
 - ■ ■ STORMWATER CATCHMENT EXTENT
 - PROPOSED HARDSTAND AREA

ISSUE	AMENDMENT	DATE
A	ISSUED FOR PERMIT	20.09.15
B	ISSUED FOR PERMIT	21.03.16
C	ISSUED FOR PERMIT	21.03.16

PROJECT
93 ABBOTSFORD ROAD
BOWEN HILLS

CLIENT
YMCA

TITLE
FIGURE 3
STORMWATER CATCHMENT
LAYOUT

TERREANE ENGINEERING
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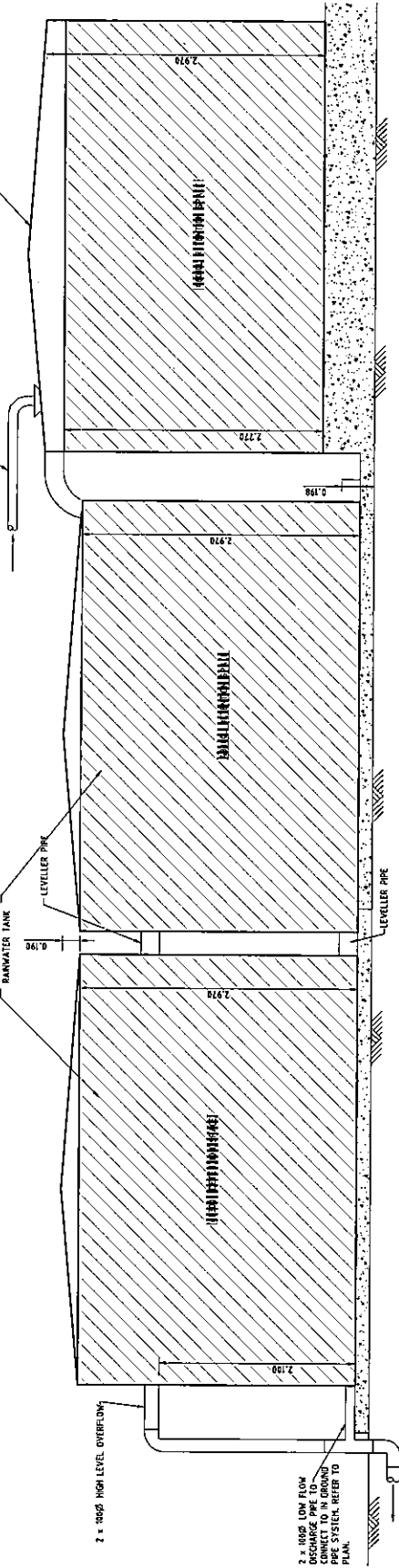
Drawn By	Scale	Date	Rev.
1463-SK03	25:11.09		C

PLAN
SCALE 1:250

SCALE 1:250 (A1)
SCALE BEFORE REDUCTION

ROOFWATER TANK FOR NORTH EAST ROOF AREAS (ROOF 1)

BASIN LEVEL	STORAGE VOLUME m ³	DISCHARGE Qm ³ /s
0.00	0.00	0.000
0.10	1.66	0.010
0.20	4.98	0.018
0.30	8.31	0.023
0.40	11.63	0.028
0.50	14.95	0.031
0.60	18.27	0.035
0.70	21.59	0.038
0.80	24.92	0.040
0.90	28.24	0.043
1.00	31.56	0.045
1.10	34.88	0.048
1.20	38.20	0.050
1.30	41.53	0.052
1.40	44.85	0.054
1.50	48.17	0.056
1.60	51.49	0.058
1.70	54.81	0.060
1.80	58.14	0.062
1.90	61.46	0.063
2.00	64.78	0.065
2.10	68.10	0.067
2.20	71.43	0.068
2.30	74.75	0.069
2.40	78.07	0.070
2.50	81.39	0.071
2.60	84.71	0.072
2.70	88.04	0.073
2.80	91.36	0.074
2.90	94.68	0.075
2.95	96.67	0.076

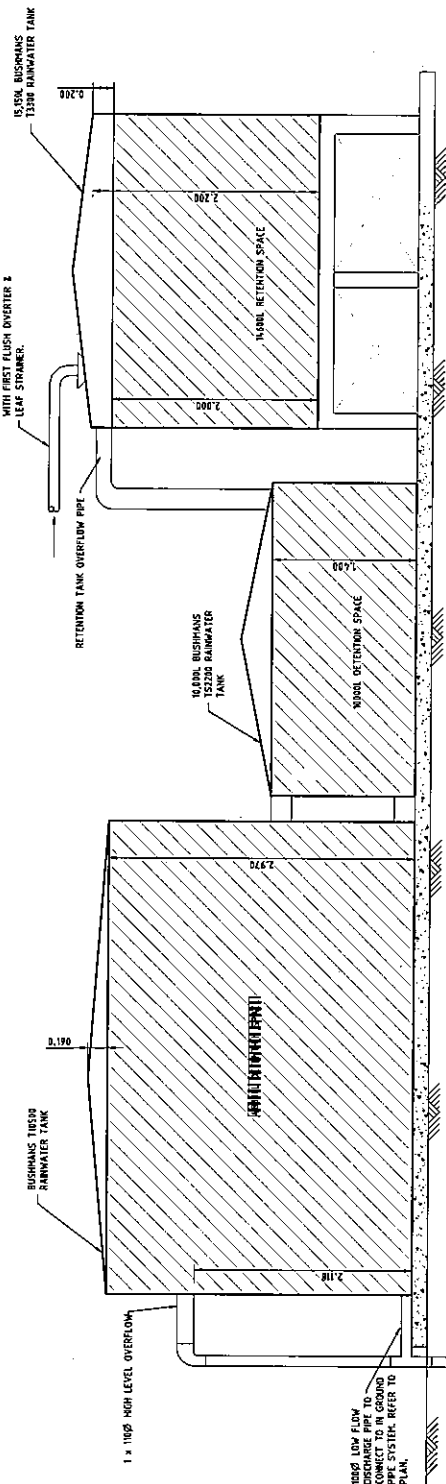


BUSHMANS T10500 ROOFWATER TANK DETAIL
FOR NORTH WEST ROOF AREAS (ROOF 1)

SCALE 1:25

ROOFWATER TANK FOR NORTH WEST ROOF AREAS (ROOF 2)

BASIN LEVEL	STORAGE VOLUME m ³	DISCHARGE Qm ³ /s
0.00	0.00	0.000
0.10	1.20	0.000
0.20	3.59	0.017
0.30	5.98	0.023
0.40	8.37	0.029
0.50	10.76	0.033
0.60	13.15	0.037
0.70	15.54	0.041
0.80	17.93	0.044
0.90	20.33	0.047
1.00	22.72	0.050
1.10	25.11	0.052
1.20	27.50	0.055
1.30	29.89	0.057
1.40	32.28	0.060
1.50	34.67	0.062
1.60	37.06	0.064
1.70	39.45	0.066
1.80	41.84	0.068
1.90	44.23	0.070
2.00	46.62	0.072
2.10	49.01	0.074
2.20	51.40	0.076
2.30	53.79	0.078
2.40	56.18	0.080
2.50	58.57	0.082
2.60	60.96	0.084
2.70	63.35	0.086
2.80	65.74	0.088
2.90	68.13	0.090
2.95	70.52	0.092



BUSHMANS T10500, T3300 & T52200 ROOFWATER TANK DETAIL
FOR NORTH WEST ROOF AREAS (ROOF 2)

SCALE 1:25

ISSUE

DATE

REVISION

BY

CHKD

APPD

PROJECT

93 ABBOTSFORD ROAD

BOWEN HILLS

CLIENT

YMCA

TITLE

FIGURE 4

DETENTION DESIGN DETAILS

& MODELLING RESULTS

TERRACE ENGINEERING

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93 ABBOTSFORD ROAD

Drawn By

Checked By

Scale

1:25

1463-SK04

C

SCALE 1:25 (A1)

SCALE BEFORE REDUCTION

STORMWATER RUNOFF XP-RAFTS SUMMARY DETAILS

ARI	CRITICAL STORM EVENT (mm)	RAINWATER TANKS FOR NORTH EAST ROOF AREA			RAINWATER TANKS FOR NORTH WEST ROOF AREA			FREE DRAINING AREA (m ² /s)	Q/TOTAL (m ³ /s)
		INLET (m ³ /s)	OUTLET (m ³ /s)	STAGE (m)	INLET (m ³ /s)	OUTLET (m ³ /s)	STAGE (m)		
2	25	0.102	0.047	1.066	0.086	0.050	1.026	0.059	0.155
10	25	0.119	0.061	1.732	0.124	0.068	1.791	0.107	0.232
20	25	0.174	0.066	2.071	0.145	0.084	2.249	0.133	0.273
50	98	0.185	0.0983	2.497	0.156	0.086	2.493	0.139	0.339
100	98	0.208	0.114	2.812	0.175	0.123	2.835	0.167	0.395

STORMWATER RUNOFF XP-RAFTS SUMMARY DETAILS

ARI (YEAR)	EXISTING PEAK DISCHARGE (M ³ /S)	DEVELOPED MITIGATED PEAK DISCHARGE (M ³ /S)	DIFFERENCE (M ³ /S)
2	0.089	0.105	-0.033
10	0.296	0.232	-0.064
20	0.351	0.273	-0.078
50	0.390	0.339	-0.051
100	0.446	0.395	-0.051

ISSUE	AMENDMENT	DATE
A	ISSUED S&SMP REV 0	26.11.09
B	ISSUED S&SMP REV 1	09.02.10
C	ISSUED S&SMP REV 2	23.06.09

93
PRODUCE

ABSTRACT

CLIENT

344

TITLE

Figure 1

100

XP-F

1538

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1

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1

Dealing

38

Drinking Water

1

1

Appendix A

HYDROLOGY CALCULATIONS



PO Box 417 Booval, Qld 4304

P 07 3281 6603 F 07 3281 6602 E mail@terranecivil.com.au

Page 18

Project: 93 Abbotsford Road, Bowen Hills

Rational Method Calculations - Brisbane City Council

Site: 93 Abbotsford Road, Bowen Hills (OR 93 Edmonstone Road, Bowen Hills)

Catchment Conditions:	Existing - Developed Areas onsite only
Number of Sub-Catchments:	1
Location of Discharge Point:	

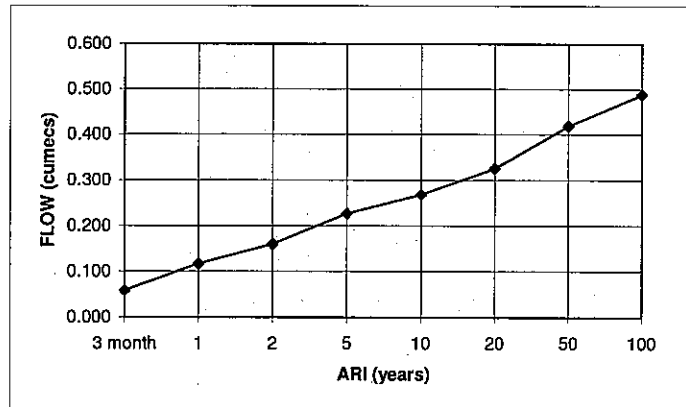
Sub-Catchment Areas	1	2	3	4	5	Total
	0.6539					0.65394 ha
C10 Runoff Coefficients	0.69					

Time of Concentration	
Upper Catchment Slope	0.8 %
Standard Inlet Time	5 min
Travel Length	0 m
Fall	m
Adopted travel velocity	0.3 m/s
Travel Time	0.0 min
Time of Concentration	5.0 min
Adopted Time of Concentration	5.0 min

ARI (years)	Rainfall Intensity (mm/hr)	Fy (Qudm Table 5.04.3)	Runoff Coefficients				Discharges (m ³ /s)				
			1				1				Total
1	117	0.80	0.55	-	-	-	0.117	-	-	-	0.12
2	151	0.85	0.58	-	-	-	0.160	-	-	-	0.16
5	191	0.95	0.65	-	-	-	0.227	-	-	-	0.23
10	215	1.00	0.69	-	-	-	0.269	-	-	-	0.27
20	248	1.05	0.72	-	-	-	0.325	-	-	-	0.33
50	291	1.15	0.79	-	-	-	0.418	-	-	-	0.42
100	325	1.20	0.83	-	-	-	0.487	-	-	-	0.49

Peak Overland Flow Rate

ARI (years)	Discharges (m ³ /s)
3 month	0.058
1	0.117
2	0.160
5	0.227
10	0.269
20	0.325
50	0.418
100	0.487



Rational Method Calculations - Brisbane City Council

Site: 93 Abbotsford Road, Bowen Hills (OR 93 Edmonstone Road, Bowen Hills)

Catchment Conditions:	Proposed - Developed Areas onsite only		
Number of Sub-Catchments:	3	1. Roof Area 1	2. Roof Area 2
Location of Discharge Point:	3. Free Drain Area		

