

Technical Memo

Purpose: Supplementary information Selfs Point Exp
From: Chris Bren, Project Development Manager
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Date: 15/03/2023

Subject: Inflow and Infiltration Assessment Selfs Point STP expansion

Background

The Macquarie Point Sewage Treatment Plant (STP) is a Level 2 Secondary Treatment facility located at Macquarie Point, Hobart. The plant treats approximately 16,000 Equivalent Tenants (ETs) from residential, business and light industrial customers within North Hobart, West Hobart, Glebe, South Hobart, Battery Point and the Hobart Central Business District (CBD), along with receiving tankered trade and septage waste.

Under the Macquarie Point Relocation Project, flows from the existing Macquarie Point STP will be transferred to an expanded facility at the Selfs Point STP. This memo provides a summary of the existing information and how risks and issues relating to Inflow and Infiltration (I&I) have been incorporated into the planned expansion of the Selfs Point Sewage Treatment Plant (STP).

This memo considers two specific areas of concern identified by the EPA during discussion in November 2022 relating to Inflow and infiltration (I&I) across the Macquarie Point catchment. Additional information was requested to support the project Environmental Impact Statement addressing the following:

1. Demonstrate sufficient data was available to show the design assumptions for peak flows from the Macquarie Point Catchment, and in particular high flows associated with I&I are appropriate; and
2. Provide additional information on sea water ingress within the Macquarie Point catchment, demonstrating the issue is understood and appropriate allowance for conductivity and total dissolved solids have been used in selecting the design parameters for the upgraded Selfs Point STP.

Key Outcomes

Key outcomes of this technical review are summarised following:

- The hydraulic characteristics of the Macquarie Point catchment are well understood, including the levels of inflow and infiltration that occur within specific sub catchments. This results in Peak Wet Weather Flow (PWWF) of typically six times the Average Dry Weather Flow (ADWF) due inflow during rain events. Hydraulic models have been developed calibrated with physical measurements and this data has been used to inform parameters throughout the project including the transfer main capacity from the proposed Macquarie Point Pump Station to the expanded Selfs Point STP and the sizing of the transfer SPS Emergency Storage.

- Periods of elevated conductivity are a known issue within the Macquarie Point catchment. The majority of elevated conductivity within the catchment is due to inflow from sea water during high tides that occur in specific sub-catchments. The volumes of sea water ingress and the specific conditions in which high conductivity events occur is understood and these are incorporated into the design parameters for the combined influent to the new Selfs Point plant.
- Sea water ingress is shown to be occurring through low lying areas of sewer main through the CBD waterfront, Salamanca and Battery Point. Parts of the sewer network through this area date from the early 1900's, and are of early concrete or vitreous clay construction with degraded spigot joints that allow high levels of ingress through low laying areas adjacent to the water front. Areas where these high levels of ingress are occurring have been identified and the requirement for their prioritisation noted within the renewals program and the wider Tas Water I&I program. As these renewals occur, peak volumes and conductivity levels will decrease. This means the design parameters adopted for Selfs Point STP expansion based on current day criteria are conservative over the long term. The concept design work undertaken to date allows for these elevated conductivity levels with no special infrastructure considerations required. Further consideration will be given through the upcoming detailed design phase.

Section One- Peak Inflows – Macquarie Point STP Catchment

This section provides overview of the infrastructure associated with the Macquarie Point sewer network and provides detail on the data collection undertaken to inform hydraulic modelling to ascertain the design parameters used under the proposed relocation to Selfs Point. This data has been used to size the transfer main capacity from the proposed Macquarie Point Pump Station and size the pump station emergency storage at Macquarie Point.

Overview of network model

The Macquarie Point network covers the Hobart CBD as well as surrounding suburbs of Battery Point, West Hobart, South Hobart, North Hobart, Mount Stuart and Glebe. It services approximately 18,650 Equivalent Tenements (ETs) and includes 8 SPS. Pipe sizes are ranging from 53 -1200 mm.

The Macquarie Point catchment data for the current Macquarie Point STP (and the proposed SPS) has been collated and analysed through the following process:

- TW engaged GHD and Mott MacDonald to provide and develop key hydraulic inputs in 2016. Mott MacDonald's role was limited to the supply of flow, rainfall and conductivity data for catchments upstream of the Macquarie Point sewerage treatment plants (STP's).
- The Macquarie Point wastewater reticulation system was divided into ten (10) sub-catchments.

A list of the Macquarie Point STP (and SPS) sub catchments and a schematic plan is provided in Figure and 2.

Flow Monitor Manhole	Address	Inlet Pipe Diameter (mm)	Net Sub-Catchment Area (Ha)	Net Lineal Metres of Pipe in Sub-Catchment
FM01	87 Campbell St (basement carpark)	451	22	7170
FM02	158 Collins St	375	42	11956
FM03	Elizabeth St and Davey St	469	35	9039
FM04	MPDC Railyard (10 Evans St)	840	1	168
FM05	98 Salamanca Pl	449	55	15968
FM06	BWS - 211 Brooker Hwy	392	74	18926
FM07	Corner Burnett and Campbell St	348	50	13645
FM08	76 Elizabeth St	304	101	24914
FM09	149 Liverpool St	448	81	213914
FM10	52 Anglesea St	582	152	36204
FM11	6 Evans St	1253x830 Ovoid	33	9112
FM12	Selfs Pt Rd (N of Rugby Park Clubrooms)	992X647 Ovoid	NA	NA
RG1	Mac Pt STP, Hunter St, Hobart.	NA	NA	NA
RG2	2A Hill St, West Hobart.	NA	NA	NA

Figure 1. Details of Macquarie Point catchment monitoring locations (Mott MacDonald)

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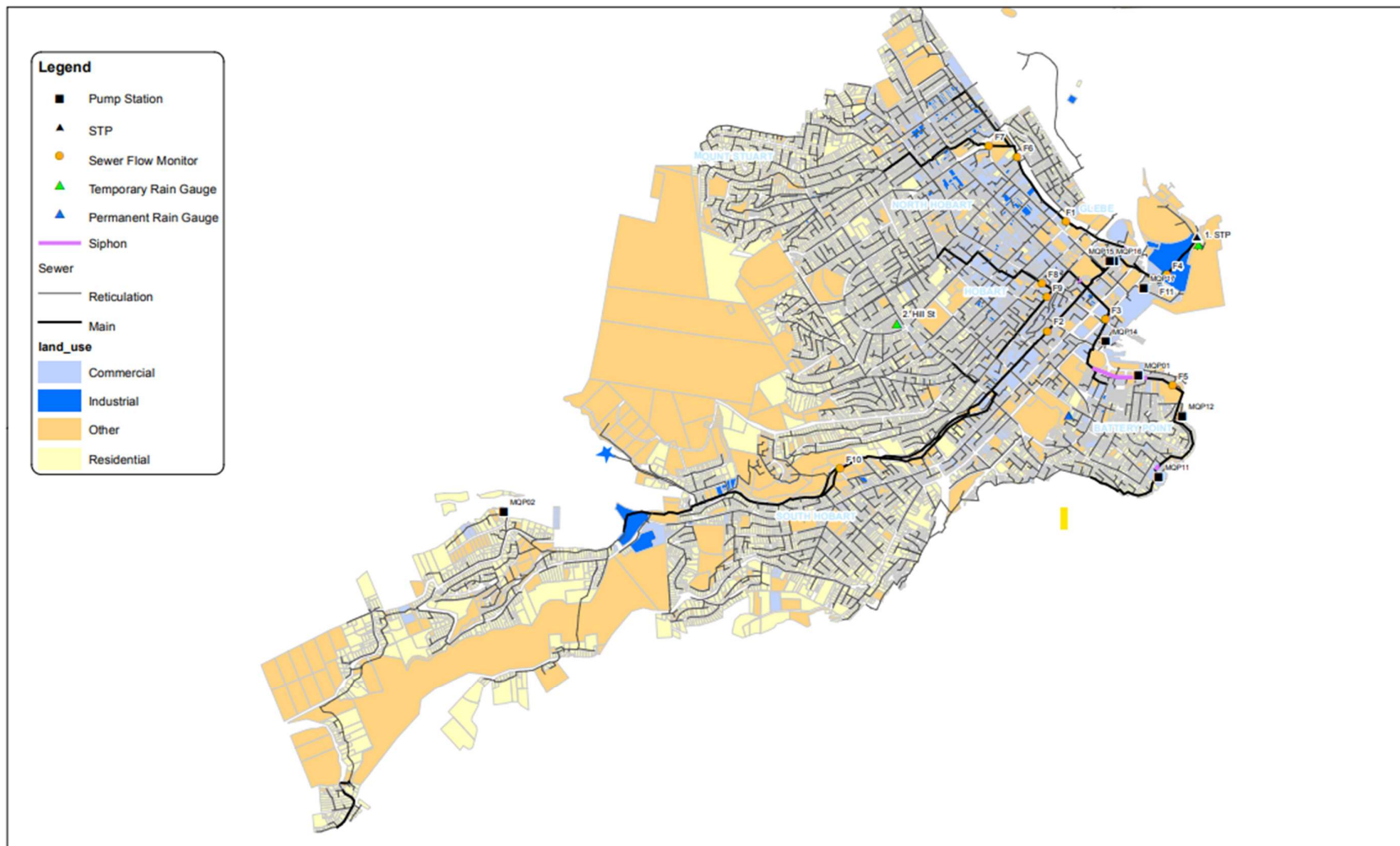


Figure 2. Macquarie Point Sewerage Network

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The monitoring network also comprised two (2) rain gauges. One gauge (FM12) was also used to measure flows to the Selfs Point STP separate to the Macquarie Point catchment.

Generally, data collection was carried out over a period of time to understand the network performance under various conditions, such as dry periods and rain events. The flow and rainfall monitoring programme was carried out over 11 weeks, from the 15th of January to the 24th March 2016.

Four (4) storms suitable for wet weather flow (WWF) capacity analysis and infiltration and inflow assessment were captured during the monitoring period. A data availability of 99.4% was supplied for the flow and rainfall monitoring network. Further details on the data collection and analysis can be found in the Inflow and Infiltration (I&I) Assessment Report by Mott MacDonald.

A range of subsequent studies and activities following the data collection are summarised below:

- GHD developed a hydraulic model for the purpose of estimating flows for the design of the proposed Macquarie Point Pump Station. The Model build report provides further information and technical details, Macquarie Point Sewerage Network – Model Build Report, GHD 2016.
- GHD calibrated the hydraulic model with the data obtained from sewer gauging. A detailed calibration report has been provided for further information, Macquarie Point Sewer Model System Modelling Document, GHD 2016.
- Development of a water balance model to incorporate new SPS, ES and upgraded Selfs Point STP, Network concept design, Aurecon 2016
- AURECON developed growth projection up to 2054 for the Mac Point catchment, refer Macquarie Point STP Relocation – 20/21 Review 2020 Network Concept Review, Aurecon 2021 (refer S.11)
- Refinement of water balance model to verify GHD concept design for Selfs Point STP, GHD 2022
- UWS incorporated the growth projection into the current model to inform design parameters in 2021/22
- TW have refined the hydraulic model to reflect new site constraints associated with the stadium proposal, TW 2022

The adopted key design flow rates (ADWF and PWWF) are given in Table as a result of the hydraulic modelling and applied growth rate for the design horizon of 30 years (2054). Historical STP inflow data for 2019 has been used as a check to understand changes to the catchments since 2016 for the ADWF. This also verifies the applied growth rate of 0.9% per annum. The PWWF is the maximum recorded flow to the Macquarie Point STP. There is no escalation in PWWF flows, as the catchments are almost entirely infill only and ongoing/future renewal programs will likely reduce inflow and infiltration.

Medium sensitivity receiving environment as per SPS guidelines stipulates minimum containment for a 1-year ARI storm event and 4 hours storage of ADWF in a dedicated emergency storage.

Table shows the results of the various 1 in 1 year design storms modelled. Under these scenarios the levels in the storage and control manhole are identified, with the 36h design storm being the critical storm duration where the levels within the storage and control manhole are the highest.

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Table 1: Key design flow rates

MAC POINT STP FLOWS	FLOW RATES (L/S)		
	2016	2019	2054 @ 0.9%
ADWF	115	118.44	161.64
PWWF	856	904	904

Table 2. Modelling outcomes 1 year ARI

DESIGN STORM DURATION	VOLUME STORED 2054 MODEL (KL)	MAX LEVEL IN STORAGE TANK 2054 MODEL (M AHD)	MAX LEVEL AT CONTROL MANHOLE 2054 MODEL (M AHD)
6hr	0	-1.2	-0.32
12hr	25	-1.15	1.38
18hr	0	-1.2	0.67
24hr	164	-0.33	1.44
36hr	1774	1.86	1.8
48hr	1759	1.84	1.78
72hr	0	0	1.21

For context, the overflow to the environment through the ERS is set at 2 m AHD, which provides a freeboard of 0.2 m at the control manhole (1.8 m) for the 36h design storm duration and a total volume of 1,774 kL stored in the ES. The ES for these modelled scenarios was based on a footprint of 19 m x 39 m (depth around 4-5.5m, volume 2 ML) within the area allocated for the storage (refer Figure).

The 4h of ADWF storage requirement was also investigated as part of the modelling. The results showed that at least 6h of storage of 2054 ADWF (162L/s) is provided within the upstream network, inclusive of the 2ML of ES.

The developed hydraulic model has been calibrated against the results from the catchment data collection (sewer gauging) to demonstrate the validity of the design overflow frequencies and design parameters adopted.

The key design basis parameters are:

- Pump station capacity, providing 1yr storm immunity based on medium sensitivity rating
- Rising main capacity (transfer from Macquarie Point to expanded Selfs Point STP (650 L/s – maximum SPS flow)
- Emergency storage is based on providing minimum of 4 hrs ADWF, currently 2 ML adopted

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The underground emergency storage for the pump station is proposed to be located upstream of the new SPS. This will connect to the incoming sewer trunk main via a new manhole and a discharge line. The sizing of the overflow storage will align with the SPS pump capacity to ensure a 1 in 1 year event is contained. A total of at least 6 hours of storage of ADWF for 2054 (162 L/s) is provided within the upstream network (2h) in addition to the ES (4h). The emergency storage structure is sized at 2 ML and will have an internal washdown system above the Emergency Relief Structure weir level of 2 m AHD

A separate Environmental Impact Statement has been prepared for the Macquarie Point Sewage Pump Station and Emergency Storage and further information on the proposed infrastructure and operation is provided within that document.

Section 2 Sea Water Ingress and Conductivity

This section summarises findings relating to sea water ingress and high conductivity events within the Macquarie Point catchment and demonstrates appropriate parameters for conductivity and total dissolved solids have been utilised in design inputs.

An Inflow and Infiltration Assessment for the Macquarie Point catchment was undertaken by Mott MacDonald in 2016. This study has been provided with the EIS.

The study installed flow monitoring and conductivity meters at twelve locations within the Macquarie Point catchments and analysed results against tidal fluctuations and weather events.

This section of the memo focusses on findings relating to sea water ingress and high conductivity events observed within the catchment.

Sea Water Ingress and Conductivity

The presence of salts in the water increases the ability of a solution to conduct an electrical current. Measurements of high conductivity equate to high levels of dissolved salts within the water. While these dissolved salts can come from a number of sources including commercial waste, the higher levels of conductivity observed through low lying areas of the Macquarie Point catchment combined with variation patterns that correlate with tidal flows indicate areas of seawater ingress within the catchment.

Of the locations analysed, the most relevant for defining characterisation of influent to the new Selfs Point plant, is the data collected from the Macquarie Point STP wet well. While information from the sub catchments is useful in identifying locations of ingress, the information from the wet well essentially shows the conductivity fluctuations coming into the existing plant. Plots of conductivity at the Macquarie Point wet well along with corresponding tide heights is shown in Fig 4 and 5 following.

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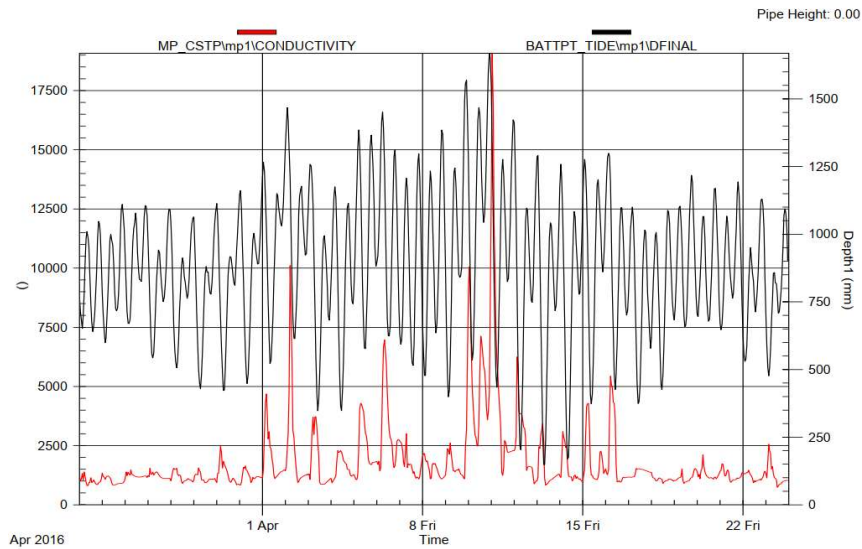


Fig 4: Conductivity and tide heights at Mac Point STP wet well (April 2016)

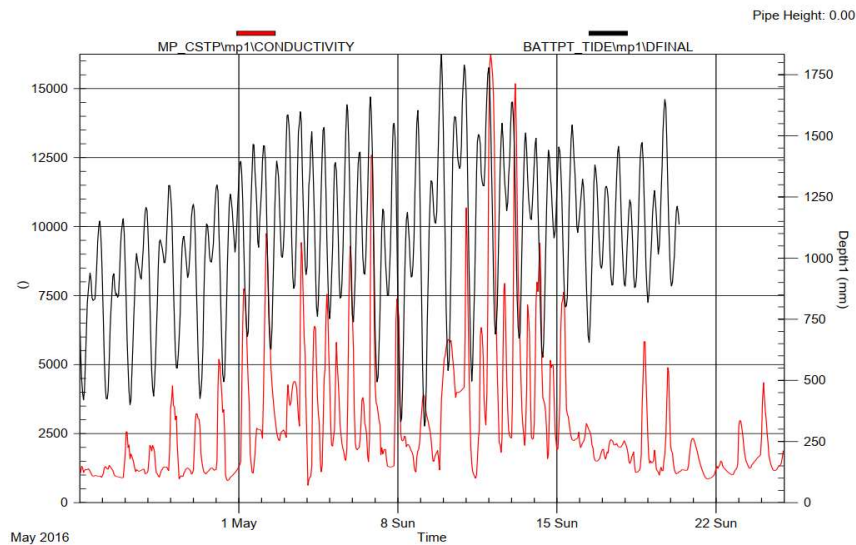


Fig 5: Conductivity and tide heights at Mac Point STP wet Well (May 2016)

The conductivity data in Fig4 and 5 show some correlation to high tide events, particularly tide heights 1600mm as measured at Battery Point, however not all high tide events result in a conductivity spike.

To understand this further, cross referencing the tide data with rain fall events has been undertaken. Rain fall data from the Botanic Gardens meter is provided in the table 3 following.

Station ID	Year	Month	Day	Rain fall (mm)	Note
94030	2016	4	1	0	
94030	2016	4	2	1	

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94030	2016	4	3	0
94030	2016	4	4	0
94030	2016	4	5	0
94030	2016	4	6	0
94030	2016	4	7	0
94030	2016	4	8	0
94030	2016	4	9	0

High tide 1650mm, high conductivity spike, no rain

94030	2016	4	10	0
94030	2016	4	11	0.4
94030	2016	4	12	0
94030	2016	4	13	0
94030	2016	4	14	0
94030	2016	4	15	0
94030	2016	4	16	0
94030	2016	4	17	0
94030	2016	4	18	0
94030	2016	4	19	0
94030	2016	4	20	0
94030	2016	4	21	1
94030	2016	4	22	2.2
94030	2016	4	23	0
94030	2016	4	24	0
94030	2016	4	25	0
94030	2016	4	26	0
94030	2016	4	27	0
94030	2016	4	28	0
94030	2016	4	29	2.6
94030	2016	4	30	1.2

Station ID	Year	Month	Day	Rain fall (mm)	Note
94030	2016	5	1	6.5	
94030	2016	5	2	5.5	
94030	2016	5	3	6.2	
94030	2016	5	4	5.4	
94030	2016	5	5	0	
94030	2016	5	6	1.4	
94030	2016	5	7	0	
94030	2016	5	8	0	
94030	2016	5	9	10.5	<i>High tide 1550-1570, Low conductivity heavy rain</i>
94030	2016	5	10	12.6	

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94030	2016	5	11	10.8	
94030	2016	5	12	0.1	High tide 1750mm, high conductivity- no rain
94030	2016	5	13	1	
94030	2016	5	14	0	
94030	2016	5	15	0.2	
94030	2016	5	16	3.4	
94030	2016	5	17	1.2	
94030	2016	5	18	0	
94030	2016	5	19	5.8	
94030	2016	5	20	4.8	
94030	2016	5	21	0	
94030	2016	5	22	0	
94030	2016	5	23	2.1	
94030	2016	5	24	1	
94030	2016	5	25	0.3	
94030	2016	5	26	0	
94030	2016	5	27	0	
94030	2016	5	28	0	
94030	2016	5	29	1.8	
94030	2016	5	30	0.3	
94030	2016	5	31	0	

Table 3: Rainfall data for April and May 2016, Hobart Botanic Gardens meter, (source BoM)

Analysis of the rain fall, tide height and conductivity data demonstrates the following key points:

- Conductivity in the Macquarie Point catchment spikes when tides above 1500mm occur (as measured at battery point)
- Where these high tides are accompanied by rain, as is often the case with low pressure systems, conductivity spikes are limited due to the level of dilution that occurs due to rain water ingress throughout the catchment.
- Where a high tide event (over 1650mm) occurs and there is no substantial rain, significant spikes in conductivity occur due to sea water ingress occurring and only dry weather flows within the sewer catchment provide dilution.

Under the proposed relocation of the Macquarie Point STP to Selfs Point, additional dilution will occur through pumping to Selfs Point and mixing with Selfs Point catchments flows. This will decrease the conductivity spikes at the Selfs Point plant inlet and is discussed further in the following section.

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Volumes of sea water ingress

The volumes of sea water ingress experienced through the catchment can be estimated based on conductivity data.

The relationship between Total Dissolved Solids (TDS (mg/L)) and Conductivity ($\mu\text{S}/\text{cm}$) is defined by the equation:

$$\text{TDS} = k \text{ EC}$$

Where EC is the conductivity (MicroSiemens $\mu\text{S}/\text{cm}$ - adjusted to 25 degrees Celsius), and the coefficient k varies with the ionic strength of the water, typically ranging from 0.5 (fresh water) to 0.7 (sea water).

To demonstrate the volume of sea water ingress within the catchment, a high conductivity event can be considered in the context of the current day Average Dry Weather Flow (ADWF) at 120 L/s. Using dry weather flows is appropriate, given as demonstrated in the previous section, the high conductivity events do not occur at times of Peak Wet Weather Flow (PWWF) due to dilution caused by rain infiltration.

TDS of influent (4hr high conductivity event, average 5000 $\mu\text{S}/\text{cm}$) = 3500 mg/L or 420 g/s based on ADWF rate).

TDS of influent (no sea water ingress at 800 $\mu\text{S}/\text{cm}$) = 480 mg/L (57.6 g/s based on ADWF rate)

The additional TDS equates to a volume of sea water at 50,000 $\mu\text{S}/\text{cm}$: 10.3 L/s

This equates to a total volume of 0.15 ML of sea water over the four hour high conductivity event.

In this case (that being a very high tide scenario), the inflow of sea water at 10.3 L/s against the ADWF of 120L/s represents ingress of 8.5% occurring through a four hour high tide period.

Under the proposed relocation of the Macquarie Point STP to Selfs Point, the influent is transferred via pumping station and emergency storage to the Selfs Point site. At the Selfs Point inlet works, the Macquarie Point catchment influent will be mixed with the Selfs Point influent. The Selfs Point catchment does not have the same extent of sea water ingress as the Macquarie Point catchment. This is due to age and location of the Selfs Point network, which has less low lying sewer in close proximity to sea water tidal zones.

To demonstrate the impact of this dilution, at current day ADWF, the resultant conductivity of the flows associated with the four hour high conductivity event discussed previously when mixed with the Selfs Point Catchment is:

(120L/s at 5000 $\mu\text{S}/\text{cm}$), diluted with Selfs Point catchment current day ADWF (94 L/s at 800 $\mu\text{S}/\text{cm}$), conductivity at the plant would be temporarily elevated to 3,190 $\mu\text{S}/\text{cm}$.

A further stage of dilution would occur within the bioreactor structure at the proposed Selfs Point STP which would provide additional buffering impact which would further dilute the transient high tide events.

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For context, the effluent reuse study prepared for the EIS is based on estimated mean salinity concentration for combined flows from the Selfs Point and Macquarie Point catchments is 1207 $\mu\text{S}/\text{cm}$, with minimum of 644 $\mu\text{S}/\text{cm}$ and maximum 4119 $\mu\text{S}/\text{cm}$.

Under WSAA's Management of Wastewater Systems Infiltration and Inflow Good Practice Guidelines recommends that an I&I severity threshold value of 8% ingress needs to be exceeded before undertaking a cost effective source detection and rehabilitation program. The Mott McDonald study concluded that it is difficult to assess the relative contributions of rain fall inundation and tidal ingress so accepted source detection programmes may not be effective. The sea water ingress levels outlined above represent just over 8% ADWF and further to this the origin of sea water ingress can be linked to specific sub catchments where inflows are significantly higher than 8%. This data has been used to inform prioritisation of identified sub catchments within the renewals program.

Impact of elevated conductivity on treatment and reuse

The basis of design for the expanded Selfs Point plant is based on median conductivity of 2,340 $\mu\text{S}/\text{cm}$ from the Macquarie Point catchment. The combined flows to the expanded Selfs Point plant are based on minimum conductivity of 644 $\mu\text{S}/\text{cm}$ and maximum 4119 $\mu\text{S}/\text{cm}$, with median value of 1207 for the combined effluent. From a process design perspective the most critical component relating to conductivity levels is ensuring rapid changes in salinity will not cause osmotic shock (cell rupture due to osmotic pressure and time taken to equalise TDS across the cell walls). This will be assessed in the context of buffering and dilution achieved through conveyance and in the bioreactors.

The salinity parameters are in line with those used for the Selfs Point reuse feasibility study. Salinity is a critical water quality parameter for sustainable irrigation, and typically conductivity values below 1000 $\mu\text{S}/\text{cm}$ have been adopted as a general indicator of recycled water suitability, however this is regarded as a conservative figure. The median salinity for combined flows from the expanded Selfs Point plant is unlikely to limit irrigation potential, however management practices will need to be implemented to exclude peaks from customer supply. This can be achieved via monitoring of effluent discharge from the plant, along with forecasting high conductivity events based on high tide/low rain fall scenarios.

Location of seawater ingress

This section looks at the location in which sea water ingress is occurring through the Macquarie Point catchment.

The sub-catchments utilised through the Macquarie Point I&I study have been shown previously in Fig 2.

Through analysis of the data, the catchments that observed highest tidal ingress were FM03, FM04, FM05 and these are shown in detail in the Figures 6-8 following.

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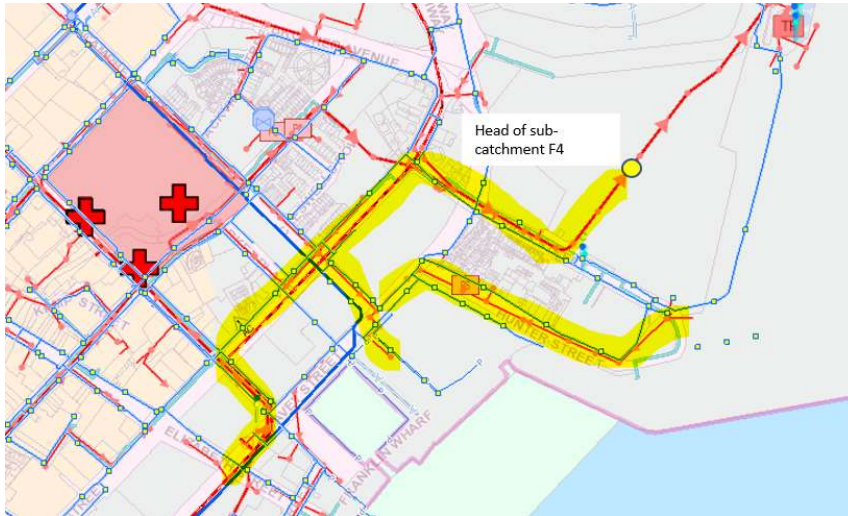


Fig 6: Sub-catchment F4 running through low lying areas adjacent to the water front around Hunter St and Franklin wharf

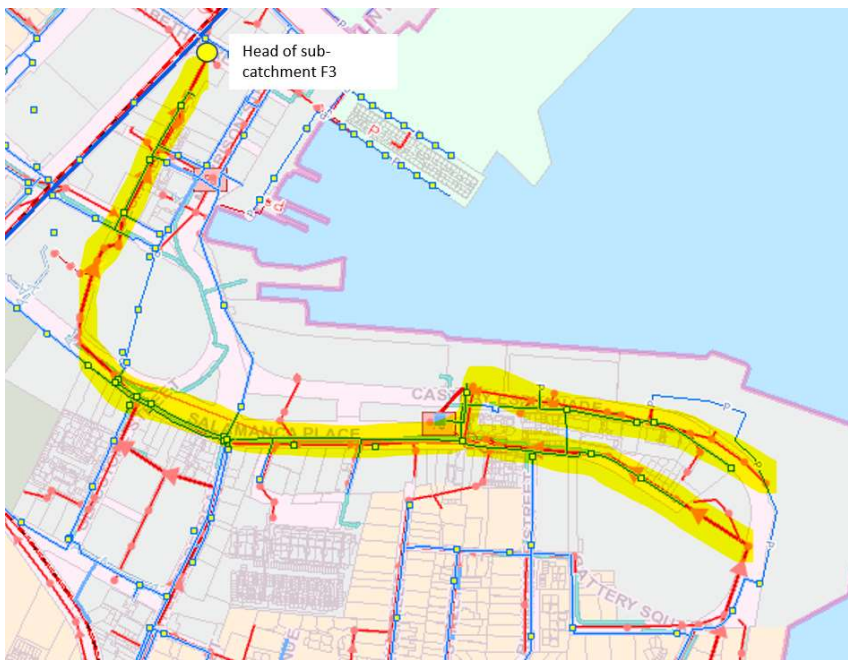


Fig 7: Sub-catchment F3 running through low lying areas adjacent to the water front through Salamanca Place

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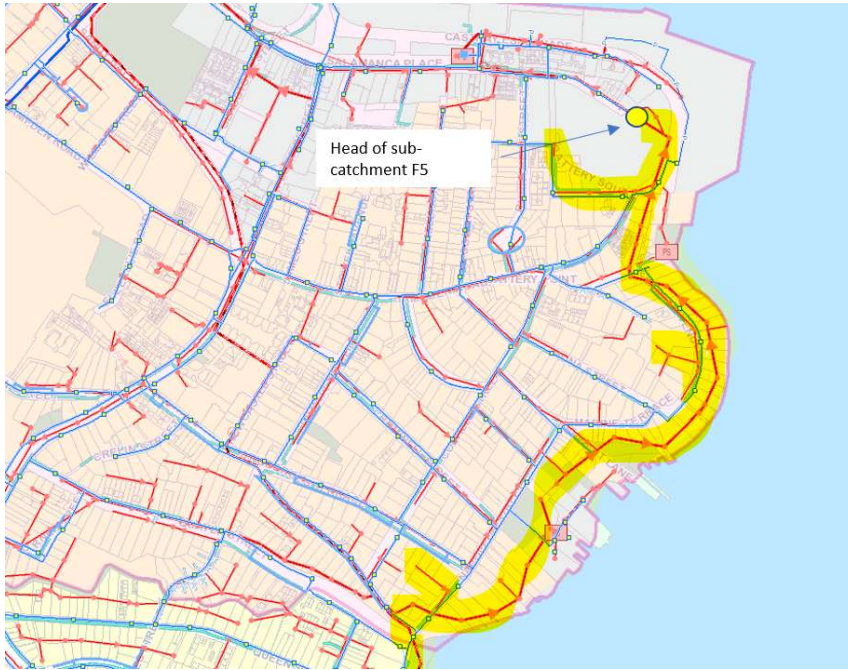


Fig 8: Sub-catchment F5 running through low lying areas adjacent to the water front through Battery Point

The Mott Mcdonald study found sub- catchments FM03 and FM04 exhibit the worst performance in terms of I&I ingress. These are a combination of tidal ingress and rain induced infiltration which can be demonstrated by the interaction of observed flows with storm events, and fluctuation in conductivity relating to tides.

Seawater ingress is shown to be occurring through low lying areas of sewer main through the CBD waterfront, Salamanca and Battery Point. Parts of the sewer network through this area date from the early 1900's and are of concrete or vitrified clay construction. Ingress can occur through aged spigot joints in concrete and vitrified clay pipe, or breaks and fissures in low lying areas adjacent to the waterfront. The priority associated with these areas have been highlighted specific consideration through the renewals program, identifying the importance of renewal of aged pipe sections within the tidal influence zone up 2m AHD.

It is noted a portion of the network associated with the FM04 sub catchment is currently in the process of being renewed under works being undertaken by Macquarie Point Development Corporation, relocating the sewer outside the Macquarie Point development footprint.

TasWater also evaluate and prioritise future investigations concerning inflow and infiltration. The FY 2022/23 Inflow & Infiltration Management plan (TW) indicates the Macquarie Point catchment ranked No. 19 out of 79 systems for risk ranked priority for I&I investigations. The 2022/23 Inflow & Infiltration Management plan is attached as an annex to this memo.

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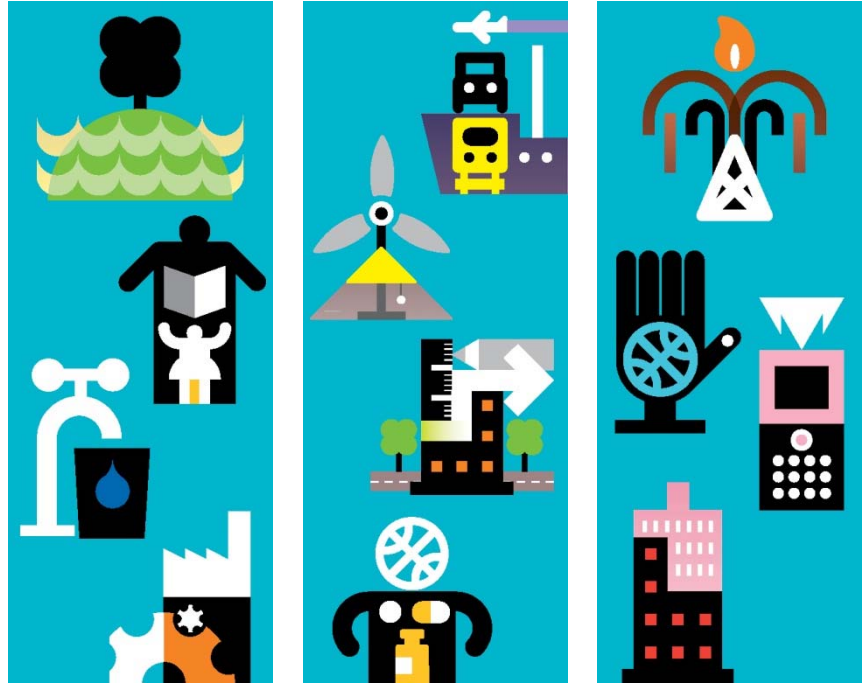
As renewals occur, I&I will reduce as areas of old sewer network are replaced with modern pipe allowing significantly less sea water ingress. As such current conditions, and the resultant parameters adopted through the design for the new Selfs Point STP represent a conservative scenario.

Summary

In summary, adequate data is available for the Macquarie Point sewer catchment to demonstrate effective parameters have been adopted for the Selfs Point STP design, and the associated Sewage Pump Station and Emergency Storage at Macquarie Point.

The peak flows associated with high levels of infiltration during rain fall events are captured in the calibrated hydraulic model and have been used for sizing the capacity of the Sewage Pump Station and transfer main, and also the pump station emergency storage.

Adequate data is also available to show the location and quantity of sea water ingress that is occurring within the Macquarie Point catchment, and to demonstrate the tide heights and meteorological conditions that lead to spikes in conductivity. The data is sufficient to define the influent characteristics for the process design for the expanded Selfs Point STP. As prioritised renewals occur throughout the network, substantial reductions in salt water ingress and resultant conductivity will occur, as such the conductivity parameters based on current day catchment performance can be viewed as conservative.



Macquarie Point Infiltration & Inflow Assessment

TasWater

July 2016

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Macquarie Point Infiltration & Inflow Assessment

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Issue and revision record

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004F	15/12/16	P Stephens	T Thompson	P Stephens	Edited FR after further GHD comment.

	Name	Date	Signature
Reviewed	Troy Thompson	15/12/16	
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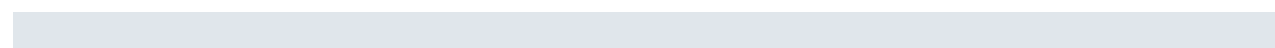
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Executive Summary

TasWater engaged GHD and Mott MacDonald to determine key technical inputs to support the process of transferring sewage from the existing Macquarie Point Sewage Treatment Plant (STP) to Selfs Point STP. Specifically, technical input is required to understand the nature of the Macquarie Point STP catchment, including dry weather and wet weather flows to the current Macquarie Point STP, in order to size proposed downstream transfer and treatment infrastructure.

The works that Mott MacDonald supplied for the Macquarie Point sewer flow monitoring and modelling study comprised:

Flow Monitoring:

- Supply, installation, calibration, operation and maintenance of a network of twelve (12) in-sewer flow meters and two (2) rainfall gauges at locations within the Macquarie Point wastewater reticulation catchment, for an initial period of seven (7) weeks. This was extended a further four (4) weeks to obtain more wet weather events. The sites were selected by TasWater and approved by Mott MacDonald and GHD as suitable locations.
- 12 conductivity probes were also installed in the Macquarie Point wastewater reticulation catchment to determine the areas with high conductivity. These were relocated during the period to try to further isolate the problem areas.

Two (2) rain gauges were installed in the catchment. After an 11-week data capture period, TasWater instructed Mott MacDonald to terminate the monitoring programme as it was determined as TasWater/GHD that enough data had been captured. Four (4) rain events (12-40mm rainfall totals) suitable for I/I assessment were captured during the eleven (11) week monitoring period. The flow and rainfall monitoring equipment was removed on 9th June 2016.

Four (4) storm events, suitable for I/I assessment, were captured during the monitoring period. The flow rates and rainfall during these storm events have been analysed to determine the extent and I/I severity in each of the Macquarie Point sub-catchments. The Macquarie Point I/I assessment has found:

- The base infiltration (BI) in Macquarie Point sub-catchments FM06, FM07 and FM08 is high. However, this is likely to be due to these sub-catchments being substantially commercial rather than residential land-use as they are either within or close to the Hobart CBD. Some of the apparent BI is likely not due to groundwater infiltration but overnight flows from commercial customers.
- The base infiltration in sub-catchment FM04 is very significant. It is likely that some of the 3.71L/Ha of net BI recorded at FM04 is tidal ingress rather than groundwater infiltration.
- The ratio of maximum observed PDWF to design flow is <0.3 for all monitoring sites other than FM03. This suggests that the Macquarie Point monitoring locations have sufficient dry weather capacity.
- The average percentage I/I ingress values for Macquarie Point is generally high with several catchments in excess of 13%. Macquarie Point is known to have tidal ingress issues particularly in catchments close to the Derwent River. It is suspected that the severe I/I ingress percentages observed in sub-catchments FM03 and FM04 are a combination of tidal ingress and rain-induced infiltration and inflow (RDII). This suspicion arises out of the observation that storm event 1 was the only storm event that occurred during the lowest range of high tides (1.26m) and in all sub-catchments the I/I ingress percentages were less than 10%. Although FM02 had high percentage I/I ingress this may not be tidally influenced as conductivity wasn't observed to be high and sewer inverts are higher in this catchment.
- Sub-catchment FM10 was found to have an average I/I ingress of 17.1%. Sub-catchment FM10 is known to have both an industrial discharge (Cascade Brewery – up to 700kL/day) and receives the leachate from a waste management facility. Significant rainfall would increase the leachate rate. It is likely that some of the increase in flow during WWF conditions can be attributed to leachate discharge and not RDII.

It is recommended that a tidal ingress study is undertaken before any infiltration and inflow source detection programme as it is not certain what the relative proportions of RDII and tidal ingress are in the total recorded I/I volume for each storm. Based on the conductivity monitoring and the results from the I/I assessment the tidal ingress study should initially be confined to catchments MP_FM03, MP_FM04 and MP_FM05. A tidal ingress investigation strategy has been provided in the recommendations.

1 BACKGROUND

The objective of this consultancy is to provide key technical inputs to support the process of transferring sewage from the existing Macquarie Point STP to Selfs Point STP. Specifically, technical input is required to understand the nature of the Macquarie Point STP catchment, including dry weather and wet weather flows to the current Macquarie Point STP, in order to size proposed downstream transfer and treatment infrastructure.

TasWater engaged GHD and Mott MacDonald to provide the key hydraulic inputs. Mott MacDonald's role was limited to the supply of flow, rainfall and conductivity data for catchments upstream of the Macquarie Point and Selfs Point sewerage treatment plants (STP's). A basic capacity analysis and infiltration and inflow assessment is also required to supplement the hydraulic modelling undertaken by GHD.

The Macquarie Point wastewater reticulation system was divided into ten (10) sub-catchments using HVQ sewer flow gauges as boundary gauges (with gauge FM11 acting as a duplicate backup for the base gauge at FM4). The monitoring network also comprised two (2) rain gauges. One gauge (FM12) was also used to measure flows to the Selfs Point STP separate to the Macquarie Point catchment.

The flow and rainfall monitoring equipment was installed from the 15th to the 24th March 2016. After an 11-week data capture period, TasWater instructed Mott MacDonald to terminate the monitoring programme. Four (4) storms suitable for wet weather flow (WWF) capacity analysis and infiltration and inflow assessment were captured during the monitoring period. A data availability of 99.4% was supplied for the flow and rainfall monitoring network. The flow and rainfall monitoring equipment was removed on 9th of June 2016.

2 MONITORING DETAILS

The Macquarie Point infiltration and inflow assessment involved dividing the wastewater reticulation system into eleven (11) sub-catchments using sewer HVQ (depth, velocity and flow) flow gauges. A catchment map of the wastewater network is presented in Figure 2.1.

FM11 was installed one manhole upstream of the Macquarie Point STP base gauge (FM04). FM11 has no significant net catchment and was installed as 'check gauge' for the FM04 base gauge. Therefore an infiltration and inflow assessment was not undertaken for FM11.

FM12 was installed to monitor the flow into the Selfs Point STP. Selfs Point is outside of the Macquarie Point catchment, no catchment area or pipe lengths were supplied, so an infiltration and inflow assessment was also not undertaken for FM12.

A schematic diagram (the relationship of the flow gauges to each other in the network) is presented in Figure 2.2. The schematic diagram is required to calculate net flows – the flow contribution of a particular sub-catchment after the upstream flow contributions are removed.

Details of the Macquarie Point flow and rainfall monitoring locations are provided in Table 2.1.

Table 2.1: Details of the Macquarie Point Monitoring Locations

Flow Monitor Manhole	Address	Inlet Pipe Diameter (mm)	Net Sub-Catchment Area (Ha)	Net Lineal Metres of Pipe in Sub-Catchment
FM01	87 Campbell St (basement carpark)	451	22	7170
FM02	158 Collins St	375	42	11956
FM03	Elizabeth St and Davey St	469	35	9039
FM04	MPDC Railyard (10 Evans St)	840	1	168
FM05	98 Salamanca Pl	449	55	15968
FM06	BWS - 211 Brooker Hwy	392	74	18926
FM07	Corner Burnett and Campbell St	348	50	13645
FM08	76 Elizabeth St	304	101	24914
FM09	149 Liverpool St	448	81	213914
FM10	52 Anglesea St	582	152	36204
FM11	6 Evans St	1253x830 Ovoid	33	9112
FM12	Selfs Pt Rd (N of Rugby Park Clubrooms)	992X647 Ovoid	NA	NA
RG1	Mac Pt STP, Hunter St, Hobart.	NA	NA	NA
RG2	2A Hill St, West Hobart.	NA	NA	NA

The twelve (12) flow monitoring locations were HVQ installations. FlowShark Triton+ (GSM telemetered) monitors were used with a velocity sensor centred in the invert of the pipe and a downward-looking ultrasonic sensor centred at the crown of the pipe. The sensors were installed on an expandable sensor band approximately one pipe diameter up the inlet pipe of the manhole.

The velocity data from the velocity sensor was used to calculate flow using the Continuity equation (Quantity = Area x Mean Velocity).

Conductivity loggers were also installed at a 12 locations selected by TasWater/GHD. These did not all correspond with flow meter installations. The locations can be seen in Table 2.2 below.

Table 2.2: Conductivity Monitoring Locations

Site no.	Address of location
C1	87 Campbell St (basement carpark)
C2	158 Collins St
C3	Elizabeth and Davey Sts
C5	102-104 Salamanca Pl
C6A	80 Elizabeth St
C6B	112 Liverpool St
C11	6 Evans St
C7	Napoleon St SPS - Wet Well
C8	Salamanca SPS - Wet Well
C9	Morrison St SPS - Wet Well
C10	Hunter St SPS - Wet Well
CSTP	Macquarie Pt STP - Wet Well

Site installation sheets (Appendix A), hydrographs (Appendix B), flow balance plots (Appendix C), synthesised dry v wet weather hydrographs (Appendix D) and conductivity plots (Appendix E) have been supplied in the Appendices of this report.