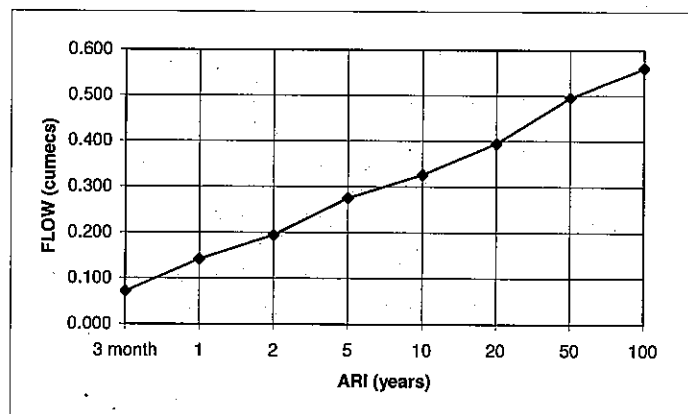
Sub-Catchment Areas	1	2	3	4	5	Total	ha
	0.2389	0.2008	0.2142			0.6539	
C10 Runoff Coefficients	0.90	0.9	0.70				

Time of Concentration	
Upper Catchment Slope	0.8 %
Standard Inlet Time	5 min
Travel Length	0 m
Fall	m
Adopted travel velocity	0.3 m/s
Travel Time	0.0 min
Time of Concentration	5.0 min
Adopted Time of Concentration	5.0 min

ARI (years)	Rainfall Intensity (mm/hr)	Fy (Qudm Table 5.04.3)	Runoff Coefficients				Discharges (m ³ /s)				
			1				1				Total
1	117	0.80	0.72	0.72	0.56	-	0.056	0.047	0.039	-	0.142
2	151	0.85	0.77	0.77	0.60	-	0.077	0.064	0.054	-	0.195
5	191	0.95	0.86	0.86	0.67	-	0.108	0.091	0.076	-	0.275
10	215	1.00	0.90	0.90	0.70	-	0.128	0.108	0.090	-	0.326
20	248	1.05	0.95	0.95	0.74	-	0.156	0.131	0.109	-	0.395
50	291	1.15	1.00	1.00	0.81	-	0.193	0.162	0.140	-	0.495
100	325	1.20	1.00	1.00	0.84	-	0.216	0.181	0.163	-	0.560

Peak Overland Flow Rate

ARI (years)	Discharges (m ³ /s)
3 month	0.071
1	0.142
2	0.195
5	0.275
10	0.326
20	0.395
50	0.495
100	0.560



Rational Method Calculations - Brisbane City Council

Site: 93 Abbotsford Road, Bowen Hills (OR 93 Edmonstone Road, Bowen Hills)

Catchment Conditions: Existing Conditions - Upstream Catchment
 Number of Sub-Catchments:
 Location of Discharge Point: Site

Sub-Catchment Areas	1	2	3	4	5	Total
	5.872	8.0371	1.8012	2.206		17.9163 ha
C10 Runoff Coefficients	0.86	0.88	0.71	0.9		(SDG Table BA2.1.1)

Time of Concentration	
Upper Catchment Slope	0.8 %
Standard Inlet Time	13 min
Travel Length	754 m
Fall	m
Adopted travel velocity	0.7 m/s (Catchment slope = 1.9%)
Travel Time	18.0 min
Time of Concentration	31.0 min
Adopted Time of Concentration	31.0 min

Catchment Breakdown

- 1 Low-Medium density Residential Area
- 2 Community Use & Commercial/Industrial Lots
- 3 Site - Existing
- 4 Remaining Road Area

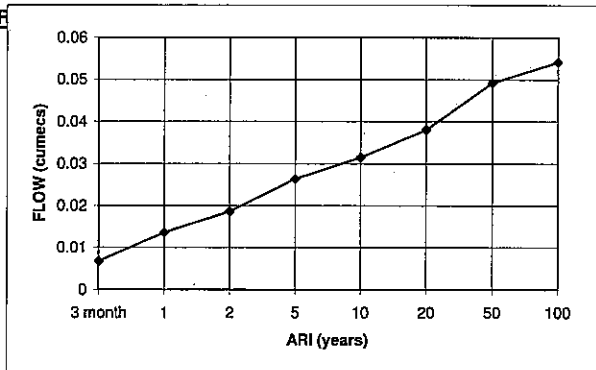
ARI (years)	Rainfall Intensity (mm/hr)	Fy (Qudm Table 5.04.3)	Runoff Coefficients				Discharges (m³/s)				
			1	2	3	4	1	2	3	4	Total
1	54	0.80	0.69	0.70	0.57	0.72	0.606	0.849	0.153	0.238	1.85
2	70	0.85	0.73	0.75	0.60	0.77	0.835	1.169	0.211	0.328	2.54
5	90	0.95	0.82	0.84	0.67	0.86	1.199	1.680	0.304	0.472	3.65
10	103	1.00	0.86	0.88	0.71	0.90	1.445	2.024	0.366	0.568	4.40
20	120	1.05	0.90	0.92	0.75	0.95	1.767	2.475	0.448	0.695	5.39
50	142	1.15	0.99	1.00	0.82	1.00	2.291	3.170	0.580	0.870	6.91
100	160	1.20	1.00	1.00	0.85	1.00	2.610	3.572	0.682	0.980	7.84

Pipe Capacity

Pipe Line	1	2	3	4	5	
Size	1650					mm Dia.
No. of Pipes	1					
Length	15.68					m
Fall	0.064					m
Grade	0.41%					%
On Grade Capacity	5.927					m³/s (Qudm Chart No. 15)
Assumed Pipe Flow	5.927					m³/s Q2
Total Pipe Flow	5.927					m³/s
Total						5.927 m³/s

Peak Overland Flow R

ARI (years)	Discharges (m³/s)
3 month	-2.04
1	-4.08
2	-3.38
5	-2.27
10	-1.52
20	-0.54
50	0.98
100	1.92



Appendix B

ON-SITE DETENTION TANK CALCULATIONS

Stage-Storage

Basin Level	SA m ²	Ave SA m ²	Thickness m	Volume m ³	Cumulative Volume m ³
0.000	0	0	0	0	0
0.100	33	17	0.10	1.66	1.661
0.200	33	33	0.10	3.32	4.983
0.300	33	33	0.10	3.32	8.305
0.400	33	33	0.10	3.32	11.627
0.500	33	33	0.10	3.32	14.950
0.600	33	33	0.10	3.32	18.272
0.700	33	33	0.10	3.32	21.594
0.800	33	33	0.10	3.32	24.916
0.900	33	33	0.10	3.32	28.238
1.000	33	33	0.10	3.32	31.560
1.100	33	33	0.10	3.32	34.882
1.200	33	33	0.10	3.32	38.204
1.300	33	33	0.10	3.32	41.527
1.400	33	33	0.10	3.32	44.849
1.500	33	33	0.10	3.32	48.171
1.600	33	33	0.10	3.32	51.493
1.700	33	33	0.10	3.32	54.815
1.800	33	33	0.10	3.32	58.137
1.900	33	33	0.10	3.32	61.459
2.000	33	33	0.10	3.32	64.781
2.100	33	33	0.10	3.32	68.103
2.200	33	33	0.10	3.32	71.426
2.300	33	33	0.10	3.32	74.748
2.400	33	33	0.10	3.32	78.070
2.500	33	33	0.10	3.32	81.392
2.600	33	33	0.10	3.32	84.714
2.700	33	33	0.10	3.32	88.036
2.800	33	33	0.10	3.32	91.358
2.900	33	33	0.10	3.32	94.680
2.980	33	33	0.06	1.99	96.674

Tank Size	46400 L	X 2
Tank dimensions	4.6 Diameter	
Surface Area of Tank	16.61 m ²	
Nb. of Tanks	1	
Total Surface Area	16.61	

Orifice Calculation

Q. Office

$$Q = 0.67 \cdot A \sqrt{2gh}$$

Stage-Discharge Relationship

Low flow Orifice

Orifice Dia

Dariusz J. Jurek

Basin Level	Head	Q _{critical}	Q _{critical2}
0.00	0.00	0.000	0.000
0.10	0.05	0.005	0.010
0.20	0.15	0.009	0.018
0.30	0.25	0.012	0.023
0.40	0.35	0.014	0.028
0.50	0.45	0.016	0.031
0.60	0.55	0.017	0.035
0.70	0.65	0.019	0.038
0.80	0.75	0.020	0.040
0.90	0.85	0.021	0.043
1.00	0.95	0.023	0.045
1.10	1.05	0.024	0.048
1.20	1.15	0.025	0.050
1.30	1.25	0.026	0.052
1.40	1.35	0.027	0.054
1.50	1.45	0.028	0.056
1.60	1.55	0.029	0.058
1.70	1.65	0.030	0.060
1.80	1.75	0.031	0.062
1.90	1.85	0.032	0.063
2.00	1.95	0.033	0.065
2.10	2.05	0.033	0.067
2.20	2.15	0.034	0.068
2.30	2.25	0.035	0.070
2.40	2.35	0.036	0.071
2.50	2.45	0.036	0.073
2.60	2.55	0.037	0.074
2.70	2.65	0.038	0.076
2.80	2.75	0.039	0.077
2.90	2.85	0.040	0.080
2.96	2.91	0.040	0.080

Orifice Calculation

Office

$$Q = 0.67 \cdot A \sqrt{2gh}$$

Stage-Discharge Relationship

High flow Orifice

Orifice Dia

1	2
---	---

Basin Level	Head	Q _{Optima}	Q _{Optima2}
0.00	0.00	0.000	0.000
0.10	0.00	0.000	0.000
0.20	0.00	0.000	0.000
0.30	0.00	0.000	0.000
0.40	0.00	0.000	0.000
0.50	0.00	0.000	0.000
0.60	0.00	0.000	0.000
0.70	0.00	0.000	0.000
0.80	0.00	0.000	0.000
0.90	0.00	0.000	0.000
1.00	0.00	0.000	0.000
1.10	0.00	0.000	0.000
1.20	0.00	0.000	0.000
1.30	0.00	0.000	0.000
1.40	0.00	0.000	0.000
1.50	0.00	0.000	0.000
1.60	0.00	0.000	0.000
1.70	0.00	0.000	0.000
1.80	0.00	0.000	0.000
1.90	0.00	0.000	0.000
2.00	0.00	0.000	0.000
2.10	0.00	0.000	0.000
2.20	0.00	0.000	0.000
2.30	0.10	0.007	0.015
2.40	0.20	0.010	0.021
2.50	0.30	0.013	0.026
2.60	0.40	0.015	0.029
2.70	0.50	0.016	0.033
2.80	0.60	0.018	0.036
2.90	0.70	0.019	0.039
2.95	0.75	0.020	0.041

Stage-Storage Discharge Relationship

Basin LEVEL	Storage Volume m ³	Discharge Q m ³ /s
0.00	0.00	0.0000
0.10	1.66	0.0104
0.20	4.98	0.0181
0.30	8.31	0.0233
0.40	11.63	0.0276
0.50	14.95	0.0313
0.60	18.27	0.0346
0.70	21.59	0.0376
0.80	24.92	0.0404
0.90	28.24	0.0430
1.00	31.56	0.0454
1.10	34.88	0.0478
1.20	38.20	0.0500
1.30	41.53	0.0521
1.40	44.85	0.0542
1.50	48.17	0.0561
1.60	51.49	0.0580
1.70	54.81	0.0599
1.80	58.14	0.0617
1.90	61.46	0.0634
2.00	64.78	0.0651
2.10	68.10	0.0667
2.20	71.43	0.0683
2.30	74.75	0.0696
2.40	78.07	0.0709
2.50	81.39	0.0723
2.60	84.71	0.0739
2.70	88.04	0.0758
2.80	91.36	0.0774
2.90	94.68	0.0791
3.00	98.00	0.0808

RAINWATER TANK DESIGN - Roof 2 Area

Stage-Storage					Cumulative	
Basin Level	SA m ²	Ave SA m ²	Thickness m	Volume m ³	Volume m ³	Volume m ³
0.000	0	0	0	0	0	0
0.100	24	12	0.10	1	1	1.196
0.200	24	24	0.10	2	2	3.587
0.300	24	24	0.10	2	2	5.978
0.400	24	24	0.10	2	2	8.370
0.500	24	24	0.10	2	2	10.761
0.600	24	24	0.10	2	2	13.152
0.700	24	24	0.10	2	2	15.543
0.800	24	24	0.10	2	2	17.935
0.900	24	24	0.10	2	2	20.326
1.000	24	24	0.10	2	2	22.717
1.100	24	24	0.10	2	2	25.109
1.200	24	24	0.10	2	2	27.500
1.300	24	24	0.10	2	2	29.891
1.400	24	24	0.10	2	2	32.283
1.500	17	20	0.10	2	2	34.309
1.600	17	17	0.10	2	2	35.970
1.700	17	17	0.10	2	2	37.631
1.800	17	17	0.10	2	2	39.292
1.900	17	17	0.10	2	2	40.953
2.000	17	17	0.10	2	2	42.614
2.100	17	17	0.10	2	2	44.275
2.200	17	17	0.10	2	2	45.936
2.300	17	17	0.10	2	2	47.597
2.400	17	17	0.10	2	2	49.258
2.500	17	17	0.10	2	2	50.919
2.600	17	17	0.10	2	2	52.580
2.700	17	17	0.10	2	2	54.242
2.800	17	17	0.10	2	2	55.903
2.900	17	17	0.10	2	2	57.564
2.960	17	17	0.06	1	1	58.560