Figure 2.1: Macquarie Point Sub-Catchment & Sewer Plan

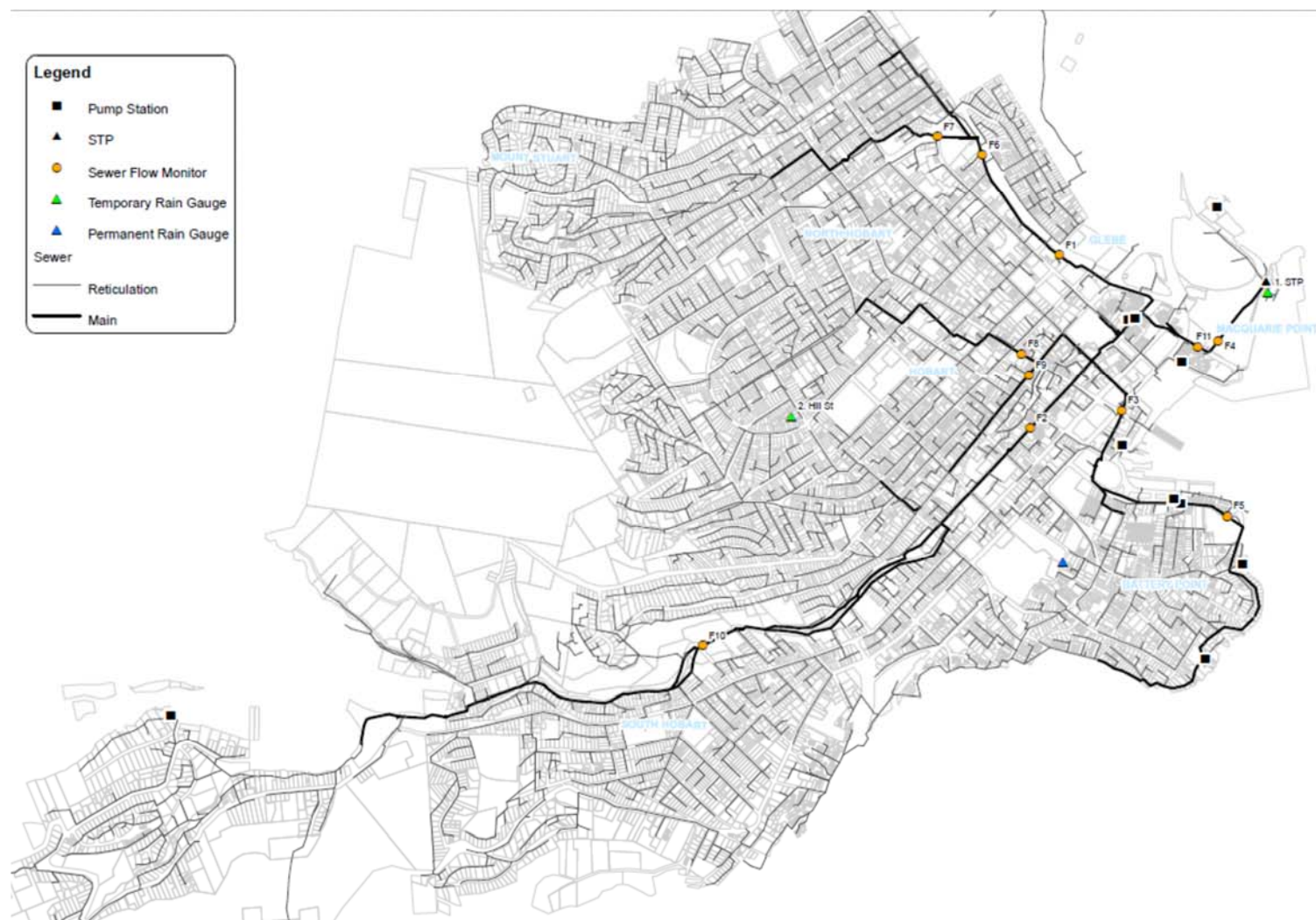
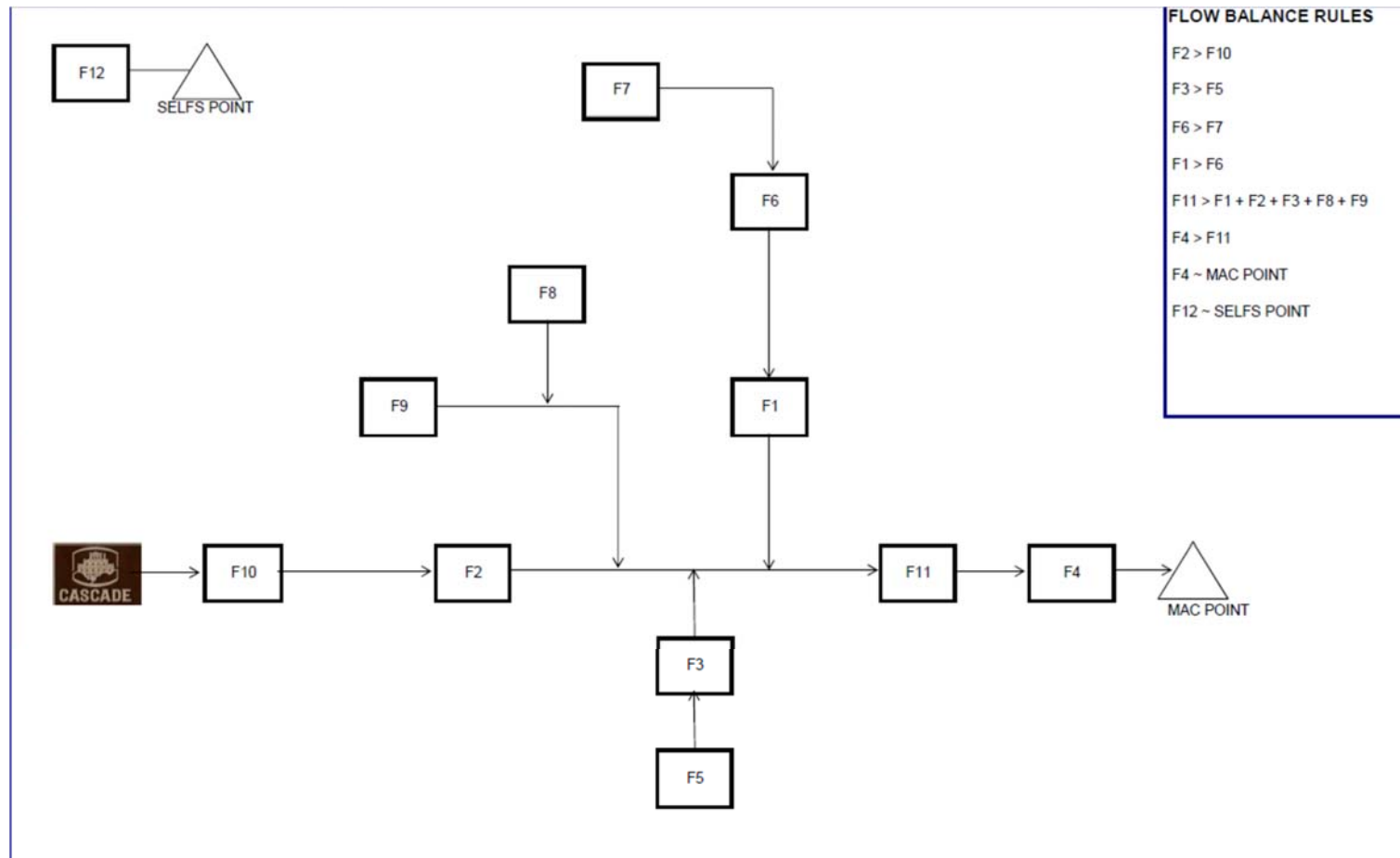


Figure 2.2: Macquarie Point Flow Schematic

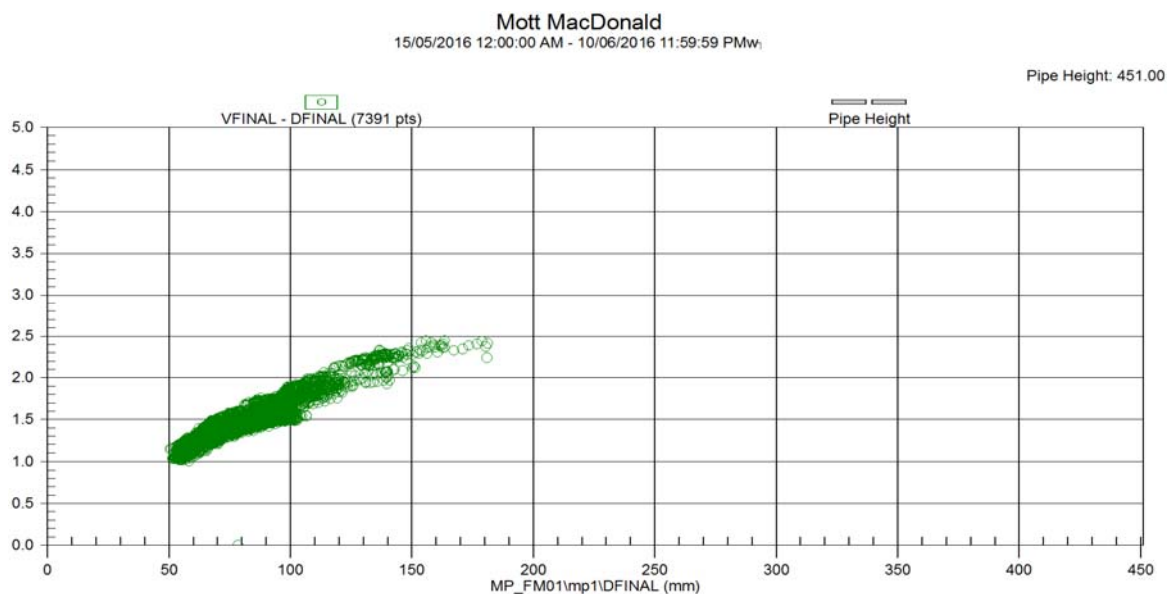


3 HYDRAULIC PERFORMANCE

A narrative interpretation of hydraulic performance recorded at each flow monitoring location as determined using a scattergraph of flow depth and velocity data has been provided in this section. The scattergraph interpretation evaluates the ability of each flow monitoring location to accommodate flow quantities observed during average dry weather and maximum wet weather conditions observed during the flow monitoring period. Each point plotted on the scatterplot represents the measured depth and velocity for each single logged point taken every five minutes.

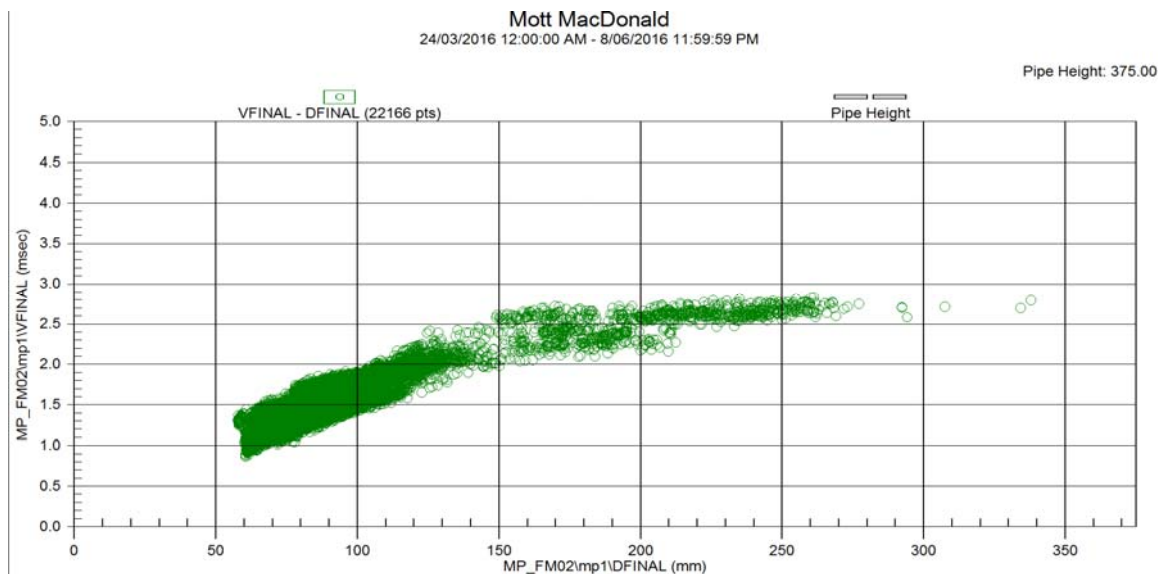
3.1 MP_FM01 MH17252

The monitoring point at MP_FM01 was 451mm in diameter. The data shows a repeatable diurnal pattern. The flow velocity was fast. The recorded dry and wet weather flows did not exceed 200mm during the monitoring period suggesting that the pipe has sufficient capacity under the conditions monitored. Following rain on the 1st of May there was a backup of flow in the manhole downstream of the monitoring point caused by debris. This was cleared on Friday the 13th of May to restore hydraulic conditions to the state prior to the rain event. Outside the period where the debris was not present there does not appear to be backwater conditions under the conditions monitored.



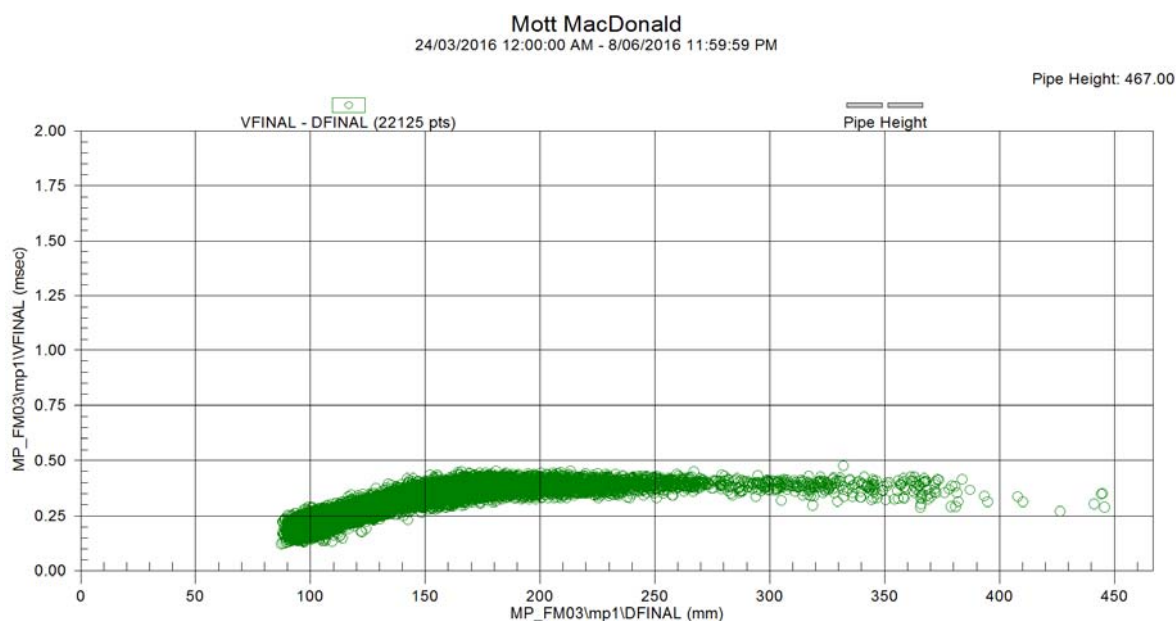
3.2 MP_FM02 MH15596

The monitoring point at MP_FM02 was 375mm in diameter. The data shows a repeatable diurnal pattern. The flow velocity was fast. The recorded dry and wet weather flows did not exceed 350mm during the monitoring period suggesting that the pipe has sufficient capacity under the conditions monitored. The relationship between depth and velocity is stable up to around 170mm in depth where the flow begins to back up.



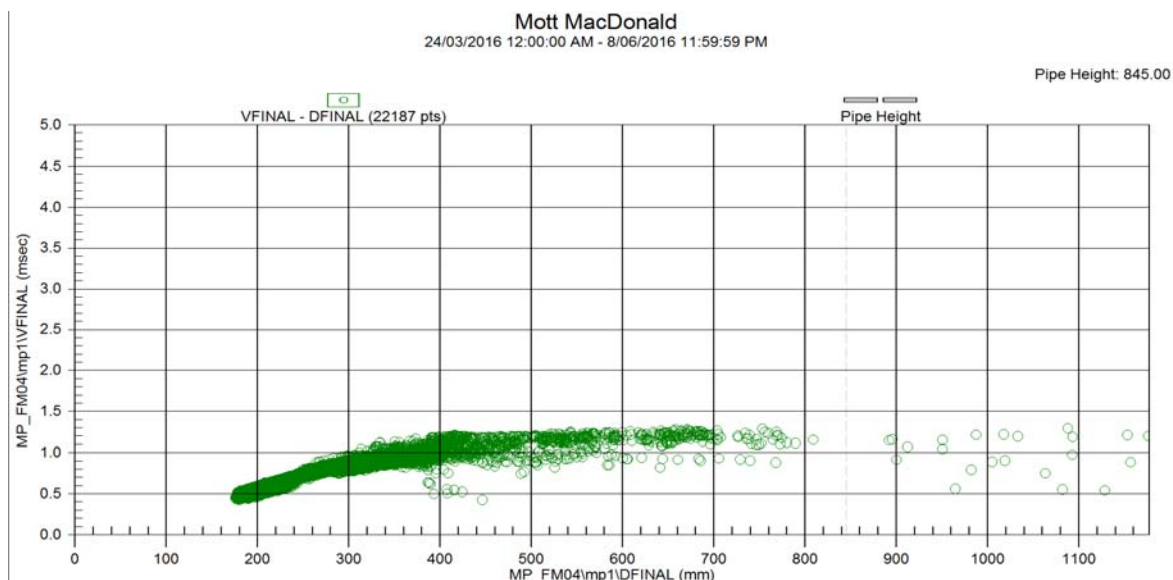
3.3 MP_FM03 MH15751

The monitoring point at FM03 was 467mm in diameter. The flow is influenced by the operation of an upstream sewage pumping station. The recorded dry and wet weather flows did briefly reach a peak of 446mm during the monitoring period suggesting that the pipe has sufficient capacity under the conditions monitored. The relationship between depth and velocity is relatively broad (approximately $\pm 0.10\text{m/s}$ for any given depth) – this scatter results from the upstream pump station operation. The recorded depth can be either during the pumping cycle (faster velocities for a given depth) or between pump cycles (slower velocities for a given depth). Backup of flows is seen above 170mm of flow depth.



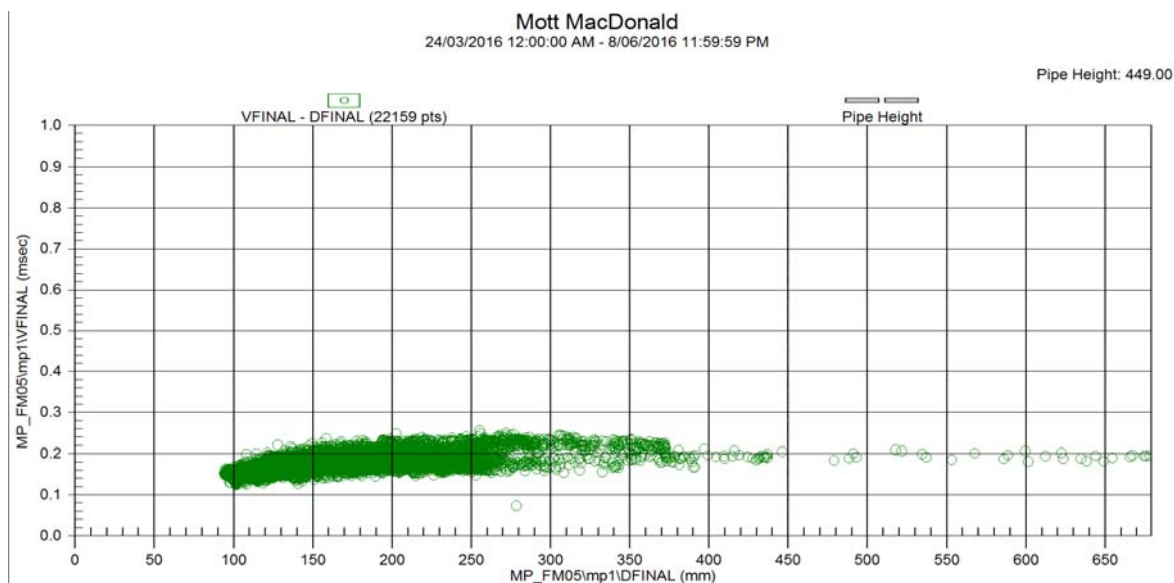
3.4 MP_FM04 MH16316

The monitoring point at MP_FM04 was 845mm in diameter. The data shows a repeatable diurnal flow during dry weather conditions. Backup of flow occurs when the flow depth is around 380mm of depth. Higher wet weather flows did cause the flow to backup beyond full pipe depth due to either downstream capacity issues or network operating conditions.



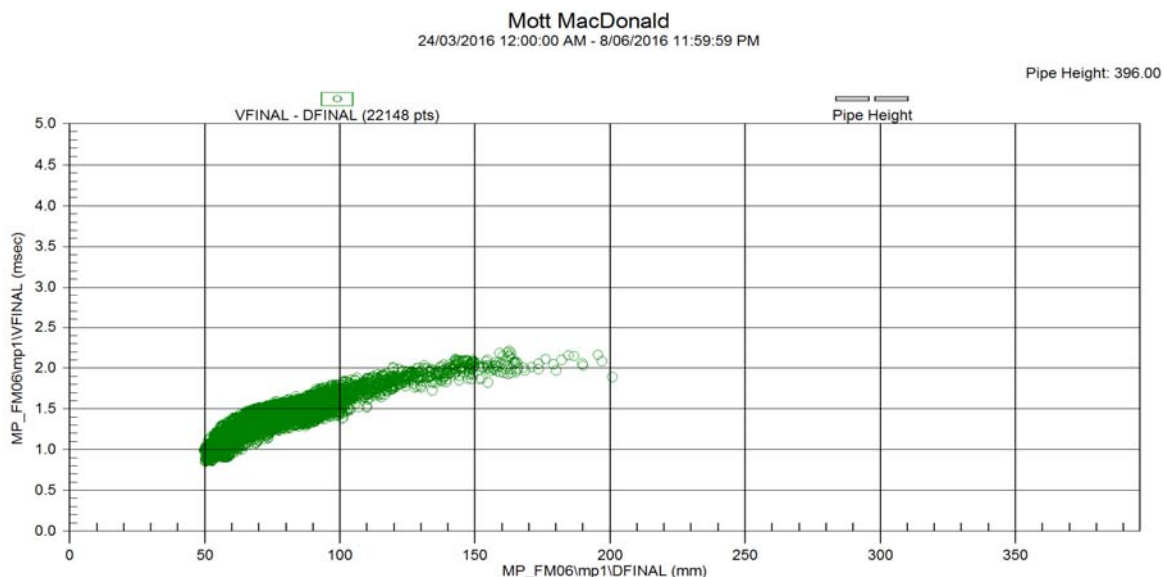
3.5 MP_FM05 MH14773

The monitoring point at MP_FM05 was 449mm in diameter. The flow is very slow and probably backed up from a constriction such as roots or debris downstream of the manhole. The recorded wet weather depth exceeded full pipe following rainfall on the 10th of May suggesting that the pipe may not have sufficient capacity for larger rainfall events. Clearing the downstream blockage may improve this. The relationship between depth and velocity is repeatable but is very flat indicating the flow being under backup throughout the period.



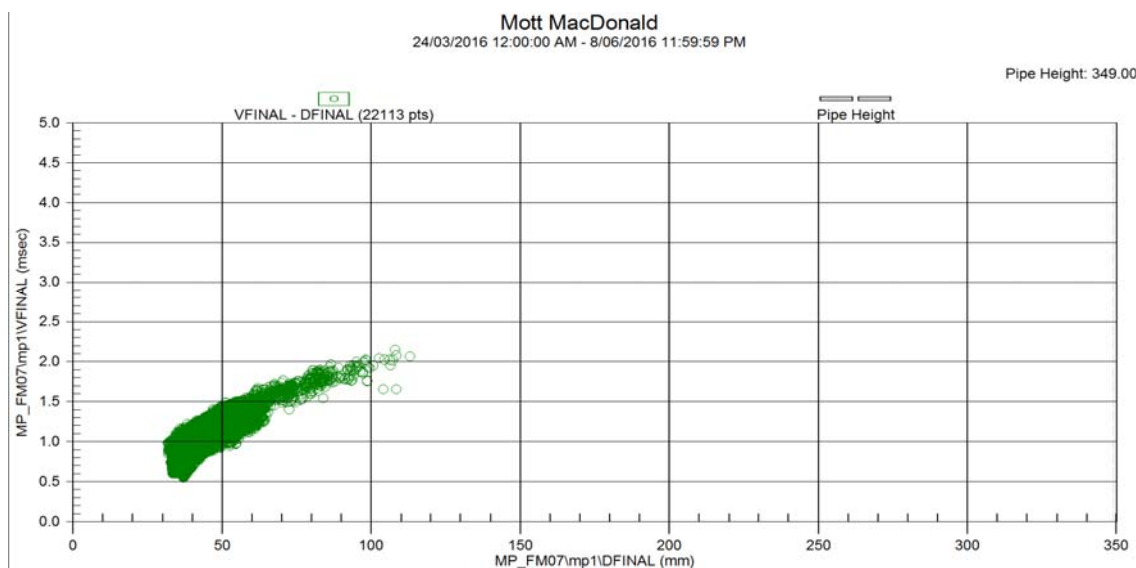
3.6 MP_FM06 MH18526

The monitoring point at MP_FM06 was 396mm in diameter. The data shows a repeatable diurnal pattern. The flow was fast. The recorded dry and wet weather flows did not exceed 200mm during the monitoring period suggesting that the pipe has sufficient capacity under the conditions monitored. The relationship between depth and velocity is relatively broad (approximately $\pm 0.15\text{m/s}$ for any given depth). Backwater conditions were not observed during the monitoring period.



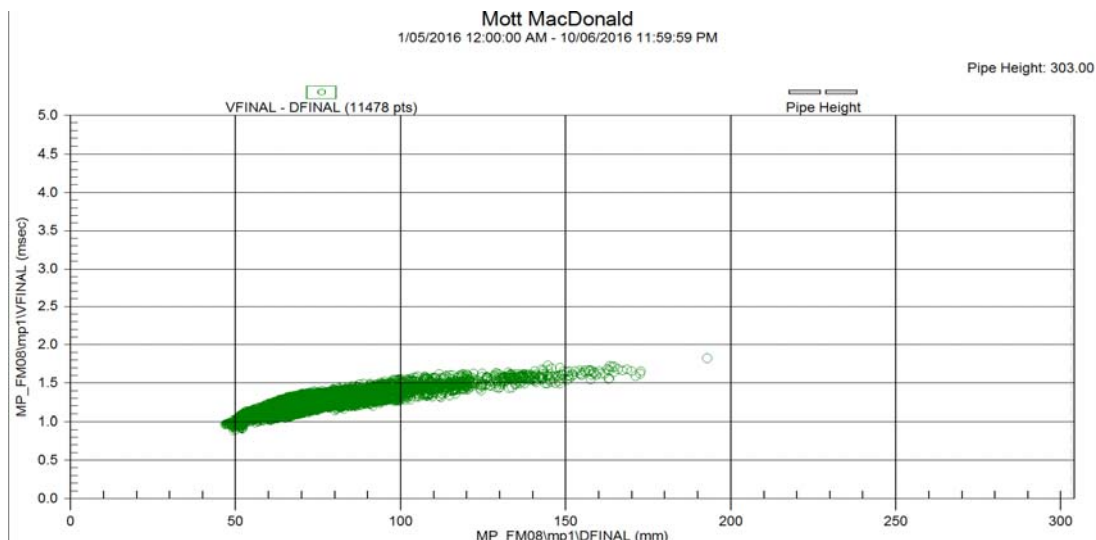
3.7 MP_FM07 MH38394

The monitoring point at MP_FM7 was 349mm in diameter. There is a significant grade change through the manhole. Under minDWF and ADWF conditions the flow is shallow and steady. At depths exceeding 70mm the flow is fast and shallow. The recorded dry and wet weather flows did not exceed 115mm during the monitoring period suggesting that the pipe has sufficient capacity under the conditions monitored. There is broad depth vs. velocity scatter below 70mm suggesting non-uniform hydraulic conditions. Backup of flows is not seen for the flows measured during the period.



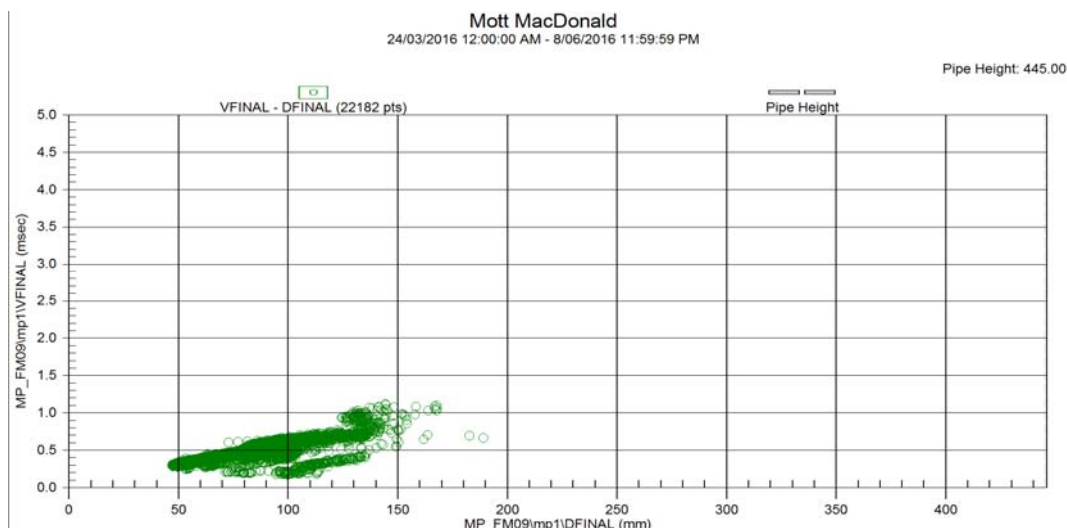
3.8 MP_FM08 (80 Elizabeth St)

The monitoring point at MP_FM08 was 303mm in diameter. The data shows a repeatable diurnal pattern. The flow was fast. The recorded dry and wet weather flows did not exceed 200mm during the monitoring period suggesting that the pipe has sufficient capacity under the conditions monitored. The relationship between depth and velocity is relatively broad (approximately $\pm 0.10\text{m/s}$ for any given depth). Backup of flows is not seen for the flows measured during the period.



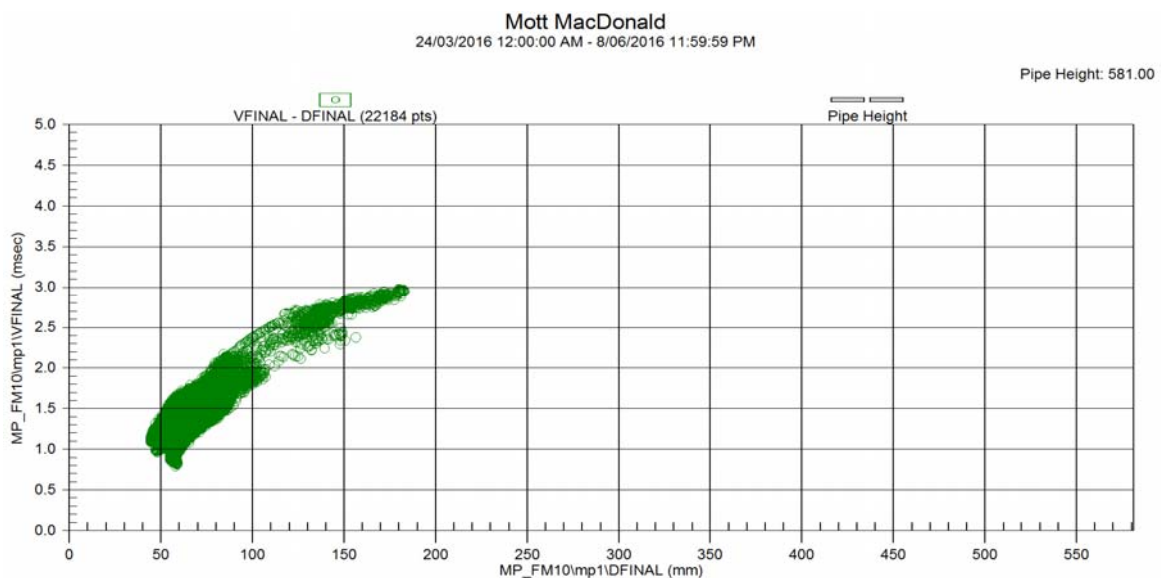
3.9 MP_FM09 MH16028

The monitoring point at MP_FM09 was 450mm in diameter. The data shows a repeatable diurnal pattern. The flow was fast. The recorded dry and wet weather flows did not exceed 200mm during the monitoring period suggesting that the pipe has sufficient capacity under the conditions monitored. The relationship between depth and velocity is relatively broad (approximately $\pm 0.10\text{m/s}$ for any given depth). Backup of flows (evident by multiple d vs. v relationships) was seen between the 25th and 29th of May with a temporary hydraulic change (likely from downstream debris blockage).



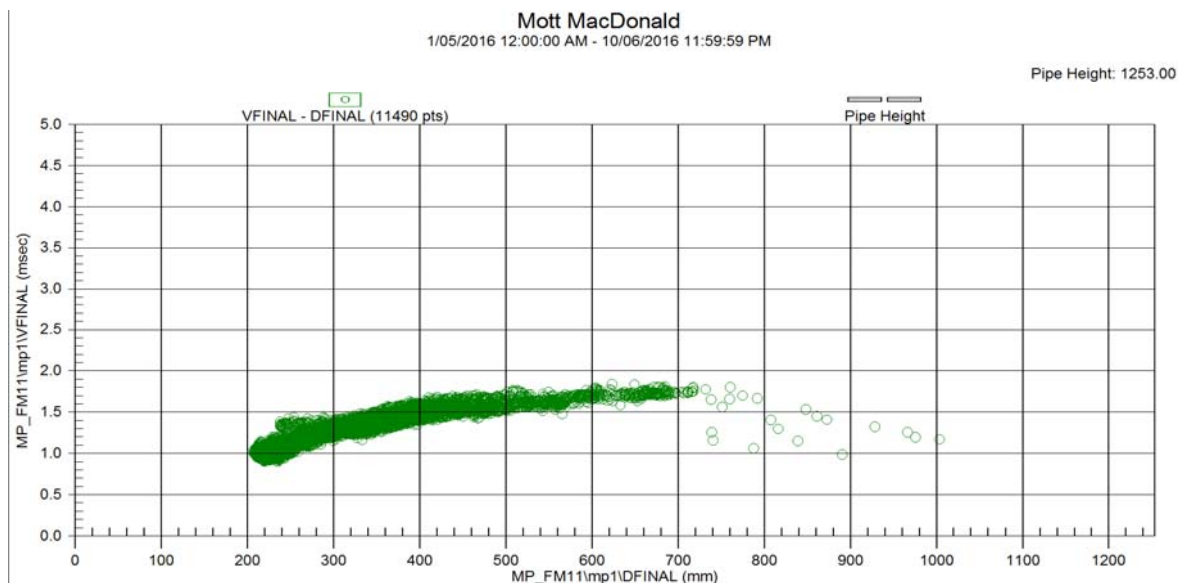
3.10 MP_FM10 MH13542

The monitoring point at MP_FM10 was 581mm in diameter. The data shows a repeatable diurnal pattern with periodic large discharge spikes. The flow was fast. The recorded dry and wet weather flows did not exceed 190mm during the monitoring period suggesting that the pipe has sufficient capacity under the conditions monitored. The relationship between depth and velocity is relatively broad (approximately $\pm 0.15\text{m/s}$ for any given depth) with multiple changes in hydraulic conditions as evidenced by at least three (3) depth vs. velocity relationships. This is likely due to a shift in debris downstream of the monitoring point. Backwater conditions due to pipe capacity issues were not observed during the monitoring period.



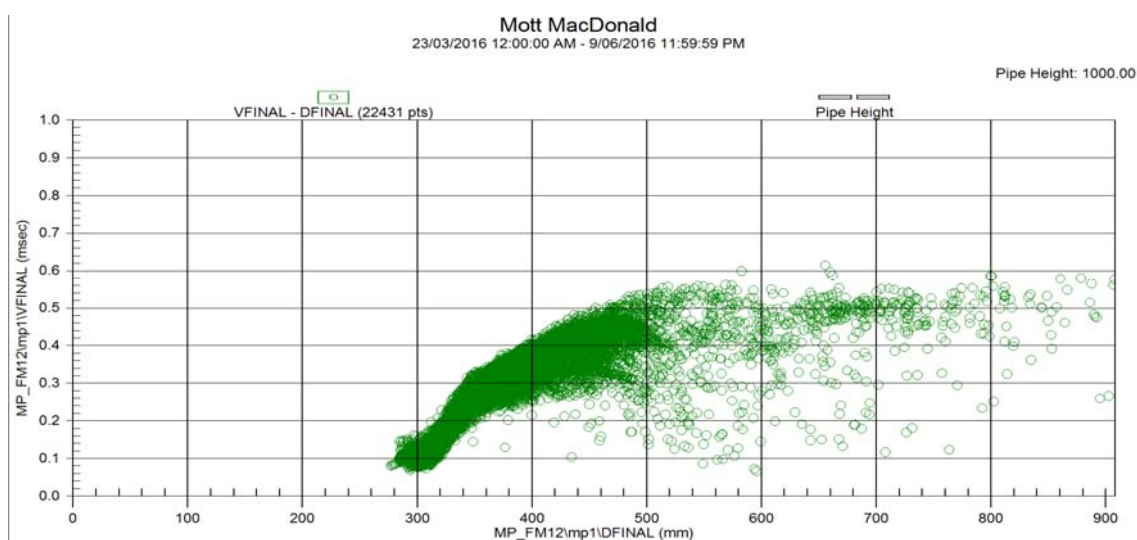
3.11 MP_FM11 MH16259

The monitoring point at MP_FM11 was an ovoid pipe with maximum height of 1253mm and width of 830mm. A detailed depth to wetted area relationship was developed for MP-FM11 using in-situ geometry measurements and ACAD. The data shows a repeatable diurnal pattern. This gauge was used as a check gauge to the base gauge MP_FM04. The flow was steady and deep. The recorded dry and wet weather flows did not exceed 1010mm during the monitoring period suggesting that the pipe has sufficient capacity under the conditions monitored. The relationship between depth and velocity is relatively broad (approximately $\pm 0.10\text{m/s}$ for any given depth). Backwater conditions were observed at depths above 700mm. This is likely a result of the operations or capacity at the downstream STP.



3.12 MP_FM12 MH16259

The monitoring point at MP_FM12 was an ovoid pipe with maximum height of 992mm and width of 647mm. A detailed depth to wetted area relationship was developed for MP-FM12 using in-situ geometry measurements and ACAD. This gauge records the flows into the Selfs Point wastewater treatment plant and was not part of the model calibration for Macquarie Point. The data has a repeatable diurnal pattern. The flow was slow. There was varying levels of silt (from 50-90mm) during the monitoring period. The recorded dry and wet weather flows did not exceed 910mm during the monitoring period suggesting that the pipe has sufficient capacity under the conditions monitored. The relationship between depth and velocity is relatively broad (approximately ± 0.10 m/s for any given depth) to a depth of 380mm due to the varying silt levels. Backwater conditions were observed at depths above 380mm. This is likely a result of the operations or capacity at the downstream STP.



4 CAPACITY ANALYSIS

GHD supplied Mott MacDonald with the design flow for each monitoring point. The design flows are used to undertake the pipe capacity analysis. The pipe on grade capacities are based on

- Measured pipe Diameter
- Pipe gradient obtained from TasWater GIS data.

Table 4.1: Pipe diameter and design flow for each Macquarie Point monitoring point

Sub-catchment	Pipe Diameter (mm)	Pipe on grade capacity (L/s)
F01	451	496
F02	375	302
F03	469	84
F04	840	808
F05	449	131
F06	392	278
F07	348	382
F08	304	134
F09	448	186
F10	582	1207
F11	1253x830 Ovoid	876
F12	992x647 Ovoid	450

A requirement of the capacity analysis is to calculate the ratios of maximum observed dry and wet weather flow rate to pipe on grade capacity for each monitoring point. The results of this analysis are presented in Table 4.2

Table 4.2: Ratios of maximum observed dry and wet weather flow rate to design full-pipe flow rate

Sub-catchment	Design Flow (L/s)	Max. Observed PDWF (L/s)	Ratio of max. PDWF to Pipe on Grade Capacity	Max. Observed PWWF (L/s)	Ratio of max. PWWF to Pipe on Grade Capacity
F01	496	47.8	0.10	145	0.29
F02	302	58.0	0.19	292	0.97
F03	84	35.1	0.42	60.0	0.71
F04	808	236	0.29	716	0.89
F05	131	16.8	0.13	29.4	0.22
F06	278	38.2	0.14	128	0.46
F07	382	15.6	0.04	53.7	0.14
F08	134	28.2	0.21	70.6	0.53
F09	186	30.4	0.16	59.4	0.32
F10	1207	40.6	0.03	212	0.18
F11	876	227	0.26	741	0.85
F12	450	107	0.24	300	0.67

The observations that arise from analysing the ratios of maximum observed dry and wet weather flow rate to design full-pipe flow rate for each Macquarie Point monitoring point are:

1. The ratio of maximum observed PDWF to design flow is <0.3 for all monitoring sites other than FM03. This suggests that the Macquarie Point monitoring locations have sufficient dry weather capacity. FM03 was found to have an observed PDWF to design flow of 0.42.
2. The ratio of maximum observed PWWF to design flow is <1.0 for all monitoring sites. This would suggest that the manhole surcharge evidence observed during the site inspection at some sites was due to blockages and downstream operational constraints rather than pipe capacity issues or due to the previous occurrence of storm events of greater magnitude than those captured during the study.
3. 70% of Macquarie Point monitoring locations have a ratio of maximum observed PWWF to design flow of <0.6. The three monitoring locations (MP_FM02, MP_FM03 and MP_FM04) with a ratio of maximum observed PWWF to design flow of >0.6 are catchments with observed tidal ingress issues.
4. MP_FM04 and MP_FM05 were the only sites to show surcharge during wet weather, due to either downstream capacity issues or network operating conditions.

Another requirement of the capacity analysis is to calculate the ratios of maximum observed dry and wet weather flow depth to pipe diameter for each monitoring point. The results of this analysis are presented in Table 4.3.

Table 4.3: Ratios of maximum observed dry and wet weather flow depth to pipe diameter

Sub-catchment	Pipe Diameter (m)	Max. Observed PDWF Depth (m)	Ratio of max. PDWF Depth to Diameter	Max. Observed PWWF Depth (m)	Ratio of max. PWWF Depth to Diameter
F01	0.451	0.105	0.23	0.180	0.40
F02	0.375	0.111	0.30	0.340	0.91
F03	0.469	0.251	0.54	0.450	0.96
F04	0.840	0.415	0.49	1.180	1.40
F05	0.449	0.277	0.62	0.678	1.51
F06	0.392	0.102	0.26	0.200	0.51
F07	0.348	0.064	0.18	0.110	0.32
F08	0.304	0.097	0.32	0.170	0.56
F09	0.448	0.119	0.27	0.170	0.38
F10	0.582	0.088	0.15	0.180	0.31
F11	1.253	0.408	0.33	1.000	0.80
F12	0.992	0.596	0.60	0.910	0.92

The observations that arise from analysing the ratios of maximum observed dry and wet weather flow rate to design full-pipe flow rate for each Macquarie Point monitoring point are:

1. The ratio of maximum observed PDWF depth to pipe diameter is <0.4 for all monitoring sites other than FM03 and FM05. This suggests that the Macquarie Point monitoring locations have sufficient dry weather capacity. FM03 was found to have an observed PDWF to design flow of 0.56.
2. FM05 had an observed PDWF depth to pipe diameter of 0.62. This ratio is consistent with the scattergraph analysis that illustrated the flow is very slow and probably backed up from a constriction such as roots or debris downstream of the manhole.
3. The ratio of maximum observed PWWF depth to design flow is <0.6 for all monitoring sites other than MP_FM02, MP_FM03, MP_FM04 and MP_FM05. These are the catchments with observed tidal ingress issues and downstream flow constrictions.

The final requirement of the capacity analysis is to calculate the number of days in which manhole surcharging occurred during both dry and wet weather conditions, the ratio of maximum observed silt depth to pipe diameter, average dry day velocity and the calculation of percent backwater. The results of this analysis are presented in Table 4.4.

Table 4.4: Miscellaneous hydraulic capacity calculations

Sub-catchment	Percent Backwater	Days of DWF Surchage	Days of WWF Surchage	Ratio of max. Silt to Diameter	Average DWF Velocity (m/s)
F01	24	0	0	0	1.4
F02	10	0	0	0	1.4
F03	11	0	0	0	0.3
F04	68	0	0.08	0	0.7
F05	100	0	0.09	0.11	0.2
F06	0	0	0	0	1.3
F07	37	0	0	0	1.0
F08	9	0	0	0	1.2
F09	4.5	0	0	0	0.5
F10	0	0	0	0	1.3
F11	70	0	0	0	1.3
F12	19	0	0	0.09	0.3

No dry weather manhole surcharge conditions were observed during the monitoring period at the Macquarie Point monitoring sites. This would further confirm that the Macquarie Point wastewater system has no hydraulic capacity issues over the range of dry weather flow conditions experienced during the monitoring period.

Backwater conditions and manhole surcharging were observed during wet weather on the 10th of May at FM05 probably due to downstream flow constriction associated with debris accumulation / blockages.

The average dry weather flow velocity at nine (9) sites is between 0.5 – 1.4m/s. At these velocities it is theoretically considered that siltation is unlikely to occur.

The average dry weather flow velocity at FM03, FM05 and FM12 is between 0.2 – 0.3m/s. At these velocities it is theoretically considered that siltation is likely to occur. Silt was recorded at FM05 and FM12.

Our calculation is based on the analysis of a depth vs. velocity scattergraph to determine whether variable and backwater conditions existed during the monitoring period.

5 STORMWATER INFLOW ANALYSIS

5.1 Scope of the Macquarie Point I/I Analysis

Twelve (12) wastewater flow monitors were installed for the Macquarie Point infiltration and inflow (I/I) assessment. Only (ten) wastewater flow monitors were used for the I/I assessment as:

- There is no effective catchment between FM04 and FM11 (this gauge was used as a redundant or 'check' gauge in the study). Therefore FM04 was chosen as the Macquarie Point STP base gauge.
- FM12 was monitoring the flow into the Selfs Point STP. It is not part of the Macquarie Point catchment. No details of catchment area / lineal metres of pipe for this catchment were supplied.

5.2 Dry Weather Analysis

The synthesised dry weather flows for each flow monitoring location, based on the WSAA Management of Wastewater System Infiltration & Inflow Good Practice Guideline Document (November 2011) antecedent wetness index (AWI) equation have been generated and are plotted against the wet weather events in Appendix D. The flows have been characterised according to dry weather weekday (individual days) and weekend flows (also individual days).

5.3 Dry Weather Flow Summary

Table 5.1 provides details of the gross minimum, average and maximum flow quantities for both weekday and weekend periods. The dry weather days are based on the antecedent wetness index defined in the SWMM 5.0 manual and covers the entire monitoring period.

Table 5.1: Gross dry weather flow summary for the Macquarie Point monitoring sites

Catchment	Weekday minDWF (L/s)	Weekday ADWF (L/s)	Weekday PDWF (L/s)	Weekend minDWF (L/s)	Weekend ADWF (L/s)	Weekend PDWF (L/s)
FM01	10.6	21.5	41.4	10.8	21.6	40.4
FM02	13.2	25.0	47.1	13.9	27.3	44.3
FM03	4.75	16.4	30.5	4.69	15.7	28.8
FM04	42.6	114	201	42.6	117	196
FM05	2.89	7.64	14.1	2.63	7.14	13.0
FM06	9.36	18.6	33.1	9.34	18.4	33.2
FM07	3.89	7.37	13.6	4.05	7.33	13.4
FM08	6.96	13.4	24.9	7.02	13.4	23.8
FM09	3.06	8.85	20.1	2.91	8.88	18.9
FM10	12.2	21.1	35.6	13.1	23.4	36.4

Table 5.2 provides details of the net minimum, average and maximum flow quantities for both weekday and weekend periods. The selected dry period is based on the antecedent wetness index defined in the SWMM 5.0 manual and covers the entire monitoring period 24th May to 8th June 2016

Table 5.2: Net dry weather flow summary for the Macquarie Point monitoring sites

Catchment	Weekday minDWF (L/s)	Weekday ADWF (L/s)	Weekday PDWF (L/s)	Weekend minDWF (L/s)	Weekend ADWF (L/s)	Weekend PDWF (L/s)
FM01	1.24	2.90	8.30	1.46	3.20	7.20
FM02	1.00	3.90	11.5	0.80	3.90	7.90
FM03	1.86	8.76	16.4	2.06	8.56	15.8
FM04	4.03	28.9	37.0	3.28	30.1	39.8
FM05	2.89	7.64	14.1	2.63	7.14	13.0
FM06	5.47	11.2	19.5	5.29	11.1	19.8
FM07	3.89	7.37	13.6	4.05	7.33	13.4
FM08	6.96	13.4	24.9	7.02	13.4	23.8
FM09	3.06	8.85	20.1	2.91	8.88	18.9
FM10	12.2	21.1	35.6	13.1	23.4	36.4

5.4 Dry Weather System Performance – Base Infiltration (BI)

The calculation of base infiltration (BI) can be complex. A simple, and industry accepted calculation method is to multiply the minimum (normally hourly averaged) dry weather flow (minDWF) rate by 0.88¹. This formula infers that at night 88% of flow is groundwater and 12% is wastewater. These percentages are based on many infiltration & inflow studies in the USA, but are only applicable for residential (non-trade waste) flows.

Base infiltration (BI) is caused by groundwater seepage into defective pipes, pipe joints and manhole walls located below the water table. The magnitude depends on the depth of groundwater above the defects as well as the percentage of the reticulation system that is submerged. The variation in groundwater levels and subsequent base infiltration are generally seasonal. The Macquarie Point I/I assessment was undertaken during above average rainfall and as such the groundwater levels could be anticipated to be at or above normal levels. Net base infiltration rates for each sub-catchment are provided in Table 5.3.

¹ Detailed research into base infiltration has subsequently shown that calculating base infiltration from the minDWF * 0.88 formula overstates base infiltration.

Table 5.3: Approximate Base Infiltration Rates for the Macquarie Point Sub-Catchments

Catchment	Net Catchment Size (Ha)	Net Weekday minDWF (L/s)	Approx. Base Infiltration (BI) (L/s)	BI (L/s)/ha
FM01	22.497	1.24	1.09	0.049
FM02	41.596	1.00	0.88	0.021
FM03	35.144	1.86	1.64	0.047
FM04	0.955	4.03	3.55	3.714
FM05	55.081	2.89	2.54	0.046
FM06	73.834	5.47	4.81	0.065
FM07	50.191	3.89	3.42	0.068
FM08	101.331	6.96	6.12	0.060
FM09	81.484	3.06	2.69	0.033
FM10	152.28	12.2	10.7	0.071

Source: www.h2knowhow.com

A threshold for determining whether the base infiltration rate is significant is to calculate whether the base infiltration rate exceeds 0.05 L/s/ha. The BI in Macquarie Point sub-catchments FM06, FM07 and FM08 all exceed the 0.05 L/s/ha. threshold with rates of 0.060 to 0.068 L/s/ha. This is likely to be due to the fact that these sub-catchments are substantially commercial rather than residential land-use as they are either within or close to the Hobart CBD. As stated above, the BI calculation applied is only applicable for residential (non-trade waste) flows.

Sub-catchment FM10 has flow input from the Cascade Brewery and leachate from the Waste Management Facility so the BI calculation isn't applicable.

It is likely that some of the 3.71L/Ha of net BI recorded at FM04 is tidal ingress rather than groundwater infiltration.

5.5 Analysed Storms Events

Four (4) suitable storm events occurred during the 11-week monitoring period. These four (4) storms were used to assess the RDII present in Macquarie Point. Table 5.4 summarises the details of the storm events that have been used for the inflow and infiltration analysis.

Table 5.4: Details of the selected storm events for the Macquarie Point I/I analysis

Event	Start	End	Total Rainfall	Maximum Hourly Intensity
1	00:00 01/5/16	15:55 02/5/16	12.8 - 13.2	5.4 – 5.6
2	14:15 08/5/16	08:15 12/5/16	34.2 – 40.6	7.0 – 8.0
3	00:00 19/5/16	08:20 22/5/16	13.8 – 15.2	4.8 – 5.4
4	19:50 04/6/16	23:55 09/6/16	59.6 – 76.8	5.4 – 5.8

Source: www.h2knowhow.com

The duration of the selected storm events includes the storm recovery period. The storm recovery period is often abbreviated (flow doesn't return to its pre-storm rates) to ensure that the inflow from a following storm isn't included in the analysis.

Ideally at least three (3) storm events should be analysed in the I/I assessment. The analysed storm events should have varying rainfall totals and intensities with ideally all storm events having the flow contained within the reticulation system (no wastewater overflows occurred). The Macquarie Point I/I assessment satisfied these criteria.

5.6 Wet Weather Analysis and Flow Summary

A characterisation of the flow recorded during four (4) significant wet weather events was undertaken. The flow data is presented as time-series hydrographs comparing observed flow quantities to average diurnal flow quantities for corresponding weekday and weekend dry weather periods. The dry vs. wet weather flow hydrographs are supplied in Appendix D. Tables 5.5 – 5.8 present gross and net rain-dependent inflow and infiltration (RDII) volume recorded at each flow monitoring location for the four (4) analysed storm events. The maximum wet weather flow is also summarised as the peak instantaneous flow rate observed during the storm events.

Table 5.5: Gross & net RDII in the Macquarie Point Catchment for Storm Event 1 (1/5 – 2/5/16)

Macquarie Point Sub-catchment	Gross RDII Storm Event 1 (m ³)	Net RDII Storm Event 1 (m ³)	Gross Maximum Instantaneous WWF (L/s)
FM01	656	74	67.8
FM02	2093	103	79.6
FM03	463	329	45.6
FM04	4419	388	305
FM05	134	134	17.3
FM06	582	312	67.4
FM07	270	270	26.2
FM08	582	582	47.9
FM09	237	237	32.6
FM10	1990	1990	67.5

Table 5.6: Gross & net RDII in the Macquarie Point Catchment for Storm Event 2 (8/5 – 12/5/16)

Macquarie Point Sub-catchment	Gross RDII Storm Event 2 (m ³)	Net RDII Storm Event 2 (m ³)	Gross Maximum Instantaneous WWF (L/s)
FM01	NA	NA	NA
FM02	9684	2517	143
FM03	3109	1951	63.2
FM04	24483	8891	539
FM05	1158	1158	31.0
FM06	2668	1402	125
FM07	1266	1266	55.1
FM08	1936	1936	88.8
FM09	863	863	56.4
FM10	7458	7458	131

Table 5.7: Gross & net RDII in the Macquarie Point Catchment for Storm Event 3 (19/5 – 22/5/16)

Macquarie Point Sub-catchment	Gross RDII Storm Event 3 (m ³)	Net RDII Storm Event 3 (m ³)	Gross Maximum Instantaneous WWF (L/s)
FM01	1062	NA	99.9
FM02	5501	1301	146
FM03	2978	2125	45.0
FM04	9699	NA	419
FM05	853	853	21.8
FM06	1075	596	93.2
FM07	479	479	38.9
FM08	757	757	62.0
FM09	559	559	46.5
FM10	4200	4200	137

Table 5.8: Gross & net RDII in the Macquarie Point Catchment for Storm Event 4 (4/6 – 9/6/16)

Macquarie Point Sub-catchment	Gross RDII Storm Event 4 (m ³)	Net RDII Storm Event 4 (m ³)	Gross Maximum Instantaneous WWF (L/s)
FM01	11273	1360	145
FM02	36049	4772	292
FM03	5611	2101	59.6
FM04	80843	18317	716
FM05	3510	3510	29.4
FM06	9913	6298	128
FM07	3615	3615	53.7
FM08	5850	5850	70.6
FM09	3743	3743	59.3
FM10	31277	31277	212

5.7 Wet Weather System Performance

Using the results of the short term flow monitoring, an analysis of rainfall dependent infiltration and inflow (RDII) has been undertaken. The results of this analysis are presented as follows;

1. I/I Ingress - As a percentage of rainfall falling on an area that ends up in the sewer in the form of inflow and infiltration.
2. I/I Leakage - The volume of rainfall per lineal metre of pipe within a catchment that ends up in the sewer in the form of inflow or infiltration (Litres per metre pipe per mm rain).

The RDII volume for each gauged catchment was determined by:

1. Subtracting the upstream flow (if an upstream gauge is present) from the downstream flow gauge (i.e. the flow from FM07) to get a net flow for the downstream catchment FM06.
2. Subtracting the net dry weather flow from the rain influenced flow data.

To keep the I/I analysis consistent across all sub-catchments, the rain influenced data period was defined as the start of the rain event to the end of the rain event (fast response or rain dependent inflow). The slow response time was also kept consistent across all sub-catchments as the storm recovery period was often abbreviated (flow doesn't return to its pre-storm rates) to ensure that the inflow from a following storm isn't included in the analysis.

5.7.1 Percentage I/I Ingress

For each of the Macquarie Point sub-catchments the percentage I/I ingress for each storm event was calculated, using the equation below, using the area of the catchment, rainfall total and I/I volumes.

$$\% \text{ of I/I Ingress} = [I/I \text{ Volume}] / [\text{Catchment Area} \times \text{Rain Total}]$$

Both the individual and average percentage I/I ingress of the four (4) analysed storm events was calculated and the results presented in Table 5.9.

Table 5.9: Net Percentage I/I Ingress in the Macquarie Point Sub-Catchments

Macquarie Point Sub-catchment	Storm Event 1 (1/5–2/5)	Storm Event 2 (8/5–12/5)	Storm Event 3 (19/5–22/5)	Storm Event 4 (4/6–9/6)	Average % ingress
FM01	2.6%	NA	NA	10.1%	6.4%
FM02	1.9%	14.9%	20.6%	14.9%	13.1%
FM03	7.3%	16.2%	43.8%	10.0%	19.3%
FM04	9.0%	77.0%	NA	91.0%	59.0%
FM05	1.9%	6.1%	11.2%	10.7%	7.5%
FM06	3.3%	5.6%	5.8%	14.3%	7.3%
FM07	4.2%	7.4%	6.9%	12.1%	7.7%
FM08	4.4%	4.7%	4.9%	7.5%	5.4%
FM09	2.2%	2.6%	5.0%	6.0%	4.0%
FM10	9.9%	11.6%	20.0%	26.7%	17.1%

The high tides for Hobart (Lat. 42o 53' Long. 147o 20') had a range of 1.23 – 1.60m during May through June 2016 (refer to table 5.10).

Table 5.10: Minimum / maximum high tide levels for Hobart during the monitoring period

Event	Minimum High Tide (m)	Maximum High Tide (m)	Average High Tide (m)
1	1.26	1.26	1.26
2	1.41	1.52	1.47
3	1.32	1.38	1.35
4	1.38	1.60	1.49

The average percentage I/I ingress values for Macquarie Point is generally high with several catchments in excess of 13%. Macquarie Point is known to have tidal ingress issues particularly in catchments close to the Derwent River. It is suspected that the severe I/I ingress percentages observed in sub-catchments FM03 and FM04 are a combination of tidal ingress and rain-induced infiltration and inflow (RDII). This suspicion arises out of the observation that storm event 1 was the

only storm event that occurred during the lowest range of high tides (1.26m) and in all sub-catchments the I/I ingress percentages were less than 10%.

Although FM02 had high percentage I/I ingress this may not be tidally influenced as conductivity wasn't observed to be high and sewer inverts are higher in this catchment.

Sub-catchment FM10 was found to have an average I/I ingress of 17.1%. Sub-catchment FM10 is known to have both an industrial discharge (Cascade Brewery – up to 700kL/day) and receives the leachate from a waste management facility. Significant rainfall would increase the leachate rate. It is likely that some of the increase in flow during WWF conditions can be attributed to leachate discharge and not RDII.

The WSAA Management of Wastewater System Infiltration & Inflow Good Practice Guideline Document (November 2011) recommends that a threshold value of 8% ingress needs to be exceeded before undertaking a cost-effective source detection and rehabilitation programme. It is difficult to assess the relative contributions of RDII and tidal ingress so industry accepted source detection programmes may not be effective.

5.7.2 I/I Severity (Leakage Rate)

Using the calculated net RDII volumes, the leakage rates for the four (4) analysed storm events that have been used for the wet weather analysis were calculated for each gauged catchment, with the formula below.

$$\text{Leakage rate} = [\text{I/I Volume}] / [\text{sewer length} \times \text{rainfall total}]$$

Both the individual and average I/I severity of the four (4) analysed storm events was calculated and the results presented in 5.11.

Table 5.11: I/I Severity (L/m/mm) in the Macquarie Point Catchment

Macquarie Point Sub-catchment	Storm Event 1 (1/5–2/5)	Storm Event 2 (8/5–12/5)	Storm Event 3 (19/5–22/5)	Storm Event 4 (4/6–9/6)	Average I/I Severity
FM01	0.81	NA	NA	3.18	2.00
FM02	0.65	5.19	7.16	5.20	4.55
FM03	2.84	6.31	17.0	3.90	7.51
FM04	3.27	28.0	NA	33.1	21.5
FM05	0.66	2.12	3.87	3.69	2.59
FM06	1.29	2.17	2.28	5.58	2.83
FM07	1.55	2.71	2.54	4.45	2.81
FM08	1.77	1.91	2.00	3.06	2.19
FM09	0.84	0.99	1.89	2.28	1.50
FM10	4.16	4.88	8.41	11.3	7.19

The I/I severity (expressed in L/m/mm) assessment for Macquarie Point suggests a less severe infiltration and inflow problem with only one sub-catchment (FM04) having >8L/m/mm I/I severity. Sub-catchments FM02, FM03, FM04 and FM10, similar to the percentage I/I ingress assessment,

have the most severe infiltration and inflow. The tidal ingress issues, particularly in catchments close to the Derwent River, are still relevant as is the leachate and trade waste discharges in sub-catchment FM10.

The WSAA Management of Wastewater System Infiltration & Inflow Good Practice Guideline Document (November 2011) recommends that an I/I severity threshold value of 8L/m/mm needs to be exceeded before undertaking a cost-effective source detection and rehabilitation programme. It is difficult to assess the relative contributions of RDII and tidal ingress so industry accepted source detection programmes may not be effective.

6 SUMMARY & RECOMMENDATIONS

The objective of this consultancy is to provide key technical inputs to support the process of transferring sewage from the existing Macquarie Point STP to Selfs Point STP. Specifically, technical input is required to understand the nature of the Macquarie Point STP catchment, including dry weather and wet weather flows to the current Macquarie Point STP, in order to size proposed downstream transfer and treatment infrastructure. TasWater engaged GHD and Mott MacDonald to provide the key hydraulic inputs. Mott MacDonald's role was limited to the supply of flow, rainfall and conductivity data for catchments upstream of the Macquarie Point and Selfs Point sewerage treatment plants (STP's). A basic capacity analysis and infiltration and inflow assessment was also required.

The Macquarie Point wastewater reticulation system was divided into ten (10) sub-catchments using HVQ sewer flow gauges as boundary gauges (with gauge FM11 acting as a duplicate backup for the base gauge at FM4). The monitoring network also comprised two (2) rain gauges. One gauge (FM12) was also used to measure flows to the Selfs Point STP separate to the Macquarie Point catchment.

Conductivity was also monitored at strategic locations to determine whether seawater (tidal) ingress was problematic in the Macquarie Point wastewater reticulation system.

The flow and rainfall monitoring equipment was installed from the 15th to the 24th March 2016. After an 11-week data capture period, TasWater instructed Mott MacDonald to terminate the monitoring programme. Four (4) storms suitable for wet weather flow (WWF) capacity analysis and infiltration and inflow assessment were captured during the monitoring period. A data availability of 99.4% was supplied for the flow and rainfall monitoring network. The flow and rainfall monitoring equipment was removed on 9th of June 2016.

Four (4) storm events were analysed to determine the extent and I/I severity in each of the Macquarie Point sub-catchments. The Macquarie Point I/I assessment has found:

- The base infiltration in Macquarie Point sub-catchments FM06, FM07 and FM08 is high. However this is likely to be due to these sub-catchments being substantially commercial rather than residential land-use as they are either within or close to the Hobart CBD.
- The base infiltration in sub-catchment FM04 is very significant. It is likely that some of the 3.71L/Ha of net BI recorded at FM04 is tidal ingress rather than groundwater infiltration.
- The ratio of maximum observed PDWF to design flow is <0.3 for all monitoring sites other than FM03. This suggests that the Macquarie Point monitoring locations have sufficient dry weather capacity.
- The average percentage I/I ingress values for Macquarie Point is generally high with several catchments in excess of 13%. Macquarie Point is known to have tidal ingress issues particularly in catchments close to the Derwent River. It is suspected that the severe I/I ingress percentages observed in sub-catchments FM03 and FM04 are a combination of tidal ingress and rain-induced infiltration and inflow (RDII). This suspicion arises out of the observation that storm event 1 was the only storm event that occurred during the lowest range of high tides (1.26m) and in all sub-catchments the I/I ingress percentages were less than 10%. Although

FM02 had high percentage I/I ingress this may not be tidally influenced as conductivity wasn't observed to be high and sewer inverts are higher in this catchment.

- Sub-catchment FM10 was found to have an average I/I ingress of 17.1%. Sub-catchment FM10 is known to have both an industrial discharge (Cascade Brewery – up to 700kL/day) and receives the leachate from a waste management facility. Significant rainfall would increase the leachate rate. It is likely that some of the increase in flow during WWF conditions can be attributed to leachate discharge and not RDII.

It is recommended that a tidal ingress study is undertaken before any infiltration and inflow source detection programme as it is not certain what the relative proportions of RDII and tidal ingress are in the total recorded I/I volume for each storm. Based on the conductivity monitoring and the results from the I/I assessment the tidal ingress study should initially be confined to catchments MP_FM03, MP_FM04 and MP_FM05.

Traditionally CCTV pipe and physical manhole inspection is used to determine pipe (including overflow / relief pipes to the environment) and manhole defects that contribute to infiltration. This can be a costly exercise if many manholes and long sections of pipe need to be inspected.

Night flow isolation is a technique that is used to prioritise CCTV inspection and rehabilitation works by breaking a catchment into smaller mini-catchments using portable / temporary volumetric compound weirs. The underlying assumption with night flow isolation is that between the hours of 1am and 5am the majority (>85%) of the flow is infiltration (tidal / groundwater) as commercial and residential discharges are infrequent. To determine whether the infiltration is saline, conductivity (EC) is measured simultaneously with flow. Although measurement of conductivity is useful for determining whether salt water intrusion is infiltrating into a reticulation network, a negligible flow with high conductivity has less impact on the wastewater system than a large flow with a moderate conductivity.

A dry weather period before and during the testing is chosen as conductivity readings may decrease during and immediately after rainfall due to dilution of the salt infiltration with stormwater inflow. The identified Macquarie Point sub-catchments (MP_FM03, MP_FM04 and MP_FM05) need to be divided into mini-catchments of approximately 200 - 500m pipe lengths. As it is known that seawater ingress rates are influenced by the tide level in the Derwent River, the study will need to be undertaken during a high tide of >1.5m.

At each monitoring location the conductivity measurement ($\mu\text{S}/\text{cm}$) is normalised to 25C and the salinity (g/L) calculated. The salinity is multiplied by the volumetric flow rate to provide a seawater ingress rate in tonnes/day. Similar to flow balancing (upstream flow must be less than downstream flow), a salt balance between measurement locations is undertaken to identify short sections of pipe for CCTV pipe and physical manhole inspection. This method has been successfully used on many projects to cost-effectively locate significant sources of seawater ingress.

Based on the outcomes of night isolation and subsequent rehabilitation / capital works, strategies that specifically target RDII may be cost-effective.

Appendices

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Appendix A. SITE INSTALL SHEETS

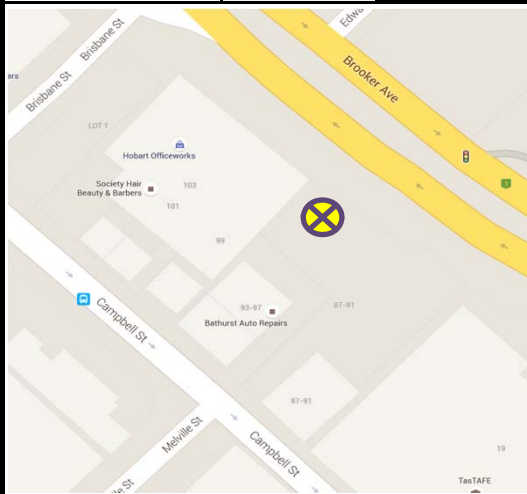
INSTALLATION REPORT



GENERAL										PAGE 1
Site Type	V Notch		HVQ	☒	Level	☐	Overflow	☐		
Client	TasWater									
Project	366374 Macquarie Point			MM Project Ref:		366374				
SITE										
Contract Site No.	MP_F1			Manhole ID.		MH17252				
Address	87 Campbell St (basement carpark)									
INSTALLATION DATE	21/03/2016			Installed by		NL/NT				
SAFETY										
Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.									
Emergency phone No.	000 or 112 from mobile			Nearest hospital		Royal Hobart Hospital 48 Liverpool St, Hobart				
Traffic	None	☒	On road	☐	On nature strip	☐	Footpath			
Additional Safety Considerations										
Refer to Project Safety Plan and Risk Assessment										
MANHOLE DETAILS										
MH Depth	5300	INLET	5280	mm	Outlet	5300	mm			
Overflow structure	Pipe	☐	Weir	☐	Other		None	☒		
Surcharge evidence to	5	m								
MONITORING POINT (PIPE) DETAILS										
Pipe Size	Vert.	451	mm	H=	451	mm				
Pipe Shape	Circular	☒	Ovoid	☐	Rectangular	☐	Other			
Silt Depth	0	mm	Silt Type		-					
Comments										
Fast flow with some surface disturbance from pipe joint upstream.										
INSTALLATION										
Monitor Type	HVQ	Monitor#	10214	U Sensor #	-					
P Sensor#		PV sensor #	8241	Conductivity	10888789					
Depth of flow at visit	86	mm								
Location										
☒	Manhole	☒	Monitoring Point	☒						
CERTIFIED AS CORRECT										
Signed					Dated					

Contract Site no.: MP_F1

Manhole ID.: MH17252



Street Map (↑N)



Sewer Map



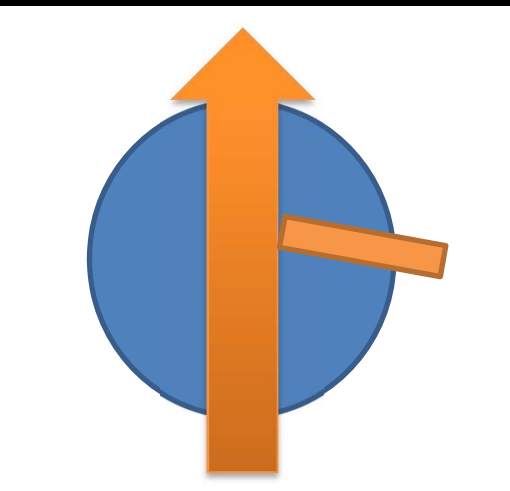
MANHOLE LOCATION



TOPSIDE VIEW OF MANHOLE



MONITORING POINT



PLAN VIEW OF MANHOLE (OUTLET AT 12)

INSTALLATION REPORT



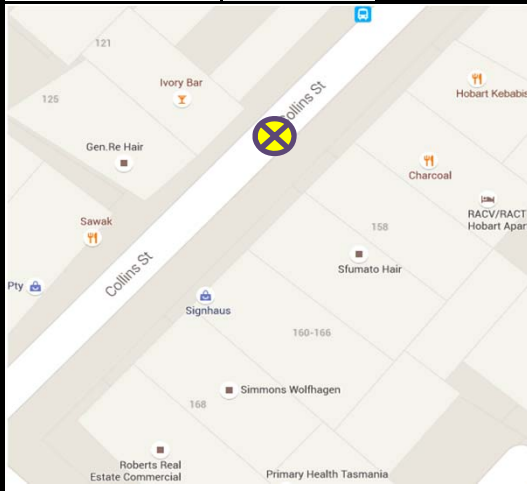
GENERAL										PAGE 1
Site Type	V Notch	☐	HVQ	☒	Level	☐	Overflow	☐		
Client	TasWater									
Project	366374 Macquarie Point				MM Project Ref:	366374				
SITE										
Contract Site No.	MP_F2				Manhole ID.	MH15596				
Address	158 Collins St									
INSTALLATION DATE	23/03/2016				Installed by	NL/NT				
SAFETY										
Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.									
Emergency phone No.	000 or 112 from mobile				Nearest hospital					
Traffic	None	☐	On road	☒	On nature strip	☐	Footpath	☐		
Additional Safety Considerations										
Refer to Project Safety Plan and Risk Assessment										
MANHOLE DETAILS										
MH Depth	2716	INLET	2636	mm	Outlet	2716	mm			
Overflow structure	Pipe	☐	Weir	☐	Other		None	☒		
Surcharge evidence to	1.2	m								
MONITORING POINT (PIPE) DETAILS										
Pipe Size	Vert.	375	mm	H=	375	mm				
Pipe Shape	Circular	☒	Ovoid	☐	Rectangular	☐	Other			
Silt Depth	0	mm	Silt Type		-					
Comments										
Fast straight through flow.										
INSTALLATION										
Monitor Type	HVQ	Monitor#	10232	U Sensor #	-					
P Sensor#	-	PV sensor #	2884	Conductivity	-					
Depth of flow at visit	80	mm								
Location										
☒	Manhole	☒	Monitoring Point	☒						
CERTIFIED AS CORRECT										
Signed					Dated					

Contract Site no.:

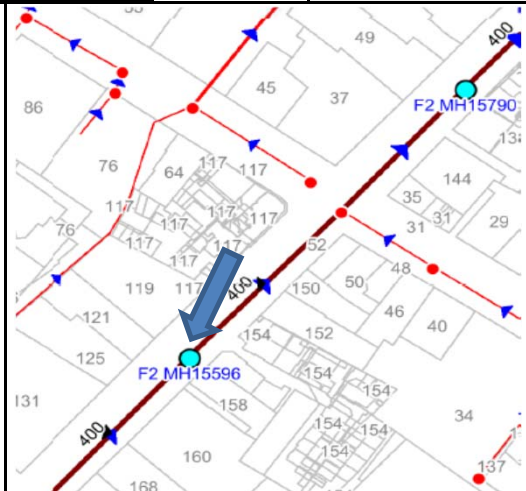
MP_F2

Manhole ID.:

MH15596



Street Map (↑N)



Sewer Map



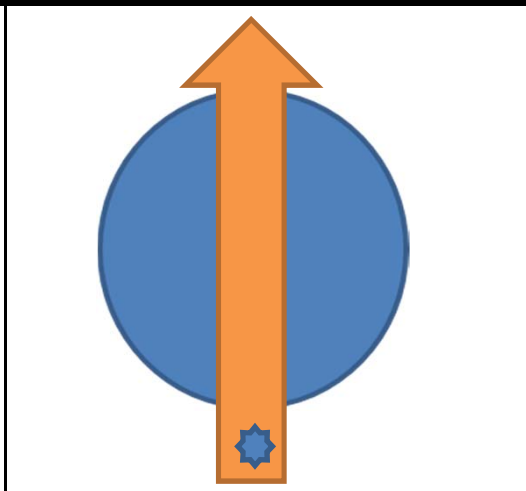
MANHOLE LOCATION



TOPSIDE VIEW OF MANHOLE



MONITORING POINT



PLAN VIEW OF MANHOLE (OUTLET AT 12)

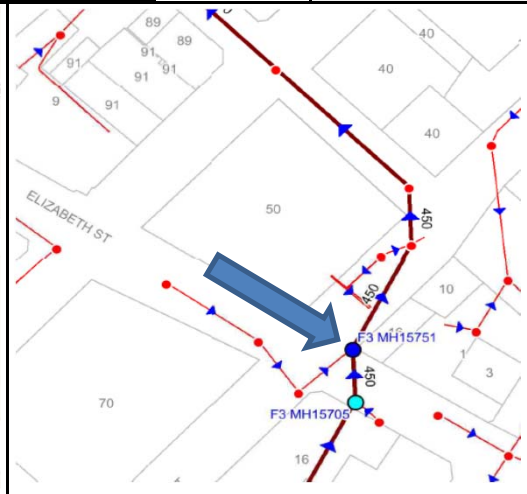
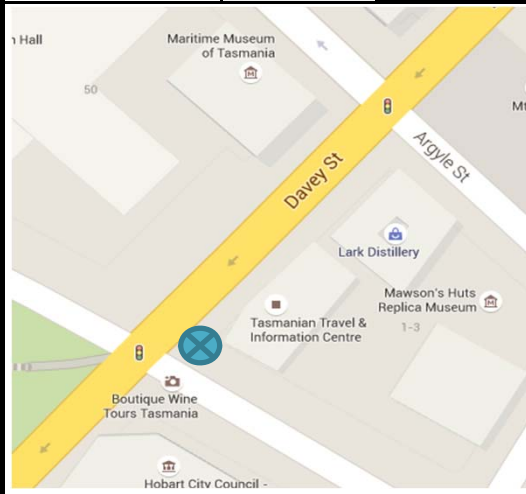
INSTALLATION REPORT



GENERAL										PAGE 1
Site Type	V Notch		HVQ	☒	Level	☐	Overflow	☐		
Client	TasWater									
Project	366374 Macquarie Point			MM Project Ref:		366374				
SITE										
Contract Site No.	MP_F3			Manhole ID.	MH15751					
Address	Elizabeth and Davey Sts									
INSTALLATION DATE	24/03/2016			Installed by		NL/NT				
SAFETY										
Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.									
Emergency phone No.	000 or 112 from mobile			Nearest hospital	Royal Hobart Hospital 48 Liverpool St, Hobart					
Traffic	None		On road		On nature strip	☐	Footpath	☒		
Additional Safety Considerations										
Refer to Project Safety Plan and Risk Assessment										
MANHOLE DETAILS										
MH Depth	2750	INLET	2750	mm	Outlet	2750	mm			
Overflow structure	Pipe	☐	Weir	☐	Other		None	☒		
Surcharge evidence to	2.75	m								
MONITORING POINT (PIPE) DETAILS										
Pipe Size	Vert.	467	mm	H=	472	mm				
Pipe Shape	Circular	☒	Ovoid	☐	Rectangular	☐	Other			
Silt Depth	0	mm	Silt Type -	-						
Comments										
Slow flow, bends through manhole but does not affect monitoring point hydraulics. Site may silt up.										
INSTALLATION										
Monitor Type	HVQ	Monitor#	52392	U Sensor #	-					
P Sensor#		PV sensor #	12513	Conductivity		10888786	☐			
Depth of flow at visit	102	mm								
Location										
☒	Manhole	☒	Monitoring Point	☒						
CERTIFIED AS CORRECT										
Signed				Dated						

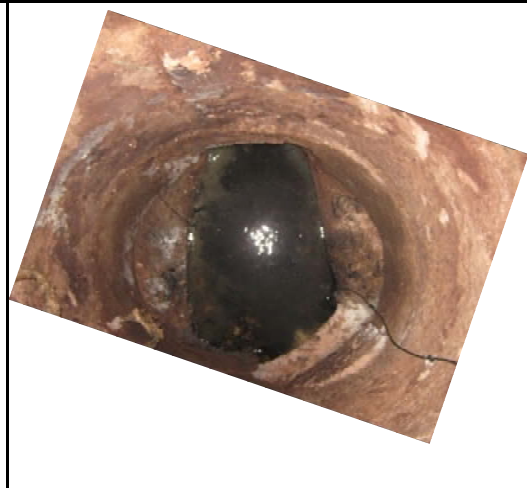
Contract Site no.: MP_F3

Manhole ID.: MH15751



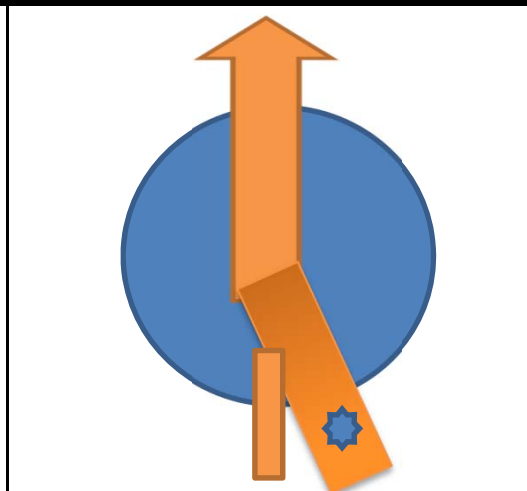
Street Map (↑N)

Sewer Map



MANHOLE LOCATION

TOPSIDE VIEW OF MANHOLE



MONITORING POINT

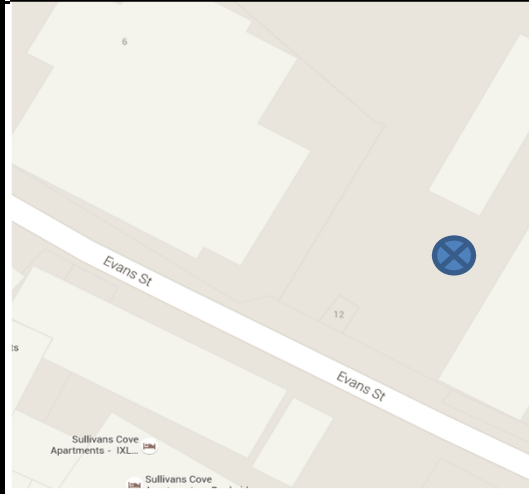
PLAN VIEW OF MANHOLE (OUTLET AT 12)

INSTALLATION REPORT

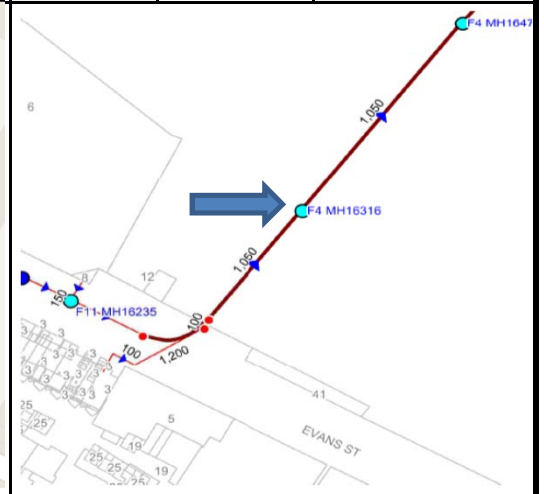


GENERAL										PAGE 1
Site Type	V Notch	☐	HVQ	☒	Level	☐	Overflow	☐		
Client	TasWater									
Project	366374 Macquarie Point				MM Project Ref:	366374				
SITE										
Contract Site No.	MP_F4				Manhole ID.	MH16316				
Address	MPDC Railyard (10 Evans St)									
INSTALLATION DATE	22/03/2016				Installed by	NL/NT				
SAFETY										
Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.									
Emergency phone No.	000 or 112 from mobile				Nearest hospital	Royal Hobart Hospital 48 Liverpool St, Hobart				
Traffic	None	☒	On road	☐	On nature strip	☐	Footpath	☐		
Additional Safety Considerations										
Workers must be inducted by Rail Authority.										
MANHOLE DETAILS										
MH Depth	3660	INLET	3410	mm	Outlet	3660	mm			
Overflow structure	Pipe	☐	Weir	☐	Other		None	☒		
Surcharge evidence to	3.4	m								
MONITORING POINT (PIPE) DETAILS										
Pipe Size	Vert.	845	mm	H=	837	mm				
Pipe Shape	Circular	☒	Ovoid	☐	Rectangular	☐	Other			
Silt Depth	0	mm	Silt Type		None					
Comments										
Key required for access. Slow straight through flow.										
INSTALLATION										
Monitor Type	HVQ	Monitor#	10182	U Sensor #	-					
P Sensor#		PV sensor #	12514	Conductivity	108887895					
Depth of flow at visit	610	mm								
Location	☒	Manhole	☒		Monitoring Point	☒				
CERTIFIED AS CORRECT										
Signed					Dated					

Contract Site no.:	MP_F4	Manhole ID.:	MH16316
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Street Map (↑N)



Sewer Map



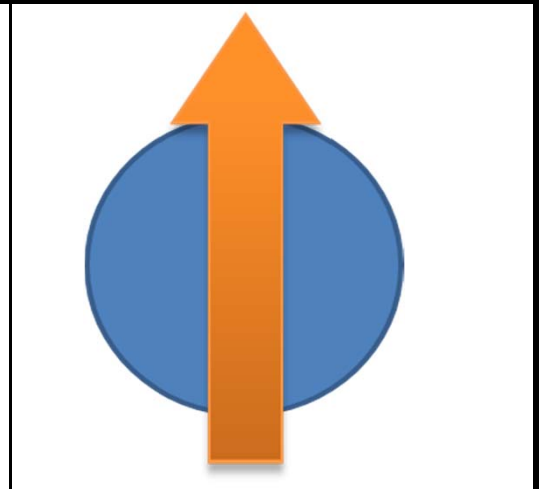
MANHOLE LOCATION



TOPSIDE VIEW OF MANHOLE



MONITORING POINT



PLAN VIEW OF MANHOLE (OUTLET AT 12)

INSTALLATION REPORT



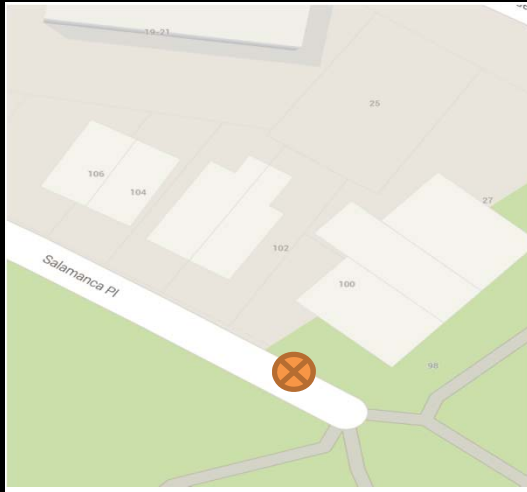
GENERAL										PAGE 1
Site Type	V Notch	☐	HVQ	☒	Level	☐	Overflow	☐		
Client	TasWater									
Project	366374 Macquarie Point				MM Project Ref:	366374				
SITE										
Contract Site No.	MP_F5				Manhole ID.	MH14773				
Address	98 Salamanca Pl									
INSTALLATION DATE	21/03/2016				Installed by	NL/NT				
SAFETY										
Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.									
Emergency phone No.	000 or 112 from mobile				Nearest hospital	Royal Hobart Hospital 48 Liverpool St, Hobart				
Traffic	None	☐	On road	☐	On nature strip	☐	Footpath	☒		
Additional Safety Considerations										
Standard, refer to Project Safety Plan and Risk Assessment										
MANHOLE DETAILS										
MH Depth	7470	INLET	7470	mm	Outlet	7470	mm			
Overflow structure	Pipe	☐	Weir	☐	Other		None	☒		
Surcharge evidence to	5.5	m								
MONITORING POINT (PIPE) DETAILS										
Pipe Size	Vert.	449	mm	H=	449	mm				
Pipe Shape	Circular	☒	Ovoid	☐	Rectangular	☐	Other			
Silt Depth	100	mm	Sandy		None					
Comments										
Slow flow with some silt. Seems to be constriction downstream of the monitoring point. Local resident does not want us to be there at night.										
INSTALLATION										
Monitor Type	HVQ	Monitor#	10233	U Sensor #	-					
P Sensor#		PV sensor #	3124	Conductivity		10888790	☐			
Depth of flow at visit	149	mm								
Location	☒	Manhole	☒		Monitoring Point	☒				
CERTIFIED AS CORRECT										
Signed					Dated					

Contract Site no.:

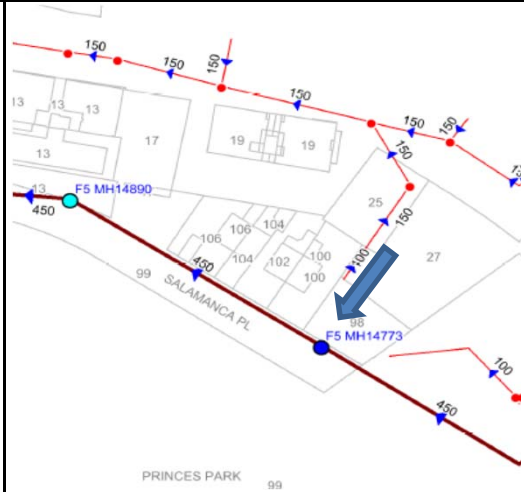
MP_F5

Manhole ID.:

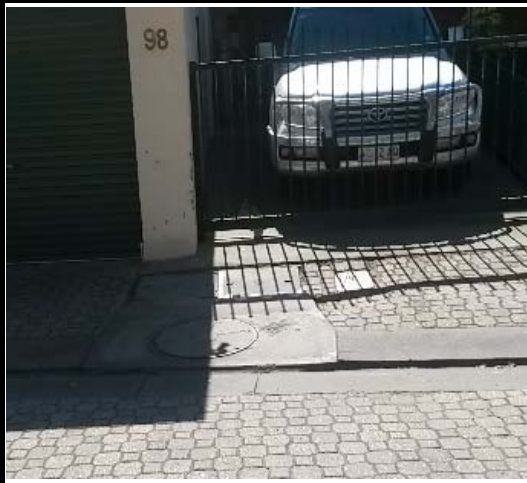
MH14773



Street Map (↑N)



Sewer Map



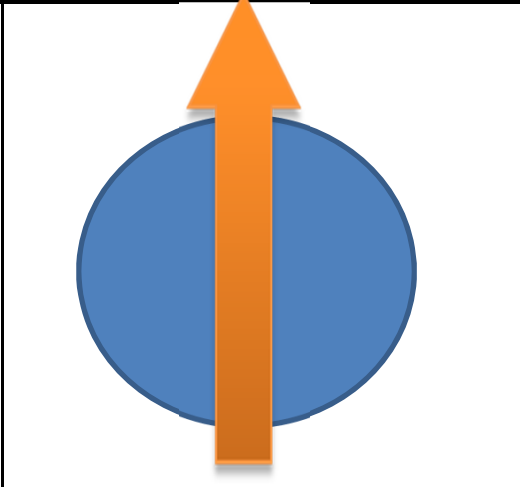
MANHOLE LOCATION



TOPSIDE VIEW OF MANHOLE



MONITORING POINT



PLAN VIEW OF MANHOLE (OUTLET AT 12)

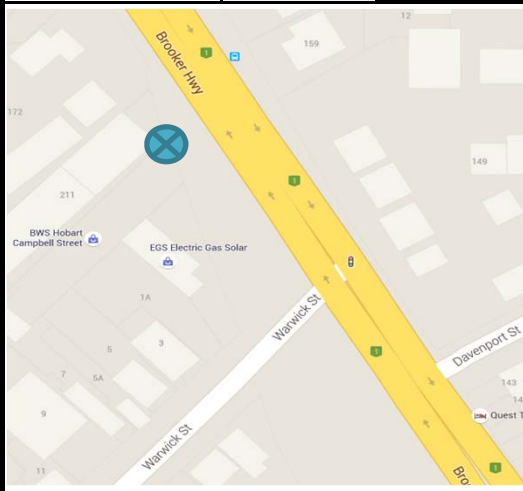
INSTALLATION REPORT



GENERAL										PAGE 1
Site Type	V Notch	☐	HVQ	☒	Level	☐	Overflow	☐		
Client	TasWater									
Project	366374 Macquarie Point				MM Project Ref:	366374				
SITE										
Contract Site No.	MP_F6				Manhole ID.	MH18526				
Address	BWS - 211 Brooker Hwy									
INSTALLATION DATE	22/03/2016				Installed by	NL/NT				
SAFETY										
Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.									
Emergency phone No.	000 or 112 from mobile				Nearest hospital	Royal Hobart Hospital 48 Liverpool St, Hobart				
Traffic	Car park	☒	On road	☐	On nature strip	☐	Footpath	☐		
Additional Safety Considerations										
Standard, refer to Project Safety Plan and Risk Assessment										
MANHOLE DETAILS										
MH Depth	4000	INLET	3900	mm	Outlet	4000	mm			
Overflow structure	Pipe	☐	Weir	☐	Other		None	☒		
Surcharge evidence to	3.5	m								
MONITORING POINT (PIPE) DETAILS										
Pipe Size	Vert.	396	mm	H=	387	mm				
Pipe Shape	Circular	☒	Ovoid	☐	Rectangular	☐	Other			
Silt Depth	0	mm	Silt Type		-					
Comments										
Fast shallow flow. Straight through manhole. Good monitoring location.										
INSTALLATION										
Monitor Type	Weir	Monitor#	10219	U Sensor #	-					
P Sensor#		PV sensor #	2903	Conductivity	-				☐	
Depth of flow at visit	77	mm								
Location										
☒	Manhole	☒		Monitoring Point	☒					
CERTIFIED AS CORRECT										
Signed					Dated					

Contract Site no.: MP_F6

Manhole ID.: MH18526



Street Map (↑N)



Sewer Map



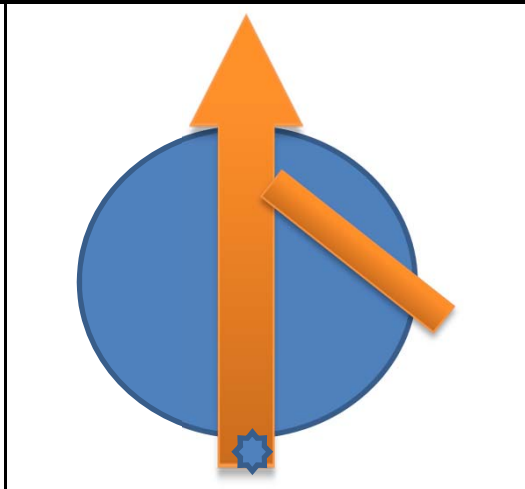
MANHOLE LOCATION



TOPSIDE VIEW OF MANHOLE



MONITORING POINT



PLAN VIEW OF MANHOLE (OUTLET AT 12)

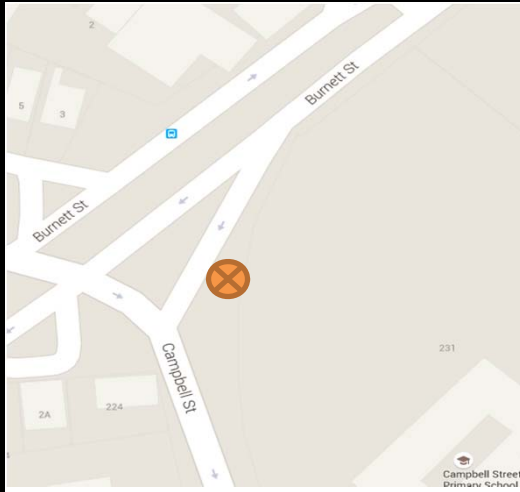
INSTALLATION REPORT



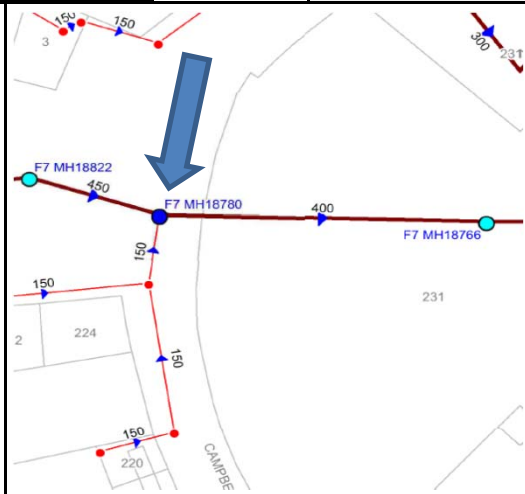
GENERAL										PAGE 1
Site Type	V Notch	☐	HVQ	☒	Level	☐	Overflow	☐		
Client	TasWater									
Project	366374 Macquarie Point				MM Project Ref:	366374				
SITE										
Contract Site No.	MP_F7				Manhole ID.	MH18780				
Address	Cnr Burnett and Campbell (231?)									
INSTALLATION DATE	22/03/2016				Installed by	NL/NT				
SAFETY										
Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.									
Emergency phone No.	000 or 112 from mobile				Nearest hospital	Royal Hobart Hospital 48 Liverpool St, Hobart				
Traffic	None		On road	☐	On nature strip	☒	Footpath	☐		
Additional Safety Considerations										
Standard, refer to Project Safety Plan and Risk Assessment										
MANHOLE DETAILS										
MH Depth	3220.000	INLET	3220	mm	Outlet	3320	mm			
Overflow structure	Pipe	☒	Weir	☐	Other		None	☒		
Surcharge evidence to	2.5	m								
MONITORING POINT (PIPE) DETAILS										
Pipe Size	Vert.	349	mm	H=	349	mm				
Pipe Shape	Circular	☒	Ovoid	☐	Rectangular	☐	Other			
Silt Depth	0	mm	Silt Type		-					
Comments										
Slight bend through manhole and a drop through the manhole. Side connection is blocked with roots but does not affect monitoring point.										
INSTALLATION										
Monitor Type	HVQ	Monitor#	10090	U Sensor #	-					
P Sensor#		PV sensor #	1723	Conductivity	-					☐
Depth of flow at visit	47	mm								
Location										
☒	Manhole	☒	Monitoring Point	☒						
CERTIFIED AS CORRECT										
Signed					Dated					

Contract Site no.: MP_F7

Manhole ID.: MH18780



Street Map (↑N)



Sewer Map



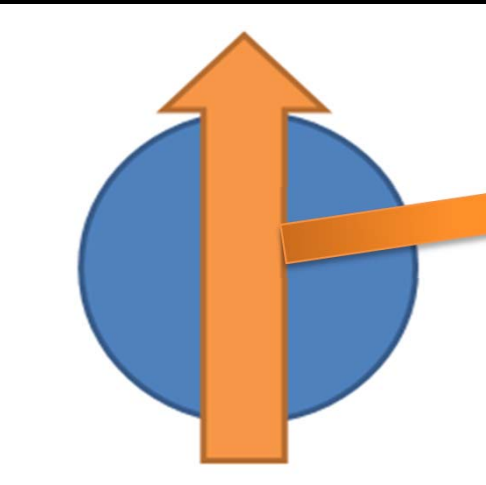
MANHOLE LOCATION



TOPSIDE VIEW OF MANHOLE



MONITORING POINT



PLAN VIEW OF MANHOLE (OUTLET AT 12)

INSTALLATION REPORT

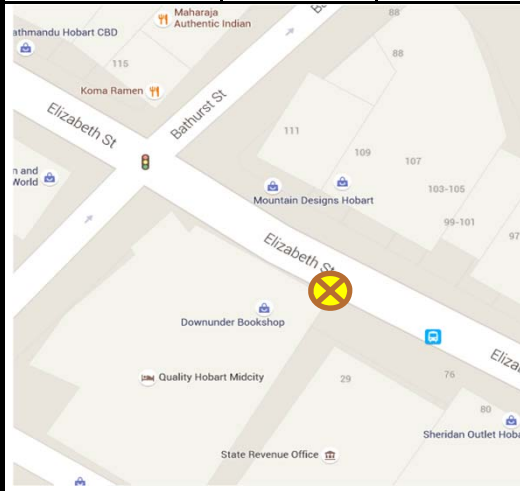


GENERAL										PAGE 1
Site Type	V Notch		HVQ	☒	Level	☐	Overflow	☐		
Client	TasWater									
Project	366374 Macquarie Point				MM Project Ref:	366374				
SITE										
Contract Site No.	MP_F8				Manhole ID.	Unknown				
Address	80 Elizabeth St									
INSTALLATION DATE	24/03/2016				Installed by	NL/NT				
SAFETY										
Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.									
Emergency phone No.	000 or 112 from mobile				Nearest hospital					
Traffic	None	☐	On road	☒	On nature strip	☐	Footpath	☐		
Additional Safety Considerations										
Located on road. Altus to provide traffic management, need to organise ahead of time through TasWater. Avoid times when bus is running.										
MANHOLE DETAILS										
MH Depth	2350	INLET	2350	mm	Outlet	2350	mm			
Overflow structure	Pipe	☐	Weir	☐	Other		None	☒		
Surcharge evidence to	2	m								
MONITORING POINT (PIPE) DETAILS										
Pipe Size	Vert.	303	mm	H=	305	mm				
Pipe Shape	Circular	☒	Ovoid	☐	Rectangular	☐	Other			
Silt Depth	0	mm	Silt Type		-					
Comments										
Straight through flow, side connection not running at time of installation.										
INSTALLATION										
Monitor Type	HVQ	Monitor#	52393	U Sensor #	-					
P Sensor#		PV sensor #	6238	Conductivity	10888793	☐				
Depth of flow at visit	60	mm								
Location										
☒	Manhole	☒		Monitoring Point	☒					
CERTIFIED AS CORRECT										
Signed					Dated					