Tank Size
Tank dimensions
Surface Area of Tank
No. of Tanks
Total Surface Area

46400 L
4.6 Diameter
16.61 m²
1
16.61

Tank Size
Tank dimensions
Surface Area of Tank
No. of Tanks
Total Surface Area

10000 L
3.05 Diameter
7.30 m²
1
7.30

Orifice Calculation

Q_{Orifice}
Q = 0.67 * A * √2gh
Stage-Discharge Relationship
Low flow Orifice
Orifice Dia 0.15 m

Basin Level	Head	Q _{Orifice}	Q _{Orifice}
0.00	0.00	0.000	0.000
0.10	0.00	0.000	0.000
0.20	0.10	0.017	0.017
0.30	0.20	0.023	0.023
0.40	0.30	0.029	0.029
0.50	0.40	0.033	0.033
0.60	0.50	0.037	0.037
0.70	0.60	0.041	0.041
0.80	0.70	0.044	0.044
0.90	0.80	0.047	0.047
1.00	0.90	0.050	0.050
1.10	1.00	0.052	0.052
1.20	1.10	0.055	0.055
1.30	1.20	0.057	0.057
1.40	1.30	0.060	0.060
1.50	1.40	0.062	0.062
1.60	1.50	0.064	0.064
1.70	1.60	0.066	0.066
1.80	1.70	0.068	0.068
1.90	1.80	0.070	0.070
2.00	1.90	0.072	0.072
2.10	2.00	0.074	0.074
2.20	2.10	0.076	0.076
2.30	2.20	0.078	0.078
2.40	2.30	0.080	0.080
2.50	2.40	0.081	0.081
2.60	2.50	0.083	0.083
2.70	2.60	0.085	0.085
2.80	2.70	0.086	0.086
2.90	2.80	0.088	0.088
2.96	2.86	0.089	0.089

Orifice Calculation

Q_{Orifice}
Q = 0.67 * A * √2gh
Stage-Discharge Relationship
High flow Orifice
Orifice Dia 0.14 m

Basin Level	Head	Q _{Orifice}	Q _{Orifice}
0.00	0.00	0.000	0.000
0.10	0.00	0.000	0.000
0.20	0.00	0.000	0.000
0.30	0.00	0.000	0.000
0.40	0.00	0.000	0.000
0.50	0.00	0.000	0.000
0.60	0.00	0.000	0.000
0.70	0.00	0.000	0.000
0.80	0.00	0.000	0.000
0.90	0.00	0.000	0.000
1.00	0.00	0.000	0.000
1.10	0.00	0.000	0.000
1.20	0.00	0.000	0.000
1.30	0.00	0.000	0.000
1.40	0.00	0.000	0.000
1.50	0.00	0.000	0.000
1.60	0.00	0.000	0.000
1.70	0.00	0.000	0.000
1.80	0.00	0.000	0.000
1.90	0.00	0.000	0.000
2.00	0.00	0.000	0.000
2.10	0.00	0.000	0.000
2.20	0.00	0.000	0.000
2.30	0.10	0.014	0.014
2.40	0.20	0.020	0.020
2.50	0.30	0.025	0.025
2.60	0.40	0.029	0.029
2.70	0.50	0.032	0.032
2.80	0.60	0.035	0.035
2.90	0.70	0.038	0.038
2.96	0.76	0.040	0.040

Stage-Storage Discharge Relationship

Basin Level	Storage Volume m ³	Discharge Q m ³ /s
0.00	0.00	0.0000
0.10	1.20	0.0000
0.20	3.59	0.0166
0.30	5.98	0.0234
0.40	8.37	0.0287
0.50	10.76	0.0332
0.60	13.15	0.0371
0.70	15.54	0.0406
0.80	17.93	0.0439
0.90	20.33	0.0469
1.00	22.72	0.0497
1.10	25.11	0.0524
1.20	27.50	0.0550
1.30	29.89	0.0574
1.40	32.28	0.0598
1.50	34.31	0.0620
1.60	35.97	0.0642
1.70	37.63	0.0663
1.80	39.29	0.0684
1.90	40.95	0.0703
2.00	42.61	0.0723
2.10	44.28	0.0742
2.20	45.94	0.0760
2.30	47.60	0.0922
2.40	49.26	0.0999
2.50	50.92	0.1062
2.60	52.58	0.1118
2.70	54.24	0.1168
2.80	55.90	0.1215
2.90	57.56	0.1260
2.96	58.56	0.1285

Appendix C

XP-RAFTS MODELLING DETAILS



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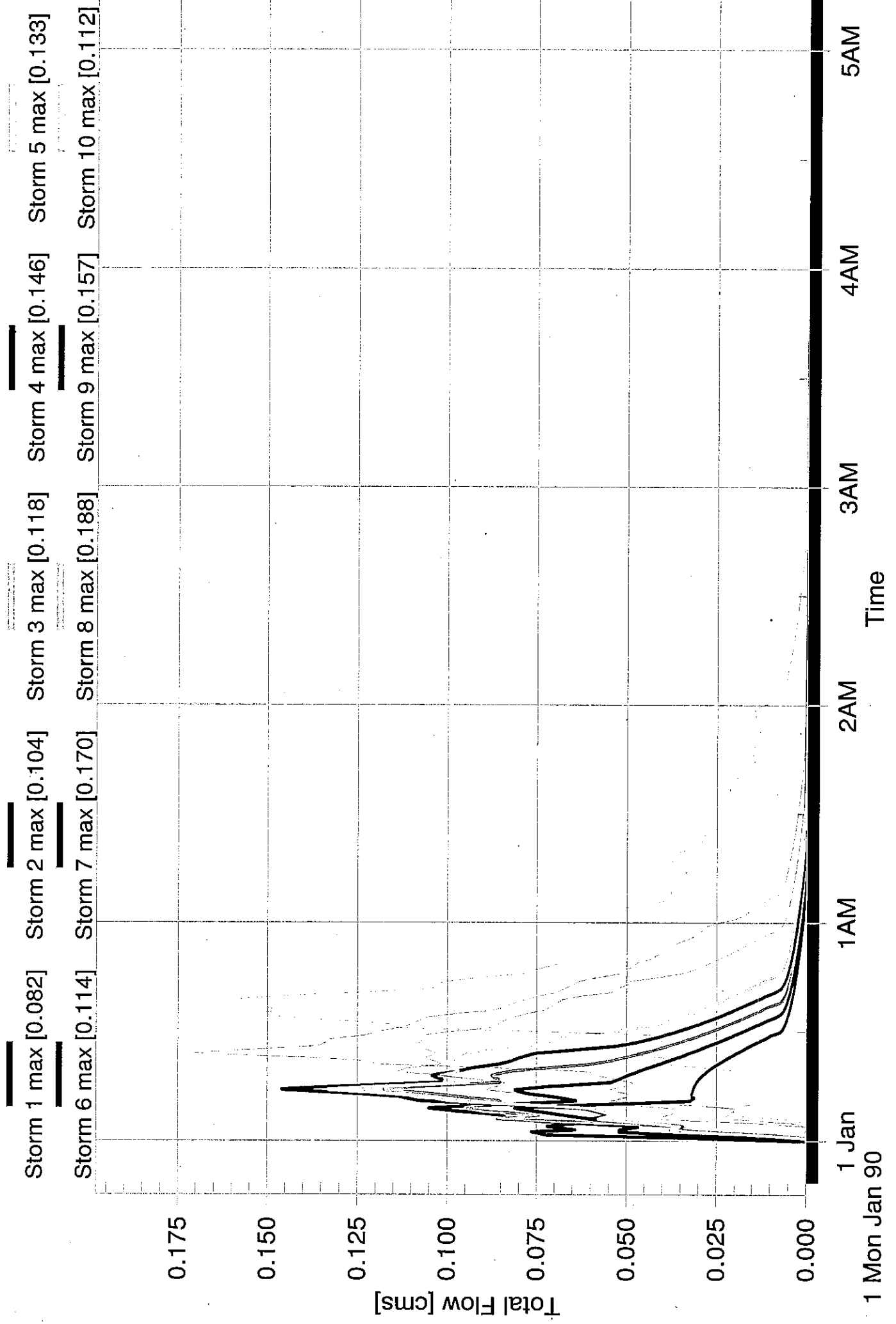
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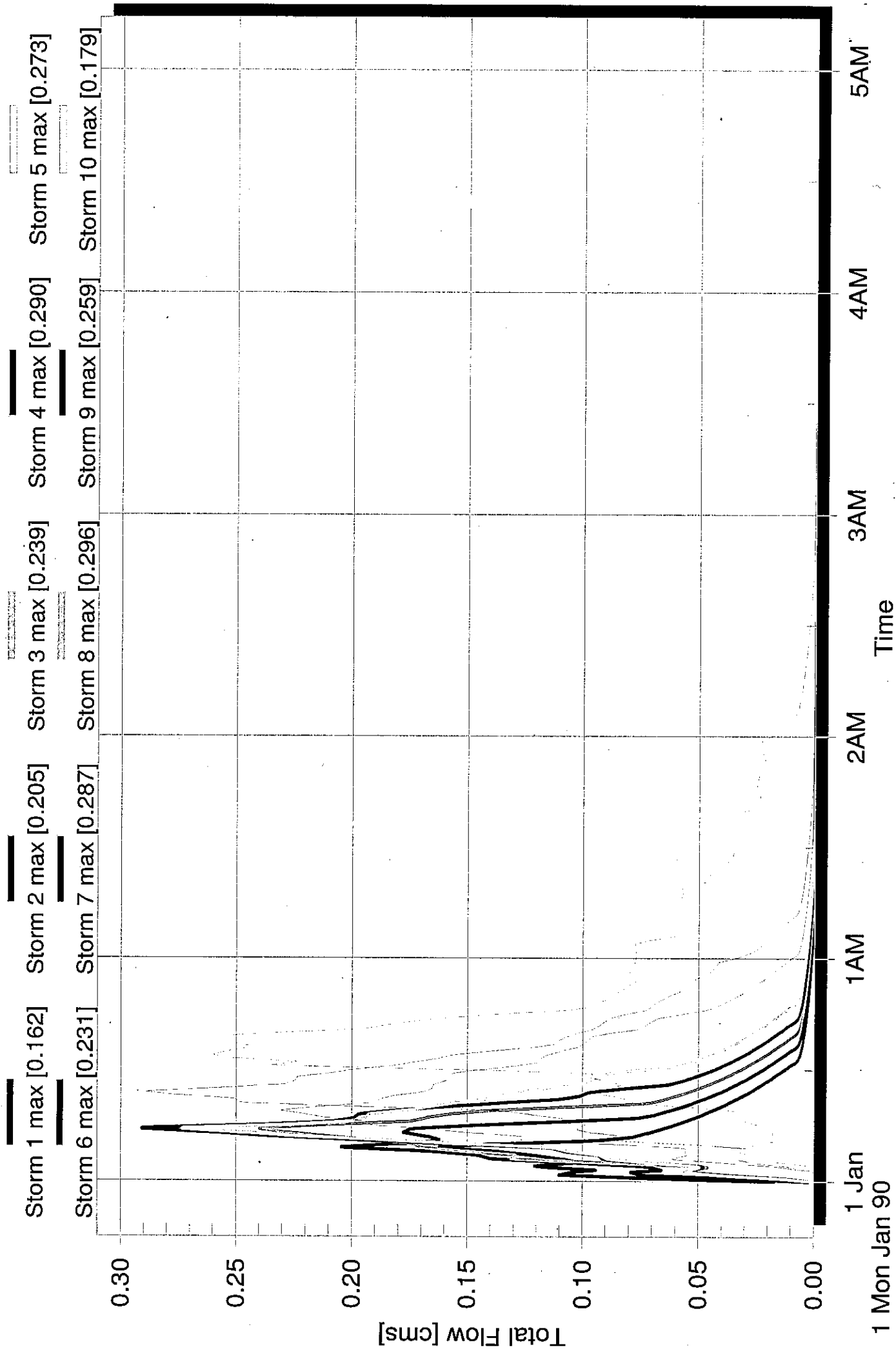
EXISTING Q2