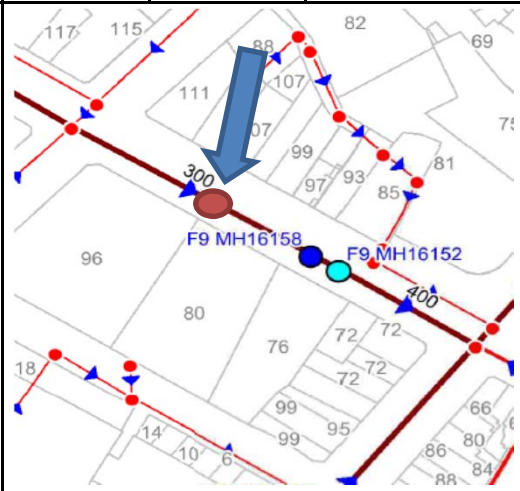
Contract Site no.: MP_F8

Manhole ID.:

Unknown



Street Map (↑N)



Sewer Map



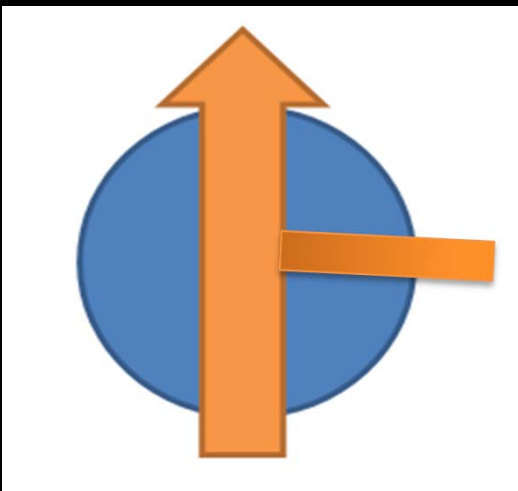
MANHOLE LOCATION



TOPSIDE VIEW OF MANHOLE



MONITORING POINT



PLAN VIEW OF MANHOLE (OUTLET AT 12)

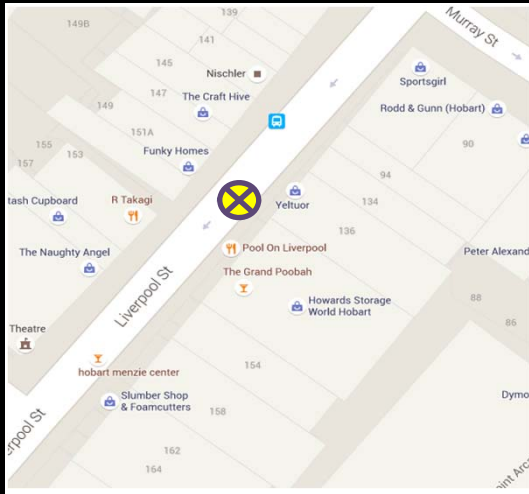
INSTALLATION REPORT



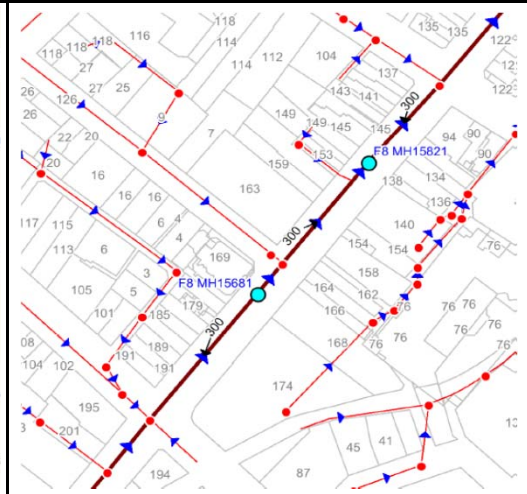
GENERAL										PAGE 1
Site Type	V Notch		HVQ	☒	Level	☐	Overflow	☐		
Client	TasWater									
Project	366374 Macquarie Point				MM Project Ref:	366374				
SITE										
Contract Site No.	MP_F9				Manhole ID.	MH16028				
Address	149 Liverpool St									
INSTALLATION DATE	24/03/2016				Installed by	NL/NT				
SAFETY										
Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.									
Emergency phone No.	000 or 112 from mobile				Nearest hospital	Royal Hobart Hospital 48 Liverpool St, Hobart				
Traffic	In Carpark		On road	☒	On nature strip	☐	Footpath	☐		
Additional Safety Considerations										
Refer to Project Safety Plan and Risk Assessment										
MANHOLE DETAILS										
MH Depth	2600	INLET	2600	mm	Outlet	2600	mm			
Overflow structure	Pipe	☐	Weir	☐	Other		None	☒		
Surcharge evidence to	2.5	m								
MONITORING POINT (PIPE) DETAILS										
Pipe Size	Vert.	450	mm	H=	455	mm				
Pipe Shape	Circular	☒	Ovoid	☐	Rectangular	☐	Other			
Silt Depth	0	mm	Silt Type		-					
Comments										
Shallow steady flow.										
INSTALLATION										
Monitor Type	HVQ	Monitor#	52393	U Sensor #	-					
P Sensor#		PV sensor #	6238	Conductivity	10888791					
Depth of flow at visit	57	mm								
Location	☒	Manhole	☒		Monitoring Point	☒				
CERTIFIED AS CORRECT										
Signed					Dated					

Contract Site no.: MP_F9

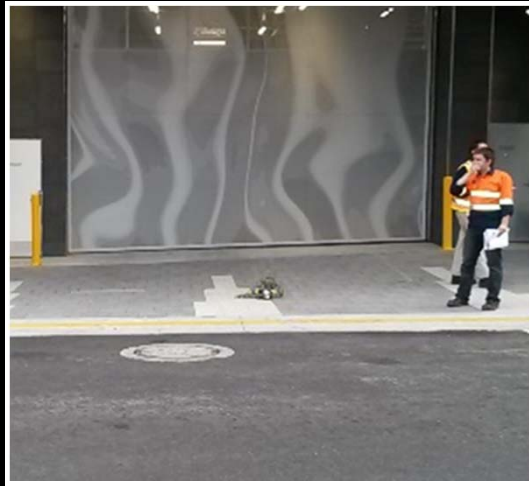
Manhole ID.: MH16028



Street Map (↑N)



Sewer Map



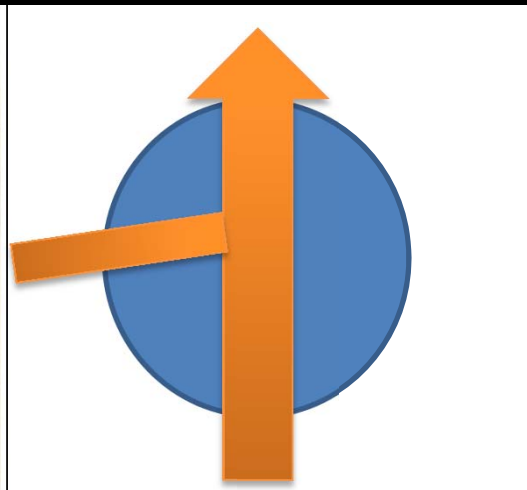
MANHOLE LOCATION



TOPSIDE VIEW OF MANHOLE



MONITORING POINT



PLAN VIEW OF MANHOLE (OUTLET @ 12 O'CLOCK)

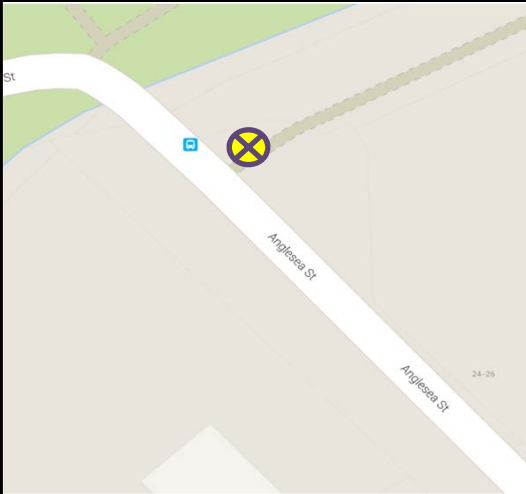
INSTALLATION REPORT



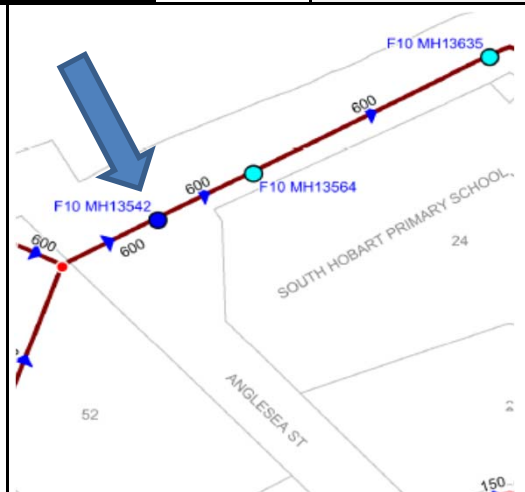
GENERAL										PAGE 1
Site Type	V Notch	☐	HVQ	☒	Level	☐	Overflow	☐		
Client	TasWater									
Project	366374 Macquarie Point				MM Project Ref:	366374				
SITE										
Contract Site No.	MP_F10				Manhole ID.	MH13542				
Address	52 Anglesea St									
INSTALLATION DATE	23/03/2016				Installed by	NL/NT				
SAFETY										
Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.									
Emergency phone No.	000 or 112 from mobile				Nearest hospital					
Traffic	None	☒	On road	☐	On nature strip	☐	Footpath	☐		
Additional Safety Considerations										
Refer to Project Safety Plan and Risk Assessment										
MANHOLE DETAILS										
MH Depth	3850	INLET	3830	mm	Outlet	3850	mm			
Overflow structure	Pipe	☐	Weir	☐	Other		None	☒		
Surcharge evidence to	1.2	m								
MONITORING POINT (PIPE) DETAILS										
Pipe Size	Vert.	581	mm	H=	583	mm				
Pipe Shape	Circular	☒	Ovoid	☐	Rectangular	☐	Other			
Silt Depth	0	mm	Silt Type		-					
Comments										
Fast shallow, straight through flow. Displaced joing 2m upstream of monitoring point causing some turbulence.										
INSTALLATION										
Monitor Type	HVQ	Monitor#	10078	U Sensor #	-					
P Sensor#	-	PV sensor #	2903	Conductivity	-					
Depth of flow at visit	65	mm								
Location	☒	Manhole	☒		Monitoring Point	☒				
CERTIFIED AS CORRECT										
Signed					Dated					

Contract Site no.: MP_F10

Manhole ID.: MH13542



Street Map (↑N)



Sewer Map



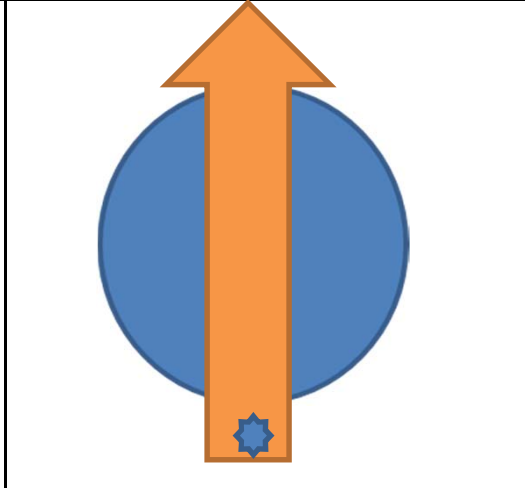
MANHOLE LOCATION



TOPSIDE VIEW OF MANHOLE



MONITORING POINT



PLAN VIEW OF MANHOLE (OUTLET AT 12 O'CLOCK)

INSTALLATION REPORT

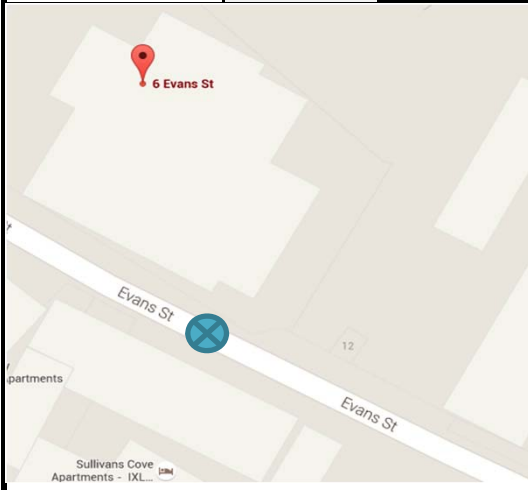


GENERAL										PAGE 1
Site Type	V Notch		HVQ	☒	Level	☐	Overflow	☐		
Client	TasWater									
Project	366374 Macquarie Point				MM Project Ref:	366374				
SITE										
Contract Site No.	MP_F11				Manhole ID.	MH16259				
Address	6 Evans St									
INSTALLATION DATE	22/03/2016				Installed by	NL/NT				
SAFETY										
Safety/emergency precautions		Refer Project Safety Plan and review Risk Assessment prior to works.								
Emergency phone No.	000 or 112 from mobile				Nearest hospital	Royal Hobart Hospital 48 Liverpool St, Hobart				
Traffic	None		On road	☒	On nature strip	☐	Footpath	☐		
Additional Safety Considerations										
Refer to Project Safety Plan and Risk Assessment										
MANHOLE DETAILS										
MH Depth	2360	INLET	2350	mm	Outlet	2360	mm			
Overflow structure	Pipe	☐	Weir	☐	Other		None	☒		
Surcharge evidence to	1.3	m								
MONITORING POINT (PIPE) DETAILS										
Pipe Size	Vert.	1253	mm	H=	830	mm				
Pipe Shape	Circular		Ovoid	☒	Rectangular	☐	Other			
Silt Depth	0	mm	Silt Type -		-					
Comments										
Slow steady straight through flow.										
INSTALLATION										
Monitor Type	HVQ	Monitor#	52388	U Sensor #	-					
P Sensor#		PV sensor #	3189	Conductivity	18887966					
Depth of flow at visit	366	mm								
Location	☒	Manhole	☒		Monitoring Point	☒				
CERTIFIED AS CORRECT										
Signed					Dated					

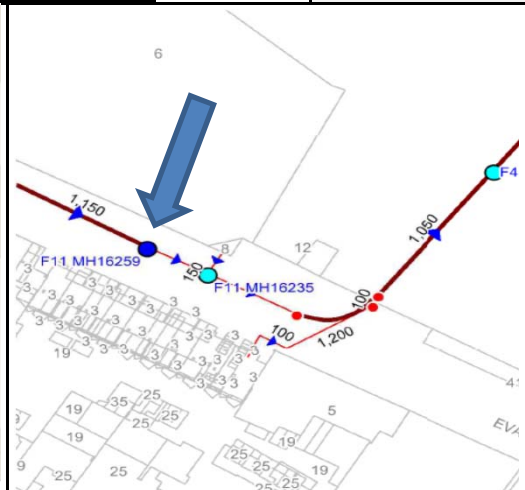
Contract Site no.: MP_F11

Manhole ID.:

MH16259



Street Map (↑N)



Sewer Map



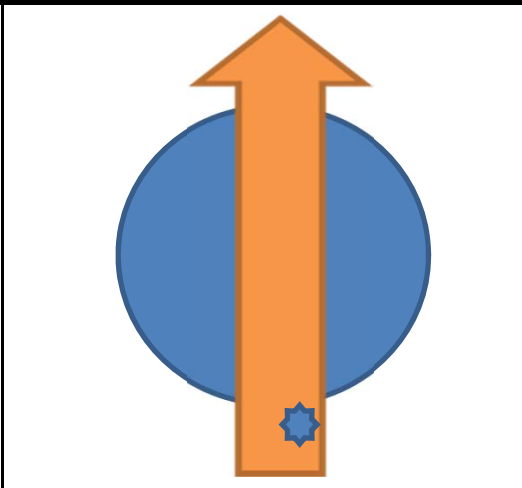
MANHOLE LOCATION



TOPSIDE VIEW OF MANHOLE



MONITORING POINT



PLAN VIEW OF MANHOLE (OUTLET AT 12 O'CLOCK)

INSTALLATION REPORT

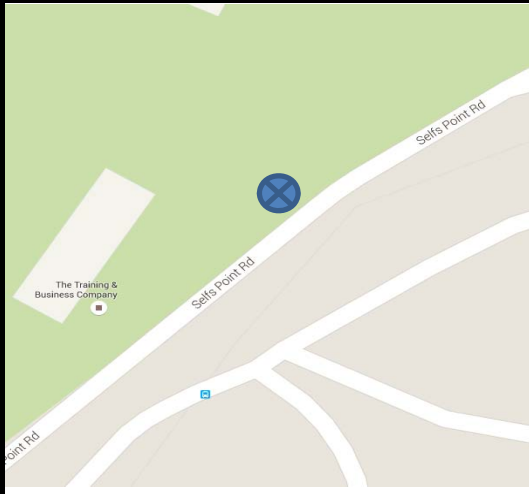


GENERAL										PAGE 1
Site Type	V Notch	☐	HVQ	☒	Level	☐	Overflow	☐		
Client	TasWater									
Project	366374 Macquarie Point				MM Project Ref:	366374				
SITE										
Contract Site No.	MP_F12				Manhole ID.	MH25196				
Address	Selfs Pt Rd (N or Rugby Park Clubrooms)									
INSTALLATION DATE	23/03/2016				Installed by	NL/NT				
SAFETY										
Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.									
Emergency phone No.	000 or 112 from mobile				Nearest hospital	Royal Hobart Hospital 48 Liverpool St, Hobart				
Traffic	None	☒	On road	☐	On nature strip	☐	Footpath	☐		
Additional Safety Considerations										
16ppm VOC prior to installation, may need extra ventilation, otherwise refer to Project Safety Plan and Risk Assessment										
MANHOLE DETAILS										
MH Depth	6450	INLET	6.411	mm	Outlet	6.415	mm			
Overflow structure	Pipe	☐	Weir	☐	Other		None	☒		
Surcharge evidence to	1.4	m								
MONITORING POINT (PIPE) DETAILS										
Pipe Size	Vert.	992	mm	H=	647	mm				
Pipe Shape	Circular	☐	Ovoid	☒	Rectangular	☐	Other			
Silt Depth	100	mm	Silt Type		Gravel, rocks					
Comments										
Slow deep flow. Around 100mm silt with large rocks along inlet and outlet pipes.										
INSTALLATION										
Monitor Type	HVQ	Monitor#	10096	U Sensor #	-					
P Sensor#		PV sensor #	3750	Conductivity	-					☐
Depth of flow at visit	445	mm								
CERTIFIED AS CORRECT										
Signed					Dated					

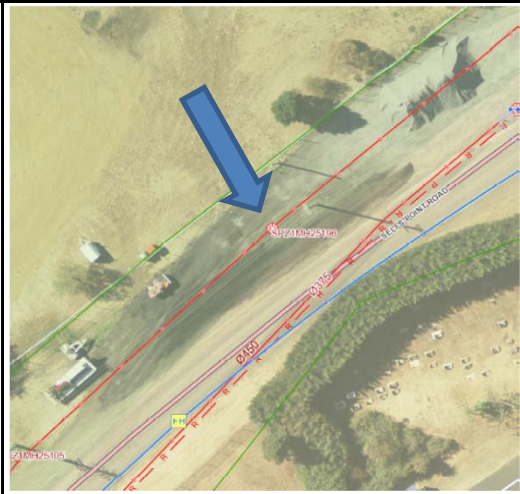
Contract Site no.: MP_F12

Manhole ID.:

MH25196



Street Map (↑N)



Sewer Map



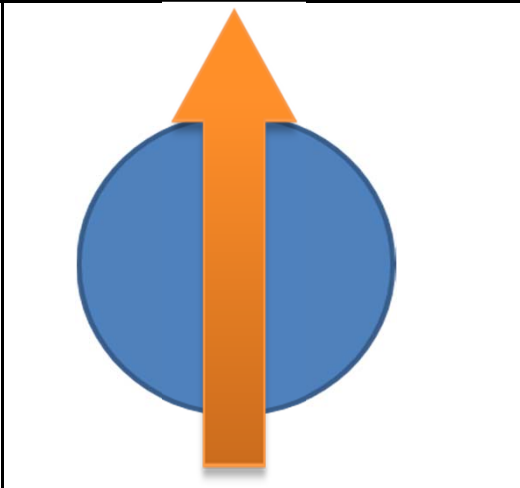
MANHOLE LOCATION



TOPSIDE VIEW OF MANHOLE



MONITORING POINT



PLAN VIEW OF MANHOLE (OUTLET @ 12 O'CLOCK)

INSTALLATION REPORT



GENERAL								PAGE 1
Site Type	RG	☒						
Client	TasWater							
Project	366374 Macquarie Point				MM Project Ref:		366374	
SITE								
Contract Site No.	MPRG1			Manhole ID.		N/A		
Address	Macquarie Point STP 20 Hunter St							
INSTALLATION DATE	24/03/2016			Installed by		TT		
SAFETY								
Safety/emergency precautions		Refer Project Safety Plan and review Risk Assessment prior to works.						
Emergency phone No.	000 or 112 from mobile			Nearest hospital		Royal Hobart Hospital 48 Liverpool St, Hobart		
Traffic	None	☒	On road	☐	On nature strip	☐	Footpath	
Additional Safety Considerations								
Sign in at control room prior to accessing equipment. Be aware of the emergency sirens and procedures on site. Be aware of other traffic on site.								
INSTALLATION								
Monitor Type	Outpost	Monitor#	19022	Conductivity #	-			
P Sensor#	N/A	V sensor #	N/A	Other	-			
Depth of flow at visit	N/A	mm						
PHOTOS TAKEN								
Location	☒							
CERTIFIED AS CORRECT								
Signed				Dated				
SITE								
Contract Site no.:	MPRG1	Manhole ID.:			N/A			
								
Street Map (↑N)				Location Photo				

INSTALLATION REPORT



GENERAL							PAGE 1
Site Type	RG	☒					
Client	TasWater						
Project	366374 Macquarie Point			MM Project Ref:	366374		
SITE							
Contract Site No.	MPRG2			Manhole ID.	N/A		
Address	Hill St Reservoir 2A Hill St, West Hobart						
INSTALLATION DATE	24/03/2016			Installed by	TT		
SAFETY							
Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.						
Emergency phone No.	000 or 112 from mobile			Nearest hospital	Royal Hobart Hospital 48 Liverpool St, Hobart		
Traffic	None	☒	On road	☐	On nature strip	☐	Footpath
Additional Safety Considerations							
Ladder required, second person should hold ladder while gauge is accessed. Person on ladder will be <2m from ground.							
INSTALLATION							
Monitor Type	Outpost	Monitor#	16542	Conductivity #	0		
P Sensor#	N/A	V sensor #	N/A	Other	0		
Depth of flow at visit	N/A	mm					
PHOTOS TAKEN							
Location	☒						
CERTIFIED AS CORRECT							
Signed				Dated			
SITE							
Contract Site no.:	MPRG2			Manhole ID.:	N/A		
Street Map (↑N)				Location Photo			

INSTALLATION REPORT



GENERAL PAGE 1

Site Type	Conductivity Only	☒
Client	TasWater	
Project	366374 Macquarie Point	MM Project Ref: 366374

SITE

Contract Site No.	C7	Manhole ID.	Wet Well
Address	Napoleon St Pumping Station		
INSTALLATION DATE	23/03/2016	Installed by	NL/NT

SAFETY

Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.		
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Emergency phone No.	000 or 112 from mobile	Nearest hospital	48 Liverpool St, Hobart
Traffic	None	On road	☐
	☒	On nature strip	☐
		Footpath	☐

Additional Safety Considerations

Ref Project Safety Plan and MMF100. TasWater need to be on site to unlock padlock for access.

INSTALLATION

Monitor Type	Hobo Logger	Monitor#	N/A	Conductivity #	10888795
P Sensor#	N/A	V sensor #	N/A	Other	N/A
Depth of flow at visit	N/A	mm			

PHOTOS TAKEN

Location	☒
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CERTIFIED AS CORRECT

Signed	Dated
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SITE

Contract Site no.:	C7	Manhole ID.:	Wet Well
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Street Map (↑N)



Location Photo



Topside View

INSTALLATION REPORT



GENERAL PAGE 1

Site Type	Conductivity Only	☒
Client	TasWater	
Project	366374 Macquarie Point	MM Project Ref: 366374

SITE

Contract Site No.	C8	GID	Wet Well
Address	Salamanca Place Pumping Station		
INSTALLATION DATE	23/03/2016	Installed by	TT

SAFETY

Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.		
Emergency phone No.	000 or 112 from mobile	Nearest hospital	48 Liverpool St, Hobart
Traffic	None	On road	☒ On nature strip ☐ Footpath

Additional Safety Considerations

Ref Project Safety Plan and MMF100. Cpne off area and keep public away while cover is open. Replace cover as soon as possible.

INSTALLATION

Monitor Type	Hobo Logger	Monitor#	N/A	Conductivity #	10888794
P Sensor#	N/A	V sensor #	N/A	Other	N/A
Depth of flow at visit	N/A	mm			

PHOTOS TAKEN

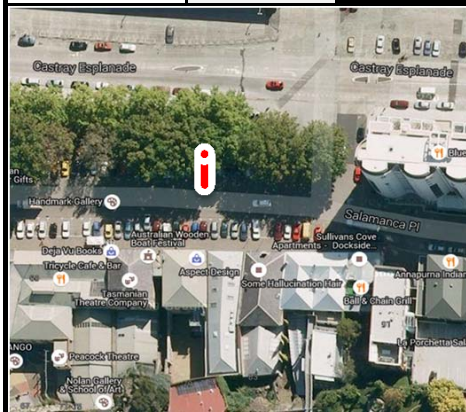
Location ☒

CERTIFIED AS CORRECT

Signed _____ Dated _____

SITE

Contract Site no.:	C8	Manhole ID.:	Wet Well
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Street Map (↑N)



Location Photo



Topside View

INSTALLATION REPORT



GENERAL PAGE 1

Site Type	Conductivity Only	☒
Client	TasWater	
Project	366374 Macquarie Point	MM Project Ref: 366374

SITE			
Contract Site No.	C9	GID	Wet Well
Address	Morrison St Pumping Station		
INSTALLATION DATE	23/03/2016	Installed by	NL/NT

SAFETY	
Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.

Emergency phone No.	000 or 112 from mobile	Nearest hospital	48 Liverpool St, Hobart
Traffic	None ☐	On road ☒	On nature strip ☐ Footpath ☐

Additional Safety Considerations
Ref Project Safety Plan and MMF100. Site in on the road. Required to have Altus do Traffic management setup. Avoid Uni Night (Wed night/Thursday morning).

INSTALLATION					
Monitor Type	Hobo Logger	Monitor#	N/A	Conductivity #	69332547
P Sensor#	N/A	V sensor #	N/A	Other	N/A
Depth of flow at visit	N/A	mm			

PHOTOS TAKEN	
Location	☒

CERTIFIED AS CORRECT	
Signed	Dated

SITE			
Contract Site no.:	C9	Manhole ID.:	Wet Well



Street Map (↑N)



Location Photo



Topside View

INSTALLATION REPORT



GENERAL PAGE 1

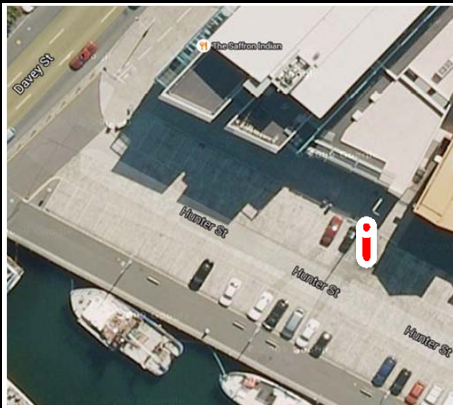
Site Type	Conductivity Only	☒
Client	TasWater	
Project	366374 Macquarie Point	MM Project Ref: 366374
SITE		
Contract Site No.	C10	Wet Well
Address	Hunter St Pumping Station	
INSTALLATION DATE	23/03/2016	Installed by TT

SAFETY			
Safety/emergency precautions		Refer Project Safety Plan and review Risk Assessment prior to works.	
Emergency phone No.	000 or 112 from mobile	Nearest hospital	48 Liverpool St, Hobart
Traffic	None ☒	On road ☐	On nature strip ☐ Footpath ☐
Additional Safety Considerations			
Ref Project Safety Plan and MMF100			

INSTALLATION					
Monitor Type	Hobo Logger	Monitor#	N/A	Conductivity #	0
P Sensor#	N/A	V sensor #	N/A	Other	N/A
Depth of flow at visit	N/A	mm			

PHOTOS TAKEN	
Location	☒
CERTIFIED AS CORRECT	
Signed	Dated

SITE	
Contract Site no.:	C10
Manhole ID.:	Wet Well



Street Map (↑N)



Location Photo



Topside View

INSTALLATION REPORT



GENERAL PAGE 1

Site Type	Conductivity Only	☒
Client	TasWater	
Project	366374 Macquarie Point	MM Project Ref: 366374

SITE

Contract Site No.	CSTP		GID	Inlet Well
Address	Macquarie Point STP 20 Hunter St			
INSTALLATION DATE	23/03/2016	Installed by	TT	

SAFETY

Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.			
Emergency phone No.	000 or 112 from mobile	Nearest hospital	48 Liverpool St, Hobart	
Traffic	None	☒	On road	☐
			On nature strip	☐
			Footpath	☐
Additional Safety Considerations				
Ref Project Safety Plan and MMF100				

INSTALLATION

Monitor Type	Hobo Logger	Monitor#	N/A	Conductivity #	10888787
P Sensor#	N/A	V sensor #	N/A	Other	N/A
Depth of flow at visit	N/A	mm			

PHOTOS TAKEN

Location ☒

CERTIFIED AS CORRECT

Signed _____ Dated _____

SITE

Contract Site no.:	CSTP	Manhole ID.:	Inlet Well
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Street Map (↑N)



Location Photo



Topside View

INSTALLATION REPORT



GENERAL PAGE 1

Site Type	Conductivity in HVQ site	☒
Client	TasWater	
Project	366374 Macquarie Point	MM Project Ref: 366374

SITE

Contract Site No.	C1	Manhole ID.	MH17252
Address	87 Campbell St (basement carpark).		
INSTALLATION DATE	23/03/2016	Installed by	NL/NT

SAFETY

Safety/emergency precautions Refer Project Safety Plan and review Risk Assessment prior to works.

Emergency phone No.	000 or 112 from mobile	Nearest hospital	48 Liverpool St, Hobart
Traffic	None ☒	On road ☐	On nature strip ☐ Footpath ☐

Additional Safety Considerations or Other details

Ref Project Safety Plan and MMF100. In carpark, keep barricaded from curious public.

INSTALLATION

Monitor Type	Hobo Logger	Monitor#	N/A	Conductivity #	10888789
P Sensor#	N/A	V sensor #	N/A	Other	N/A
Depth of flow at visit	N/A	mm			

PHOTOS TAKEN

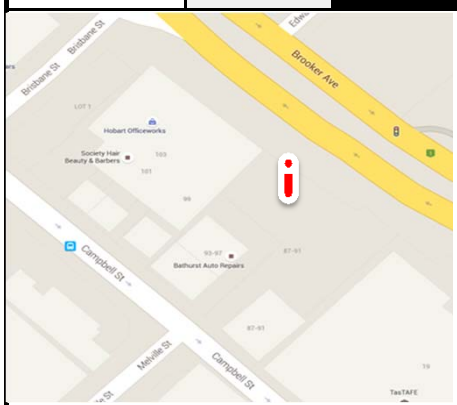
Location ☒

CERTIFIED AS CORRECT

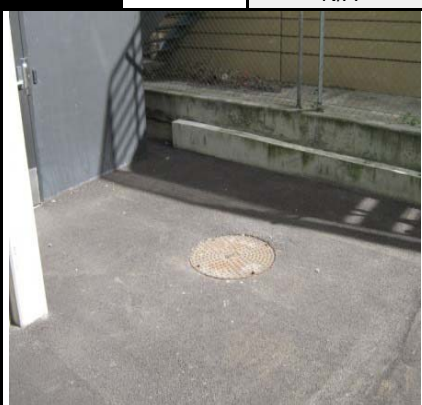
Signed _____ Dated _____

SITE

Contract Site no.:	C1	Manhole ID.:	N/A
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Street Map (↑N)



Location Photo



Topside View

INSTALLATION REPORT



GENERAL PAGE 1

Site Type	Conductivity in HVQ site ☒		
Client	TasWater		
Project	366374 Macquarie Point	MM Project Ref.	366374
SITE			
Contract Site No.	C2	Manhole ID.	MH15596
Address	158 Collins St		
INSTALLATION DATE	23/03/2016	Installed by	NL/TT

SAFETY

Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.		
Emergency phone No.	000 or 112 from mobile	Nearest hospital	48 Liverpool St, Hobart
Traffic	None ☐	On road ☒	On nature strip ☐ Footpath ☐

Additional Safety Considerations

Ref Project Safety Plan and MMF100. TasWater need to organise Altus to provide Traffic management here. Out of business hours (7pm-7am).

INSTALLATION

Monitor Type	Hobo Logger	Monitor#	N/A	Conductivity #	10888797
P Sensor#	N/A	V sensor #	N/A	Other	N/A
Depth of flow at visit	N/A	mm			

PHOTOS TAKEN

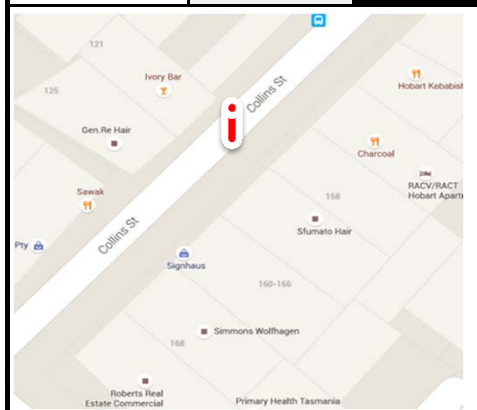
Location	☒
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CERTIFIED AS CORRECT

Signed	Dated
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SITE

Contract Site no.:	C2	Manhole ID.:	MH15596
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Street Map (↑N)



Location Photo



Topside View

INSTALLATION REPORT



GENERAL						PAGE 1
Site Type	Conductivity in HVQ site ☒					
Client	TasWater					
Project	366374 Macquarie Point		MM Project Ref:	366374		
SITE						
Contract Site No.	C3		GID	MH15751		
Address	Elizabeth and Davey Sts					
INSTALLATION DATE	23/03/2016		Installed by	TT		
SAFETY						
Safety/emergency precautions		Refer Project Safety Plan and review Risk Assessment prior to works.				
Emergency phone No.	000 or 112 from mobile		Nearest hospital	48 Liverpool St, Hobart		
Traffic	None ☐	On road ☐	On nature strip ☐	Footpath ☒		
Additional Safety Considerations						
Ref Project Safety Plan and MMF100. Barricade off area and keep public away while cover is open. Replace cover as soon as possible. Access outside Tasmanian Touris Buerau hours (8pm-6am)						
INSTALLATION						
Monitor Type	Hobo Logger	Monitor#	N/A	Conductivity #	10888786	
P Sensor#	N/A	V sensor #	N/A	Other	N/A	
Depth of flow at visit	N/A	mm				
PHOTOS TAKEN						
Location	☒					
CERTIFIED AS CORRECT						
Signed			Dated			
SITE						
Contract Site no.:	C3	Manhole ID.:	MH15751			
Street Map (↑N)		Location Photo				
Topside View						

INSTALLATION REPORT



GENERAL						PAGE 1
Site Type	Conductivity Only ☒					
Client	TasWater					
Project	366374 Macquarie Point	MM Project Ref:	366374			
SITE						
Contract Site No.	C5	GID	MH14890			
Address	102-104 Salamanca Pl					
INSTALLATION DATE	23/03/2016	Installed by	NL/TT			
SAFETY						
Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.					
Emergency phone No.	000 or 112 from mobile	Nearest hospital	48 Liverpool St, Hobart			
Traffic	None ☐	On road ☒	On nature strip ☐	Footpath ☐		
Additional Safety Considerations						
Ref Project Safety Plan and MMF100. Site in car parking area.						
INSTALLATION						
Monitor Type	Hobo Logger	Monitor#	N/A	Conductivity #	10888790	
P Sensor#	N/A	V sensor #	N/A	Other	N/A	
Depth of flow at visit	N/A	mm				
PHOTOS TAKEN						
Location	☒					
CERTIFIED AS CORRECT						
Signed						Dated
SITE						
Contract Site no.:	C5	Manhole ID.:	MH14890			
Street Map (↑N)		Location Photo				
Topside View						

INSTALLATION REPORT



GENERAL PAGE 1

Site Type	Conductivity Only	☒
Client	TasWater	
Project	366374 Macquarie Point	MM Project Ref: 366374
SITE		
Contract Site No.	C6A	GID MH16158
Address	80 Elizabeth St	
INSTALLATION DATE	23/03/2016	Installed by TT

SAFETY

Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.		
Emergency phone No.	000 or 112 from mobile	Nearest hospital	48 Liverpool St, Hobart
Traffic	None ☒	On road ☐	On nature strip ☐ Footpath ☐

Additional Safety Considerations

Ref Project Safety Plan and MMF100. TasWater need to organise Altus to provide Traffic management here. Out of business hours (7pm-7am).

INSTALLATION

Monitor Type	Hobo Logger	Monitor#	N/A	Conductivity #	10888793
P Sensor#	N/A	V sensor #	N/A	Other	N/A
Depth of flow at visit	N/A	mm			

PHOTOS TAKEN

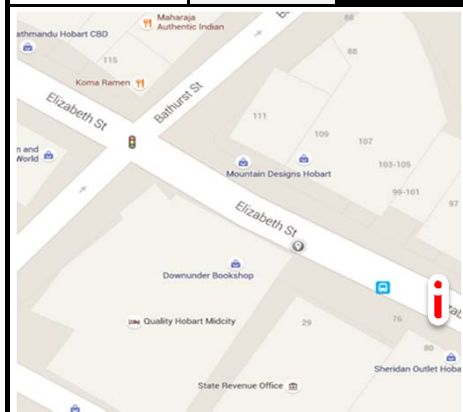
Location	☒
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CERTIFIED AS CORRECT

Signed	Dated
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SITE

Contract Site no.:	C6A	Manhole ID.:	MH16158
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Street Map (↑N)



Location Photo



Topside View

INSTALLATION REPORT



GENERAL PAGE 1

Site Type	Conductivity Only	☒
Client	TasWater	
Project	366374 Macquarie Point	MM Project Ref: 366374

SITE

Contract Site No.	C6B		GID	1 MH US of 16028
Address	112 Liverpool St			
INSTALLATION DATE	23/03/2016	Installed by	TT	

SAFETY

Safety/emergency precautions	Refer Project Safety Plan and review Risk Assessment prior to works.			
Emergency phone No.	000 or 112 from mobile	Nearest hospital	48 Liverpool St, Hobart	
Traffic	None	☒	On road	☐
			On nature strip	☐
			Footpath	☐

Additional Safety Considerations

Ref Project Safety Plan and MMF100 TasWater need to organise Altus to provide Traffic management here. Out of business hours (7pm-7am).

INSTALLATION

Monitor Type	Hobo Logger	Monitor#	N/A	Conductivity #	10888791
P Sensor#	N/A	V sensor #	N/A	Other	N/A
Depth of flow at visit	N/A	mm			

PHOTOS TAKEN

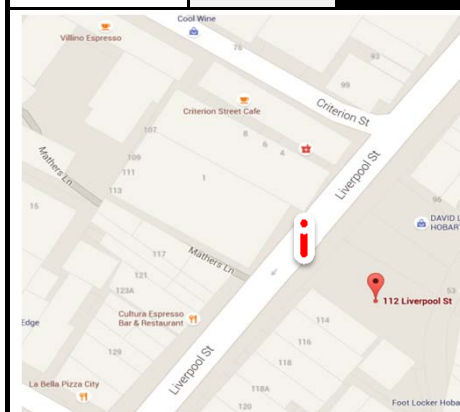
Location ☒

CERTIFIED AS CORRECT

Signed _____ Dated _____

SITE

Contract Site no.: C6B Manhole ID.: 1 MH US of 16028



Street Map (↑N)



Location Photo



Topside View

INSTALLATION REPORT

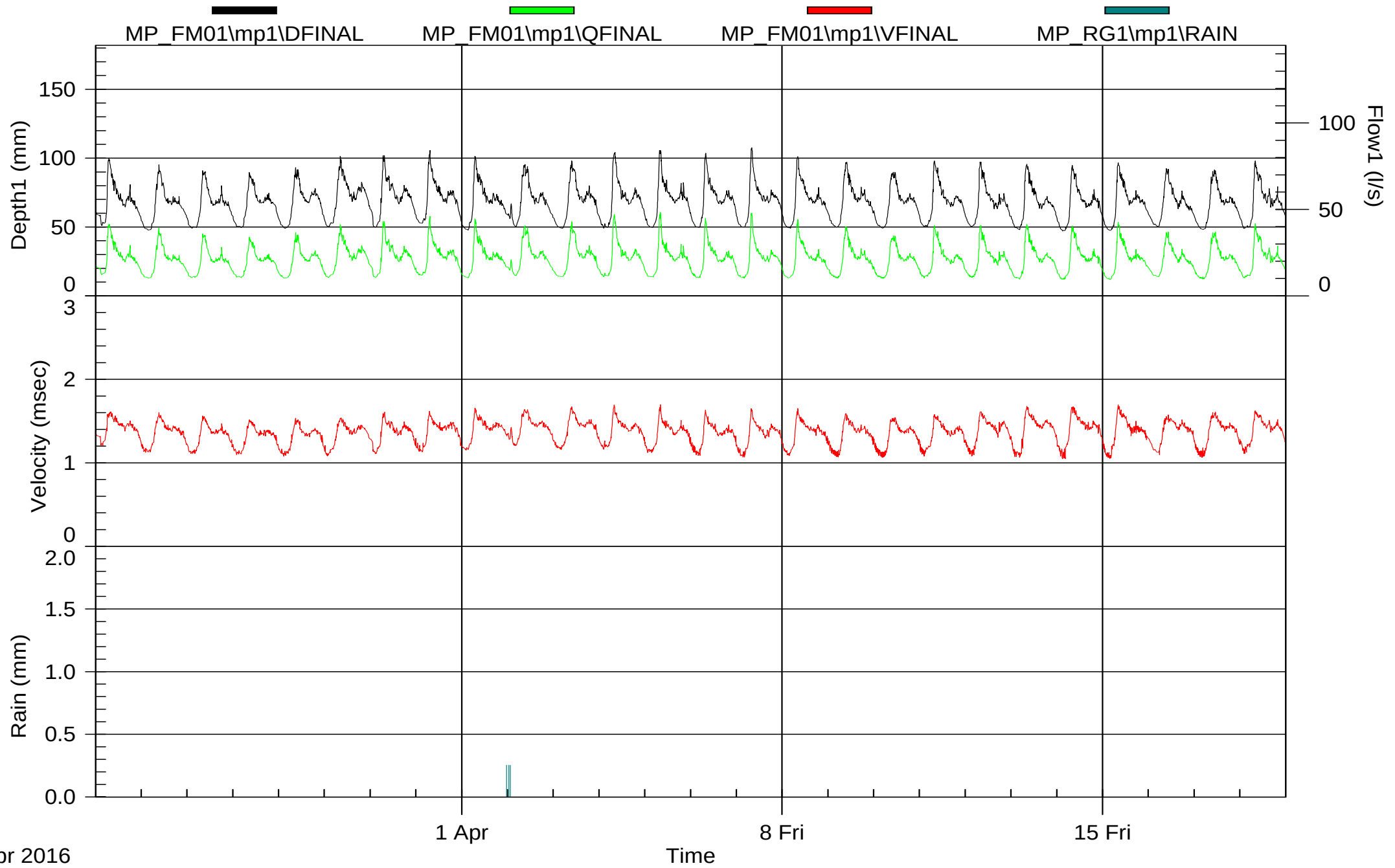


GENERAL						PAGE 1
Site Type	site				✓	
Client	TasWater					
Project	366374 Macquarie Point		MM Project Ref:	366374		
SITE						
Contract Site No.	C11			Manhole ID.	MH16259	
Address	6 Evans St					
INSTALLATION DATE	31/03/2016		Installed by	NL/NT		
SAFETY						
Safety/emergency precautions		Refer Project Safety Plan and review Risk Assessment prior to works.				
Emergency phone No.	000 or 112 from mobile		Nearest hospital	48 Liverpool St, Hobart		
Traffic	None	✓	On road	☐	On nature strip	
				☐	Footpath	
Additional Safety Considerations or Other details						
Ref Project Safety Plan and MMF100 TasWater need to organise Altus to provide Traffic management here. Out of business hours (7pm-7am).						
INSTALLATION						
Monitor Type	Hobo Logger	Monitor#	N/A	Conductivity #	10888796	
P Sensor#	N/A	V sensor #	N/A	Other	N/A	
Depth of flow at visit	N/A	mm				
PHOTOS TAKEN						
Location	✓					
CERTIFIED AS CORRECT						
Signed				Dated		
SITE						
Contract Site no.:	C11		Manhole ID.:	MH16259		
Street Map (↑N)		Location Photo				
Topside View						

Appendix B. HYDROGRAPHS

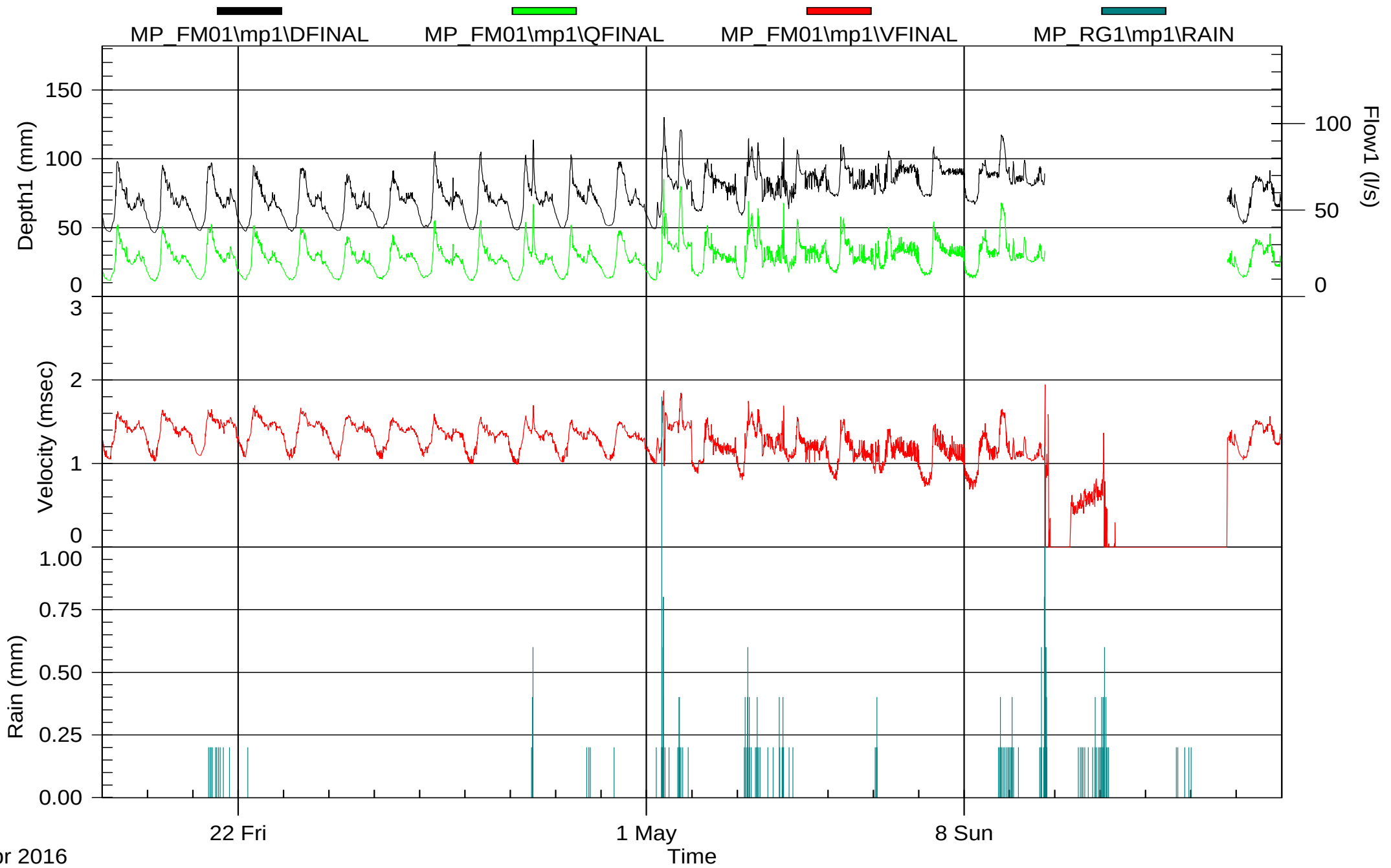
Mott MacDonald

Pipe Height: 451.00



Mott MacDonald

Pipe Height: 451.00



Mott MacDonald

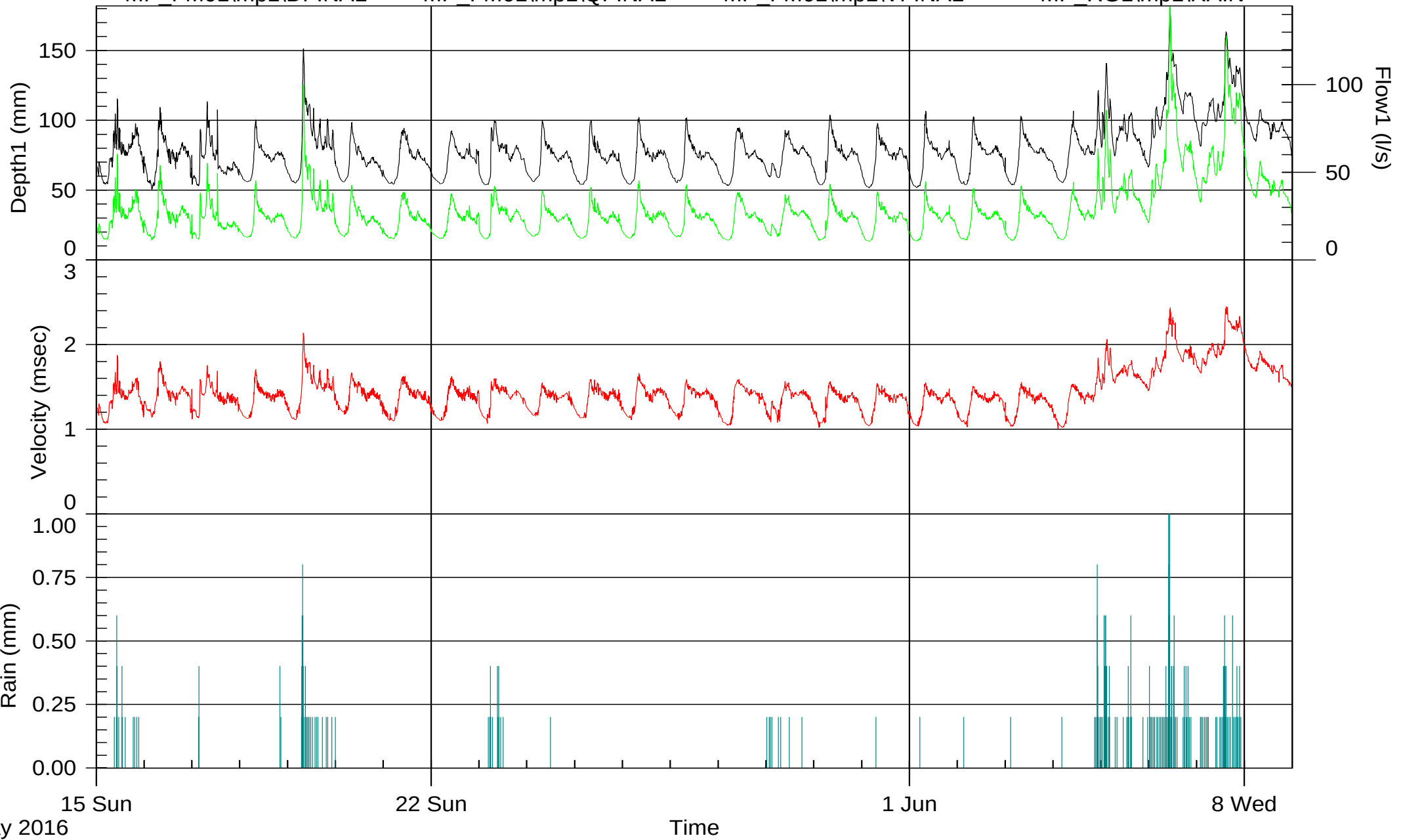
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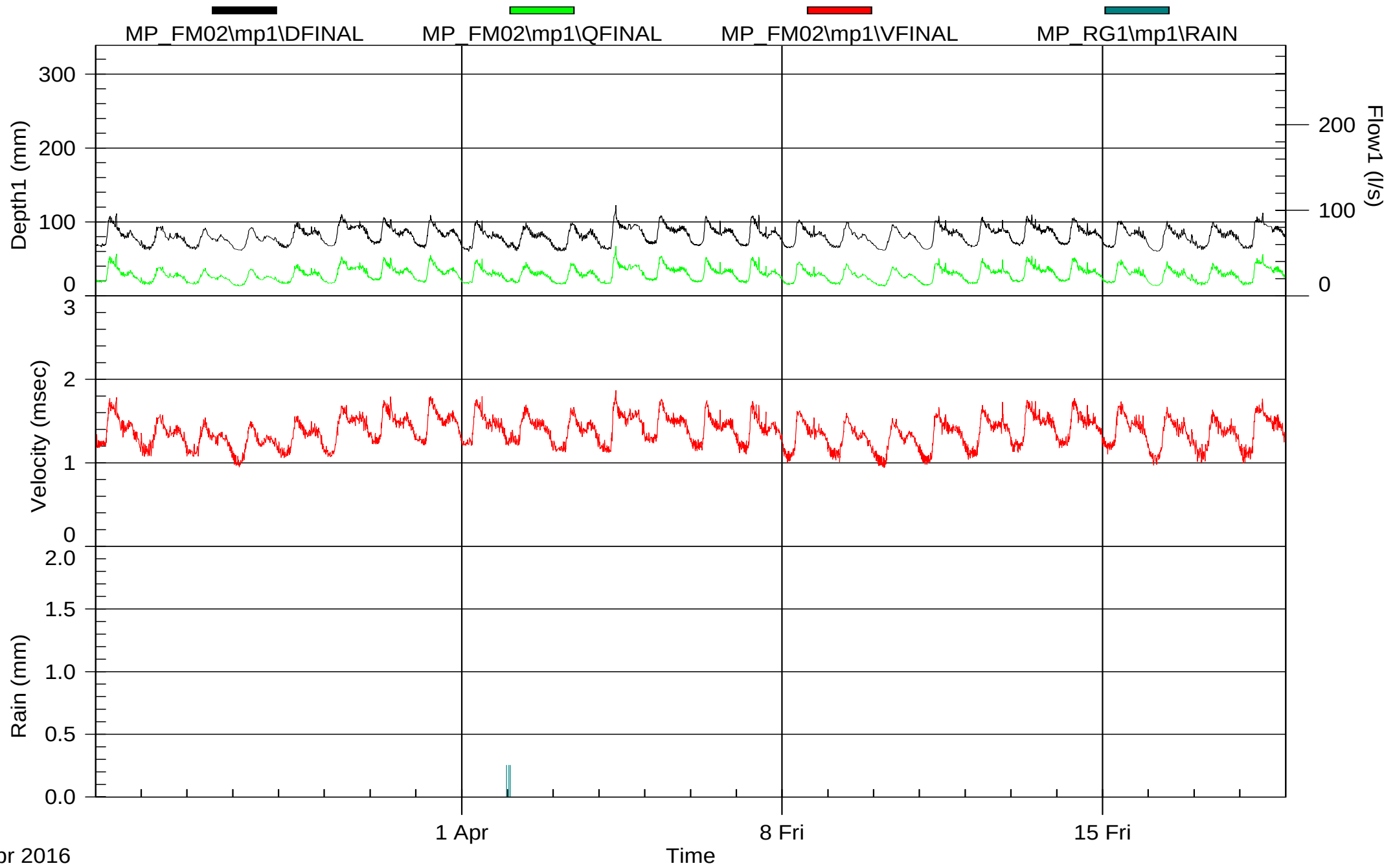
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MP_RG1\mp1\RAIN



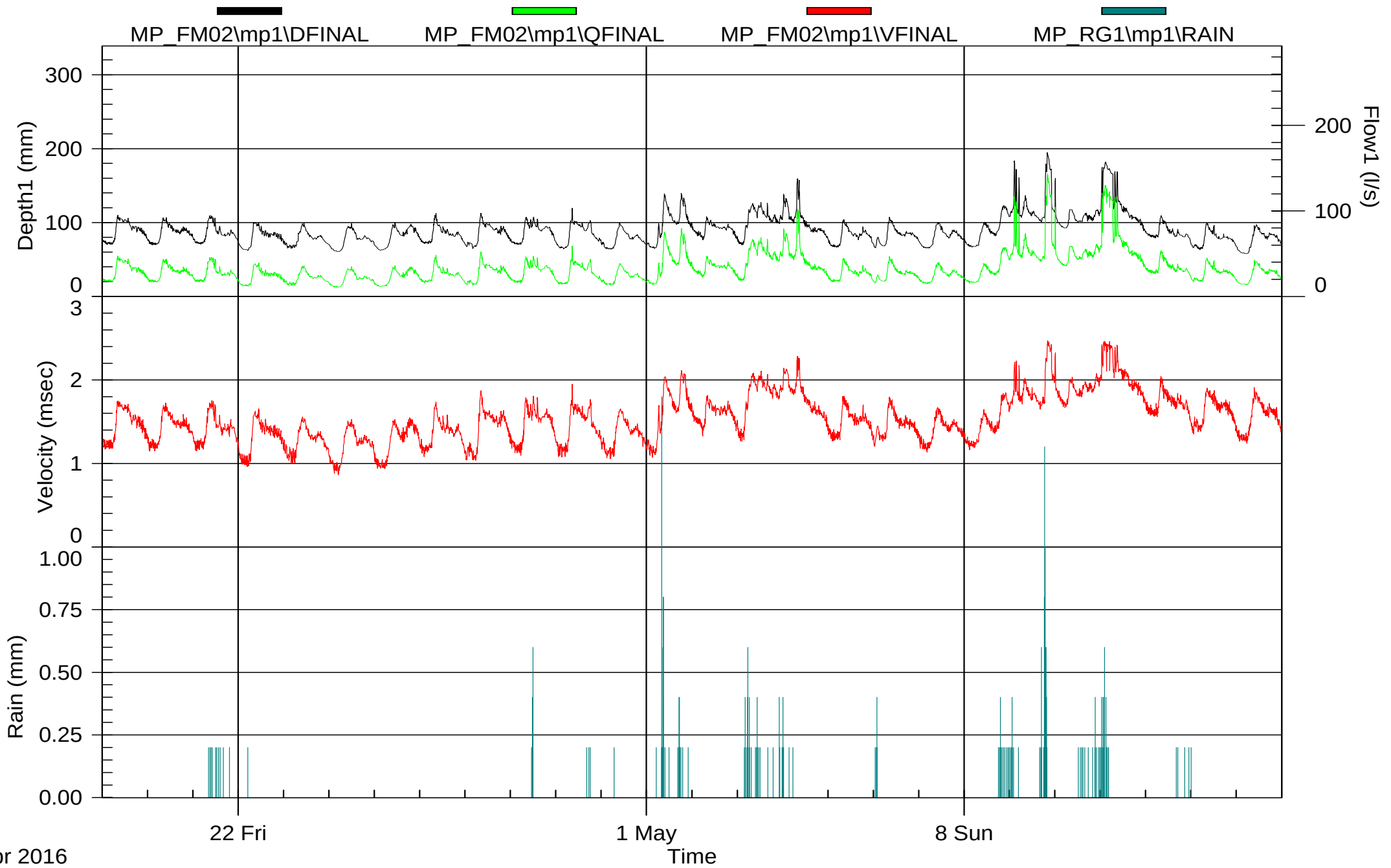
Mott MacDonald

Pipe Height: 375.00



Mott MacDonald

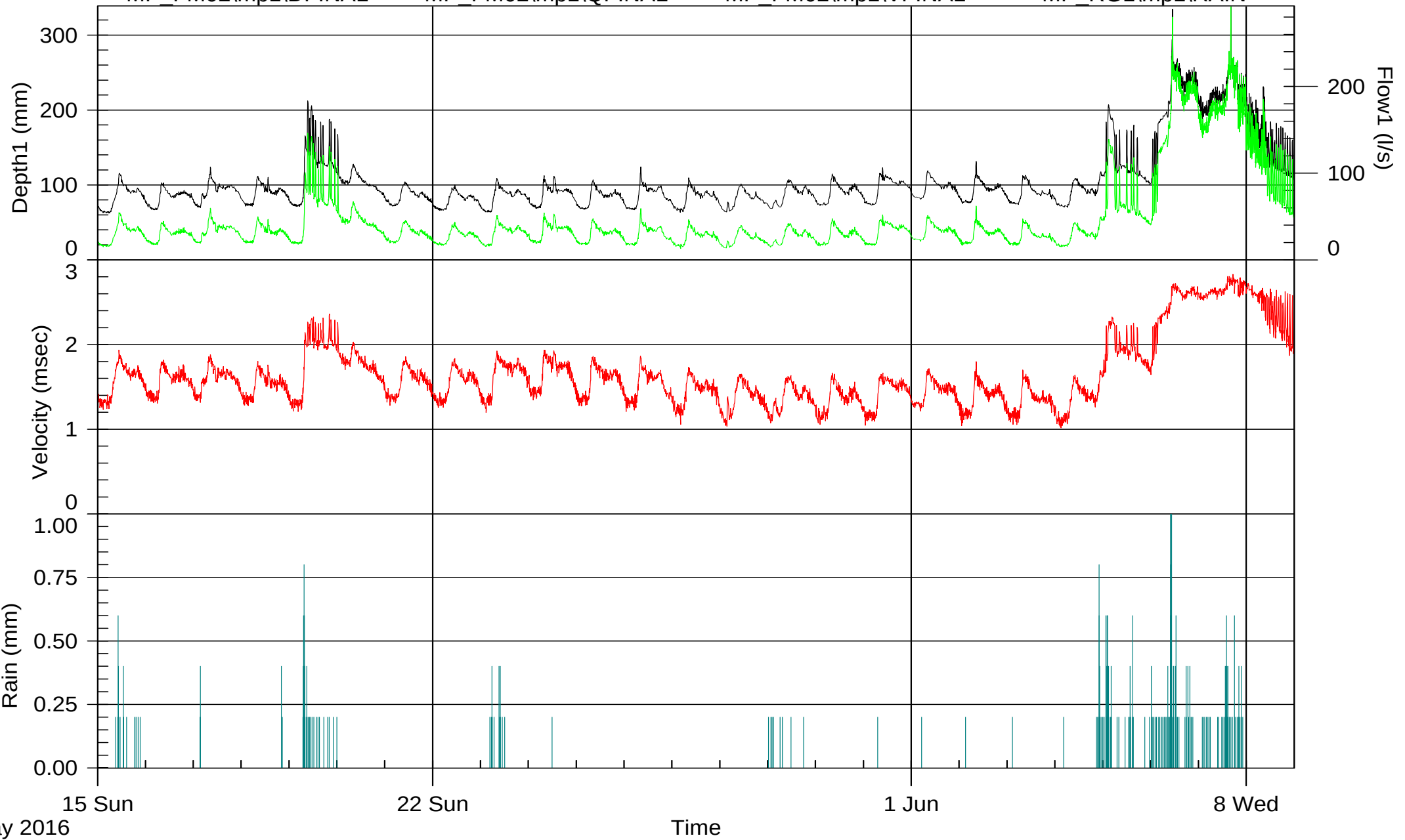
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Mott MacDonald

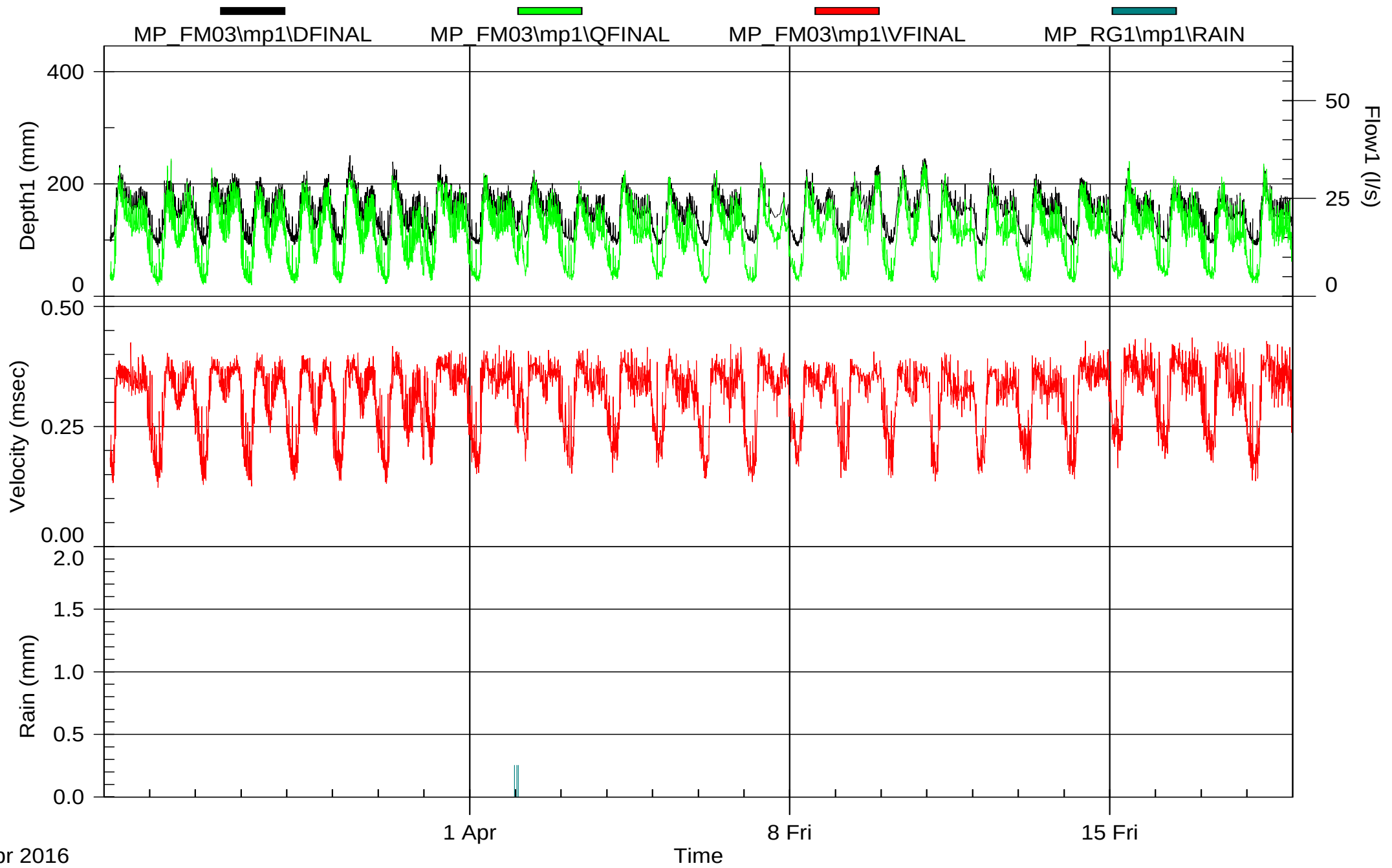
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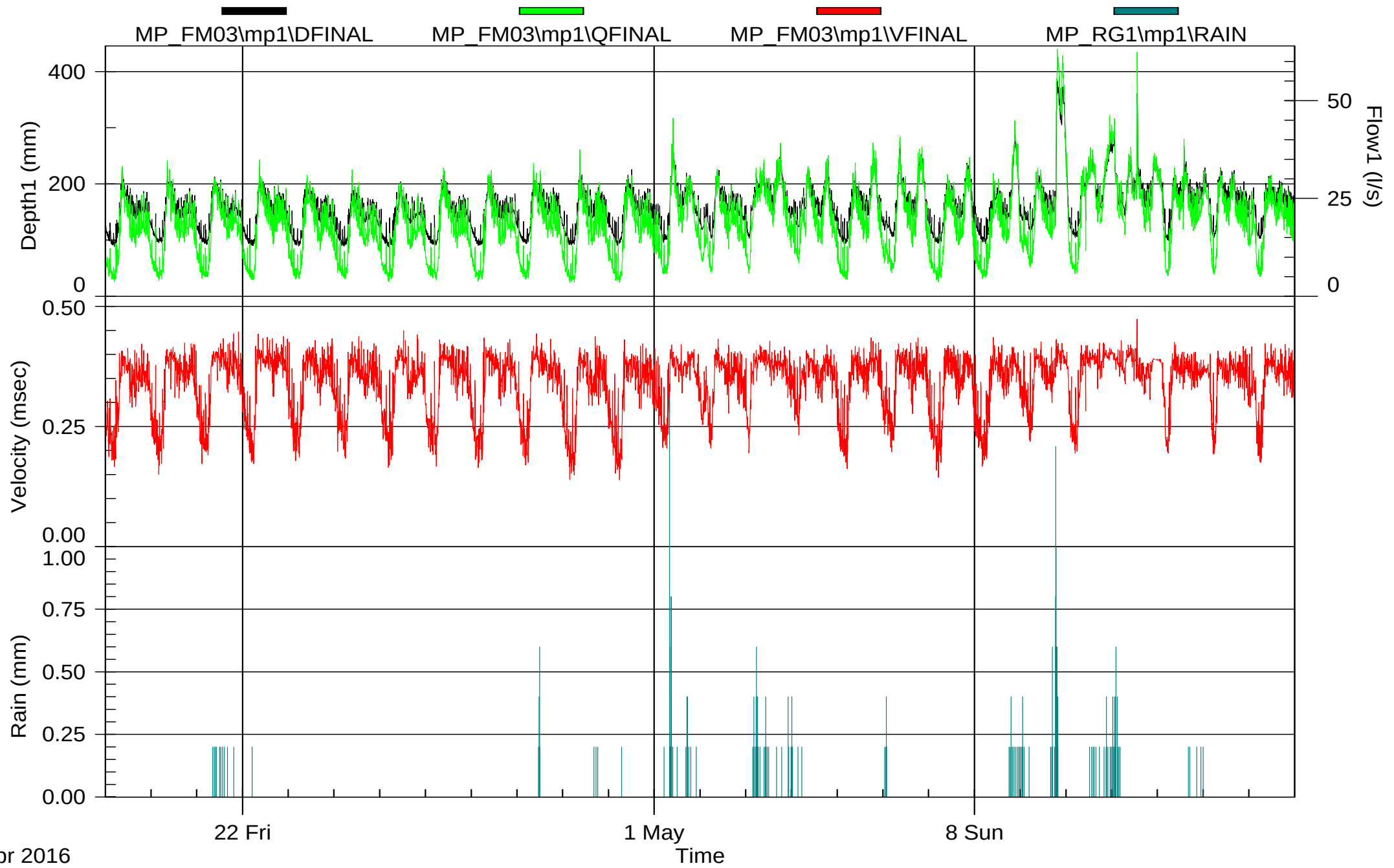
Mott MacDonald

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Mott MacDonald

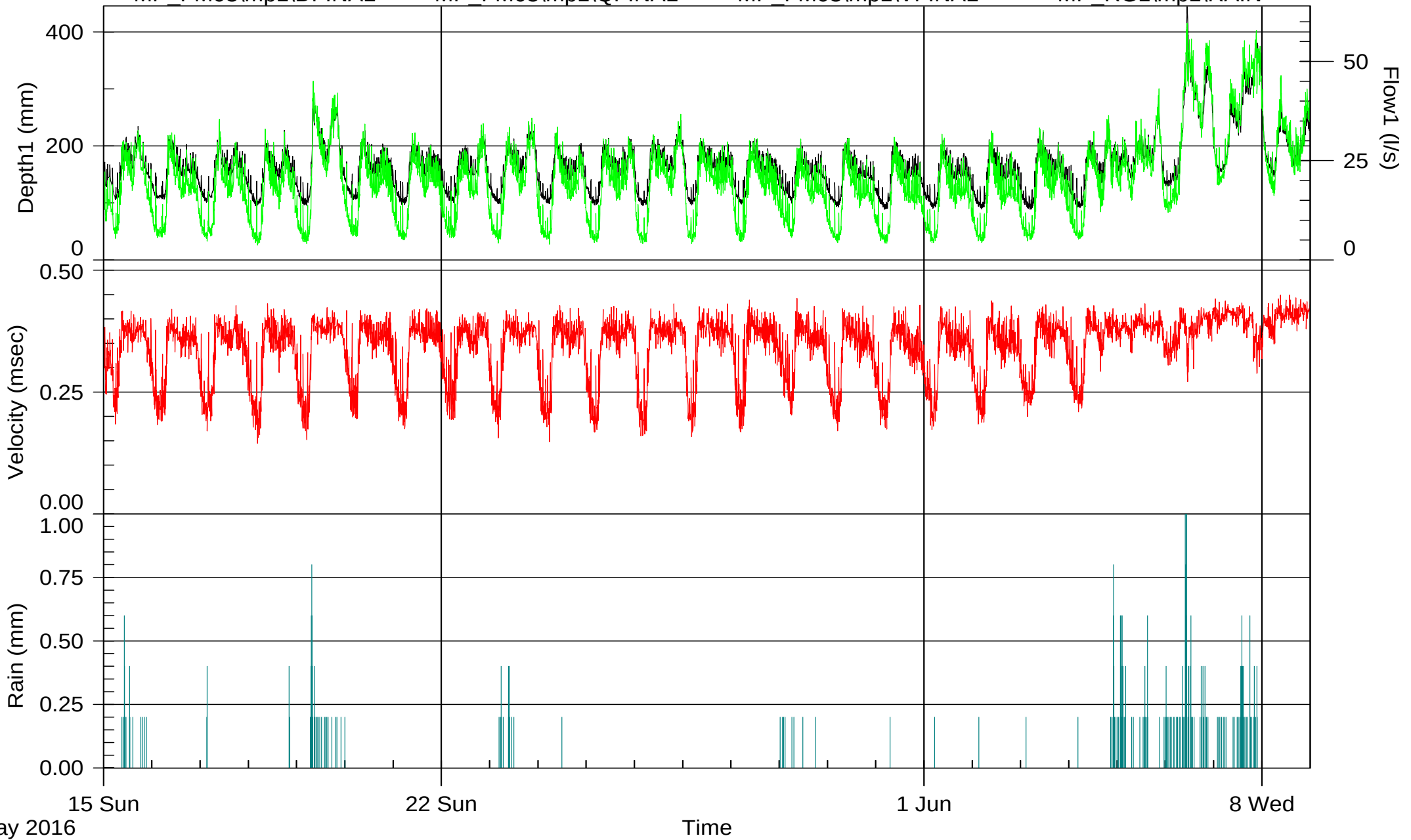
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Mott MacDonald

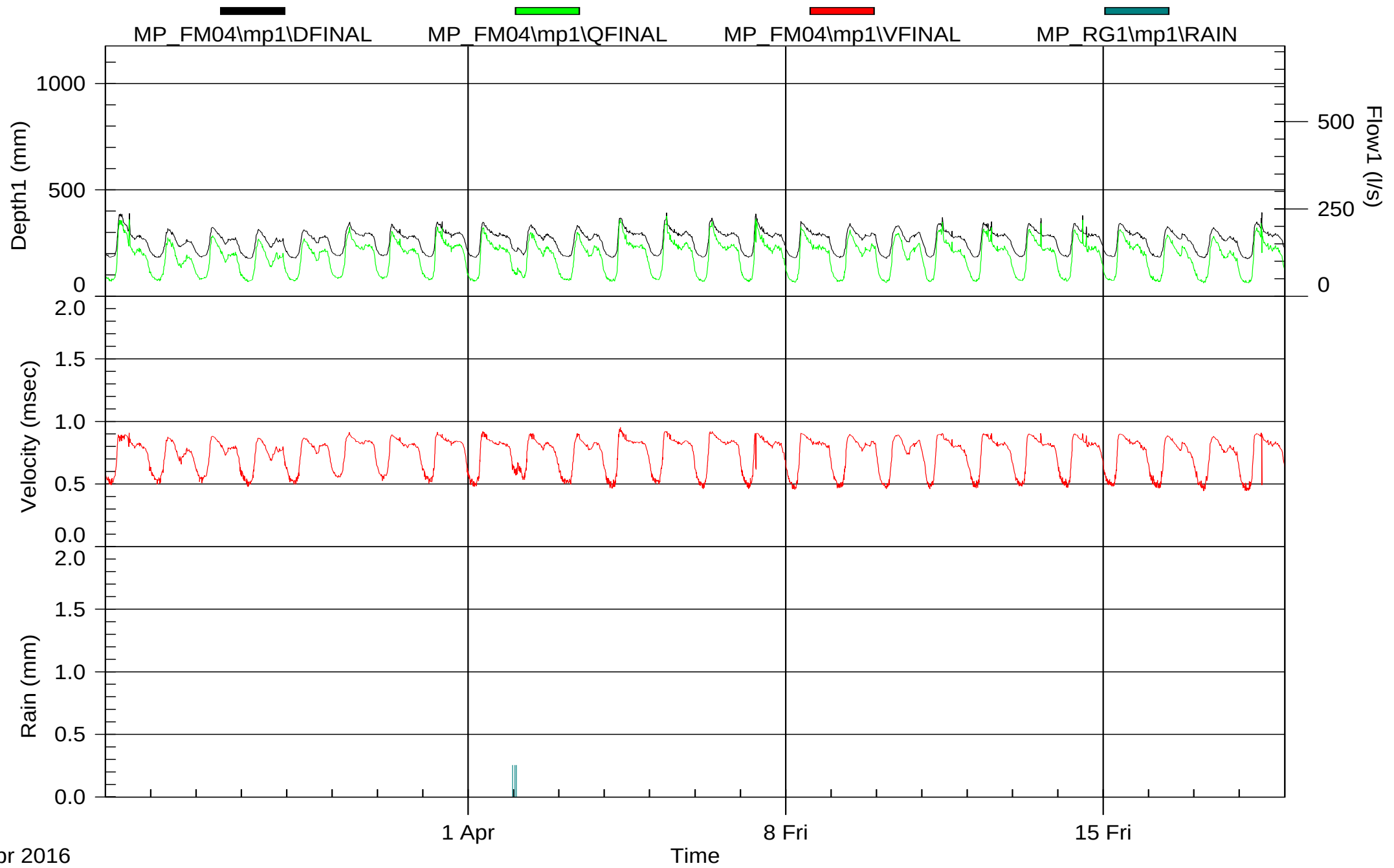
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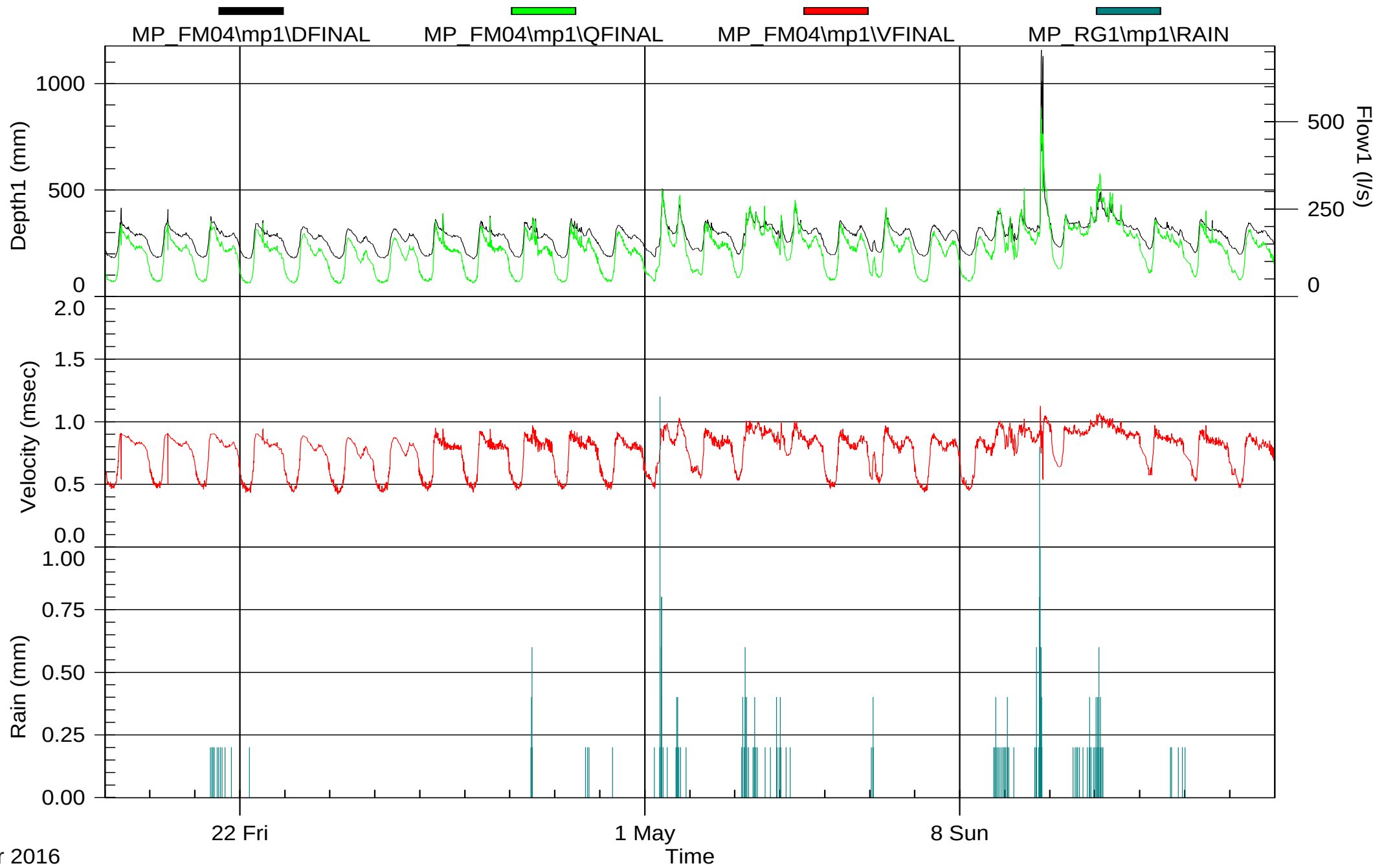
Mott MacDonald

Pipe Height: 845.00



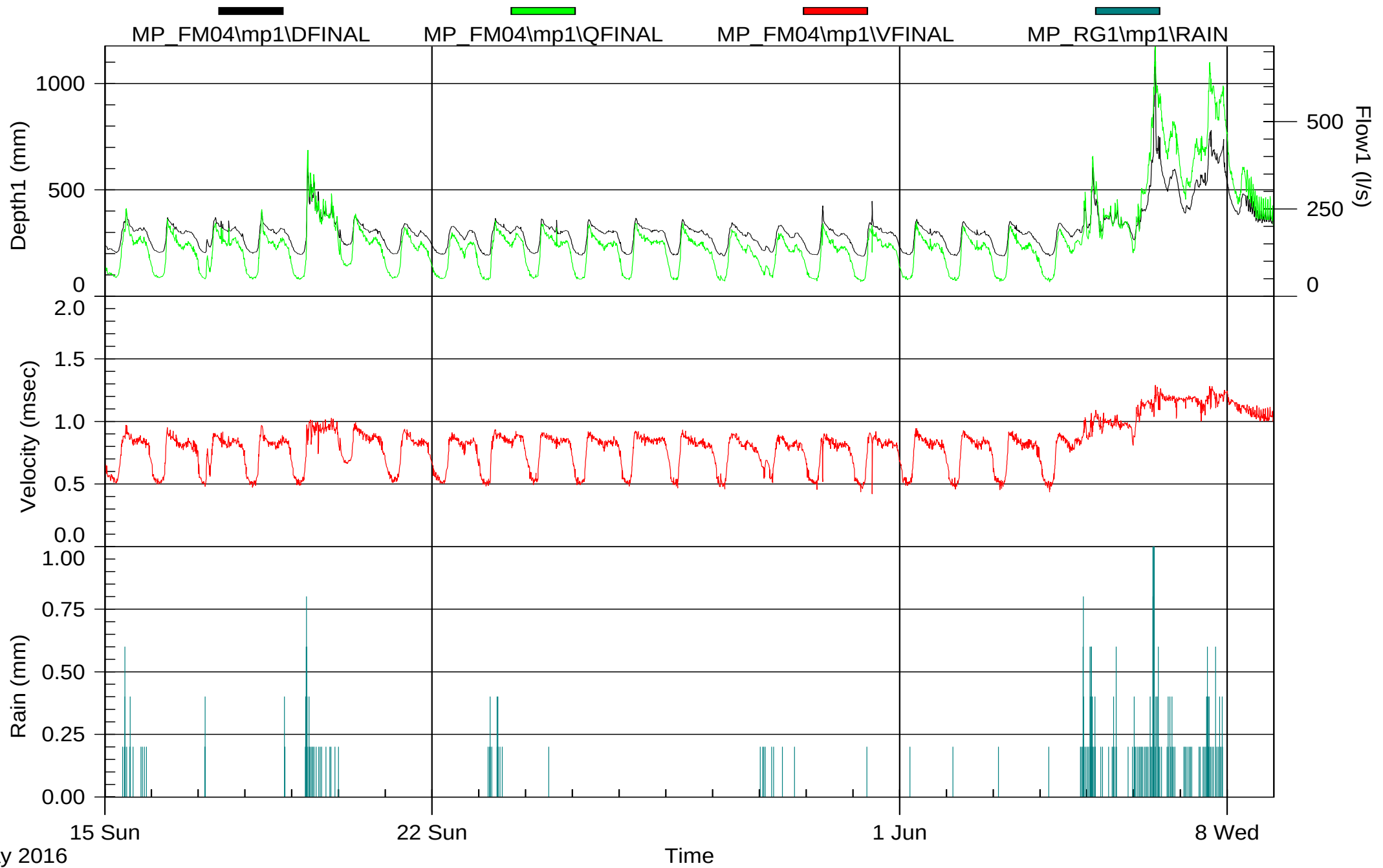
Mott MacDonald

Pipe Height: 845.00



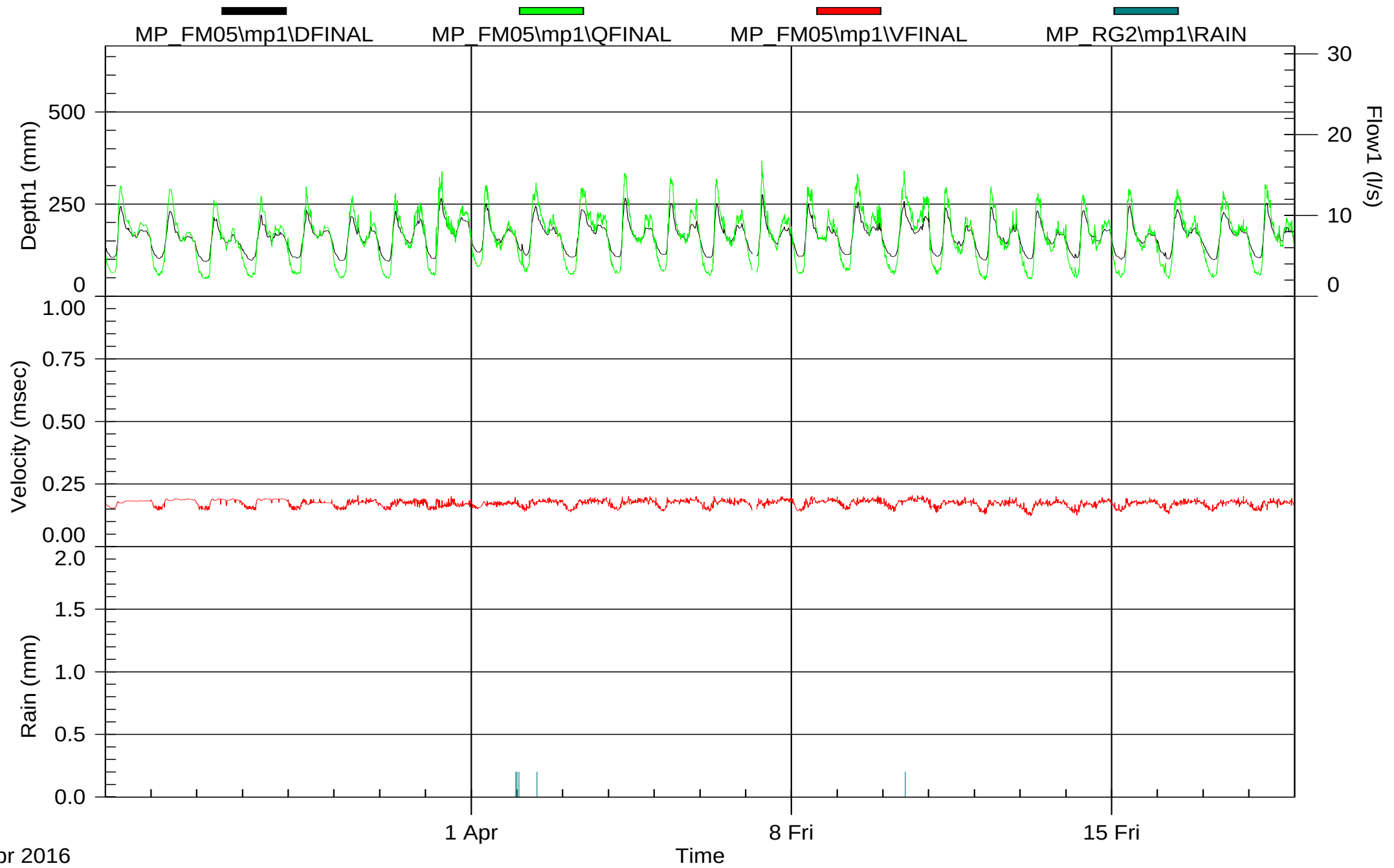
Mott MacDonald

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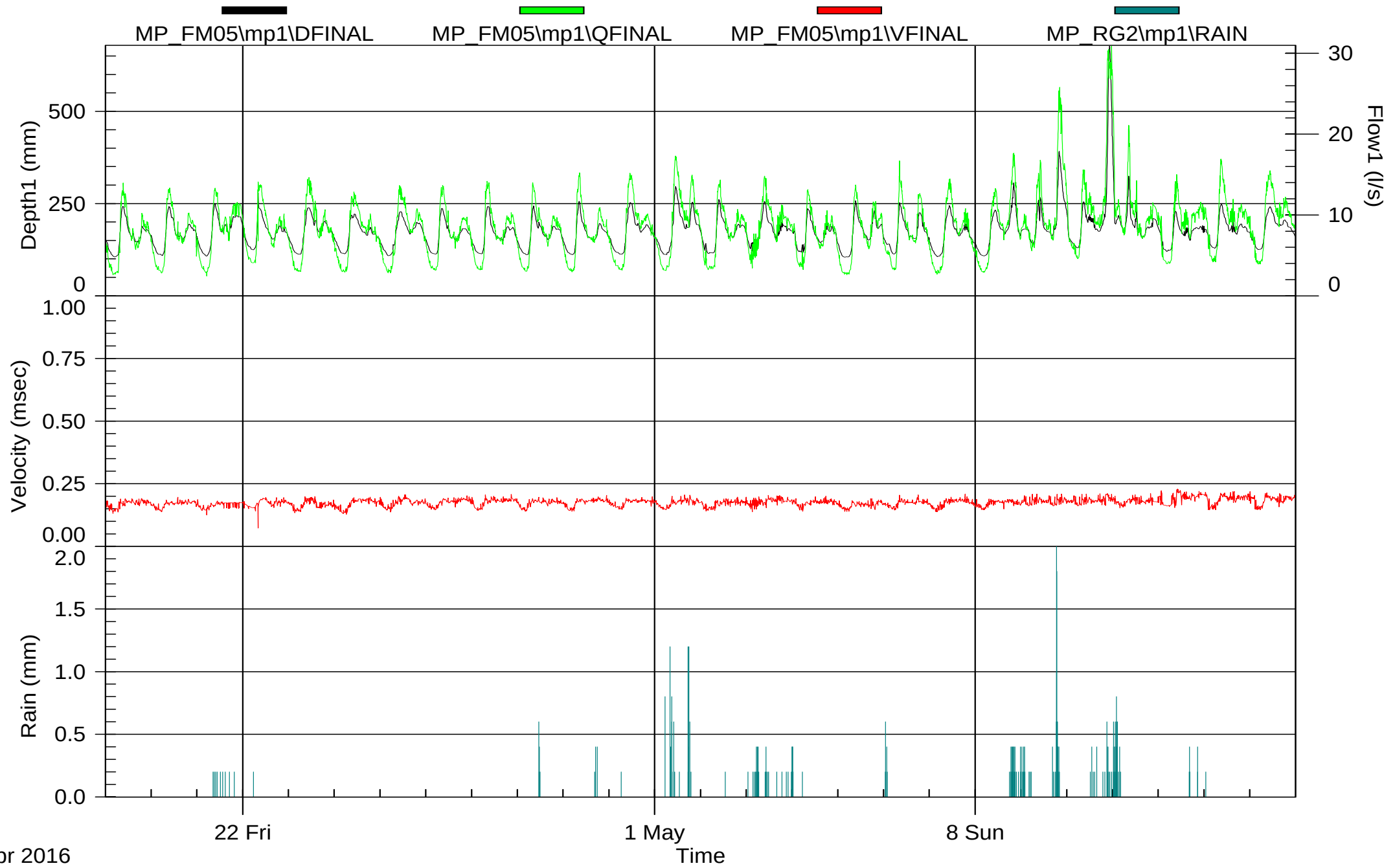
Mott MacDonald

Pipe Height: 449.00



Mott MacDonald

Pipe Height: 449.00



Mott MacDonald

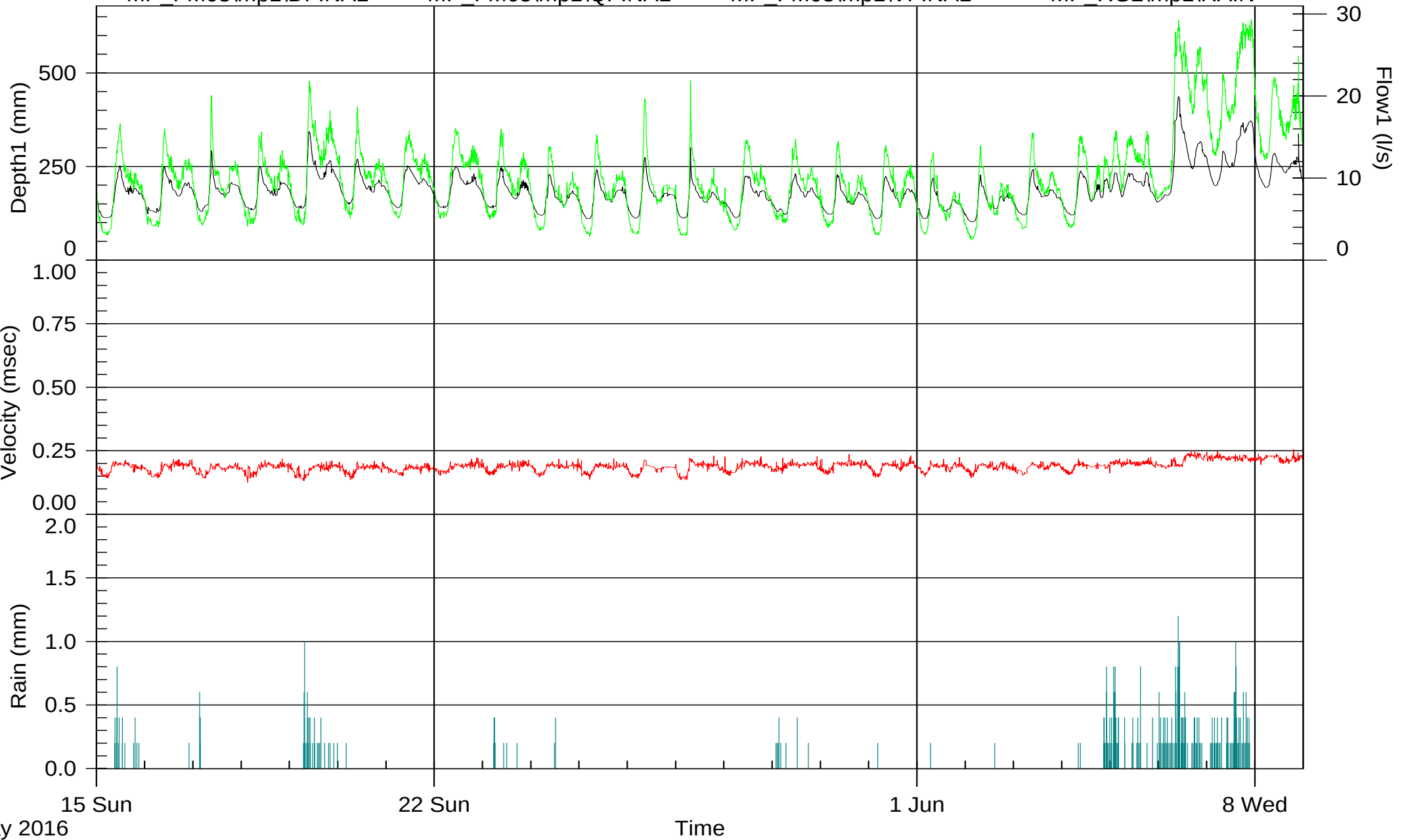
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MP_FM05\mp1\QFINAL