Total Flow



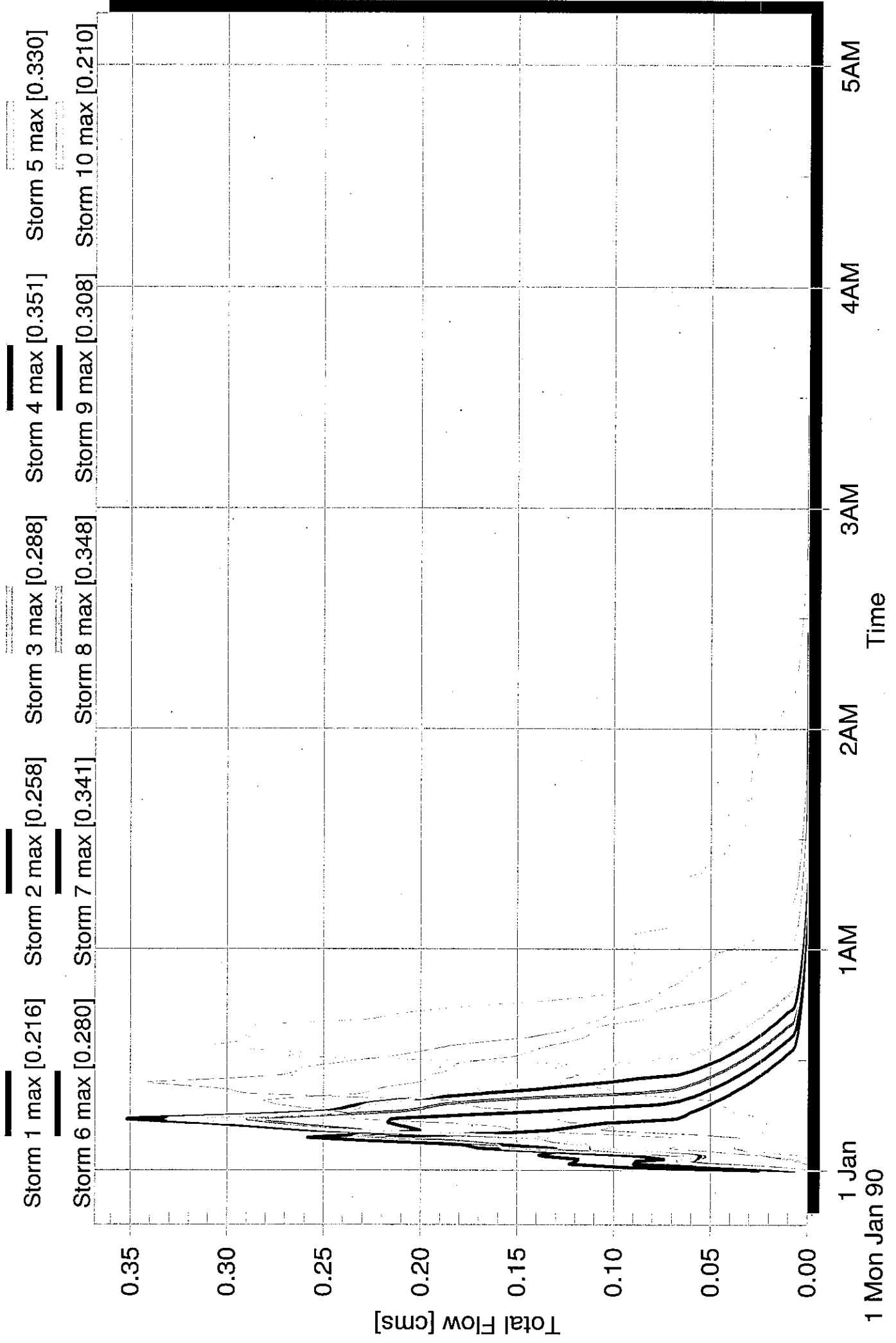
EXISTING Q10

Total Flow



EXISTING Q20

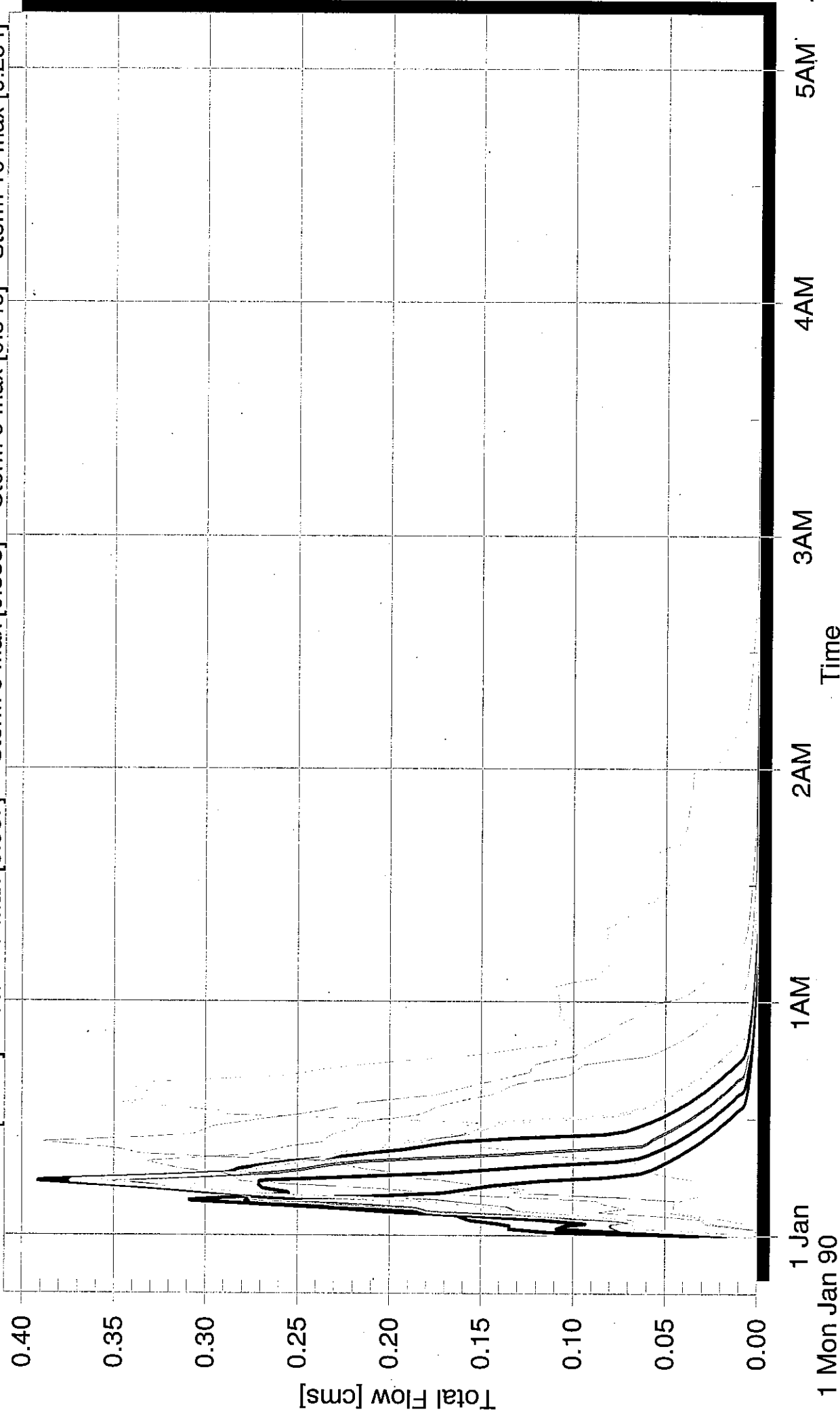
Total Flow



EXISTING Q50

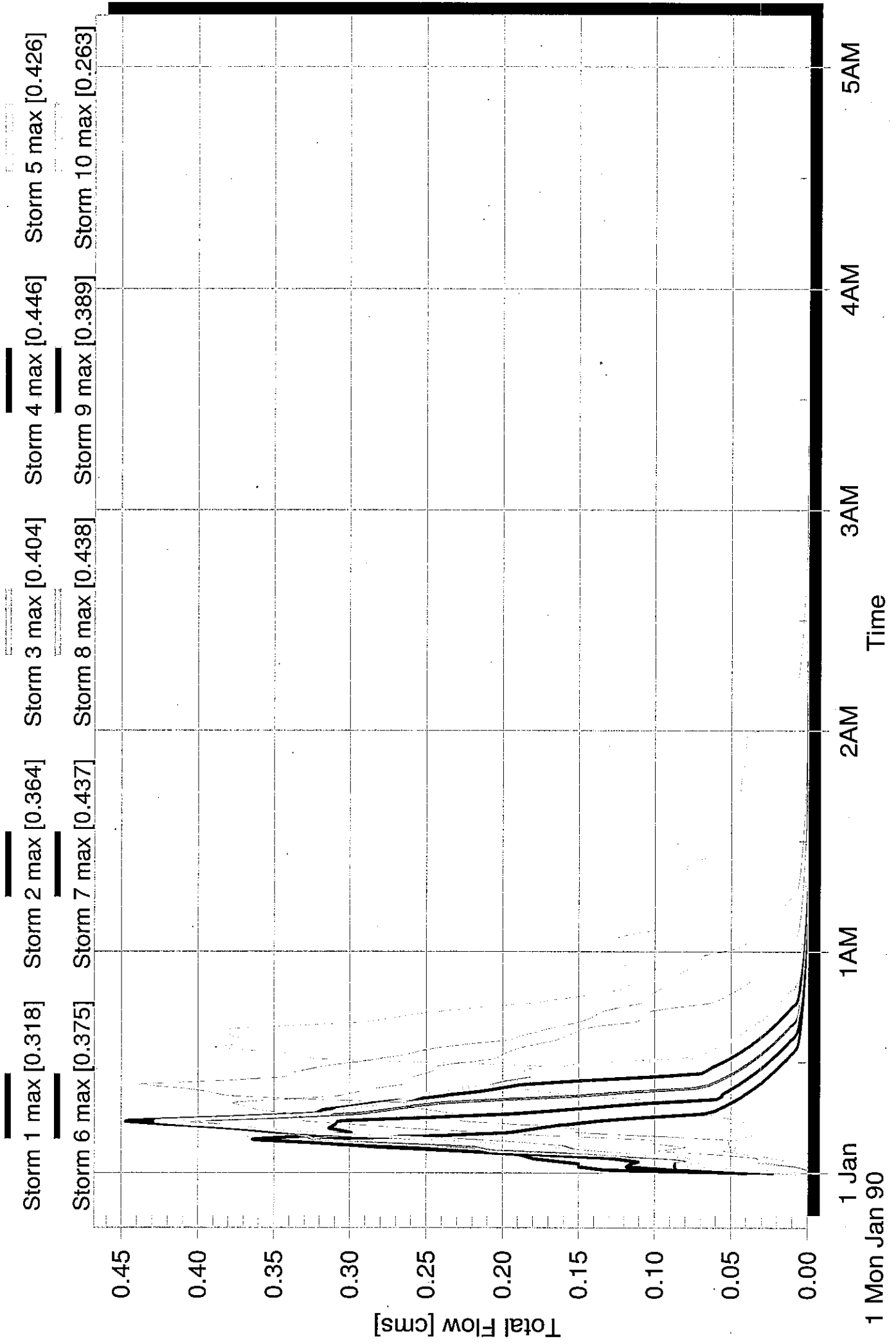
Total Flow

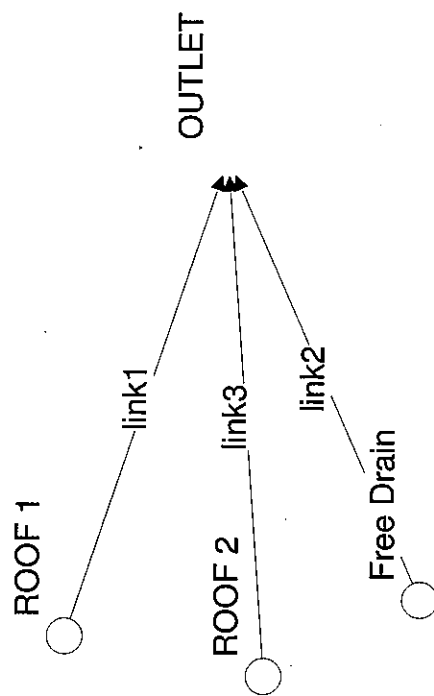
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Storm 6 max [0.330]	Storm 7 max [0.387]	Storm 8 max [0.388]	Storm 9 max [0.345]	Storm 10 max [0.234]