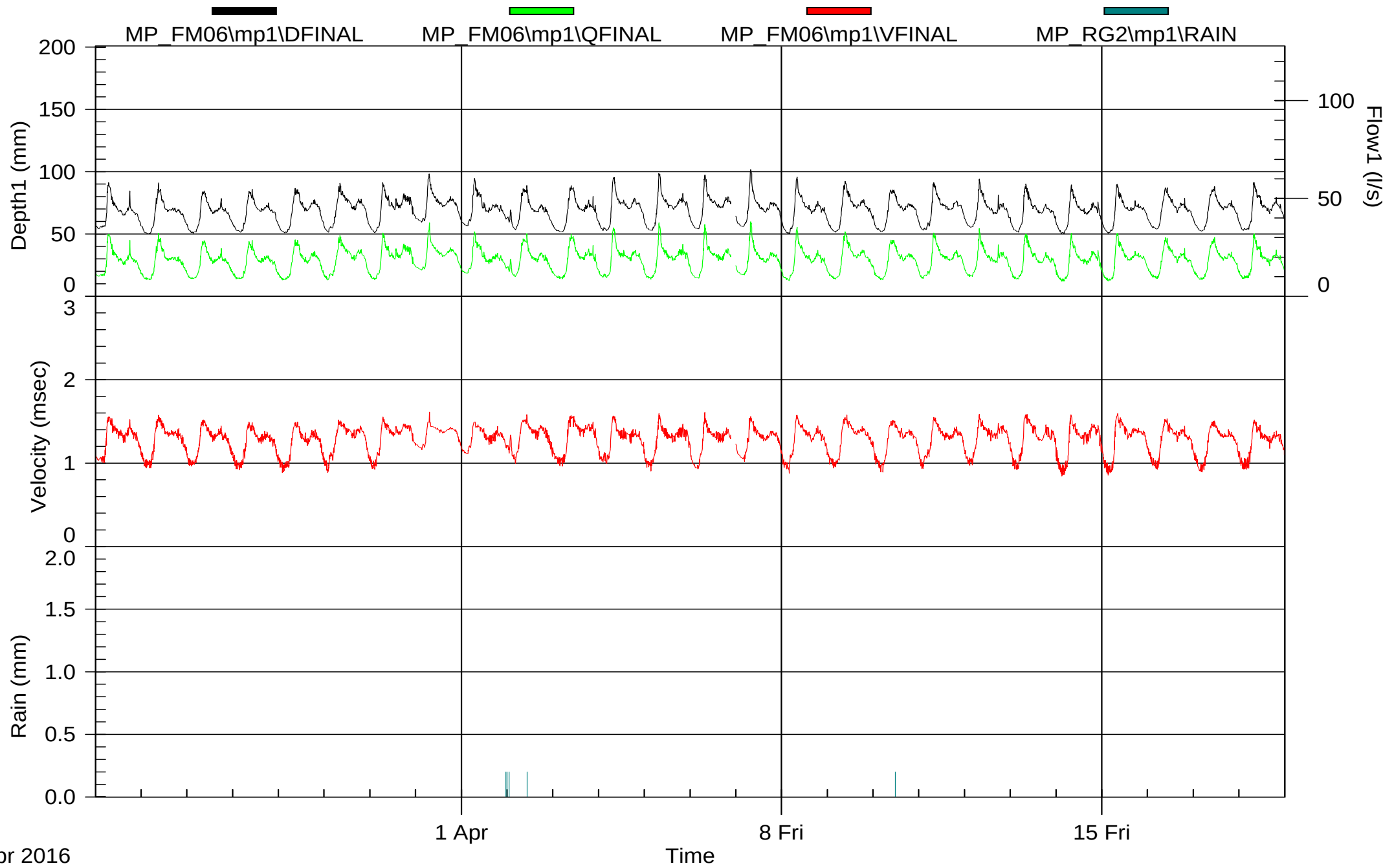
MP_FM05\mp1\VFINAL

MP_RG2\mp1\RAIN



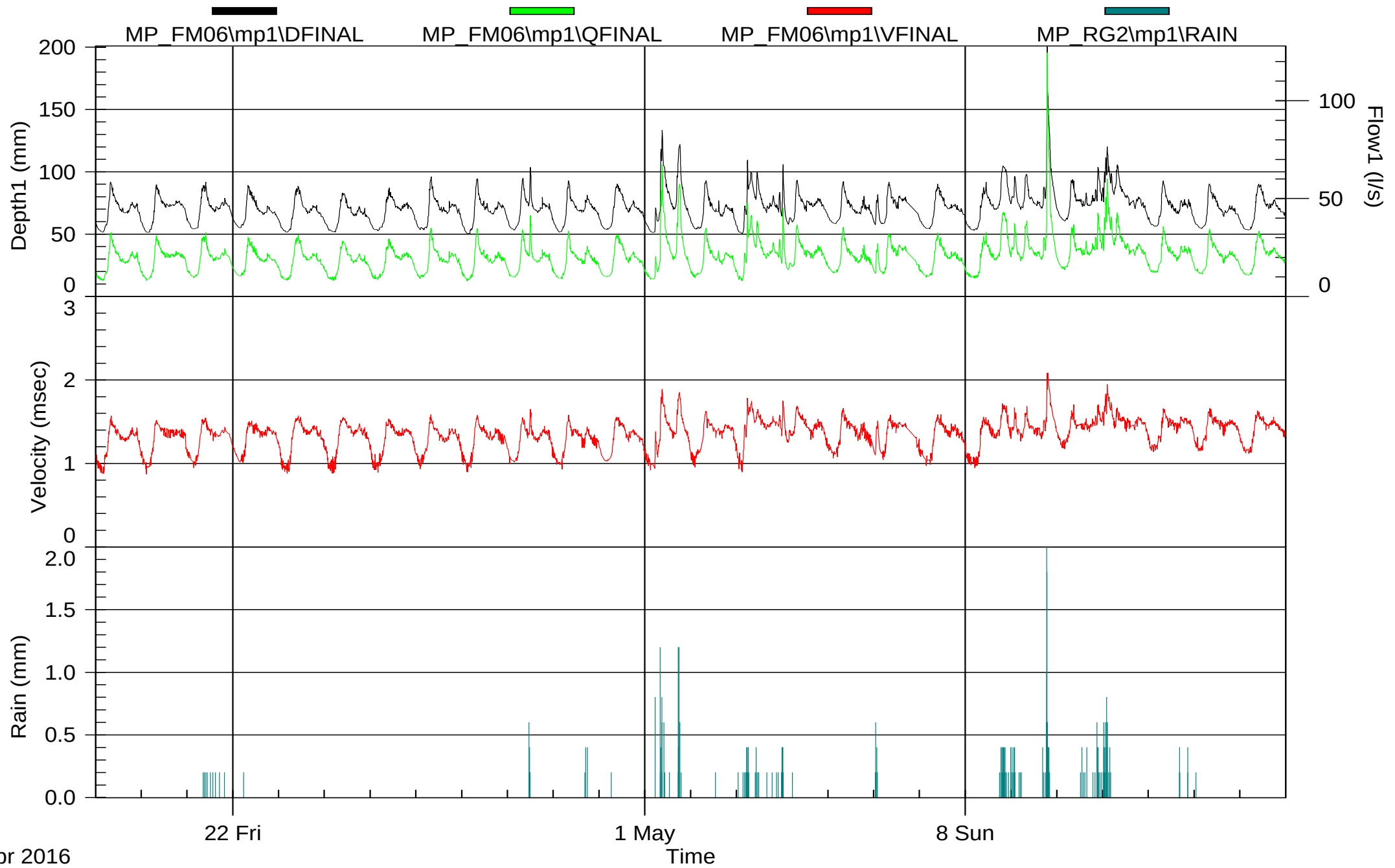
Mott MacDonald

Pipe Height: 396.00



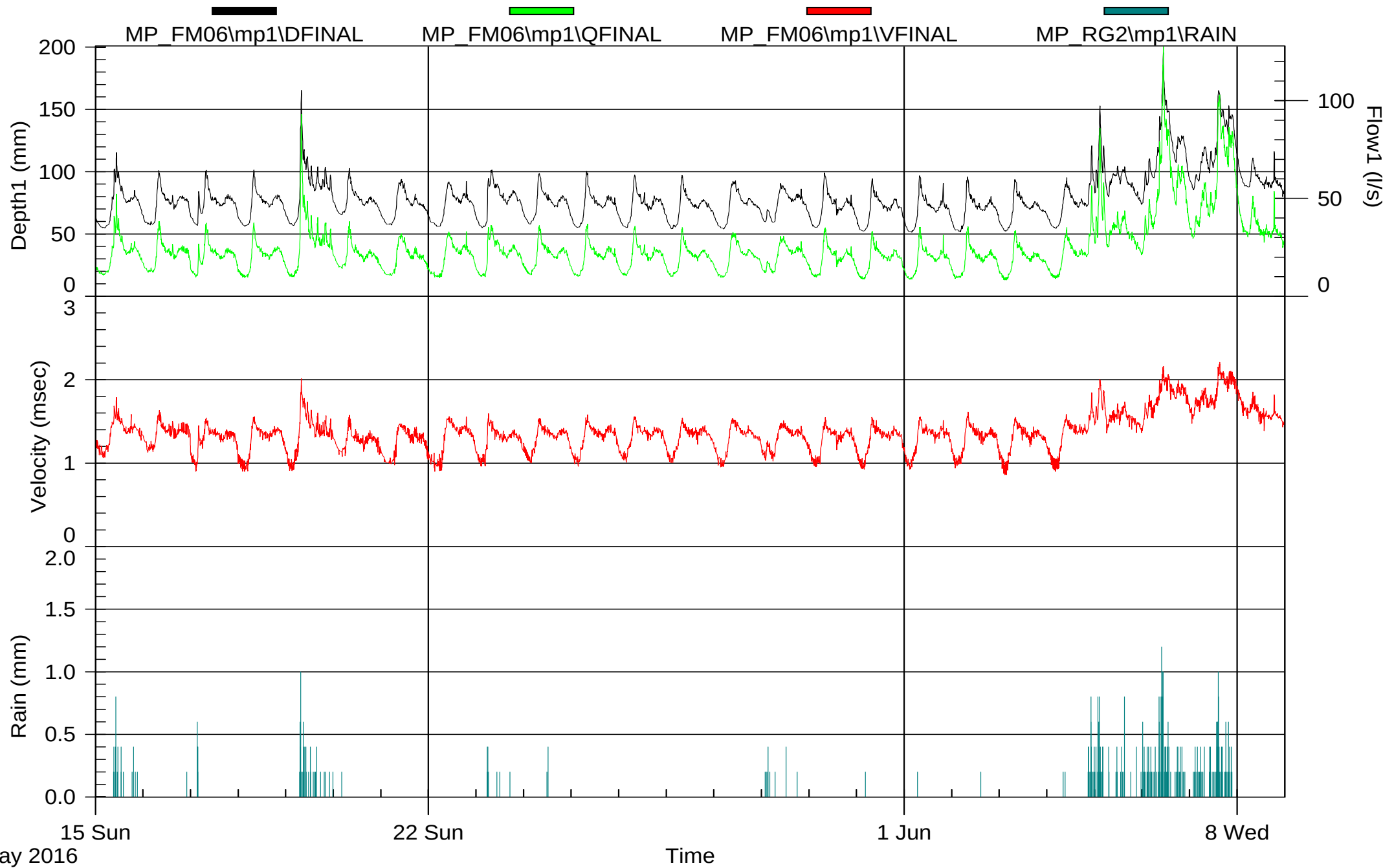
Mott MacDonald

Pipe Height: 396.00



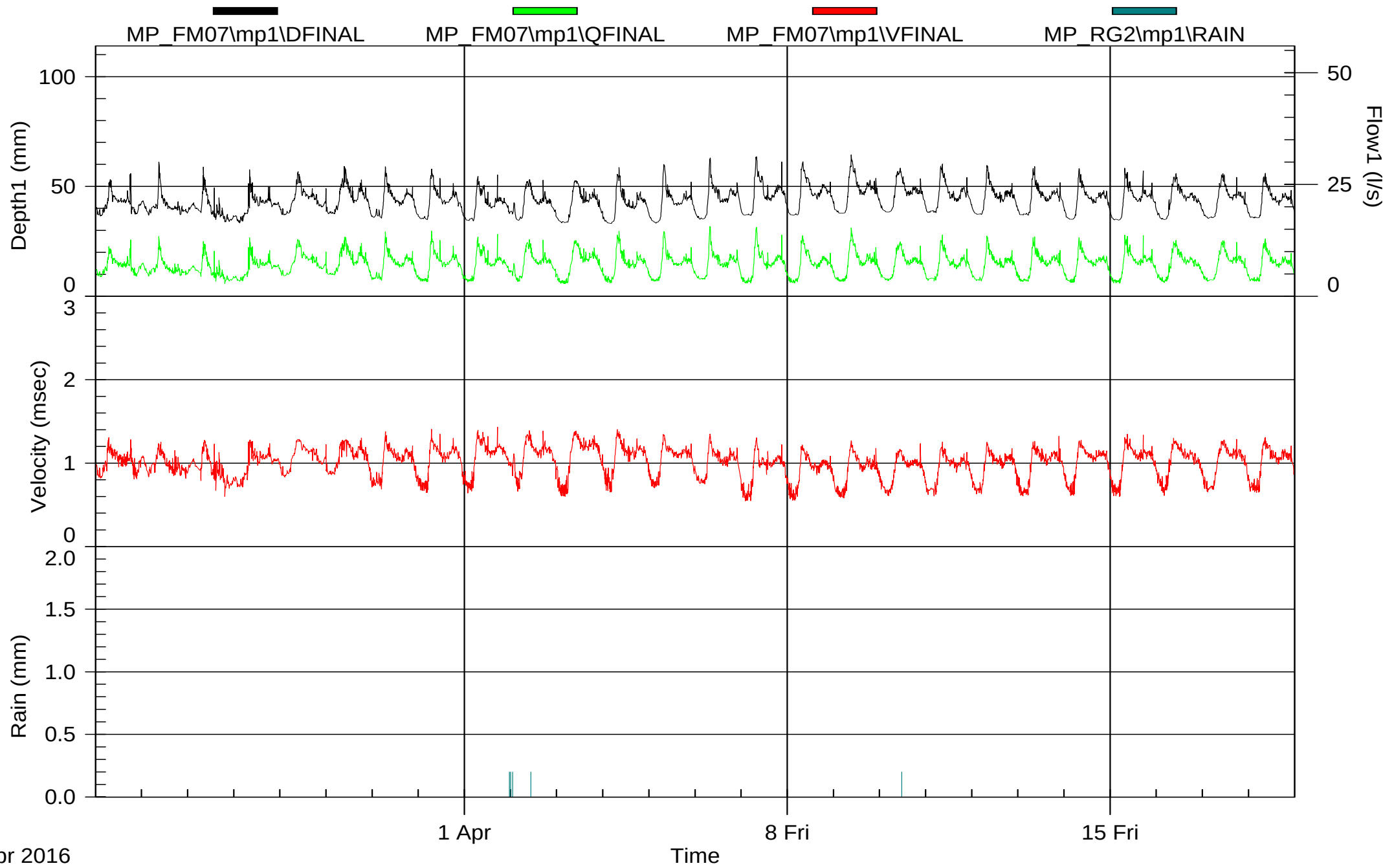
Mott MacDonald

Pipe Height: 396.00



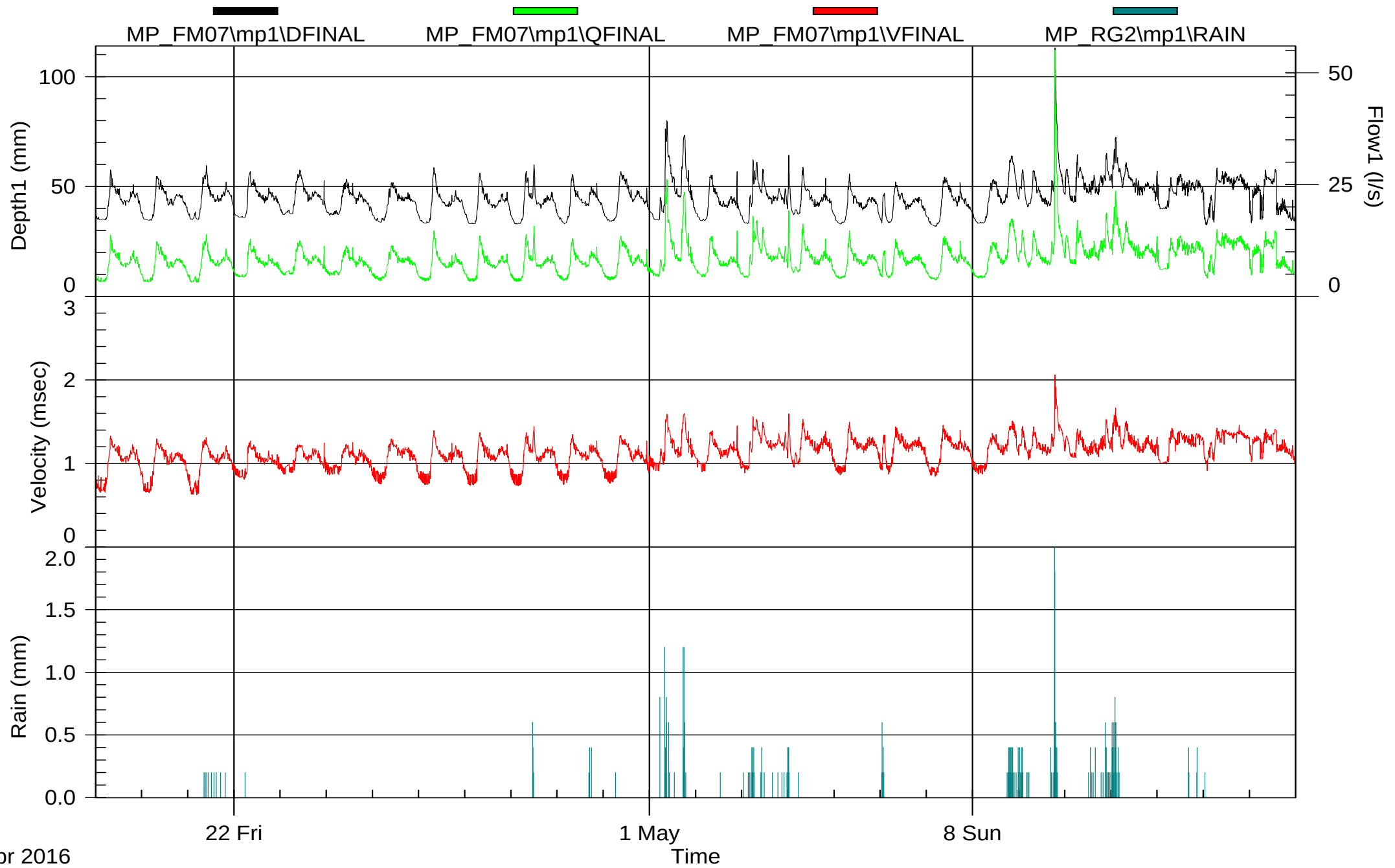
Mott MacDonald

Pipe Height: 349.00



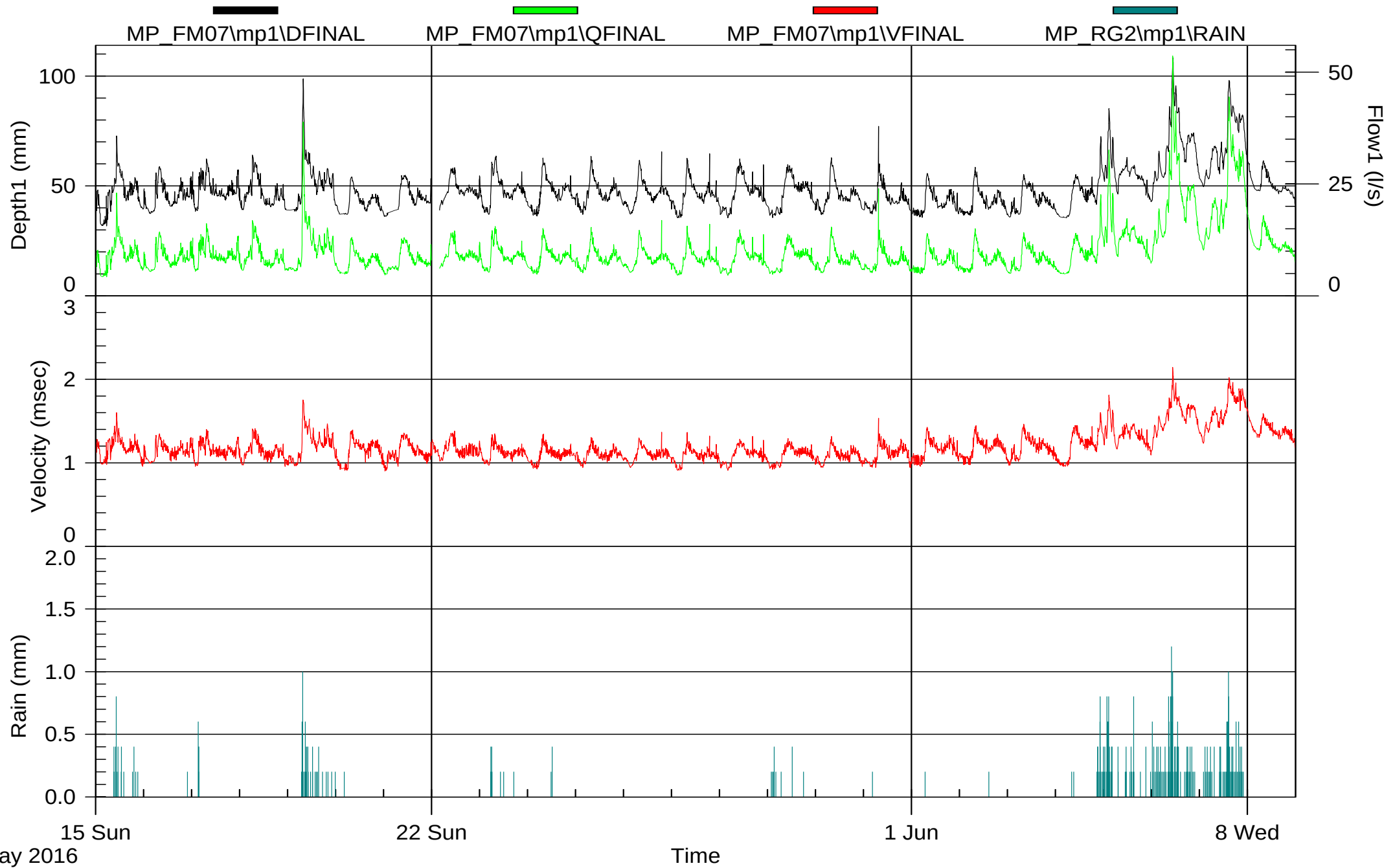
Mott MacDonald

Pipe Height: 349.00



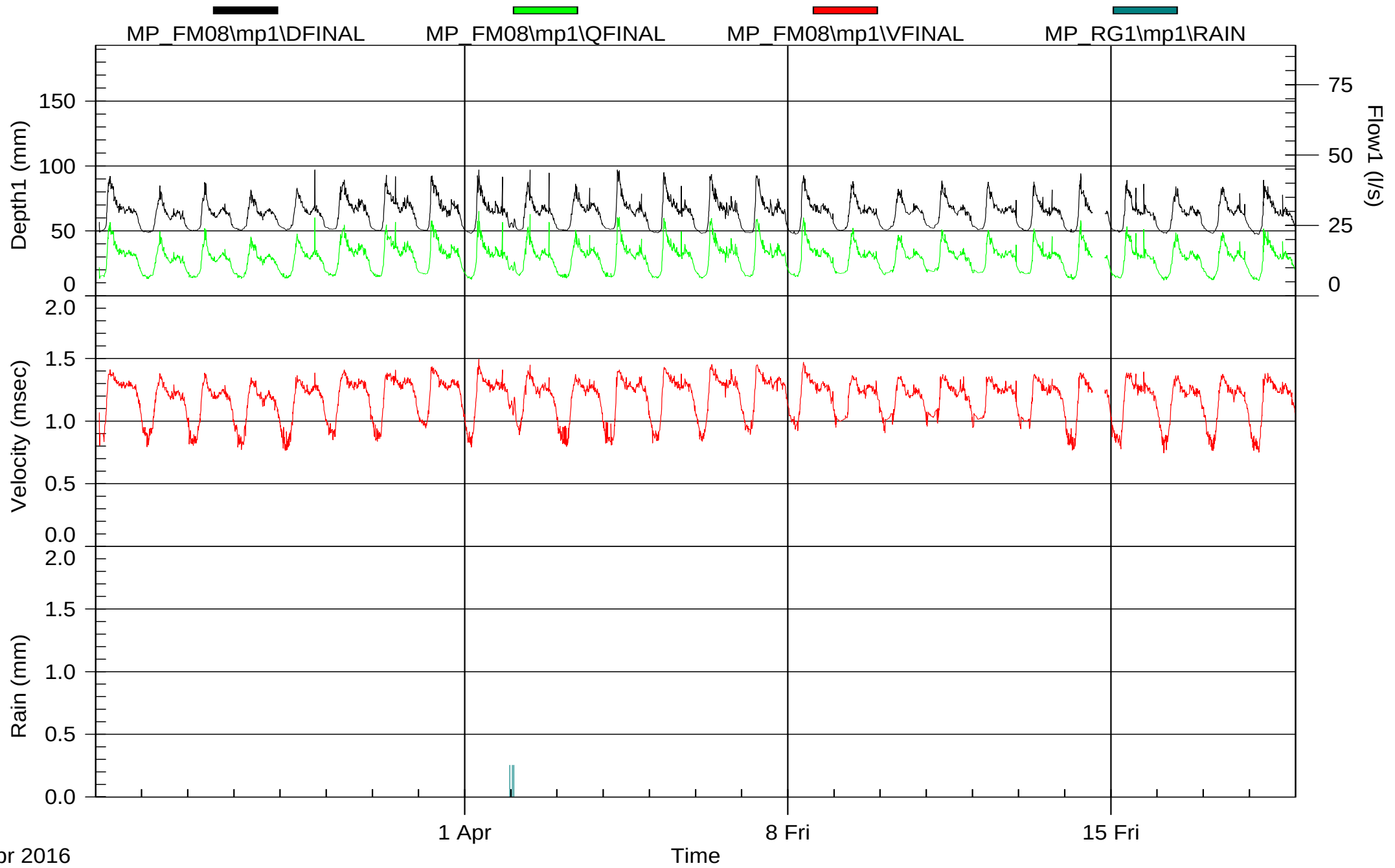
Mott MacDonald

Pipe Height: 349.00



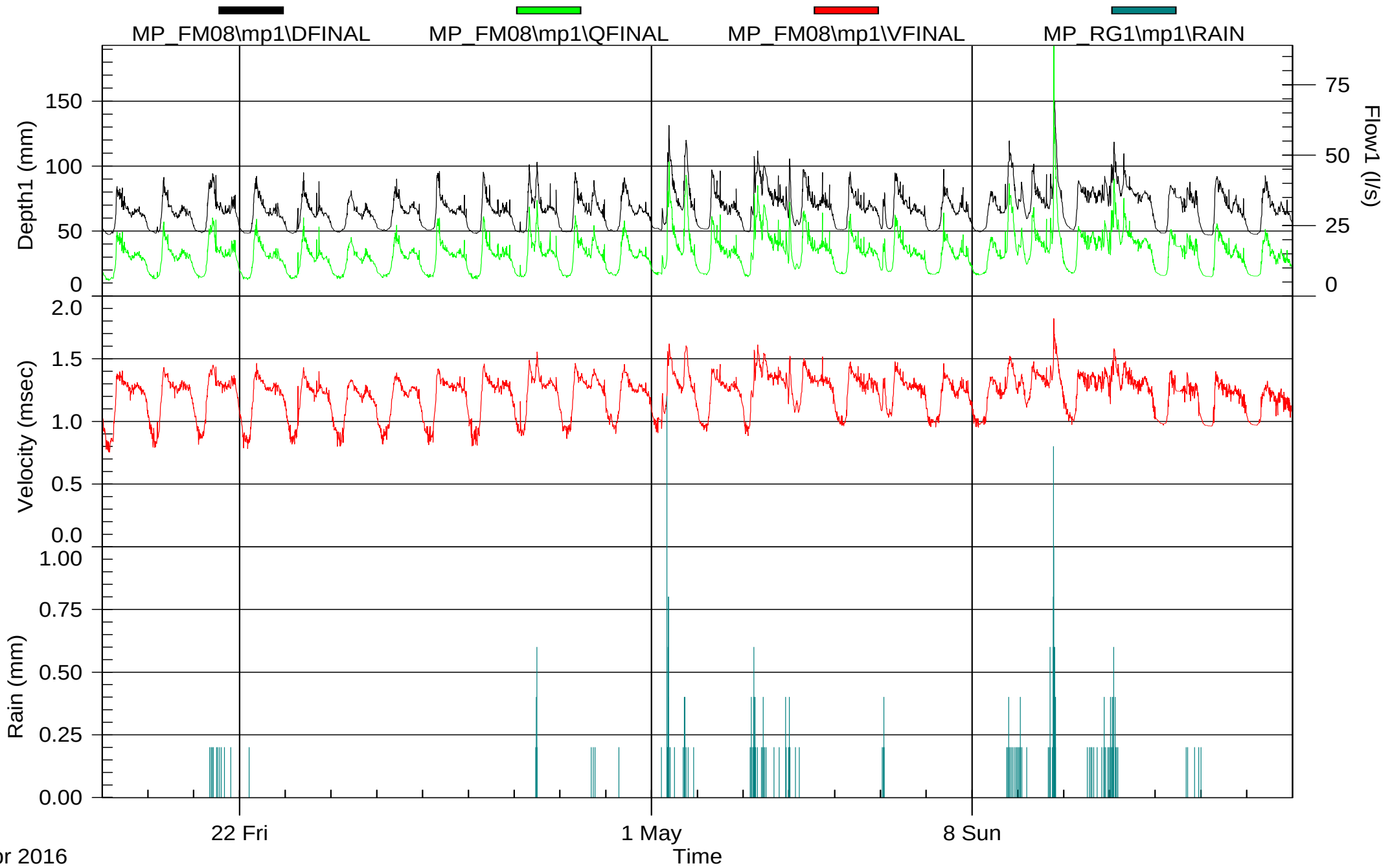
Mott MacDonald

Pipe Height: 303.00



Mott MacDonald

Pipe Height: 303.00



Mott MacDonald

Pipe Height: 303.00

MP_FM08\mp1\DFINAL

MP_FM08\mp1\QFINAL

MP_FM08\mp1\VFINAL

MP_RG1\mp1\RAIN

Depth1 (mm)

Velocity (msec)

Rain (mm)

Flow1 (l/s)

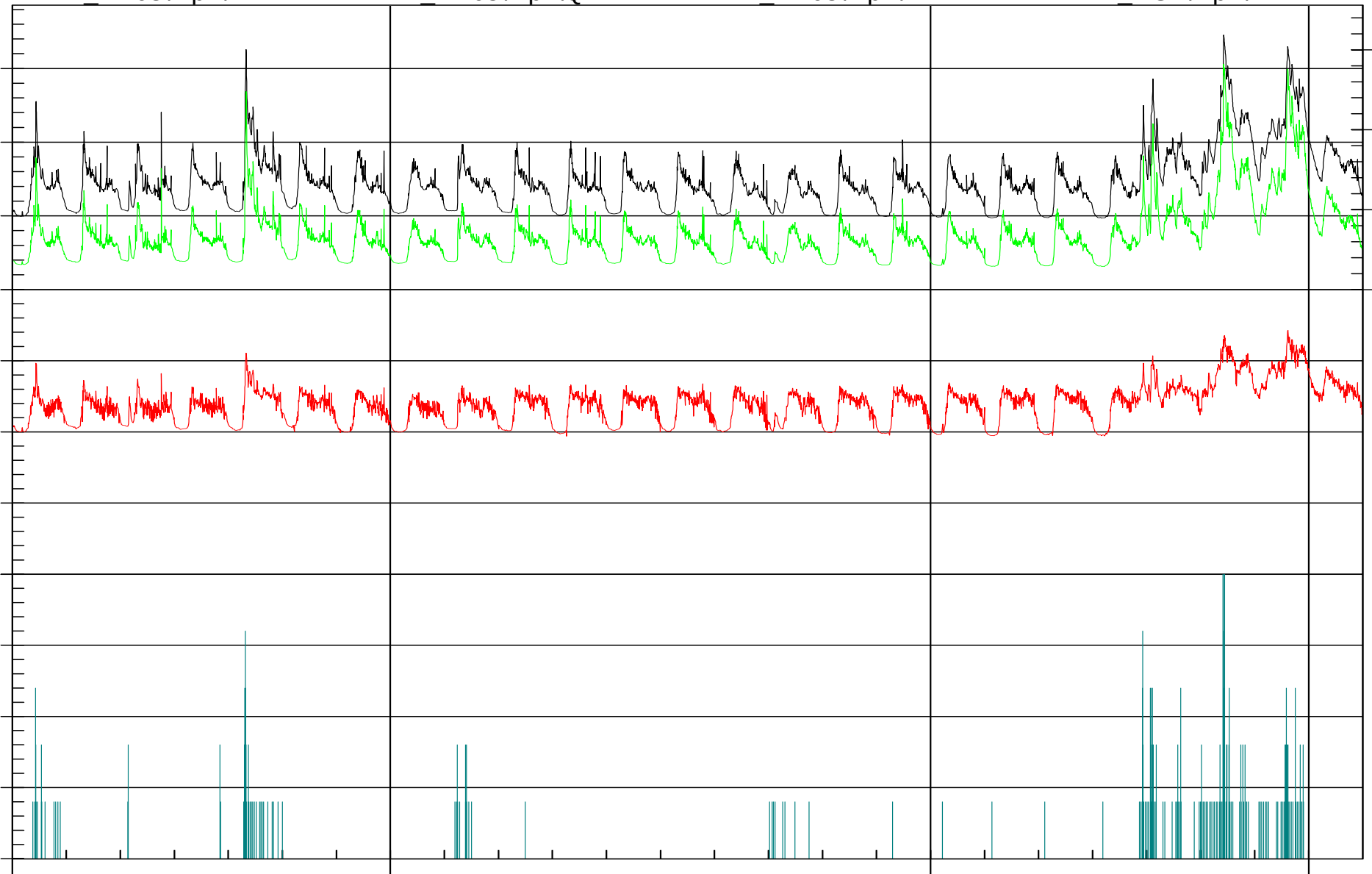
15 Sun
May 2016

22 Sun

Time

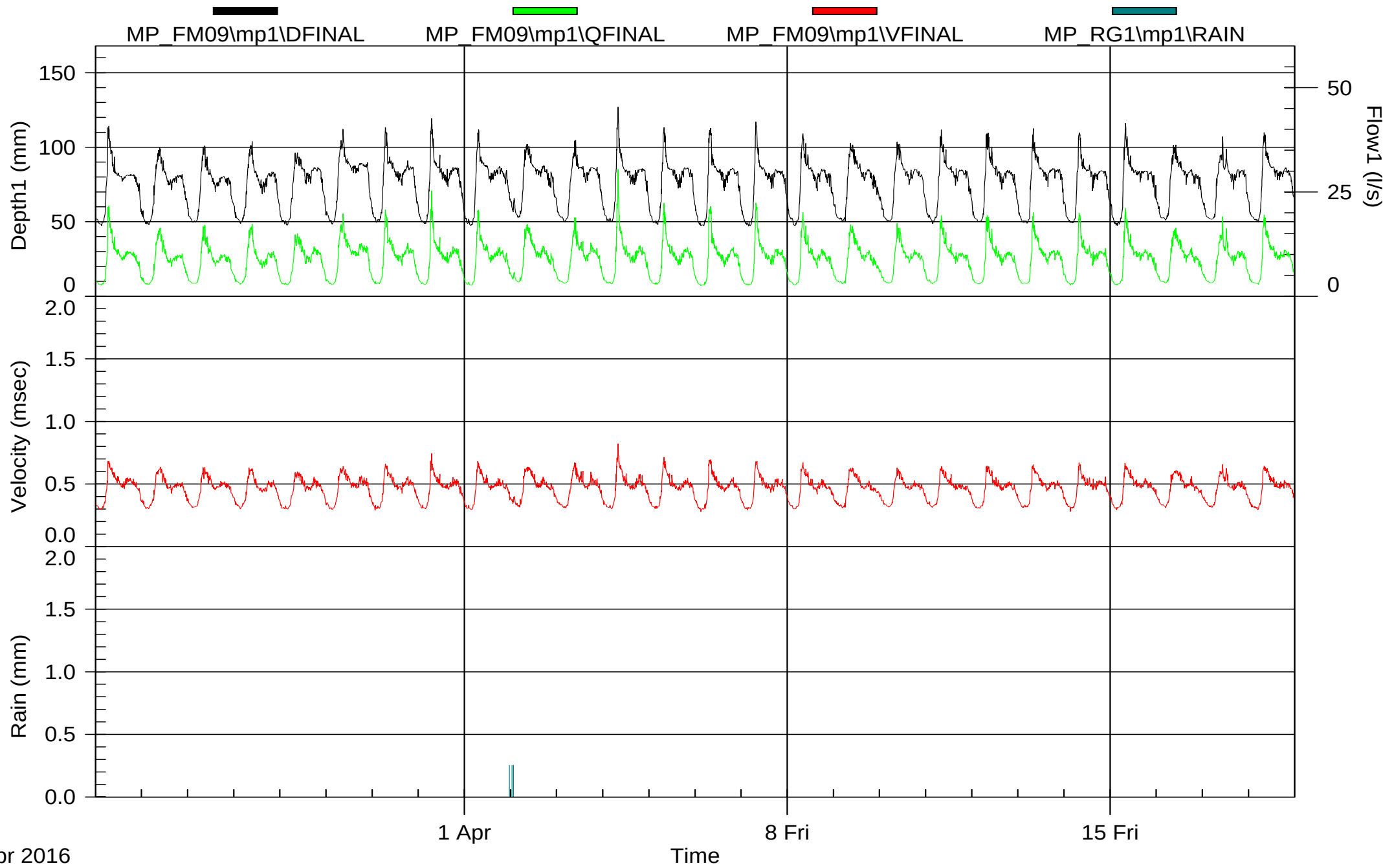
1 Jun

8 Wed



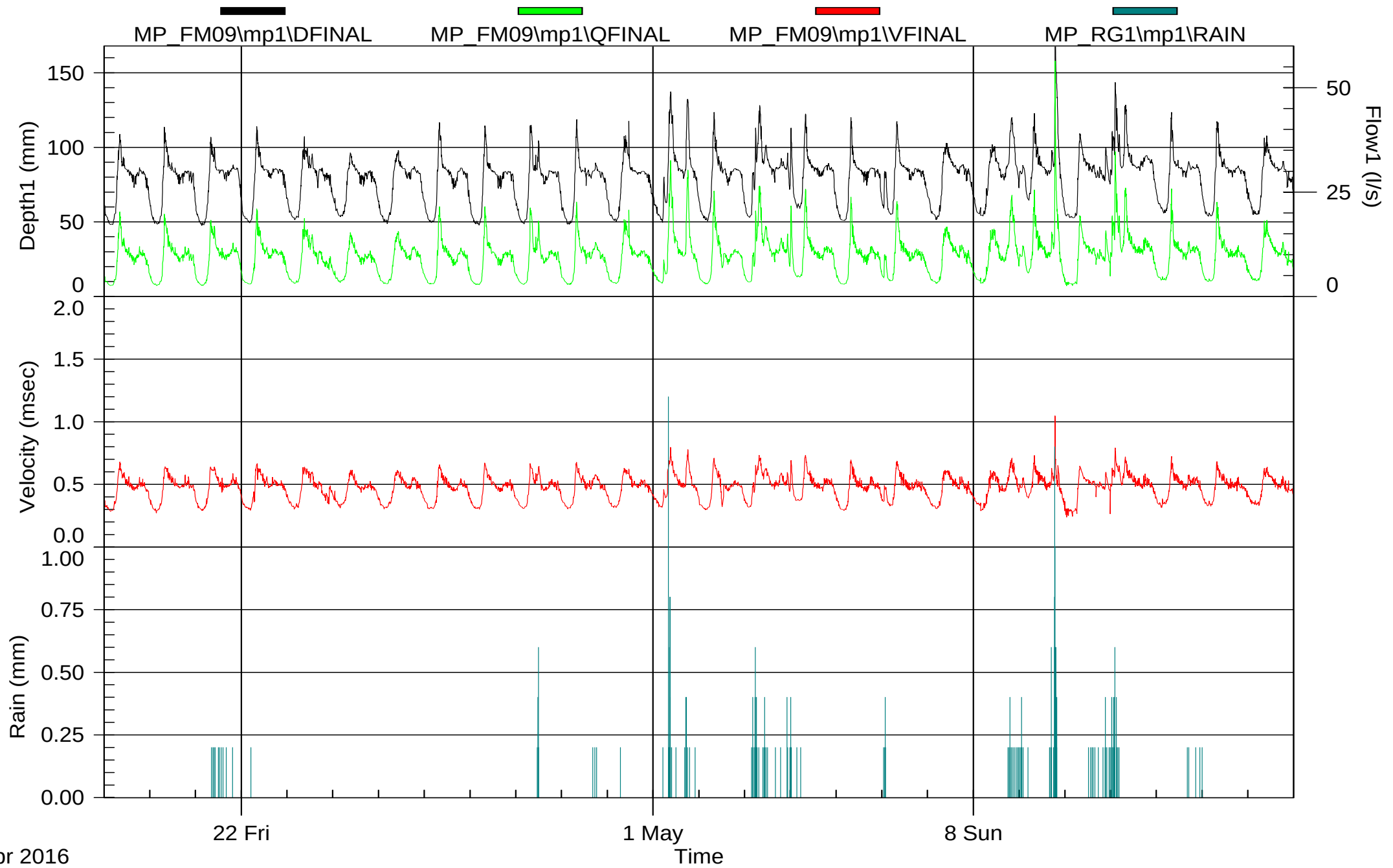
Mott MacDonald

Pipe Height: 445.00



Mott MacDonald

Pipe Height: 445.00



Mott MacDonald

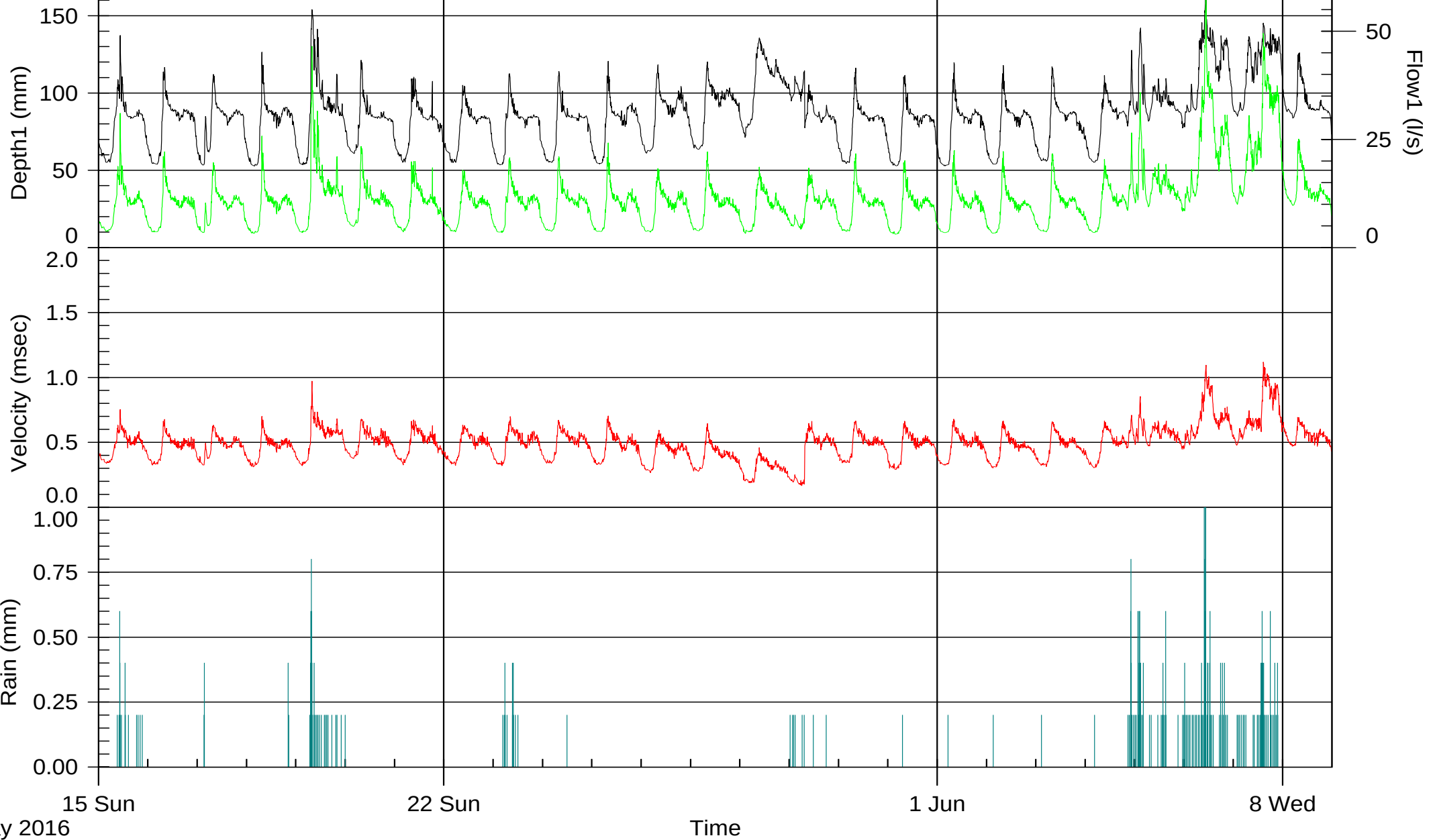
Pipe Height: 445.00

MP_FM09\mp1\DFINAL

MP_FM09\mp1\QFINAL

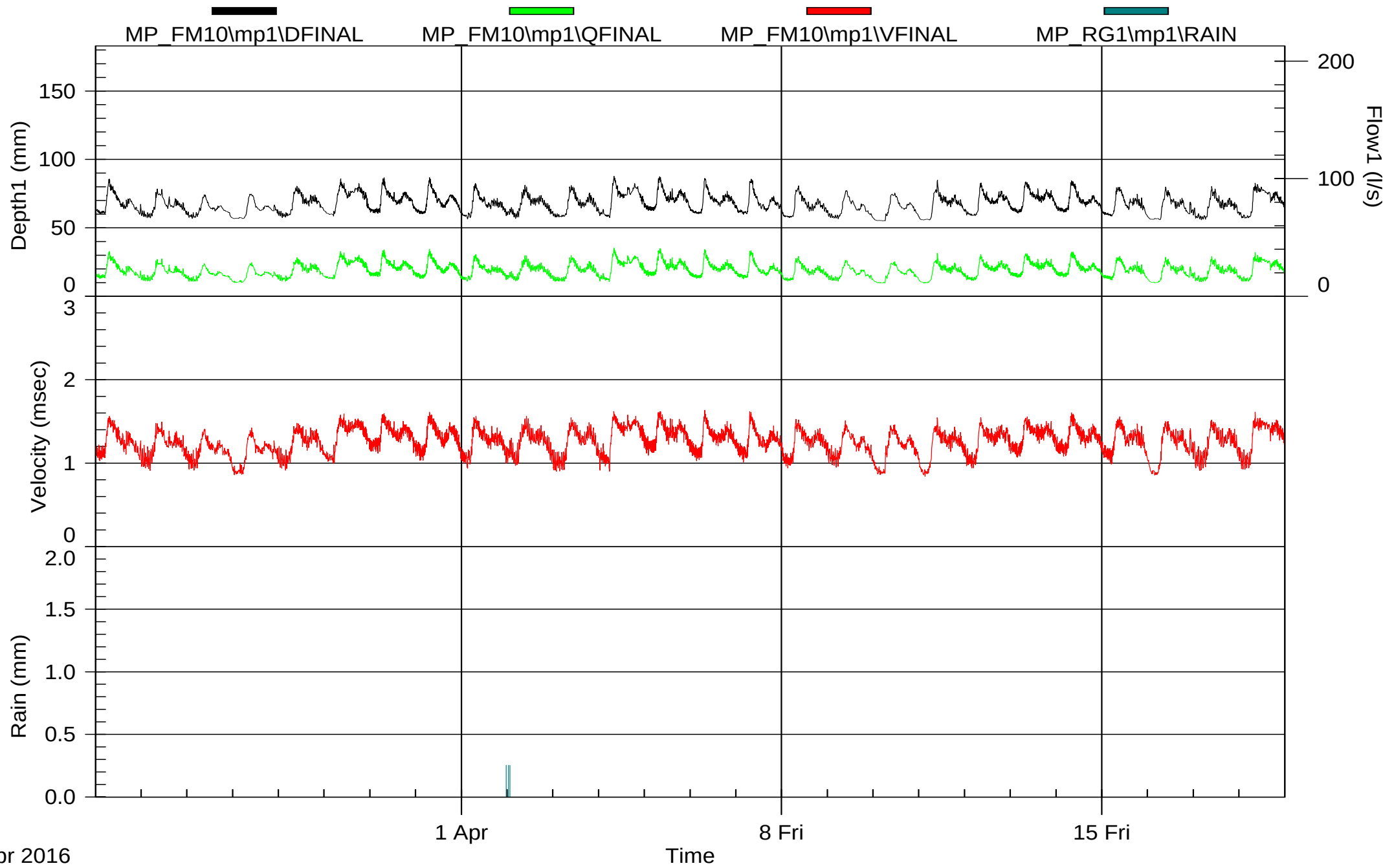
MP_FM09\mp1\VFINAL

MP_RG1\mp1\RAIN



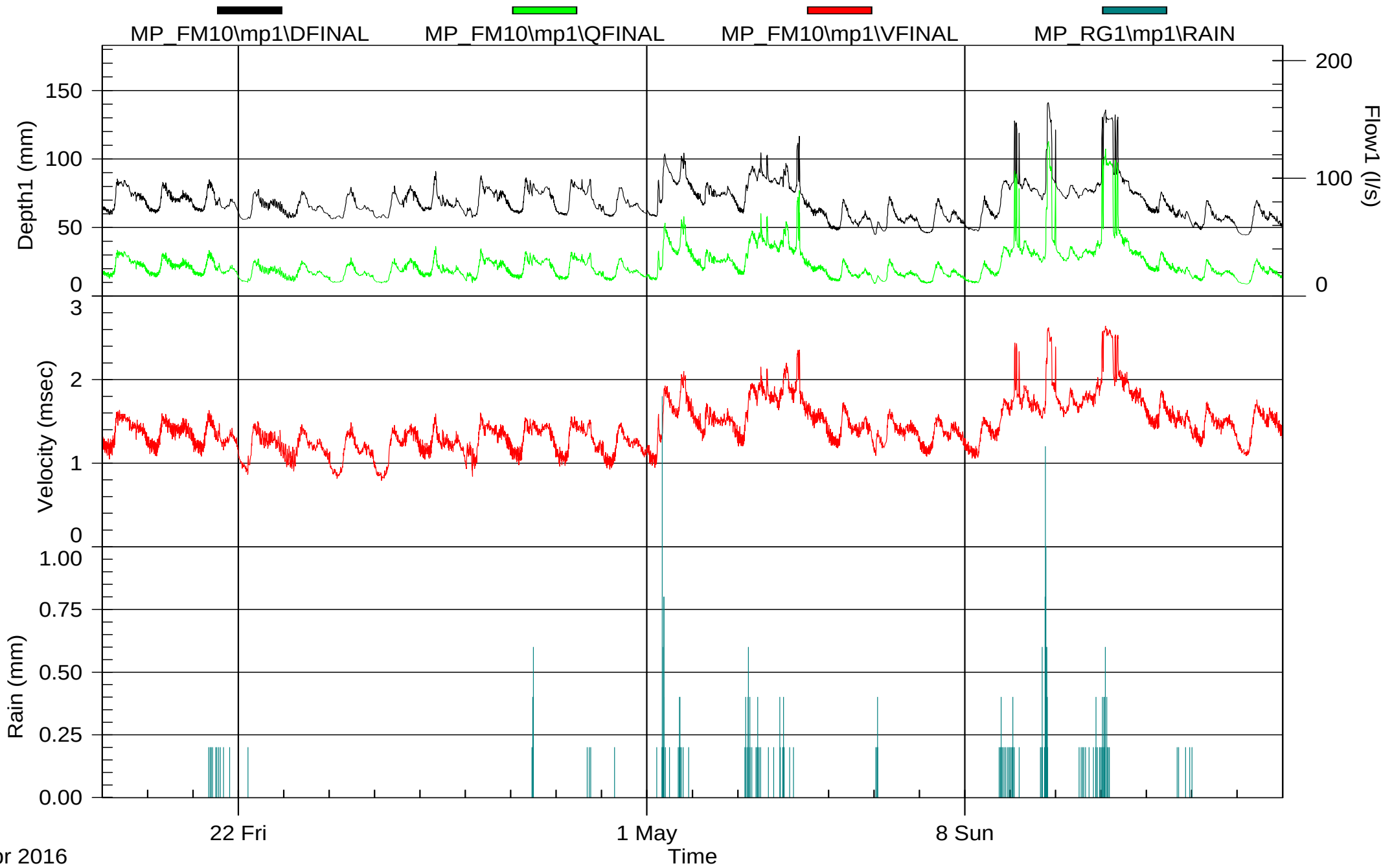
Mott MacDonald

Pipe Height: 581.00



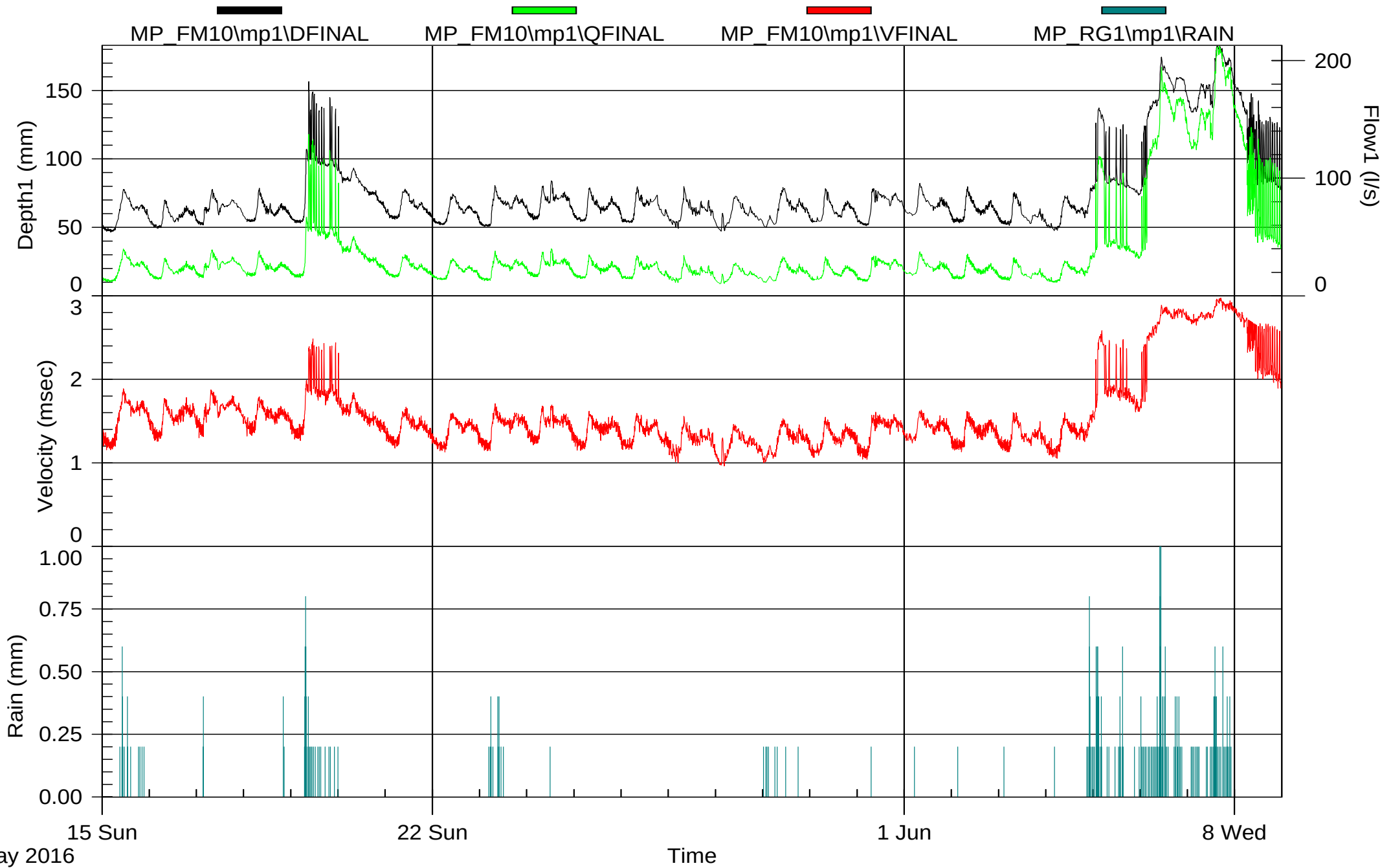
Mott MacDonald

Pipe Height: 581.00



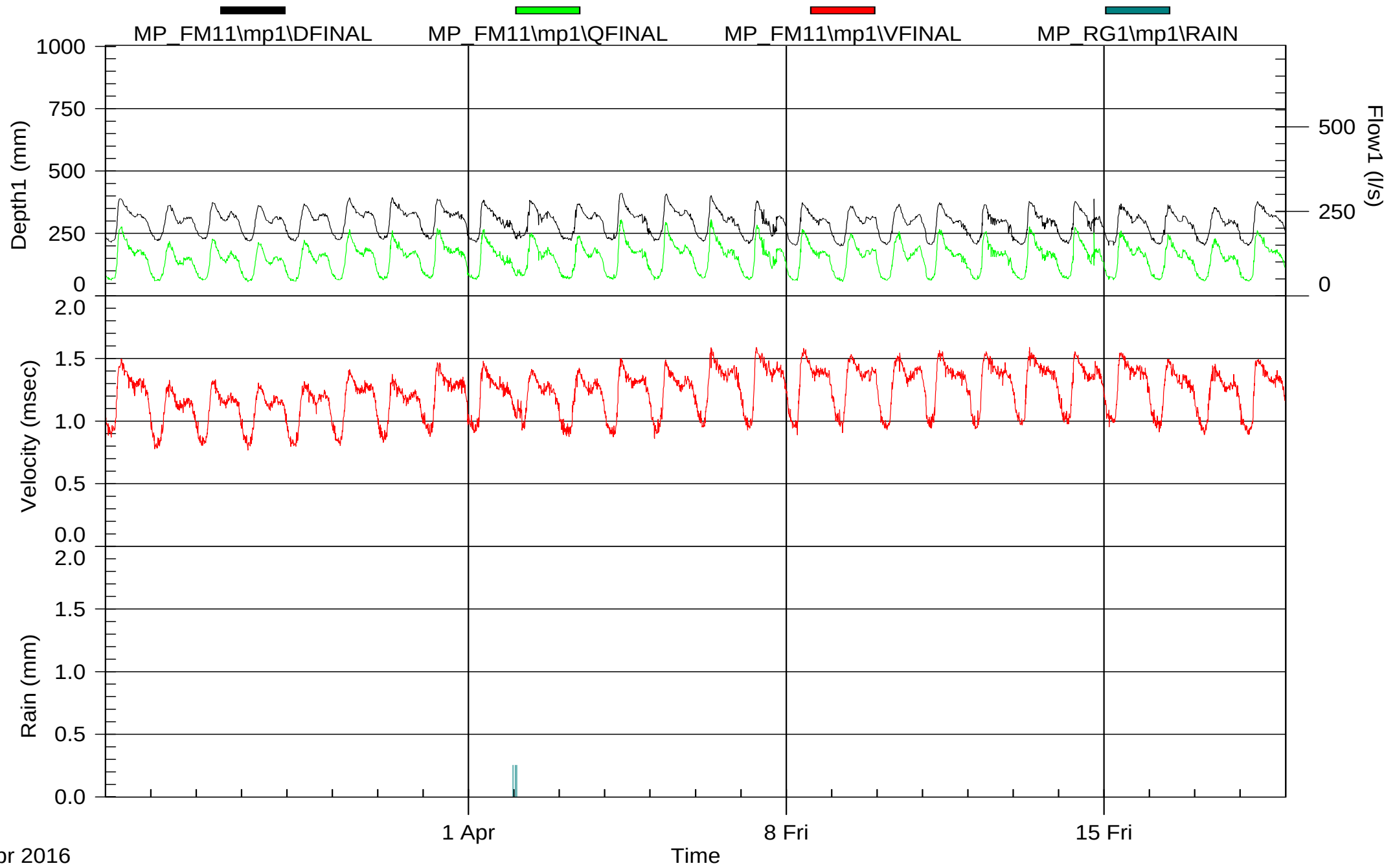
Mott MacDonald

Pipe Height: 581.00



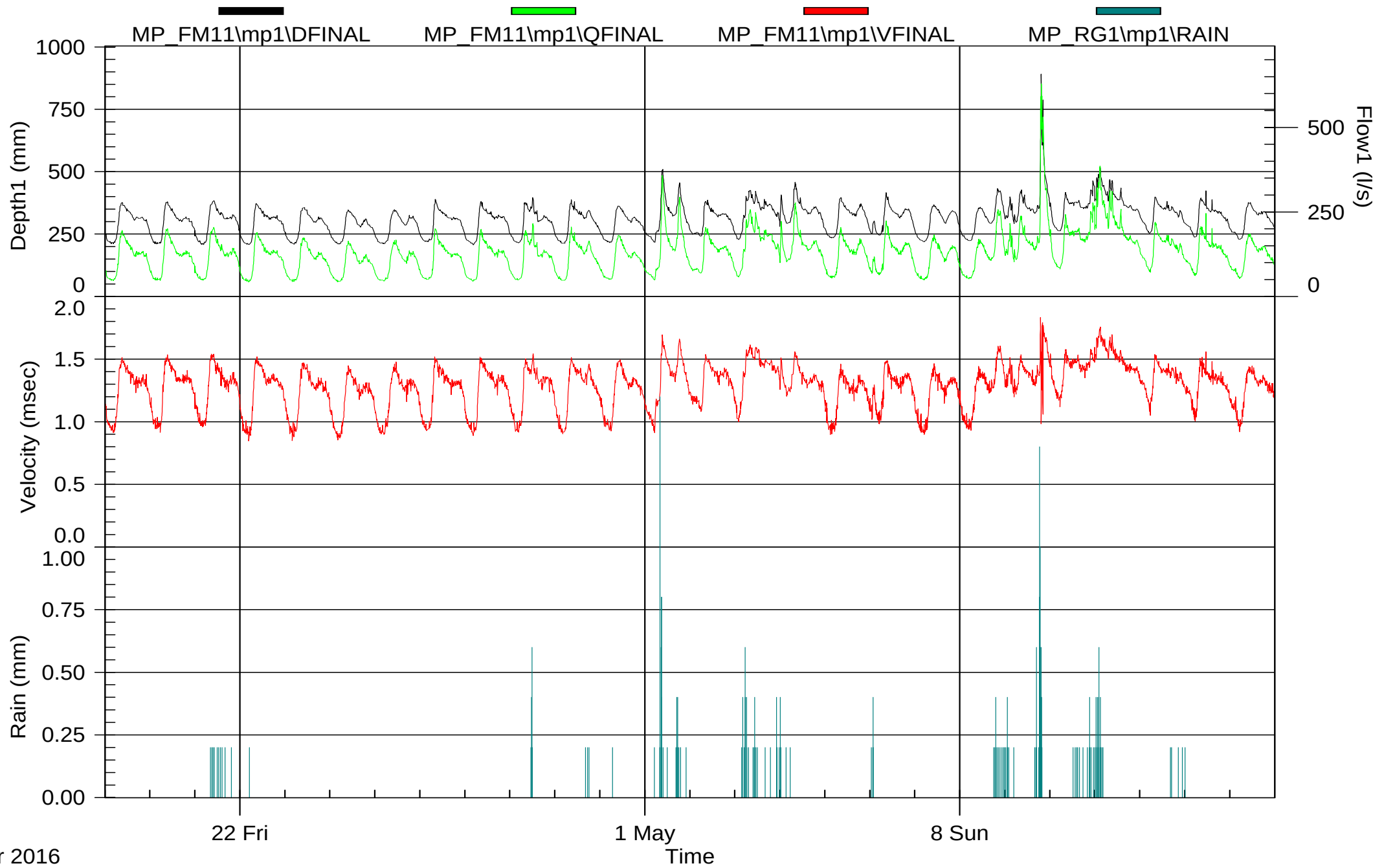
Mott MacDonald

Pipe Height: 1253.00



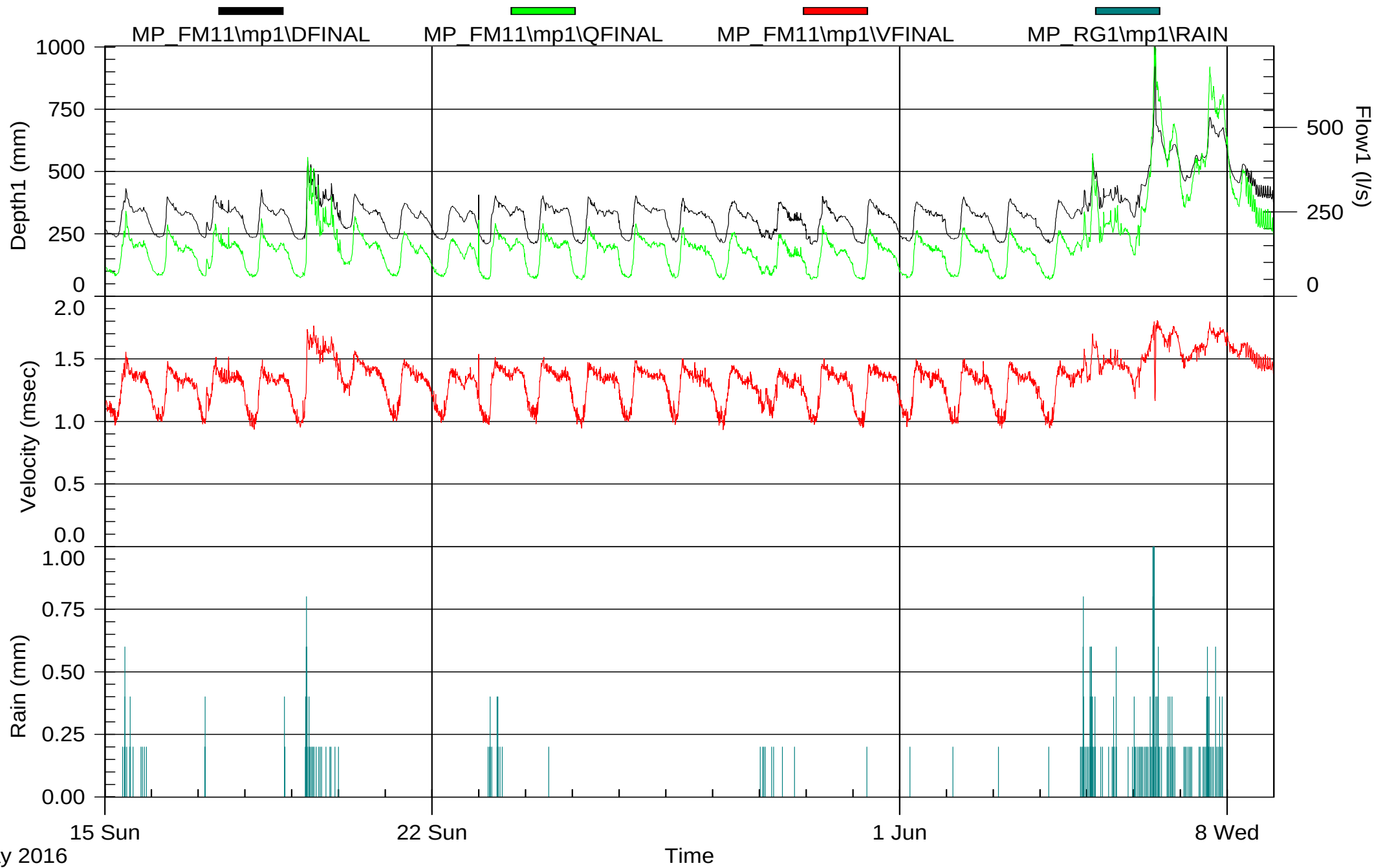
Mott MacDonald

Pipe Height: 1253.00



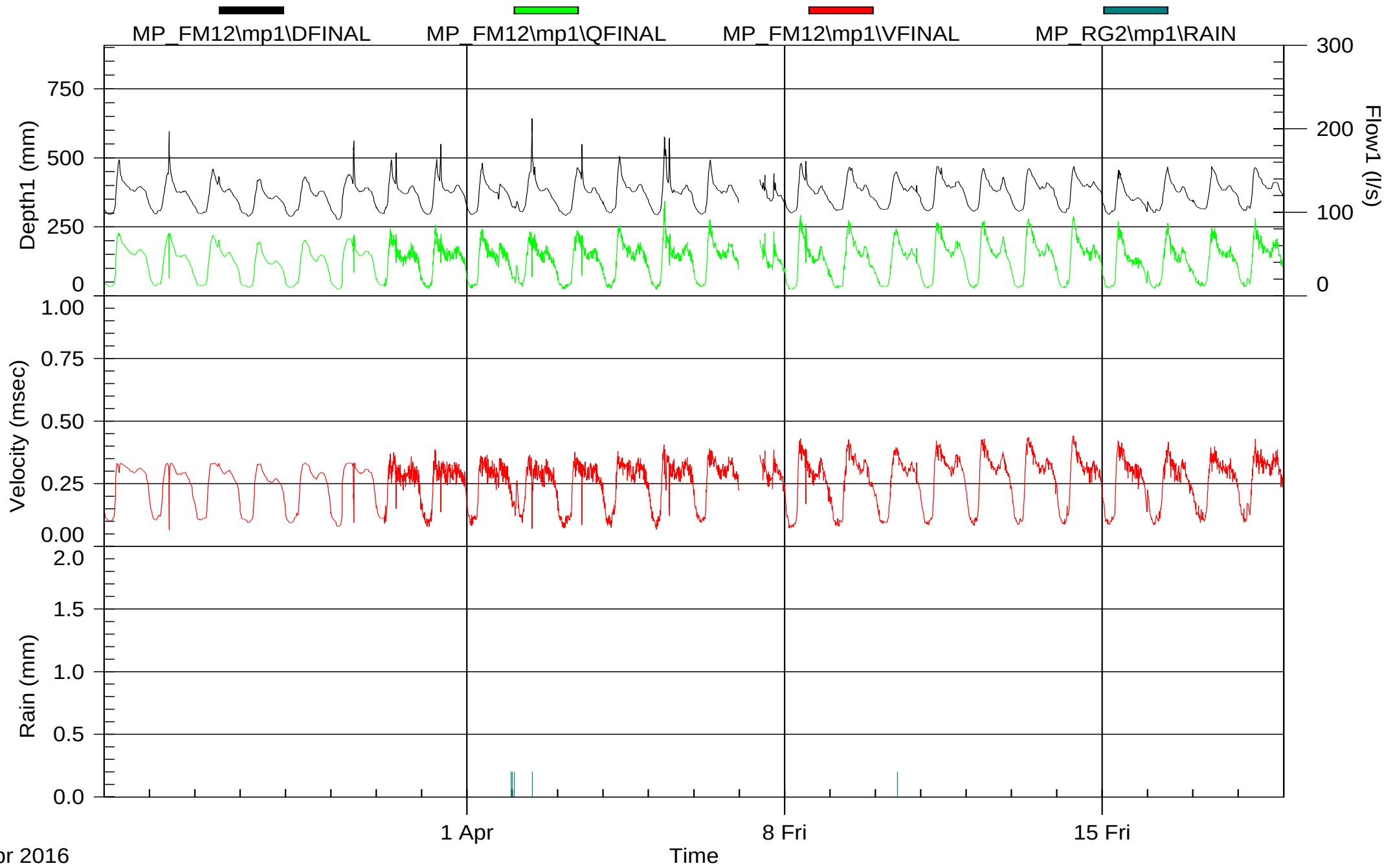
Mott MacDonald

Pipe Height: 1253.00



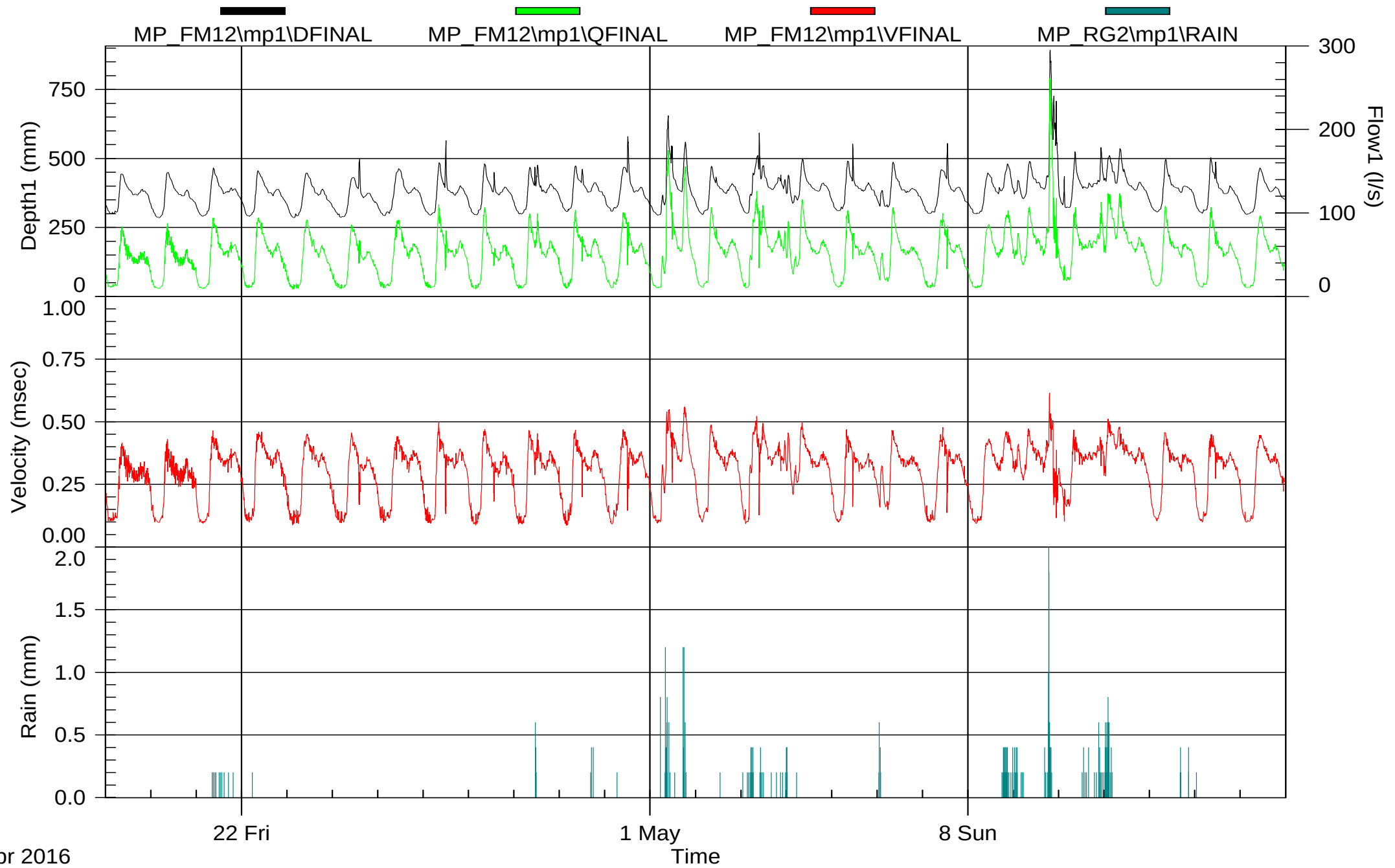
Mott MacDonald

Pipe Height: 1000.00



Mott MacDonald

Pipe Height: 1000.00



Mott MacDonald

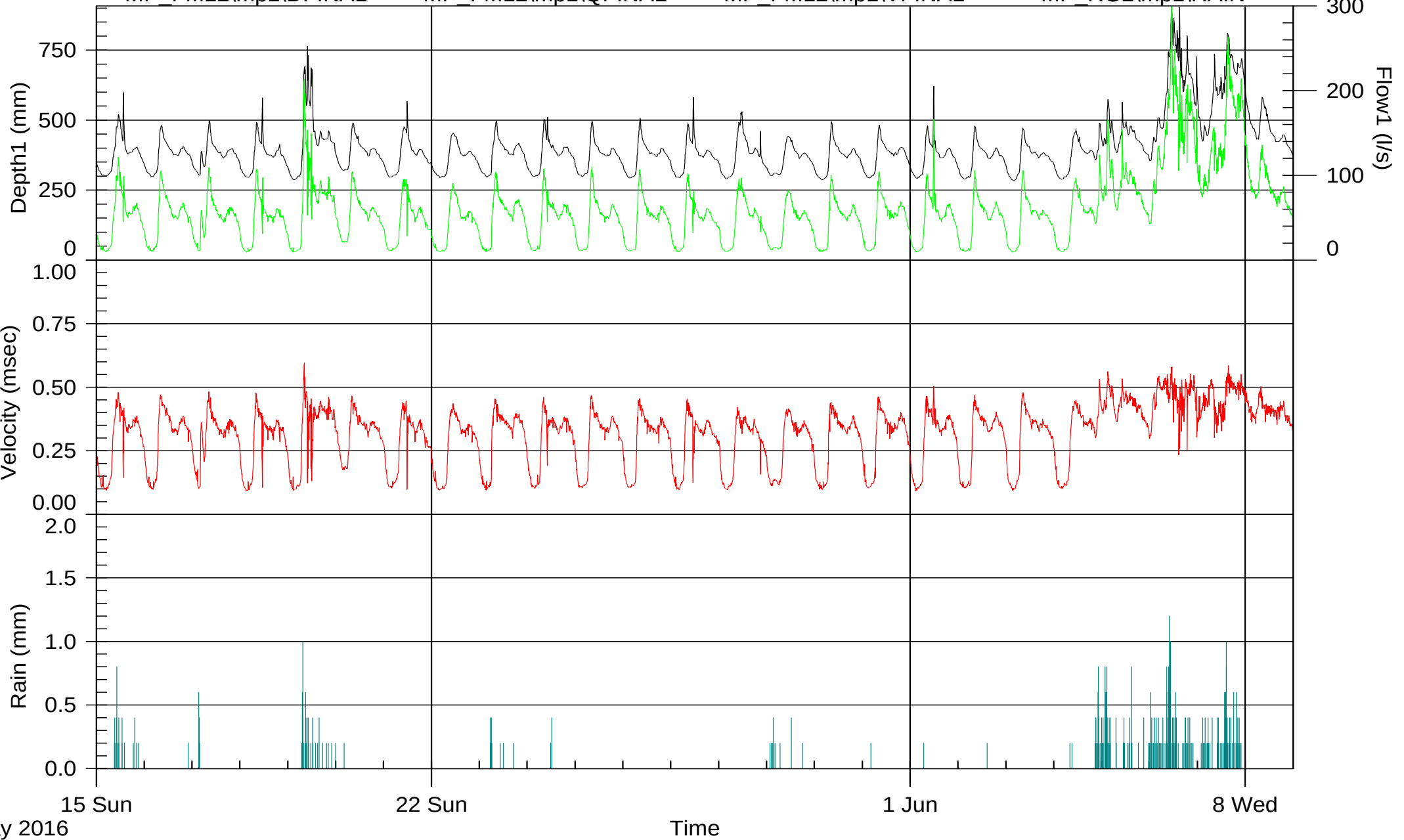
Pipe Height: 1000.00

MP_FM12\mp1\DFINAL

MP_FM12\mp1\QFINAL

MP_FM12\mp1\VFINAL

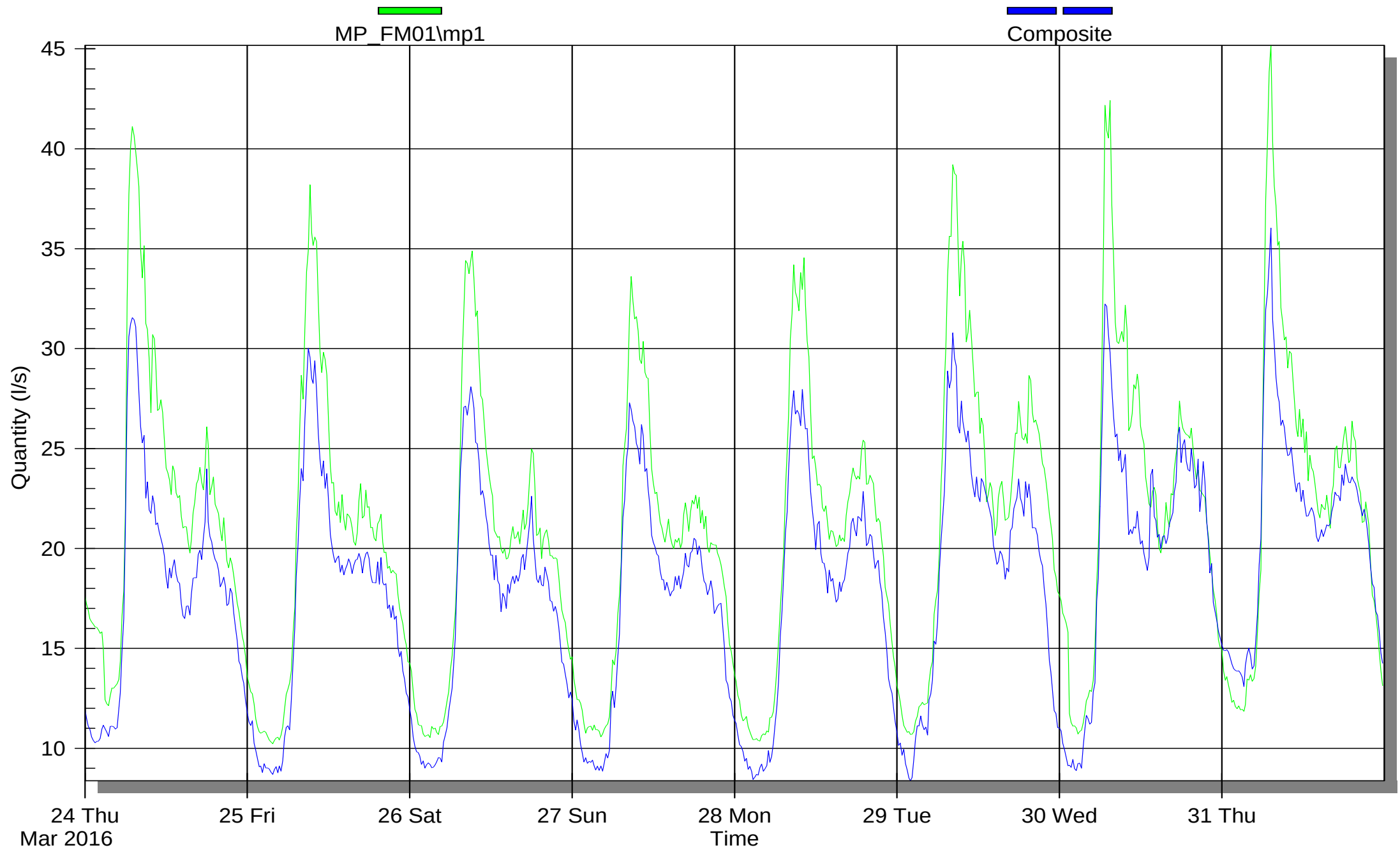
MP_RG2\mp1\RAIN



Appendix C. BALANCE REPORT

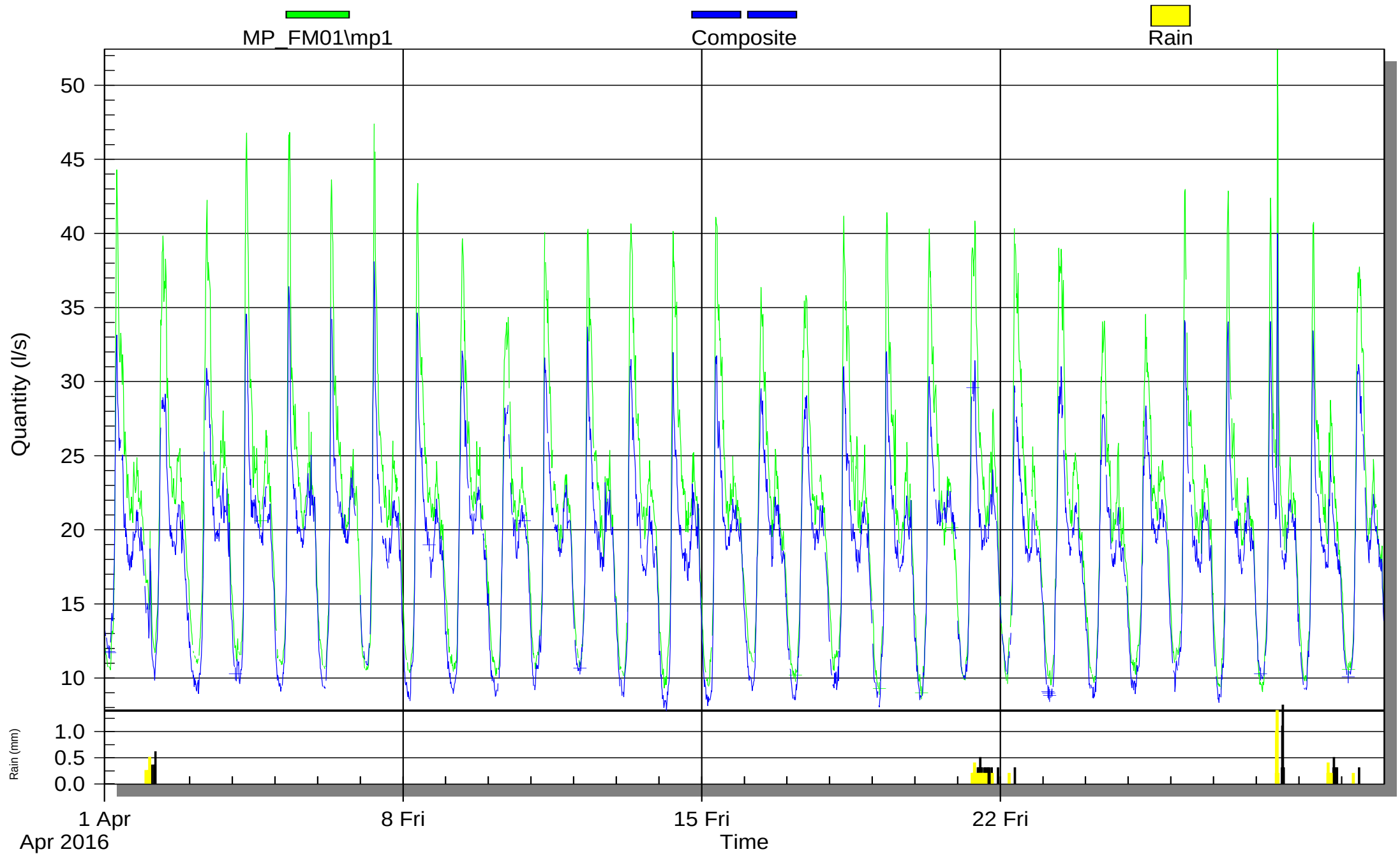
Mott MacDonald

Balance Report
Average Daily Flow



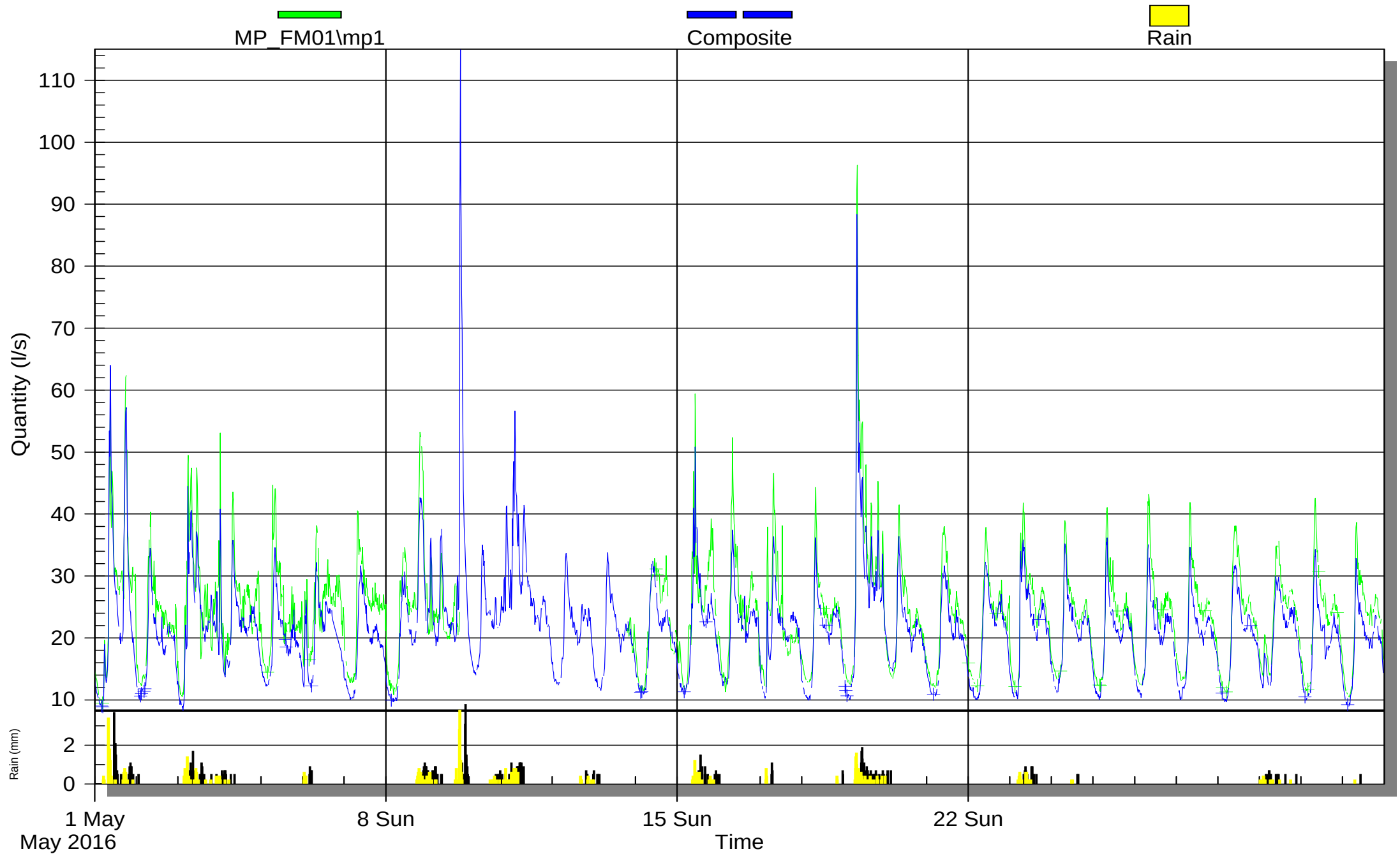
Mott MacDonald

Balance Report
Average Daily Flow