EXISTING Q100

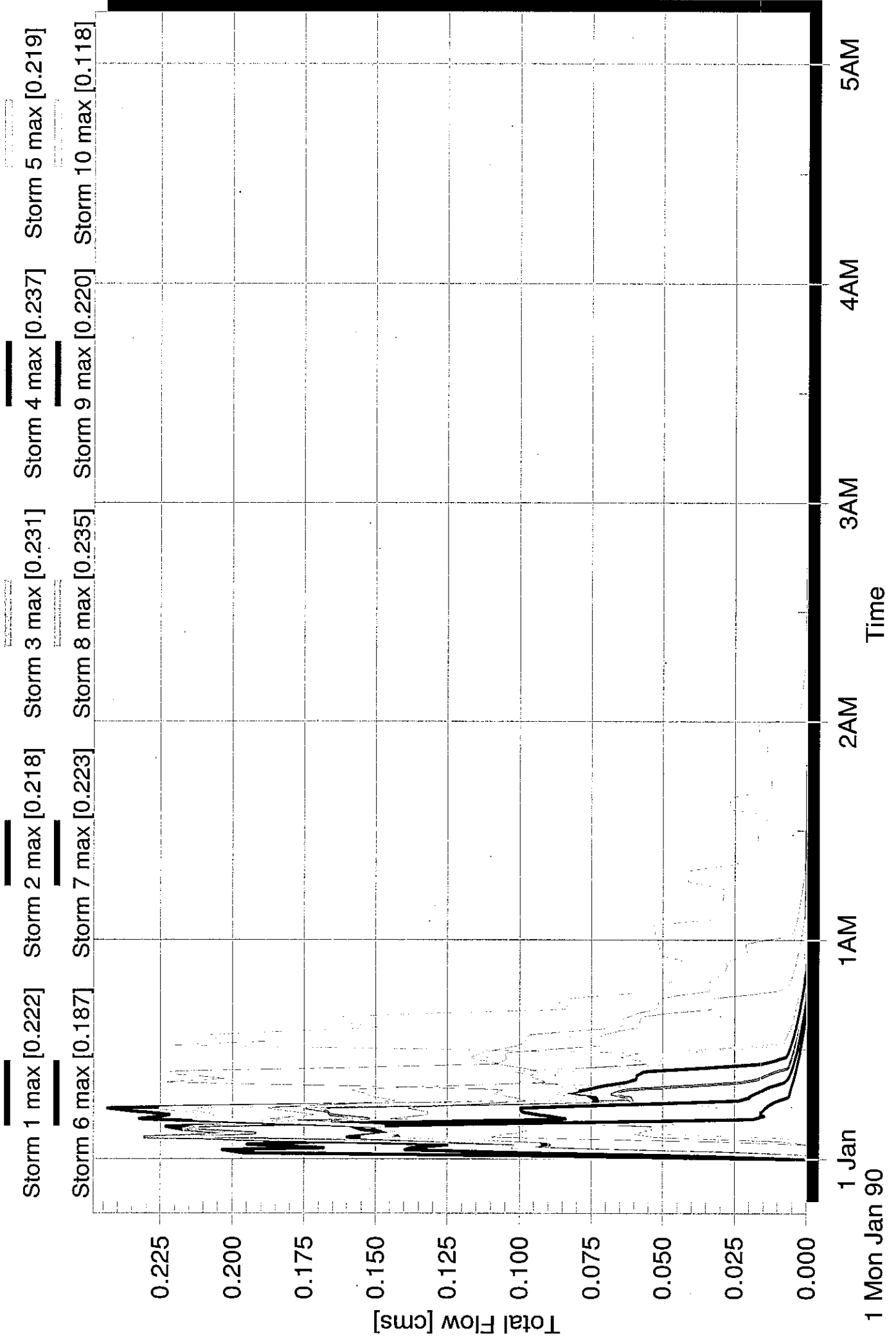
Total Flow





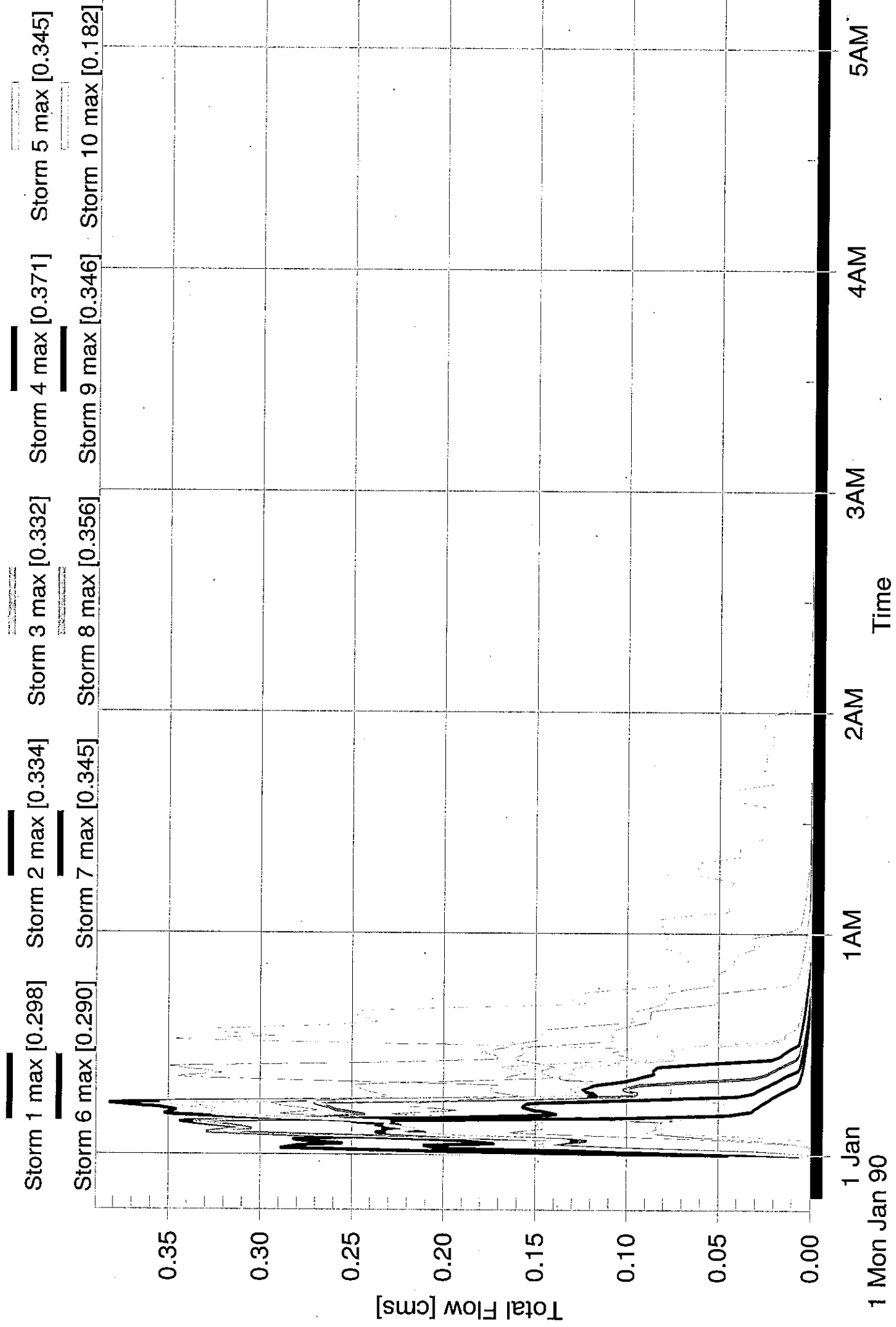
DEVELOPED Q2

Total Flow



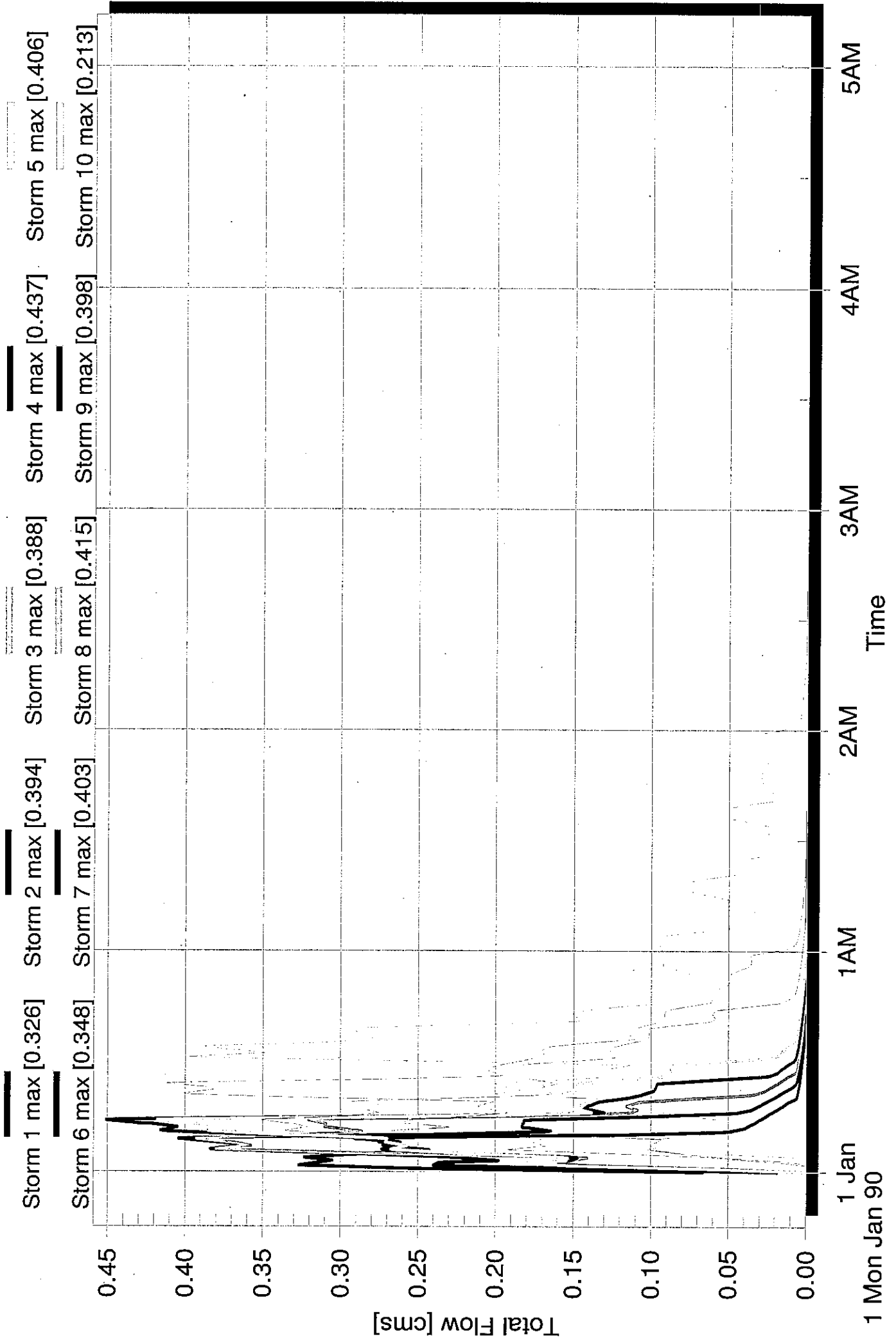
DEVELOPED Q10

Total Flow



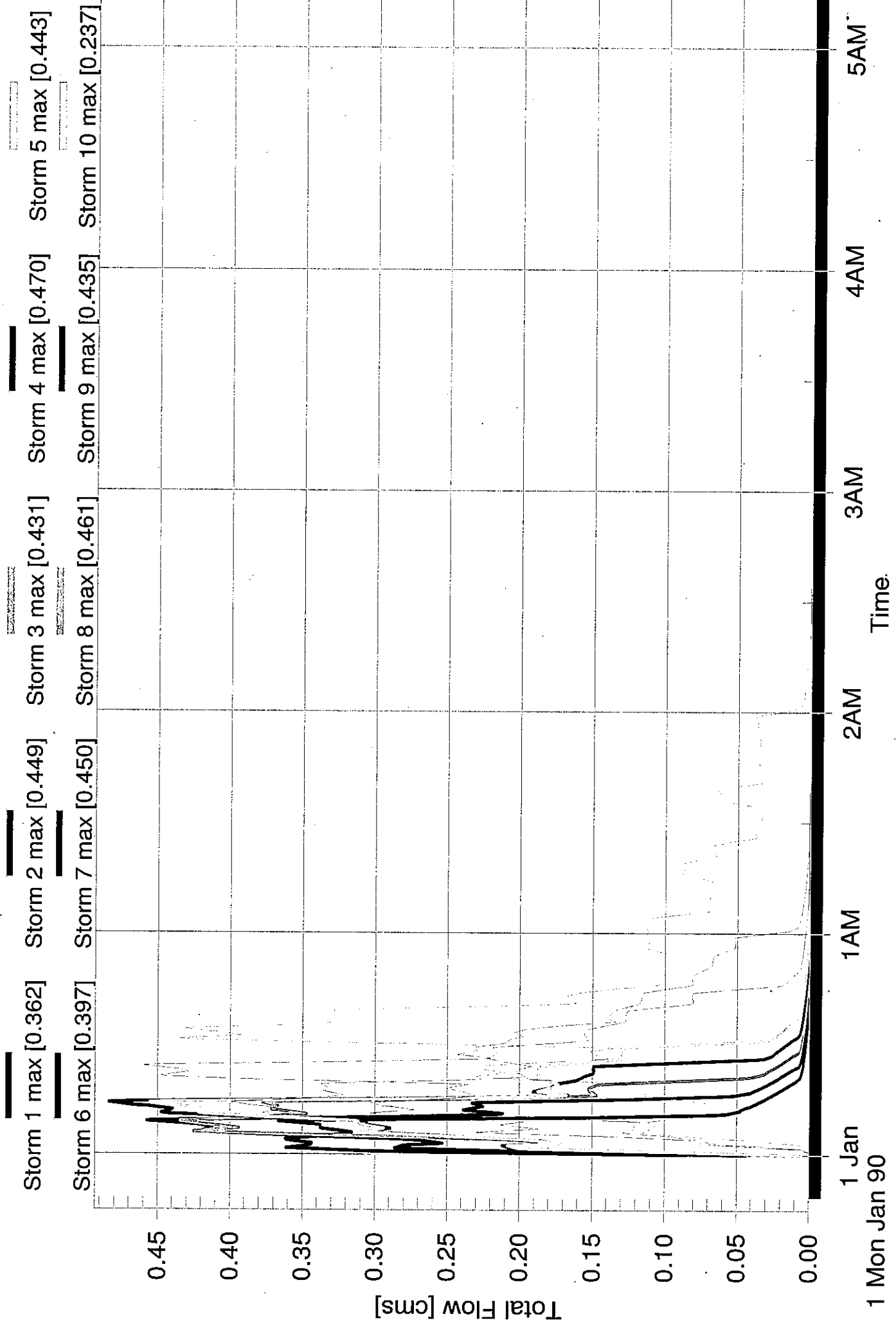
DEVELOPED Q20

Total Flow



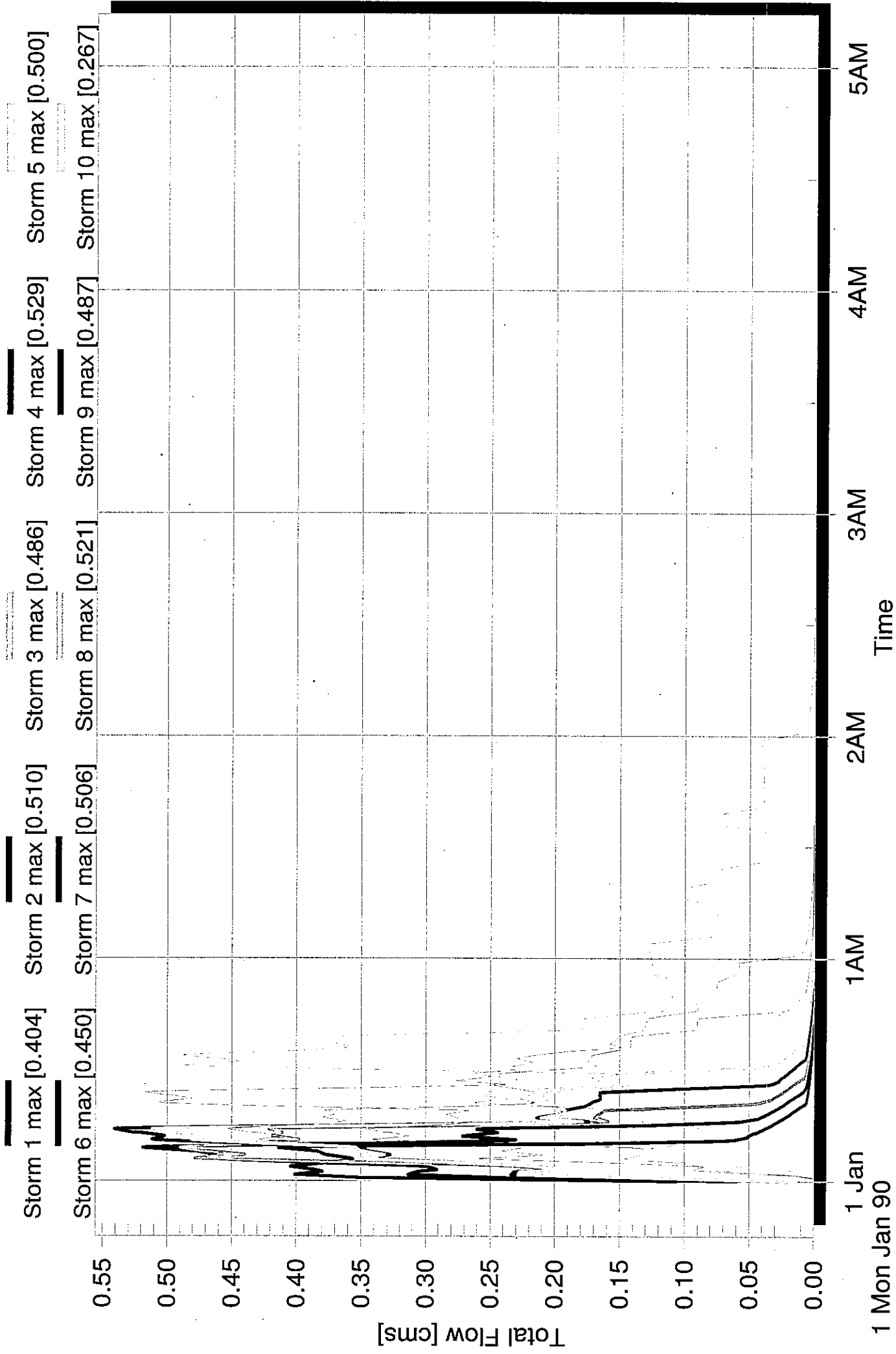
DEVELOPED Q50

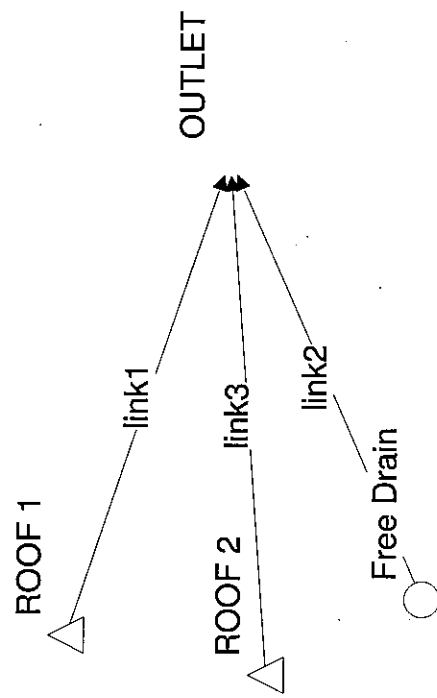
Total Flow



DEVELOPED Q100

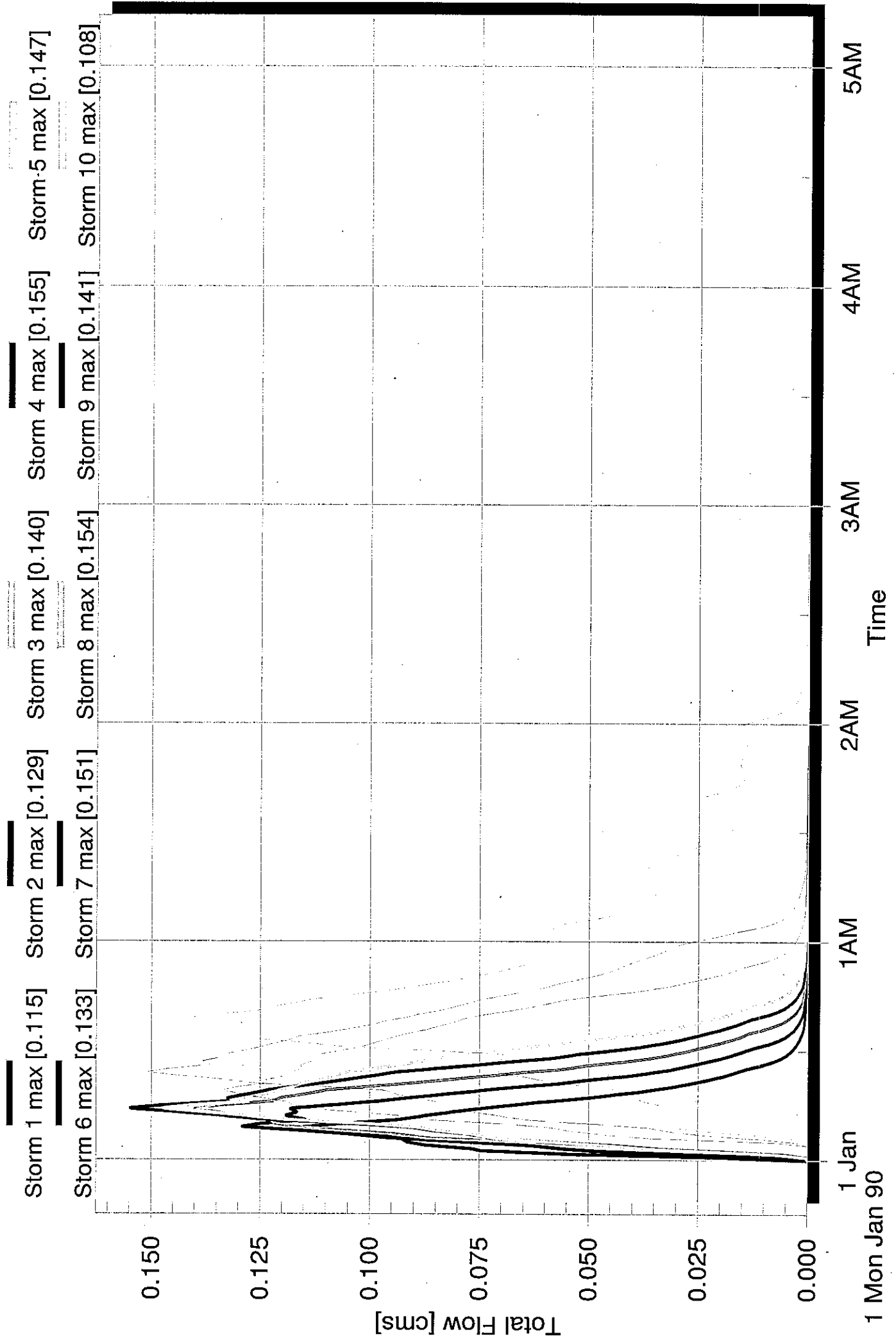
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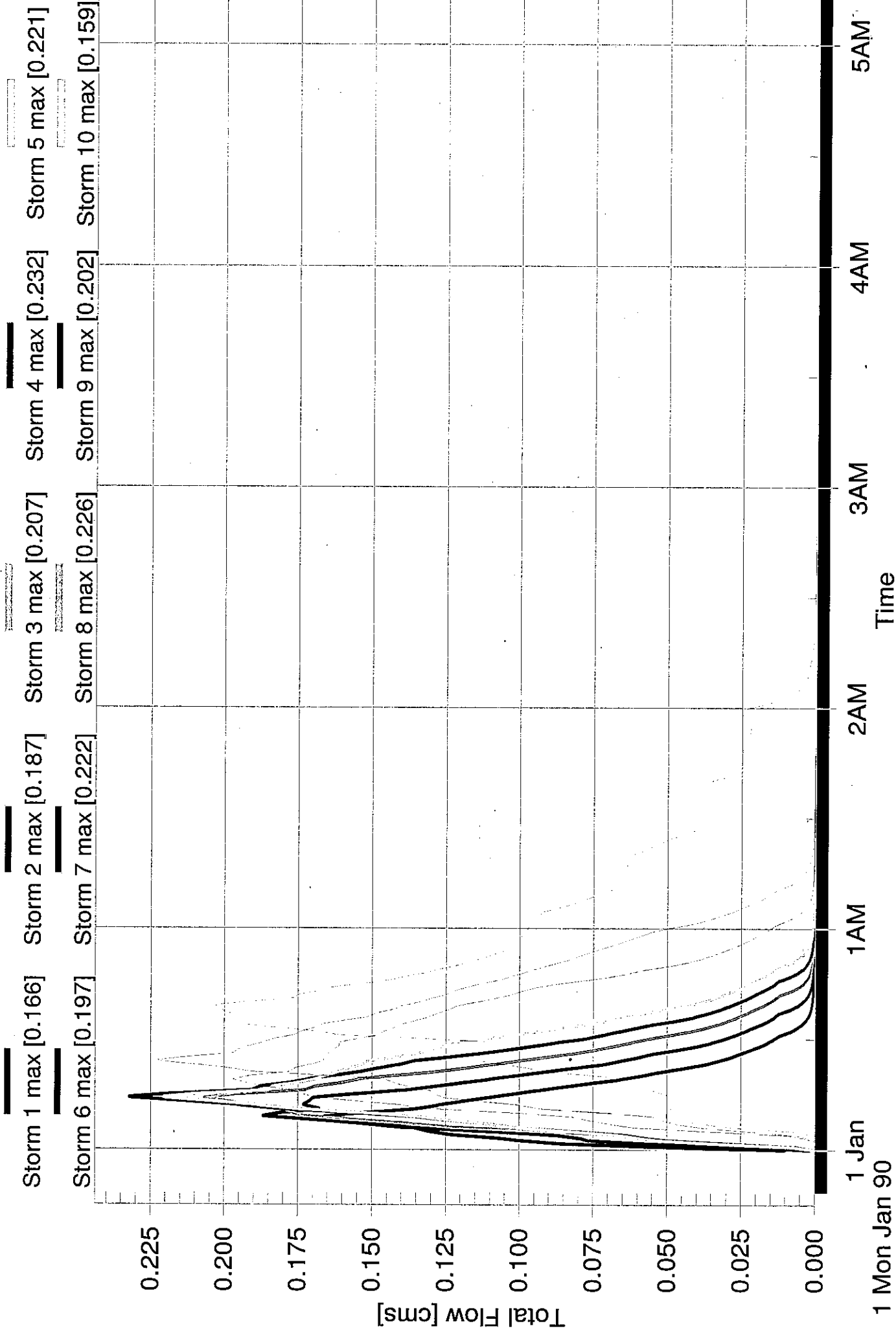
MITIGATED Q2

Total Flow



MITIGATED Q10

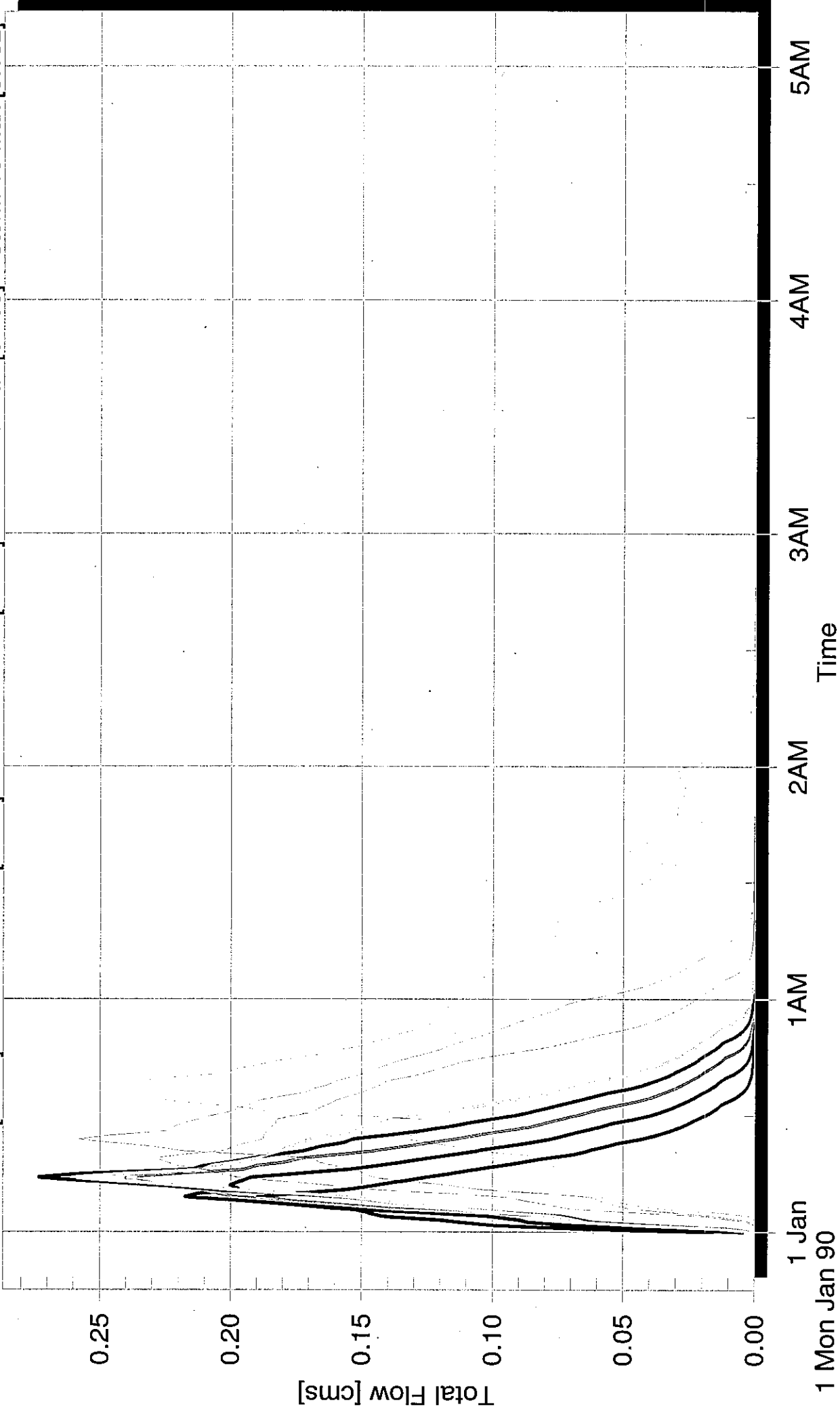
Total Flow



MITIGATED Q20

Total Flow

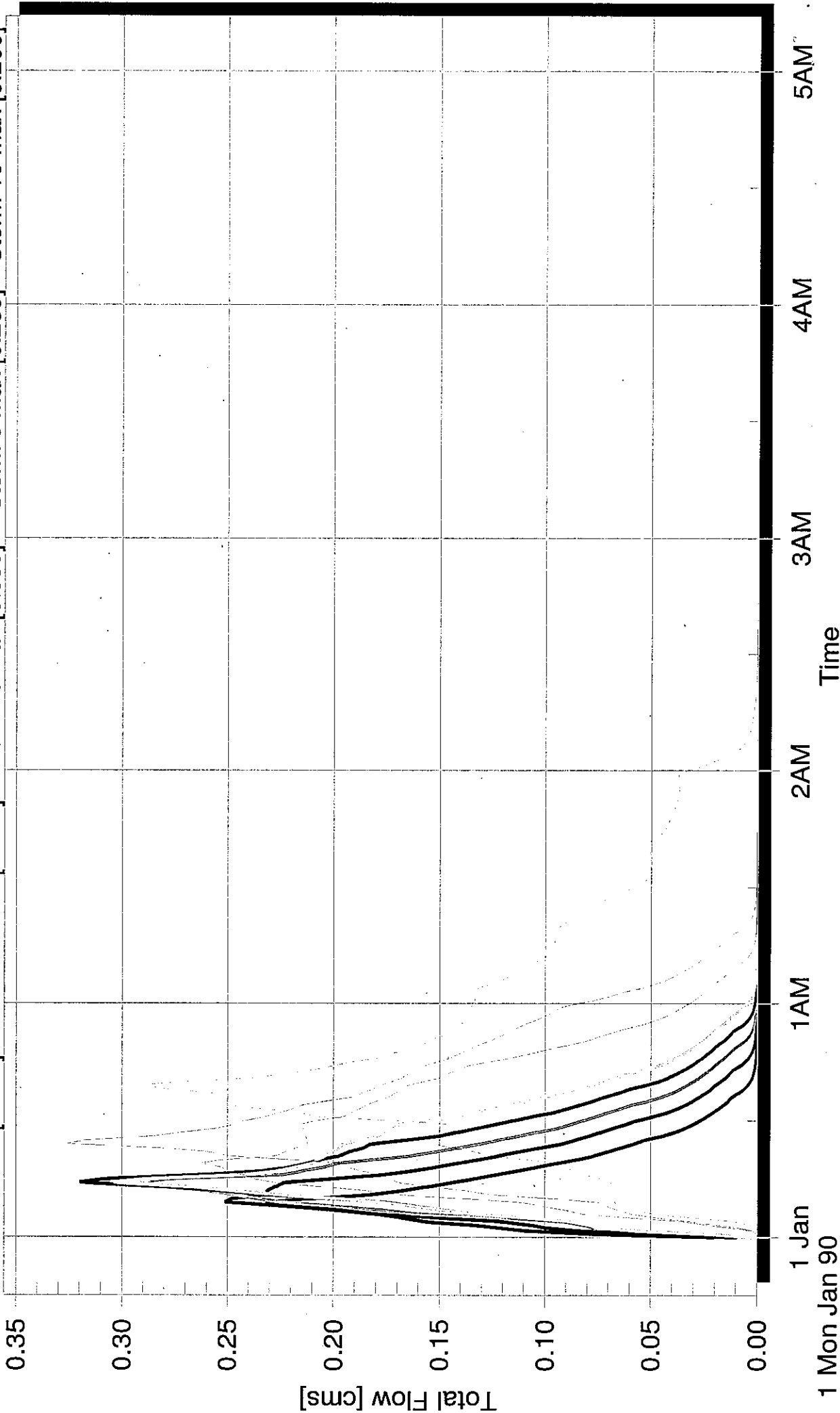
Storm 1 max [0.190]	Storm 2 max [0.217]	Storm 3 max [0.240]	Storm 4 max [0.273]	Storm 5 max [0.259]
Storm 6 max [0.228]	Storm 7 max [0.258]	Storm 8 max [0.263]	Storm 9 max [0.233]	Storm 10 max [0.182]



MITIGATED Q50

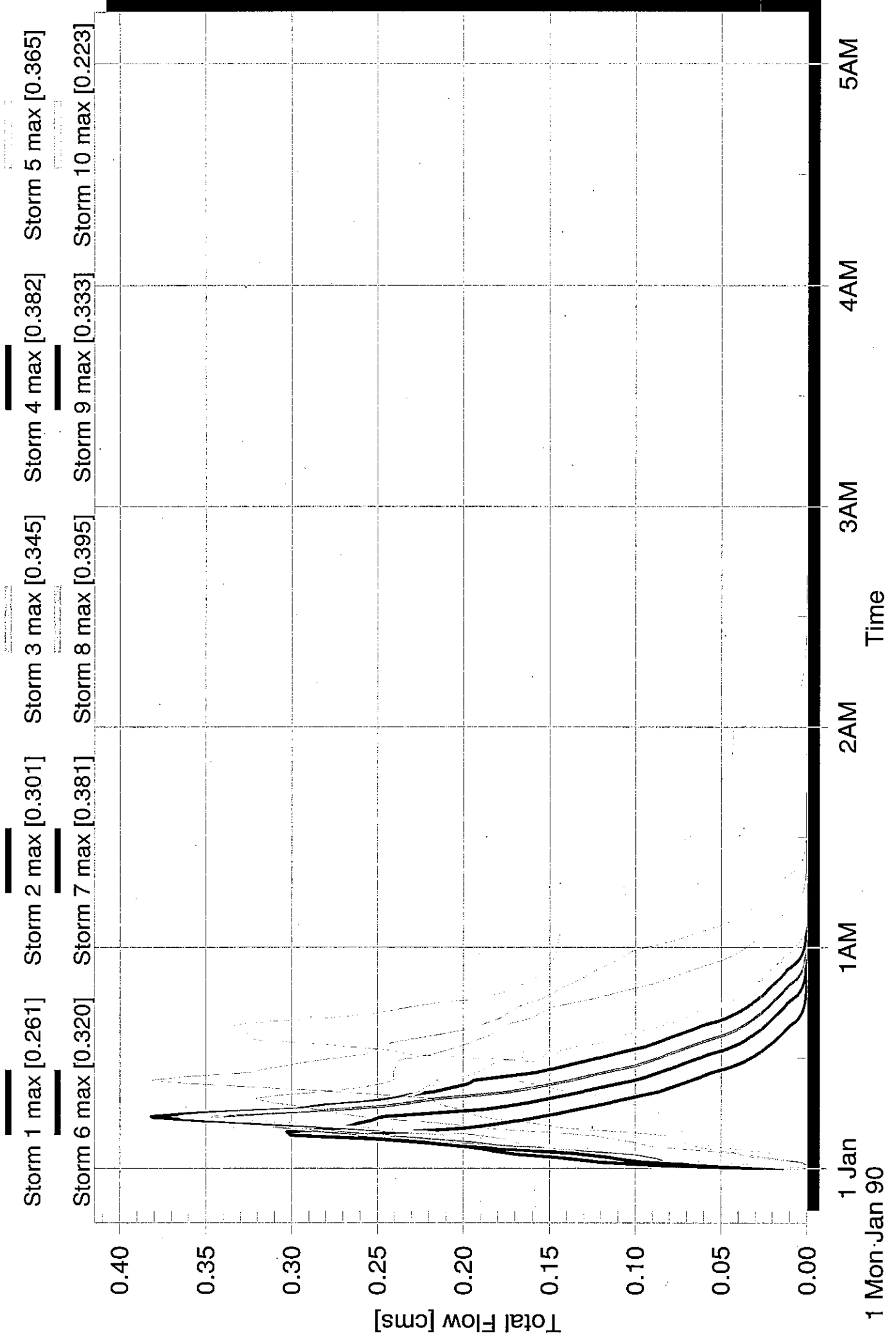
Total Flow

Storm 1 max [0.232]	Storm 2 max [0.251]	Storm 3 max [0.293]	Storm 4 max [0.320]	Storm 5 max [0.304]
Storm 6 max [0.262]	Storm 7 max [0.326]	Storm 8 max [0.339]	Storm 9 max [0.289]	Storm 10 max [0.200]



MITIGATED Q100

Total Flow



Appendix D

EROSION HAZARD ASSESSMENT REPORT



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Erosion Hazard Assessment - June 2006

The Brisbane City Council (BCC), *Erosion Hazard Assessment* form must be read in conjunction with the *Erosion Hazard Assessment- Supporting Technical Notes* (June 2006 or later version) for explanatory terms, and Certification Information.

What is an Erosion Hazard Assessment?

Soil erosion and sediment from urban development, particularly during construction activities, is a significant source of sediment pollution in Brisbane's waterways. The Erosion Hazard Assessment determines whether the risk of soil erosion and sediment pollution to the environment is 'low' or 'high', using a point scoring system to assess the risk based on BCC's requirements for stormwater management and Erosion and Sediment Control (ESC).

When is the EHA required?

An *Erosion Hazard Assessment* form must be completed and lodged with BCC for any Development Application (DA), Operational Works ESC application, or Schedule 12 Compliance Assessment ESC application.

Failure to submit this form during lodgement of an Application may result in assessment delays or refusal of the Application.

Assessment Details

- 1 Does this development or operational works/detailed design ESC application trigger the Stormwater Management Code or House Code and involve soil disturbance?

No ☐ An Erosion Hazard Assessment is not required. Go to 4

Yes ☒ Complete Assessment Table on reverse side of this form.

- 2 Is the total score equal to or greater than 17?

A 'low' risk score

Generally, if the Erosion Hazard Assessment produces a Total Score of less than 17 and no individual score is equal to, or greater than its Trigger Score, the development proposal is considered to be 'low risk' with respect to soil erosion and sediment control.

A 'high' risk score

If the Erosion Hazard Assessment produces a Total Score of 17 or greater, or any individual score is equal to or greater than its Trigger Score, the development proposal is considered to be 'high risk' with respect to soil erosion and sediment control. Applicants must lodge, with their Application, sufficient supporting information to demonstrate that the performance criteria of the Stormwater Management Code or House Code in the City Plan 2000 can be achieved.

No ☒ Refer to Council's *Erosion Hazard Assessment - Supporting Technical Notes*.

Yes ☐

- 3 Did you answer 'yes' to any Trigger Score questions?

No ☐ Refer to Council's *Erosion Hazard Assessment - Supporting Technical Notes*.

Yes ☒

- 4 Site Information and Certification

Application number (if known)

Site address

93 Abbotsford Road
Bowen Hills

Postcode

Prepared by *Print name*

Blake Peacock

Business name

Terrane Engineering

I certify that:

1. I have made all relevant enquiries and am satisfied no matters of significance have been withheld from the assessment manager; and

Where completion of the EHA Assessment Table was required, that:

2. I am a person with suitable qualifications and/or experience in erosion and sediment control; and
3. the Erosion Hazard Assessment was completed in accordance with the Erosion Hazard Assessment Supporting Technical Notes and the BCC Erosion and Sediment Control Standard (version 9 or later); and
4. the Erosion Hazard Assessment Score accurately reflects the site's overall risk of soil erosion and sediment pollution to the environment.

I acknowledge and accept that the BCC, as assessment manager, relies, in good faith, on this certification as part of its development assessment process and the provision of false or misleading information to the BCC constitutes an offence for which BCC may take punitive steps/ action against me/ enforcement action against me.

Certified by *Print name*

Blake Peacock

Certifier's signature

Date

28 / 11 / 09

Assessment Table

	Points	Score	Trigger Score	BCC Use Only
[1] AVERAGE SLOPE OF DISTURBANCE AREA - less than 3 (3 = 33H:1V) 0 - more than 3 but less than 5 (5 = 20H:1V) 1 - more than 5 but less than 10 (10 = 10H:1V) 2 - more than 10 but less than 15 (15 = 6.7H:1V) 4 - more than 15 6		0	Score equal to or greater than 4? No ☒ Yes ☐	
[2] SOIL CLASSIFICATION GROUP (AS1726) - GW, GP, GM, GC 0 - SW, SP, SM, SC, Pt 1 - MH, CH, OH 2 - ML, CL, OL, if imported fill will be used, or if soils untested 3		3	Untested	
[3] EMERSON (DISPERSION) CLASS NUMBER - Class 4, 6, 7, or 8 0 - Class 5 2 - Class 3 4 - Class 1 or 2 6		4	Score equal to or greater than 4? No ☐ Yes ☒	
[4] DURATION OF SOIL DISTURBANCE (including stabilisation period) - less than 1 month 0 - more than 1 month but less than 4 months 2 - more than 4 months but less than 6 months 4 - more than 6 months 6		0	Score equal to or greater than 4? No ☒ Yes ☐	
[5] AREA OF DISTURBANCE - less than 1000 m² 0 - more than 1000 m² but less than 5000 m² 1 - more than 5000 m² but less than 1 ha 2 - more than 1 ha but less than 4 ha 4 - more than 4 ha 6		1	Score equal to or greater than 4? No ☒ Yes ☐	
[6] WATERWAY DISTURBANCE - No disturbance to watercourse, open drain or stormwater pipe 0 - Disturbance to watercourse, open drain or stormwater pipe 4		0	Score equal to or greater than 4? No ☒ Yes ☐	
[7] REHABILITATION METHOD Percentage of area (relative to total disturbance) stabilised by seeding without mulching (ie. highest risk stabilisation method) - less than 1 0 - more than 1 but less than 5 1 - more than 5 but less than 10 2 - more than 10 4		1		
[8] RECEIVING WATERS - Open water body (eg. creek, river, bay) 1 - Enclosed water body (eg. lake, boat harbour) 2		1		
[9] SUBSOIL EXPOSURE - No subsoil exposure except for service trenches 0 - Subsoils are likely to be exposed 2		2		
[10] EXTERNAL CATCHMENTS - No external catchment 0 - External catchment diverted around the soil disturbance 1 - External catchment not diverted around the soil disturbance 4		0		
[11] ROAD CONSTRUCTION - No road construction 0 - Involves road construction works 2		0		
[12] pH OF SOILS TO BE REVEGETATED - less than pH 6 1 - more than pH 6 but less than pH 8 0 - more than pH 8, or if pH testing not done at this stage 1		1	Untested	

[13] Total Score = 13

Go to 2 (front page)

Appendix E

BCC FLOODWISE PROPERTY REPORT



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BRISBANE CITY COUNCIL

FloodWise Property Report

ABN 72 002 765 795

Dedicated to a better Brisbane

Report Reference

916593

16/10/2009 16:25:03

11663
Flood
Inust

DISCLAIMER

- 1.1 The flood information supplied does not represent the highest probable flood level that could occur on this property. A flood more severe than a Defined Flood can occur, although, such events are rare.
- 1.2 A property may be affected by several sources of flooding (e.g. Brisbane River, creek, waterway or storm tide). Council provides flood information on the highest known source. However no information is provided in regards to overland flow (see Terms and Definitions, p. 4).
- 1.3 If a property is affected by flooding, it may also be impacted by a Waterway Corridor. The Waterway Corridor indicates where development is controlled to preserve the capacity of the land to meet the waterway objectives. For further information contact the Development Assessment Customer Liaison Officer on 3403 8888.
- 1.4 Flooding may result from other sources including waterway tributaries and Localised Overland Flow / local runoff. Stormwater pipes may also be found on your property. For works in localised overland flow paths or to build over stormwater, the applicant must lodge an application for Building Over/Near Stormwater Facilities to Council for assessment. The location of stormwater pipes can be obtained from Council's Customer Service Centres. The applicant must engage a suitably qualified and experienced Registered Professional Engineer in Queensland (RPEQ) to undertake the appropriate assessments.
- 1.5 Any proposed filling of land must be undertaken in accordance with legal responsibilities and the requirements specified in the *Brisbane City Plan 2000*. Habitable floor levels are to be in accordance with the *Brisbane City Plan 2000*.
- 1.6 Defined Flood Levels shown on this report have been determined from the information available to Council at the date of issue. The Defined Flood Level for a particular property may change if more detailed information becomes available, or changes are made in the method of calculating flood levels. Changes in the condition of local creeks and waterways may further alter the effects of flooding.
- 1.7 The Flood Report is a guide only and should not be used or relied upon for development purposes. It is recommended that a Registered Surveyor and Engineer be engaged to undertake the appropriate development assessments.
- 1.8 For the reasons set out above, Council makes no warranty or representation regarding the accuracy or completeness of a FloodWise Property Report. Council disclaims any responsibility or liability in relation to the use or reliance by any person on a FloodWise Property Report.

PROPERTY DETAILS

This *FloodWise Property Report* provides defined flood levels from river, creek, waterway and storm tide flooding and ground levels for the property nominated below. The information contained in this report is only based on information currently available to Council and such information may not be complete. **APPLICANTS MUST NOTE THE DISCLAIMER ON PAGE 1 OF THIS REPORT.** This report does not provide information relating to flooding from overland flow or local runoff.

Property

You selected **93 ABBOTSFORD RD BOWEN HILLS 4006**

however, Council refers to this property as

Street Address **34 FOLKESTONE ST BOWEN HILLS QLD 4006**

Lot on Plan **L.138/SL.11563, L.137/SL.11563, L.135/B.123430, L.136/B.123430**

FLOOD LEVEL INFORMATION

If you are purchasing, renting, renovating, building or extending a dwelling, the following information may be applicable. Please note that in the case of ground levels Council's records may show levels prior to the development of recent subdivisions. In this instance confirmation of ground levels may need to be sought from the developer or builder.

All figures used in the calculations below are approximate only. For accurate results a Registered Professional Engineer should be consulted.

Minimum Ground Level **1.7 m AHD**
based on most recent Council information*

Maximum Ground Level **7.7 m AHD**
based on most recent Council information*

Highest Defined Flood Level (DFL) **2.5 m AHD**
(or 100 Year ARI Flood Level)

Highest flooding source from STORM TIDE

Flooding also occurs from RIVER

Approximate depth of flooding on this property **0.8 m**
Defined Flood Level (DFL) less the minimum ground level

Minimum habitable floor level **3.0 m AHD**
Highest defined flood level (DFL) in metres + 500 mm

* Council receives ground level information from a number of sources including design plans, as-constructed drawings, ground surveys and airborne laser scanning. This report contains Council's most recent received ground levels. For accurate levels please see a registered surveyor.

FURTHER FLOOD LEVEL INFORMATION

If you are planning a subdivision, building a new dwelling, extending an existing dwelling, and/or other similar development, the following information may also apply:

ARI Flood Level

100 Year or Highest DFL **2.5 m AHD** Flooding from: **STORM TIDE**

Flooding also occurs from: **RIVER**

50 Year **2.2 m AHD** Flooding from: **STORM TIDE**

20 Year **2.1 m AHD** Flooding from: **STORM TIDE**

5 Year **1.9 m AHD** Flooding from: **STORM TIDE**

Flooding Flags

The following may impact on development of your chosen site:

Large Allotment Flag This flag is generally for subdivision and/or development sites only. This is a large allotment over 1000 square metres and flood levels may vary significantly in different areas on the site. Further investigation must be undertaken by a suitably qualified Registered Professional Engineer in order to determine a site specific flood analysis.

TERMS AND DEFINITIONS

The following provides a glossary of important terms referred to within this report.

Australian Height Datum (AHD)

The national vertical/height benchmarking survey reference based on mean (average) sea level. Elevations quoted against mean sea level are normally followed with the abbreviation AHD. An AHD of 0.0 m is approximately equal to mean sea level.

Average Recurrence Interval (ARI)

The probability of experiencing a flood of a particular magnitude is expressed as an Average Recurrence Interval (ARI) in years. ARI is a statistical estimate of the average period in years between the occurrences of a flood event of a given size or greater (based on long term averages). For example, 5 Year ARI: during a five-year period, there is a chance that a flood event of this size or greater may occur at least once. The ARI gives no indication of when a flood of this size may occur next.

Defined Flood Level (DFL)

The flood event adopted by a local authority for management of development. The DFL does not indicate the full extent of flood-prone land. Generally the standard used is the 100 Year ARI. The DFL is used for determining the development levels for various types of development e.g. houses, subdivisions etc. Although a property may be above the DFL it may still be affected by the flood level as a result of Council's requirement for development to be above the DFL. For further information, refer to the House Code in *Brisbane City Plan 2000*, specifically Table 1: House Flood Immunity Levels for residential property. For all other development refer to Council's *Subdivision and Development Guidelines*.

TERMS AND DEFINITIONS (continued)

Minimum Habitable Floor	The minimum level at which habitable areas of development (generally including bedrooms, living rooms, kitchen, study, family and rumpus rooms) must be constructed.
Maximum Ground Level	The highest ground level on the applicant's property based on most recent ground level information. Check with a Registered Surveyor for further information on ground levels.
Minimum Ground Level	The lowest ground level on the applicant's property based on most recent ground level information. Check with a Registered Surveyor for further information on ground levels.
Overland Flow	The Stormwater runoff which exceeds the capacity of the underground drainage system (if present) and which concentrates in surface depressions, yards and gullies as it flows down a catchment. Such flooding may result from a severe thunderstorm or periods of prolonged rain. This report does not identify overland flow flood levels and associated habitable floor levels.
Waterway Corridor	The corridors defined in <i>Brisbane City Plan 2000</i> , along waterways (being a river, creek or creek tributary) which protect water flow, water quality, biodiversity, and recreation values. The potential to build or extend a home situated within a waterway corridor is restricted. For further information on this contact the Development Assessment Customer Liaison Officer on phone (07) 3403 8888.
Storm Tide	The water level which results from the rise above the normal tide level due to the combined effects of wind and atmospheric pressure caused by severe weather conditions such as tropical cyclones or storms. Such rises may lead to flooding in coastal and bayside areas of the city.

FURTHER INFORMATION ABOUT FLOODING

Council's *Be FloodWise* program has a range of publications available that provide information on flooding in Brisbane, how to prepare your home and yard to reduce the impact of flooding and flooding considerations when buying or renting, or building or renovating. This information is available from Council's regional business centres or customer service centres, by phoning Council on (07) 3403 8888, or by visiting www.brisbane.qld.gov.au/floodwise.