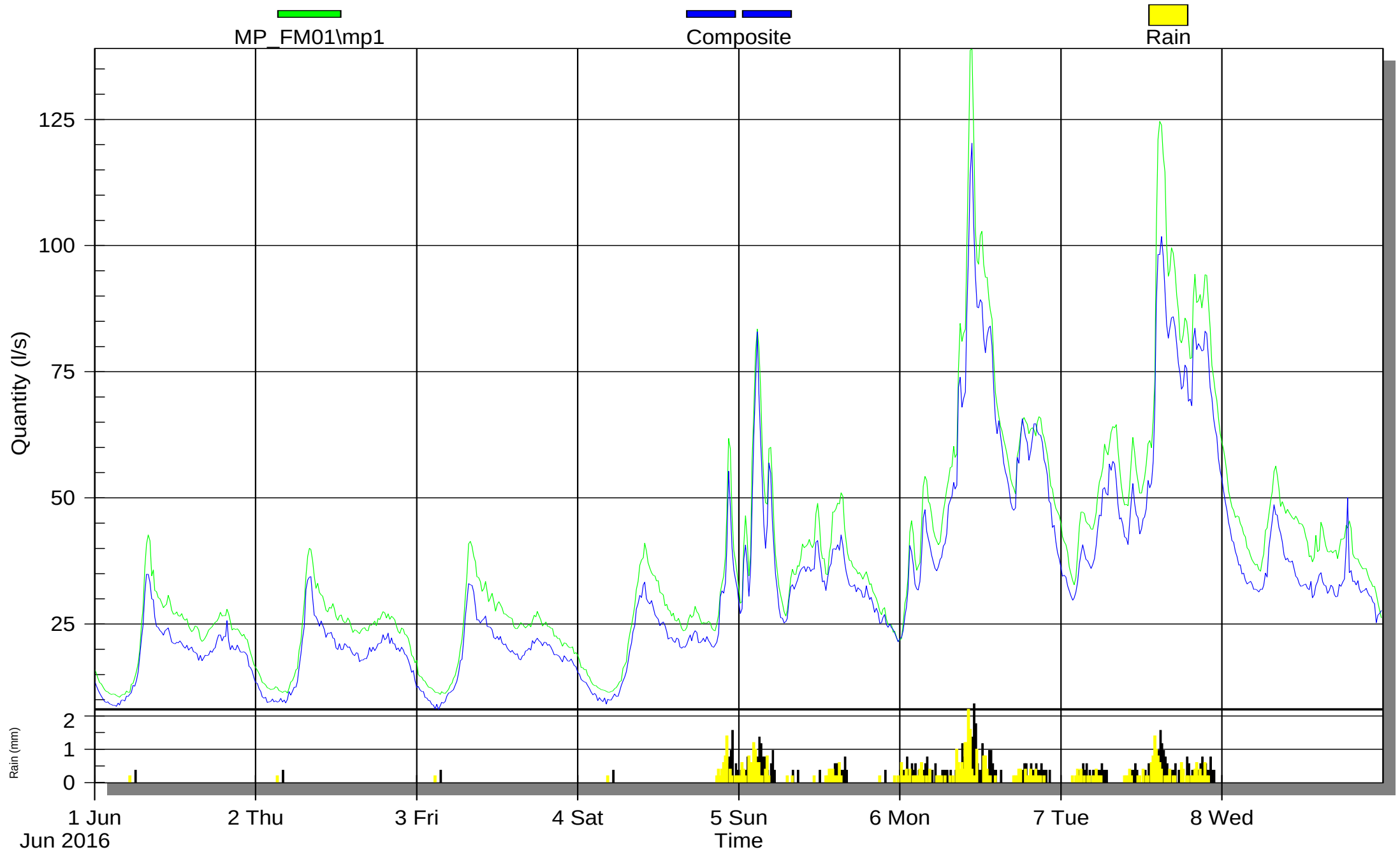
Mott MacDonald

Balance Report
Average Daily Flow



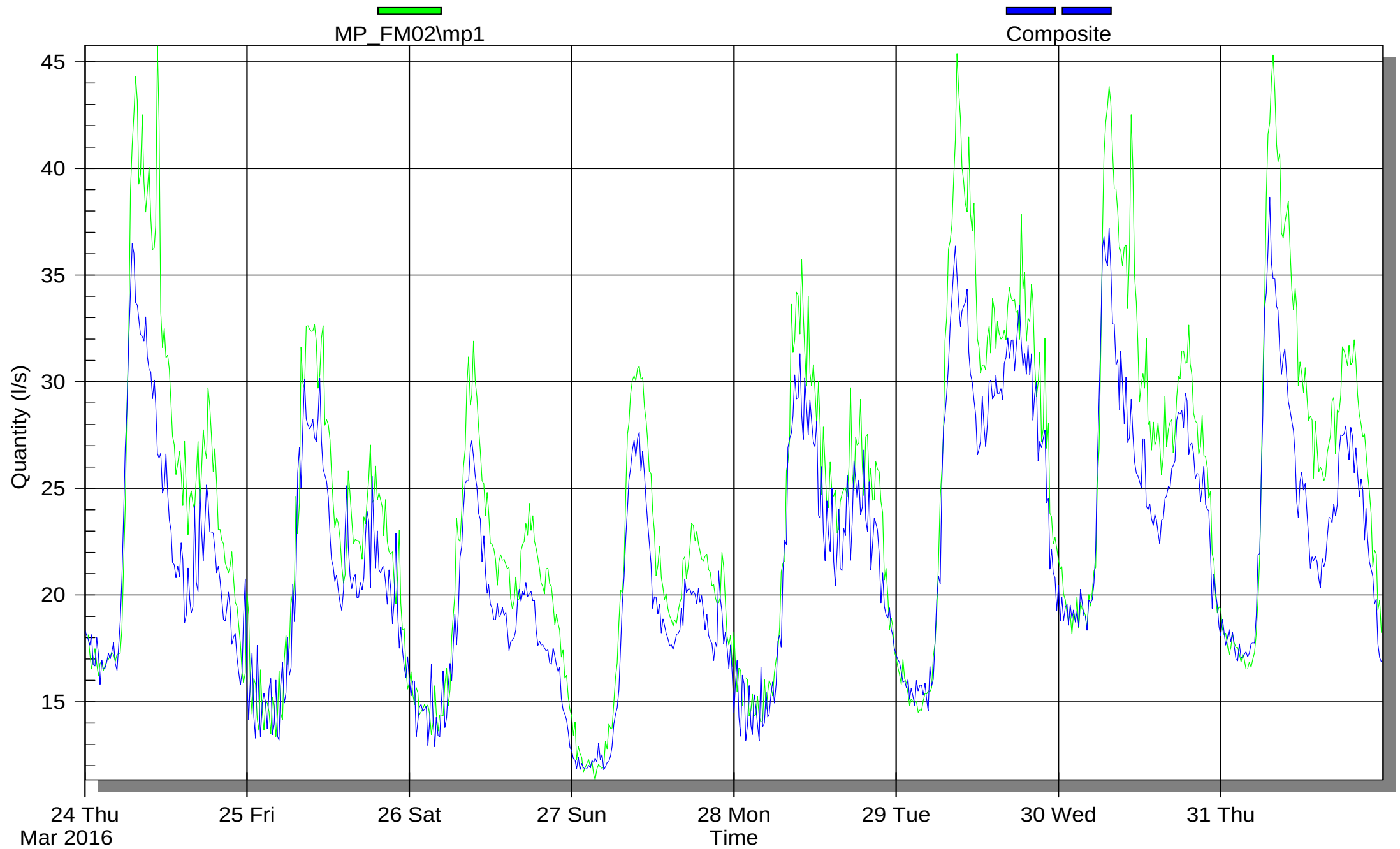
Mott MacDonald

Balance Report
Average Daily Flow



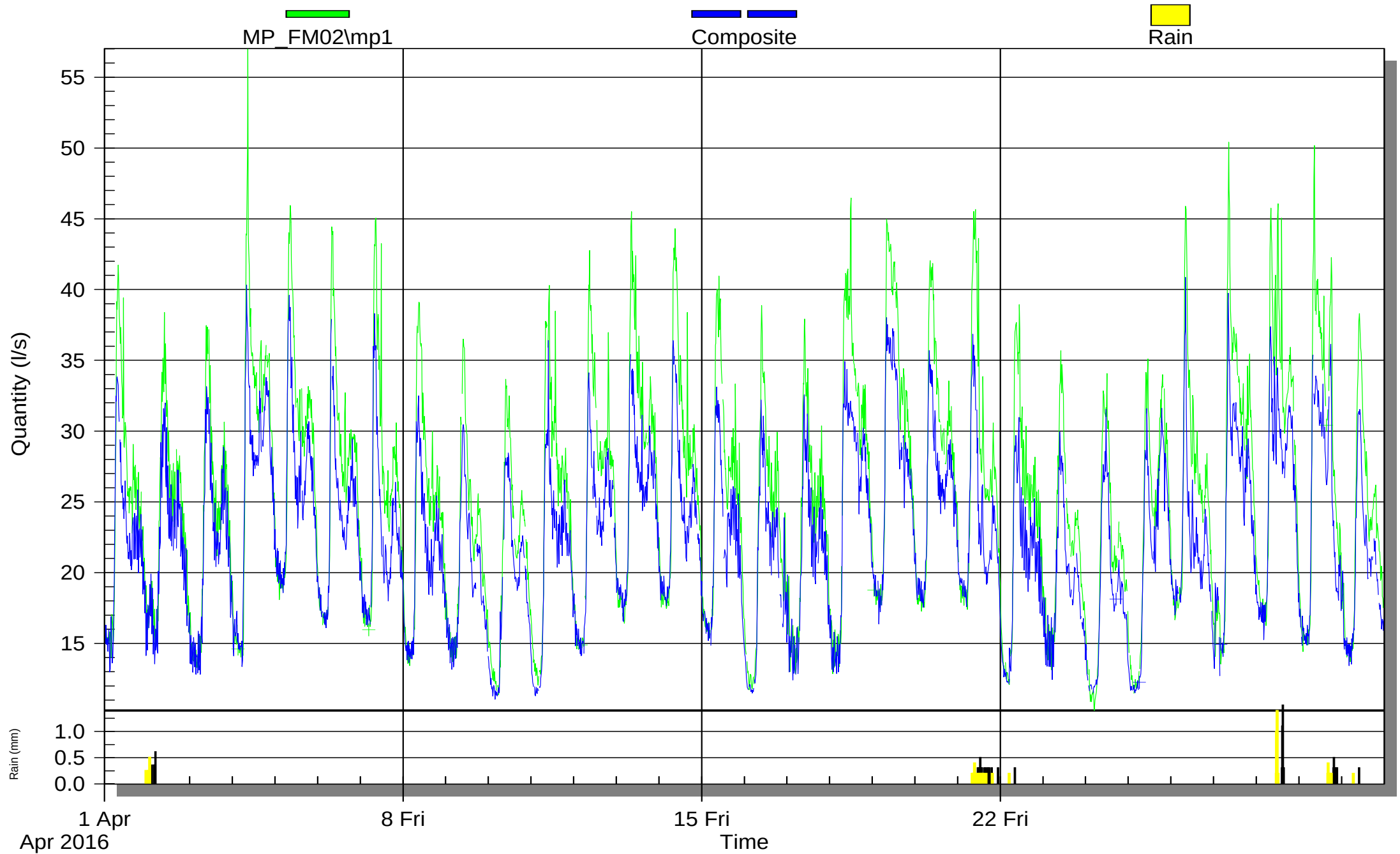
Mott MacDonald

Balance Report
Average Daily Flow



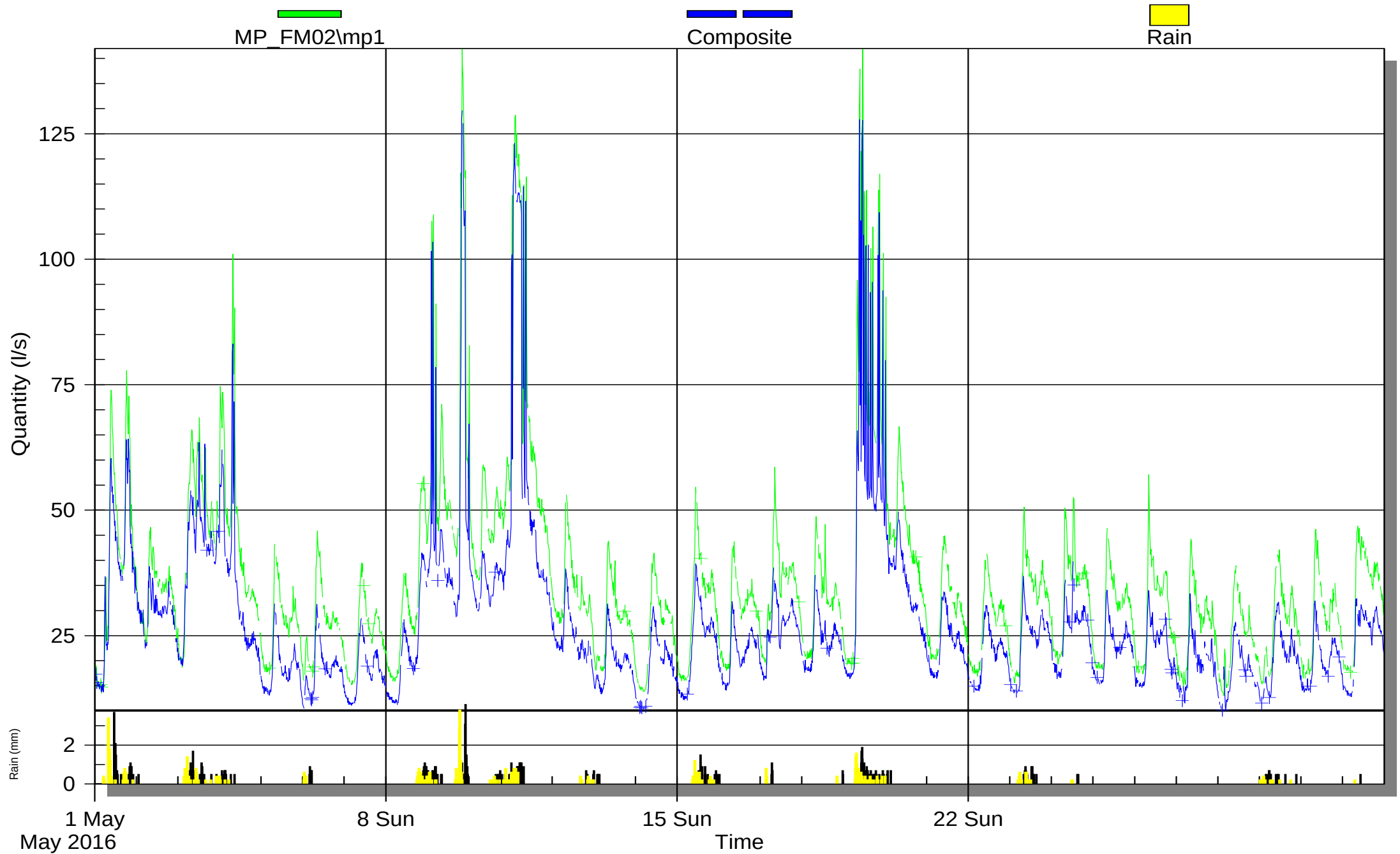
Mott MacDonald

Balance Report
Average Daily Flow



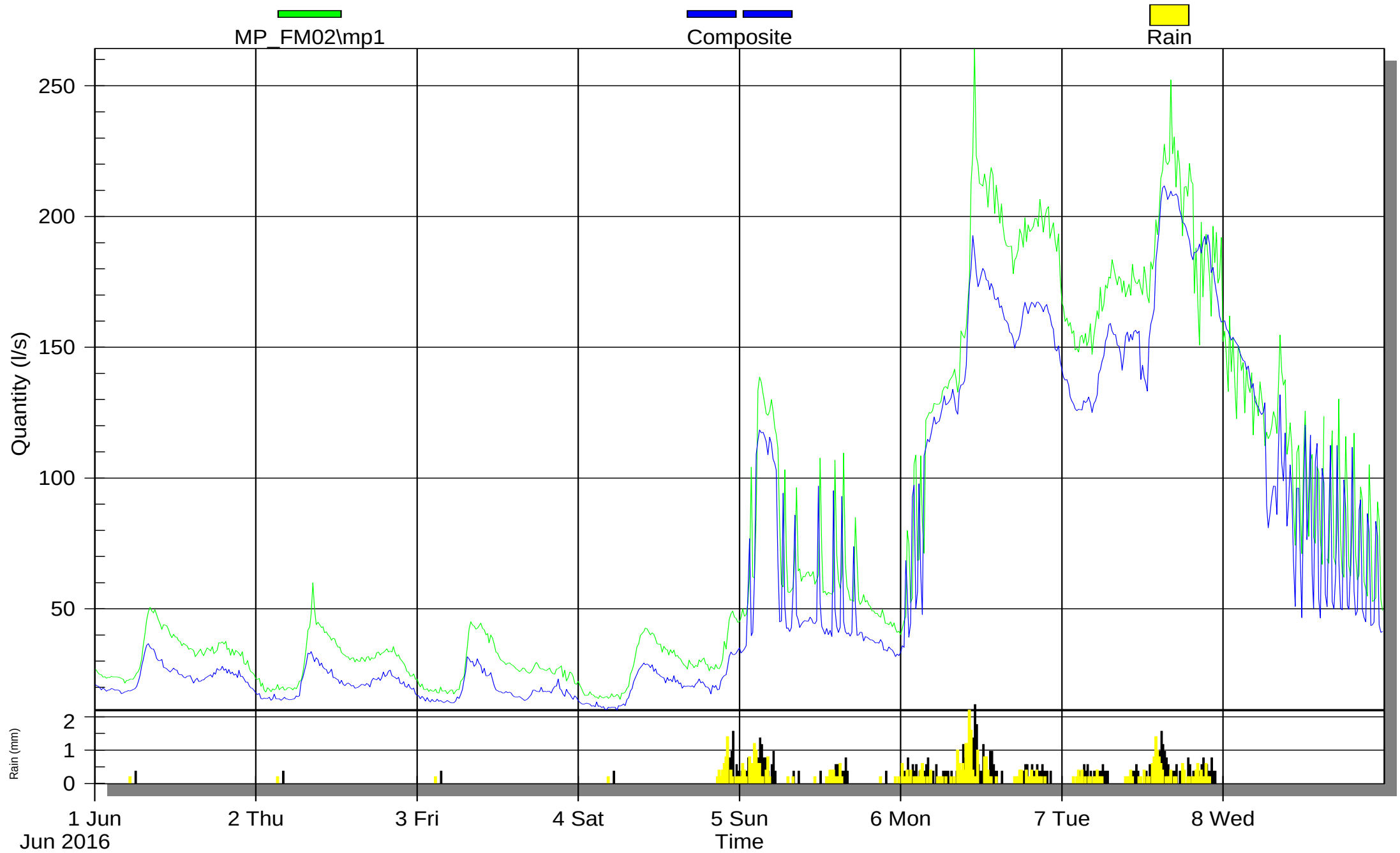
Mott MacDonald

Balance Report
Average Daily Flow



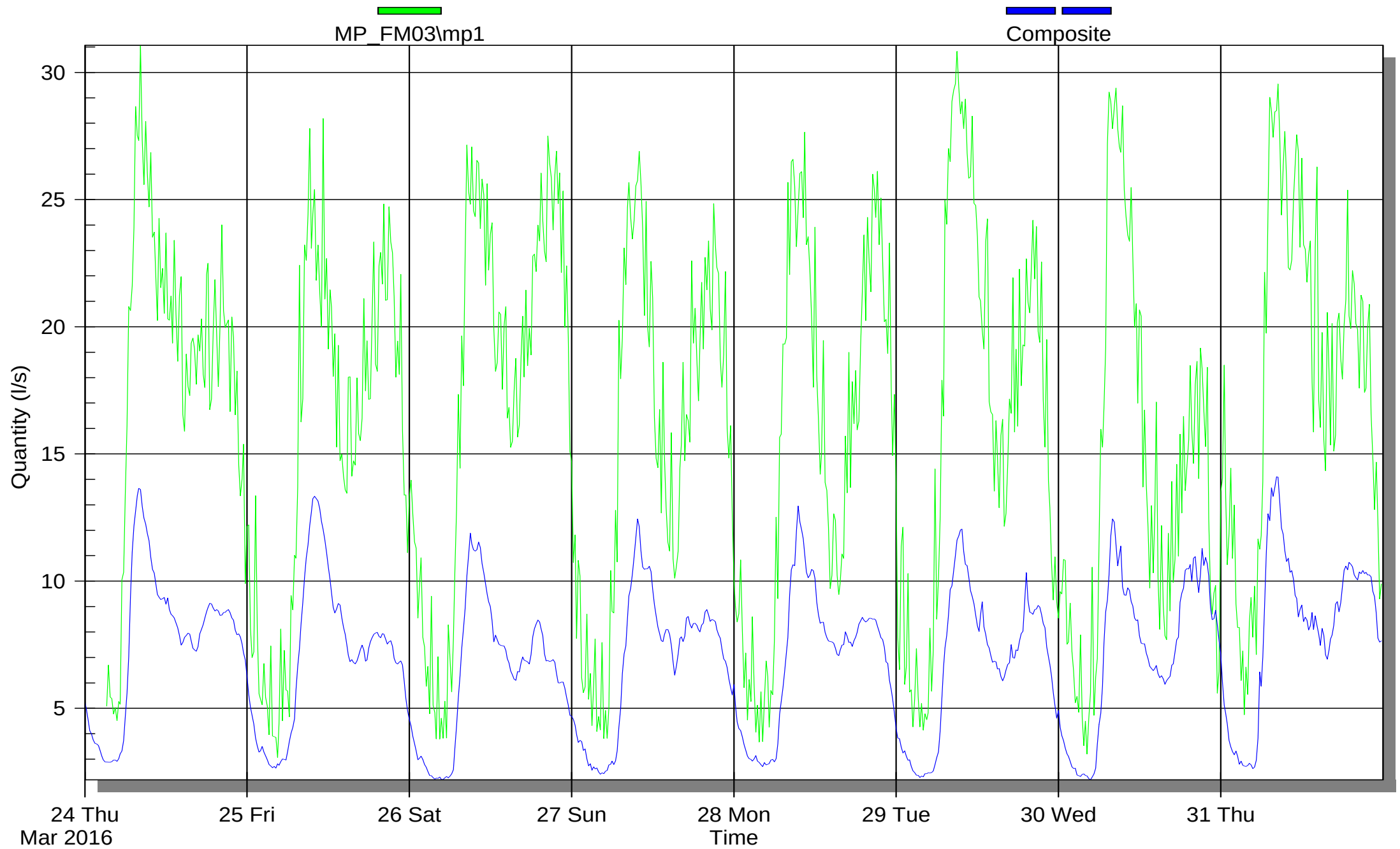
Mott MacDonald

Balance Report
Average Daily Flow



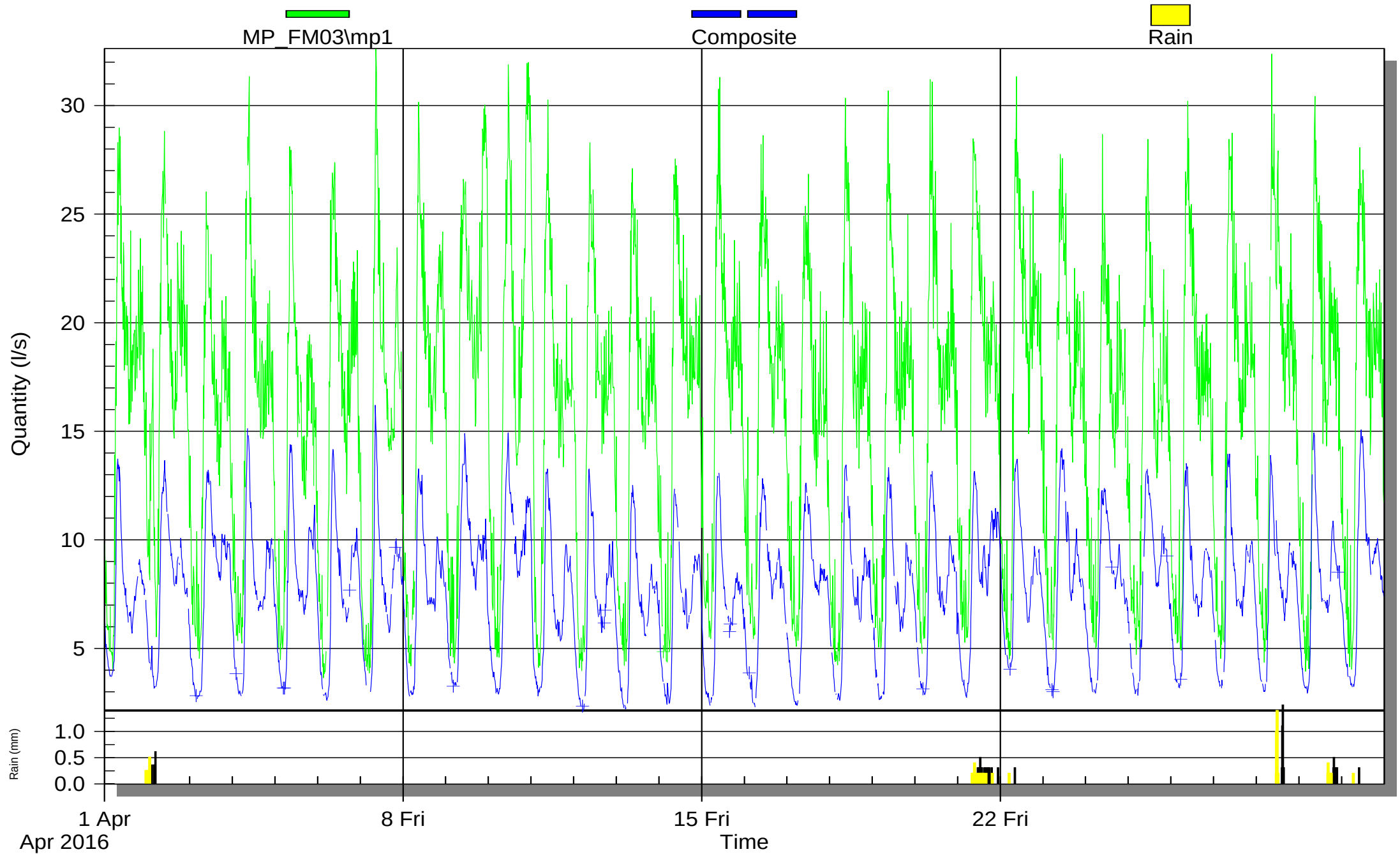
Mott MacDonald

Balance Report
Average Daily Flow



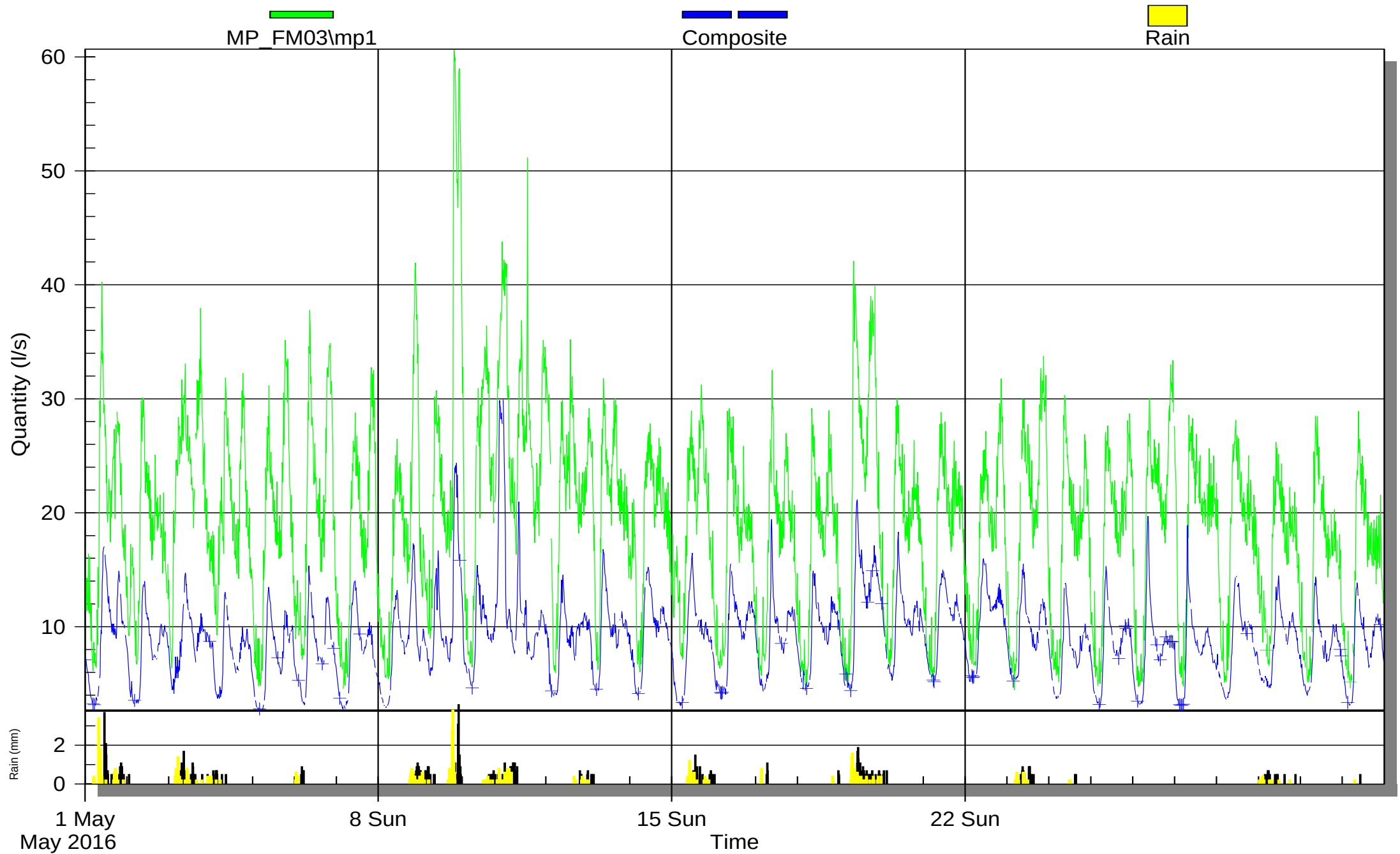
Mott MacDonald

Balance Report
Average Daily Flow



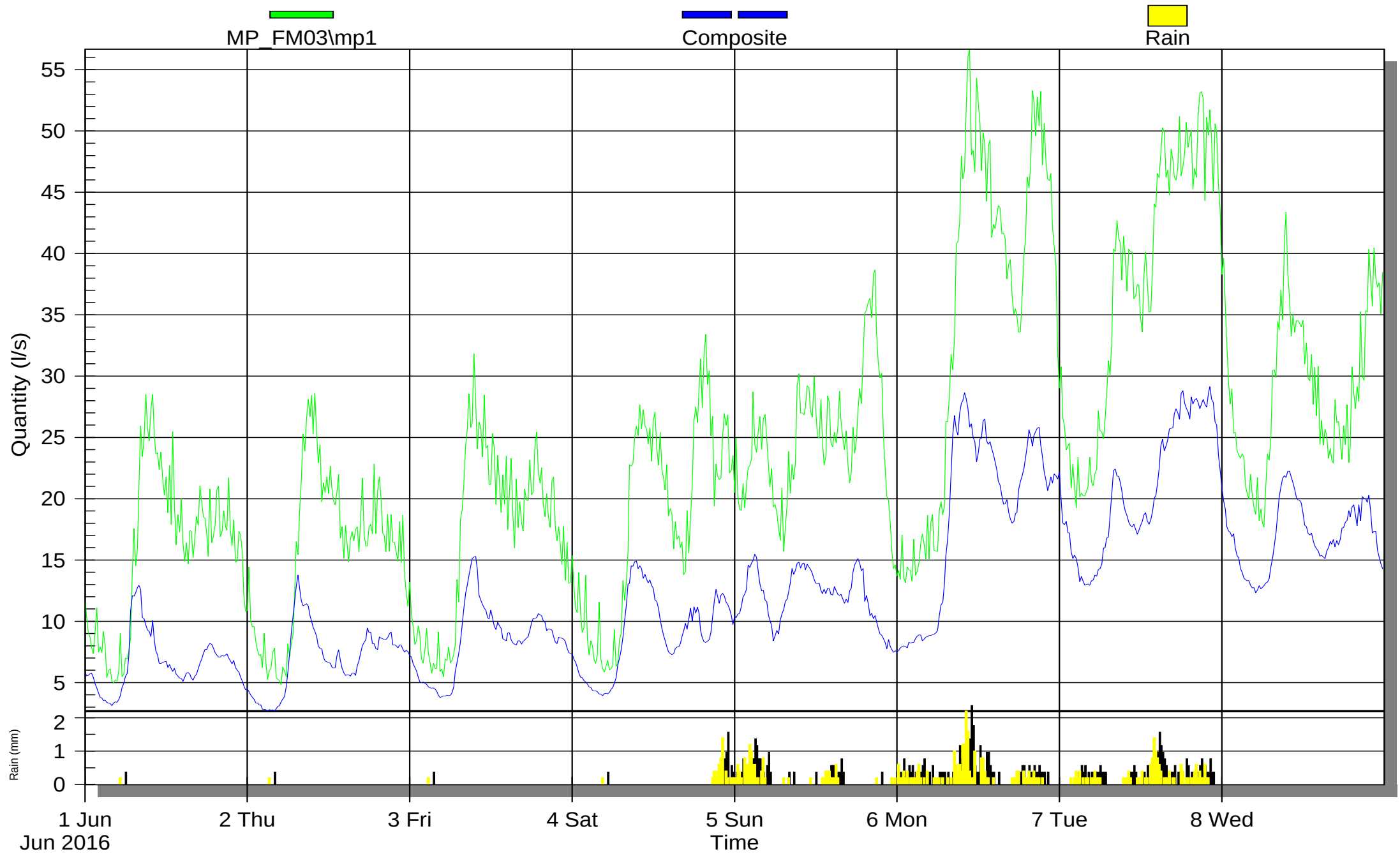
Mott MacDonald

Balance Report
Average Daily Flow



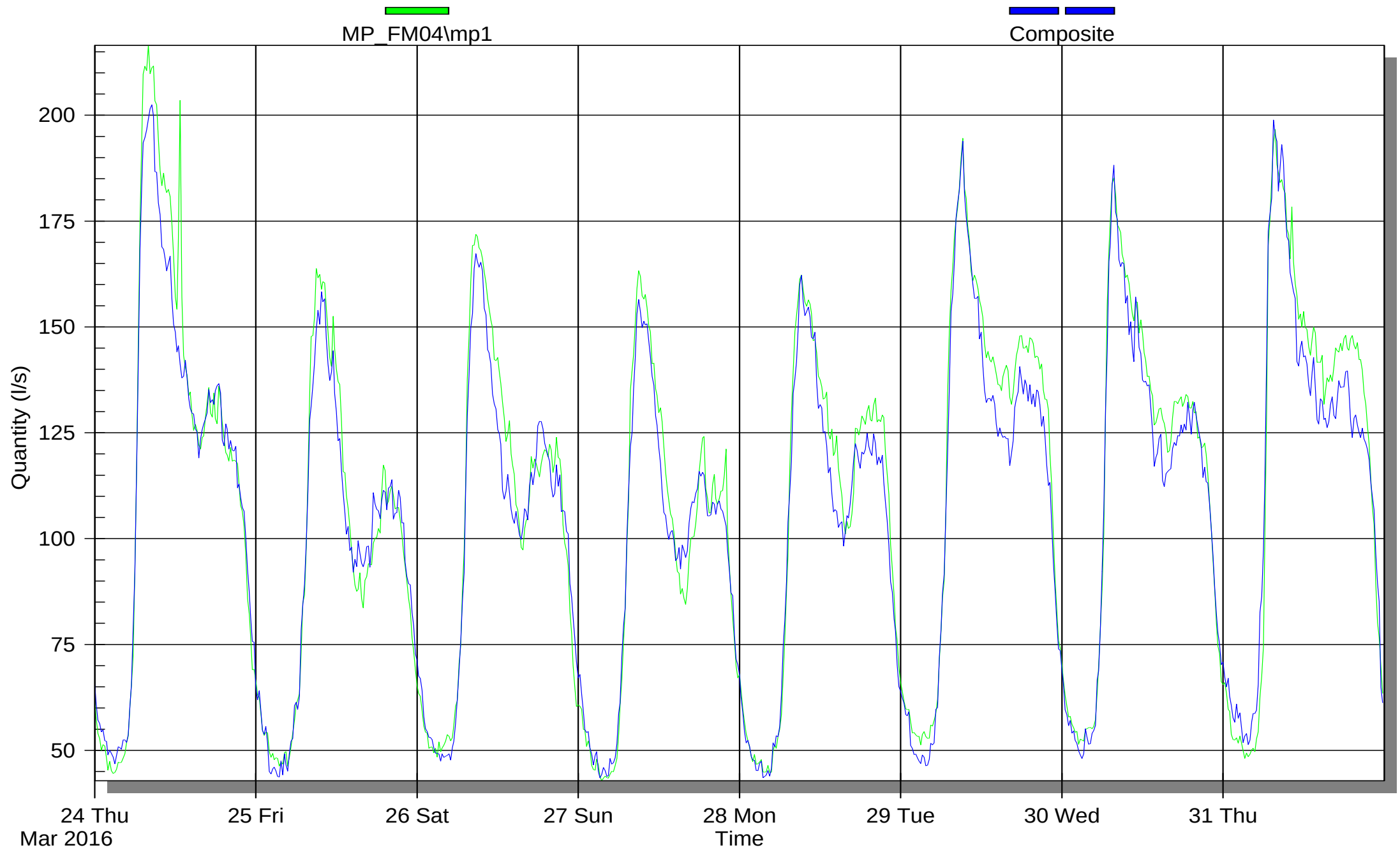
Mott MacDonald

Balance Report
Average Daily Flow



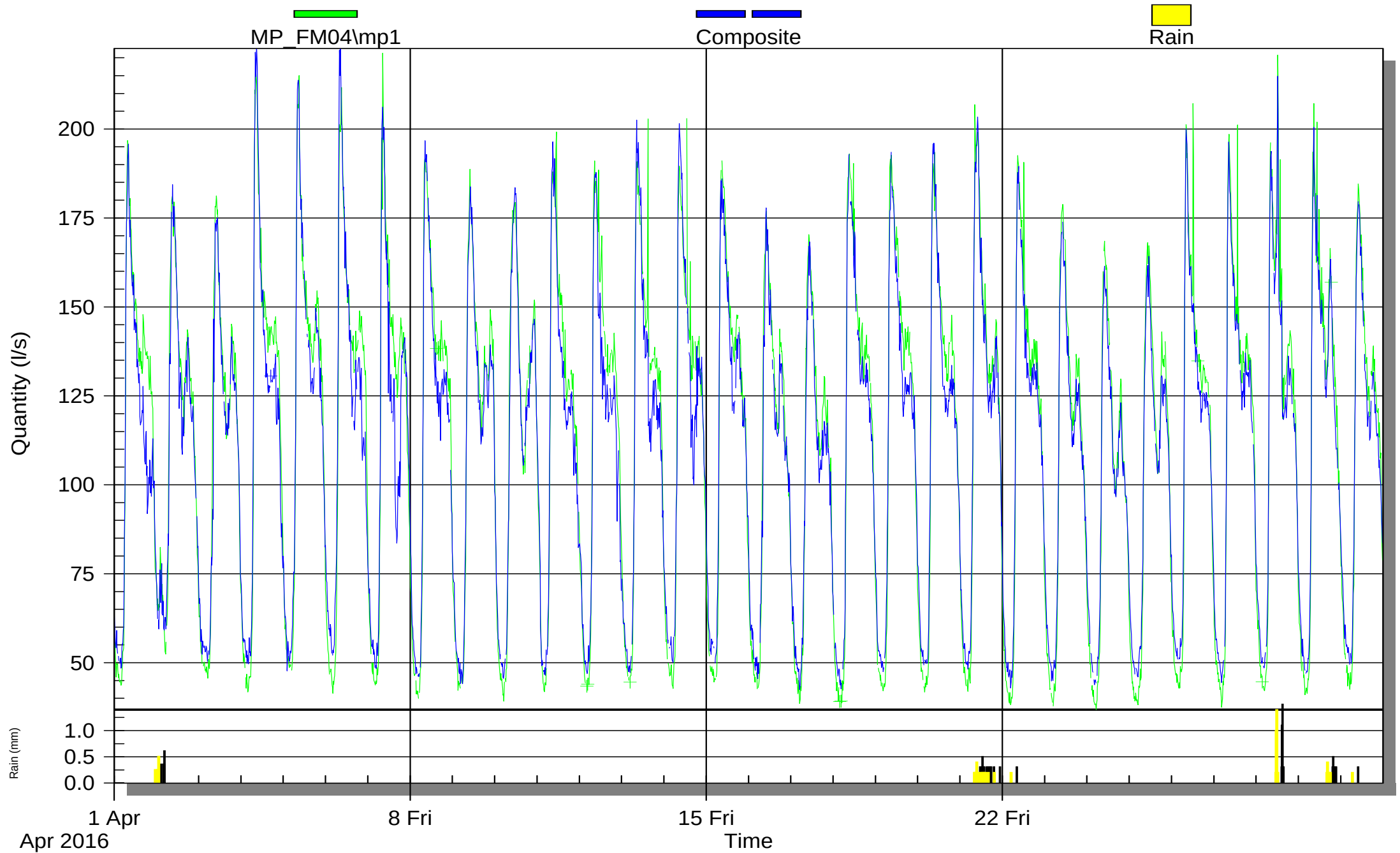
Mott MacDonald

Balance Report
Average Daily Flow



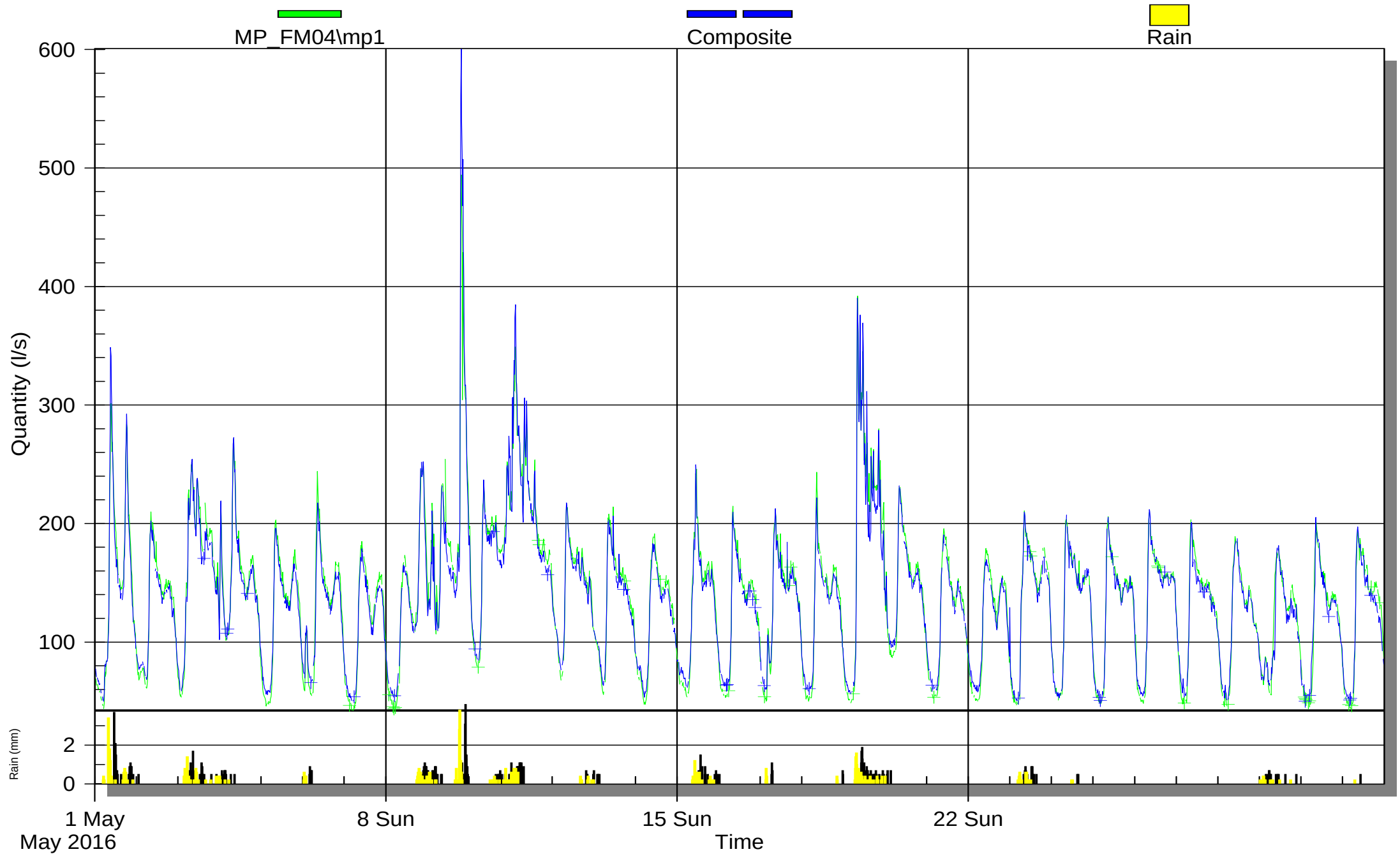
Mott MacDonald

Balance Report
Average Daily Flow



Mott MacDonald

Balance Report
Average Daily Flow



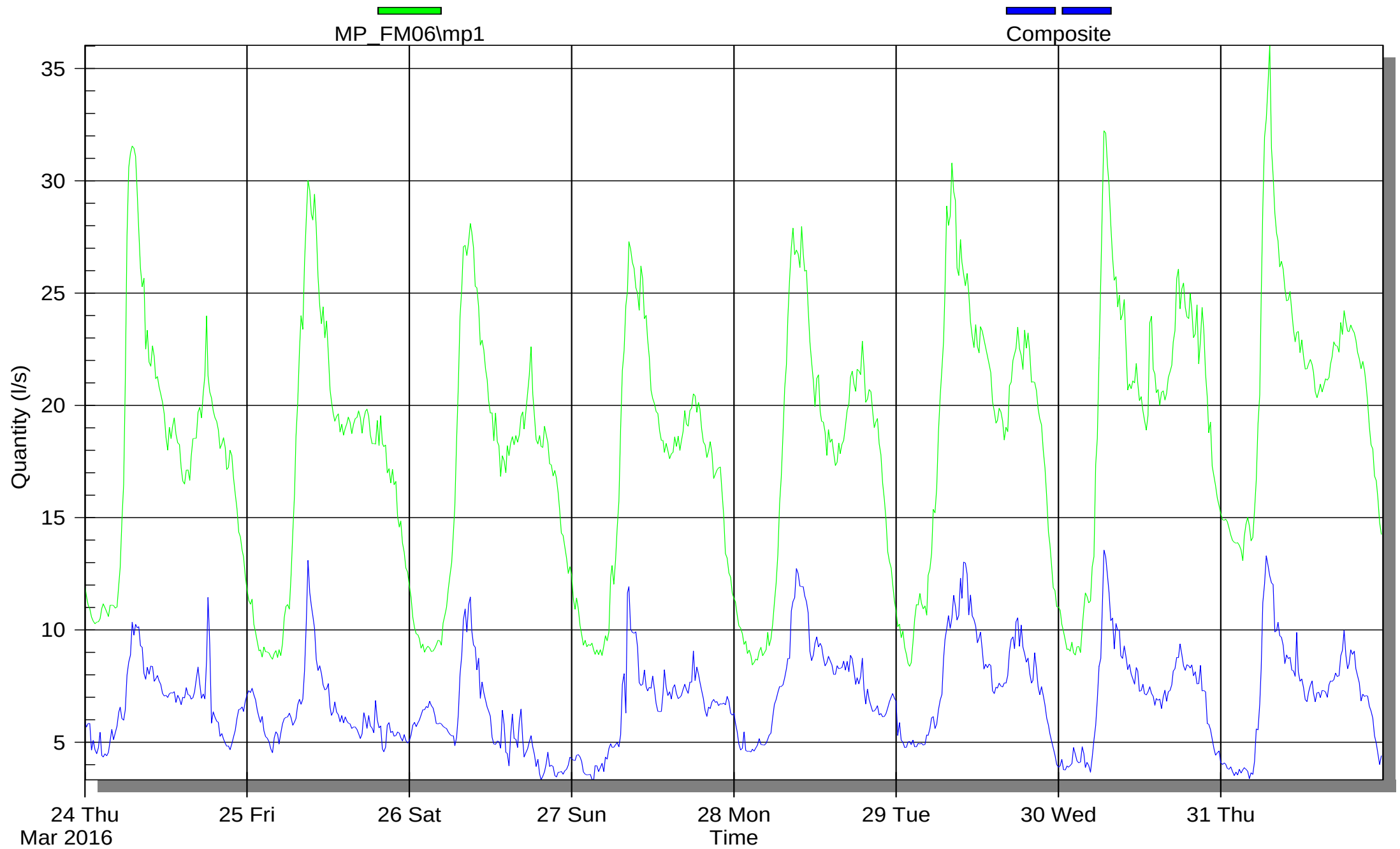
Mott MacDonald

Balance Report
Average Daily Flow



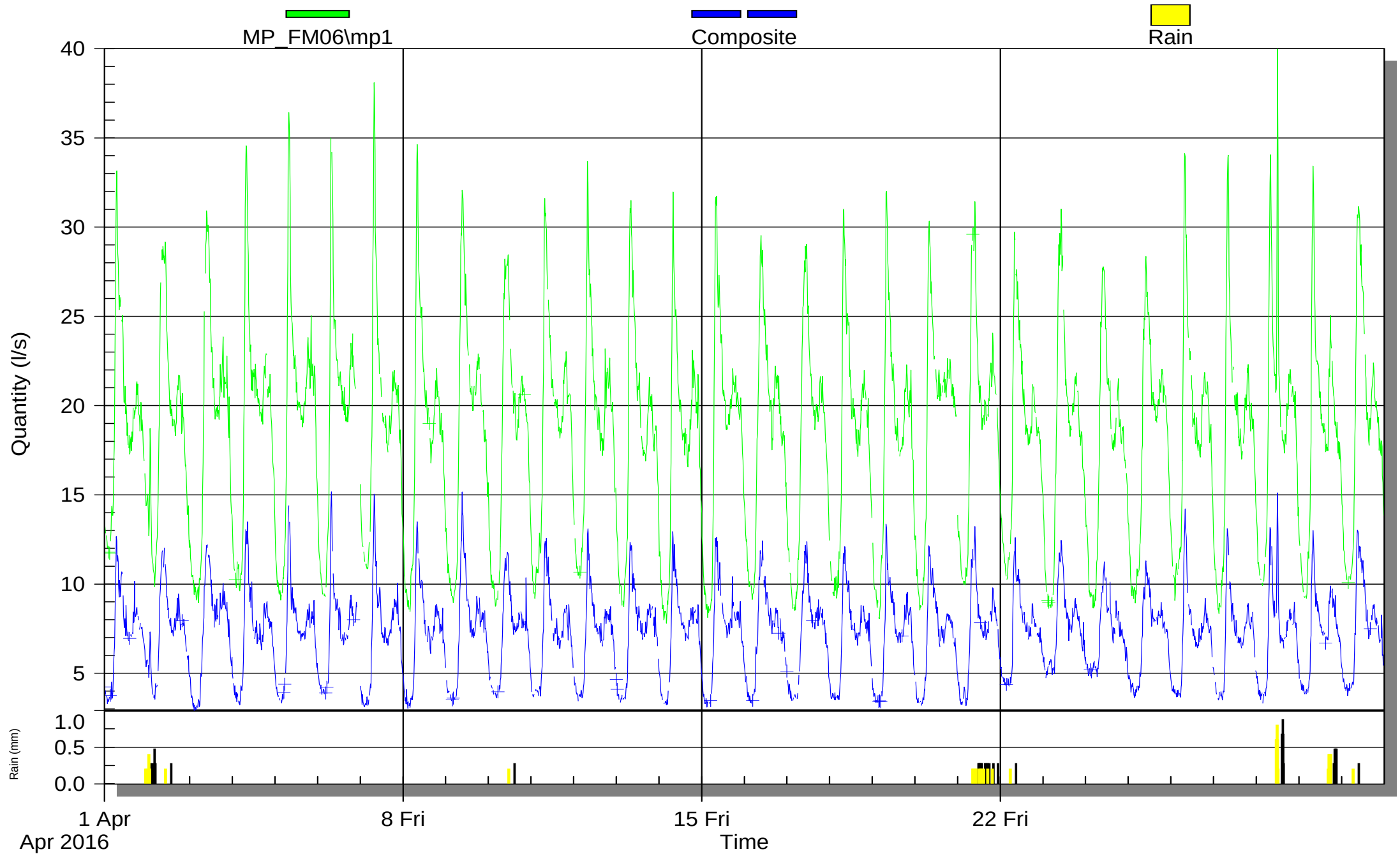
Mott MacDonald

Balance Report
Average Daily Flow



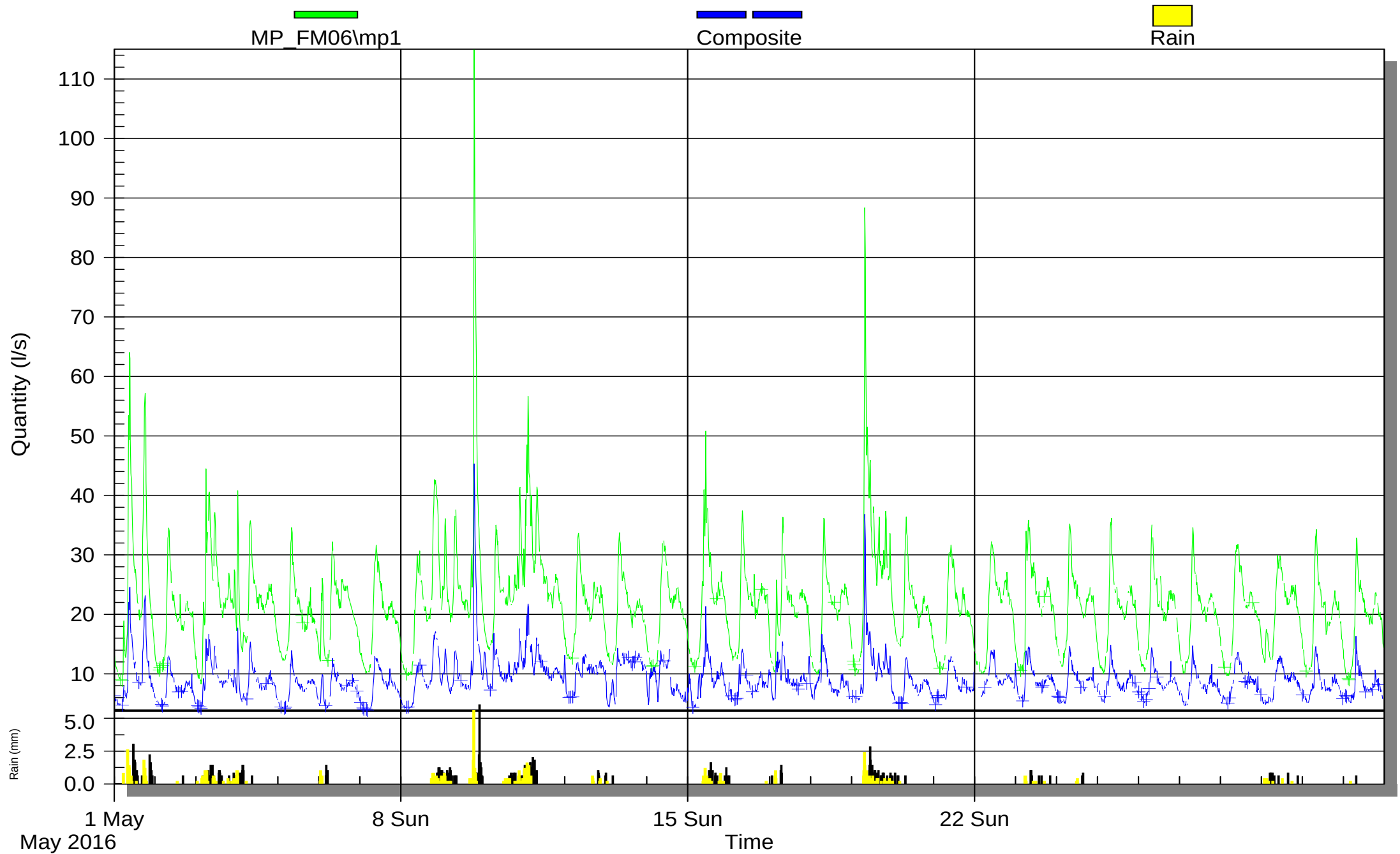
Mott MacDonald

Balance Report
Average Daily Flow



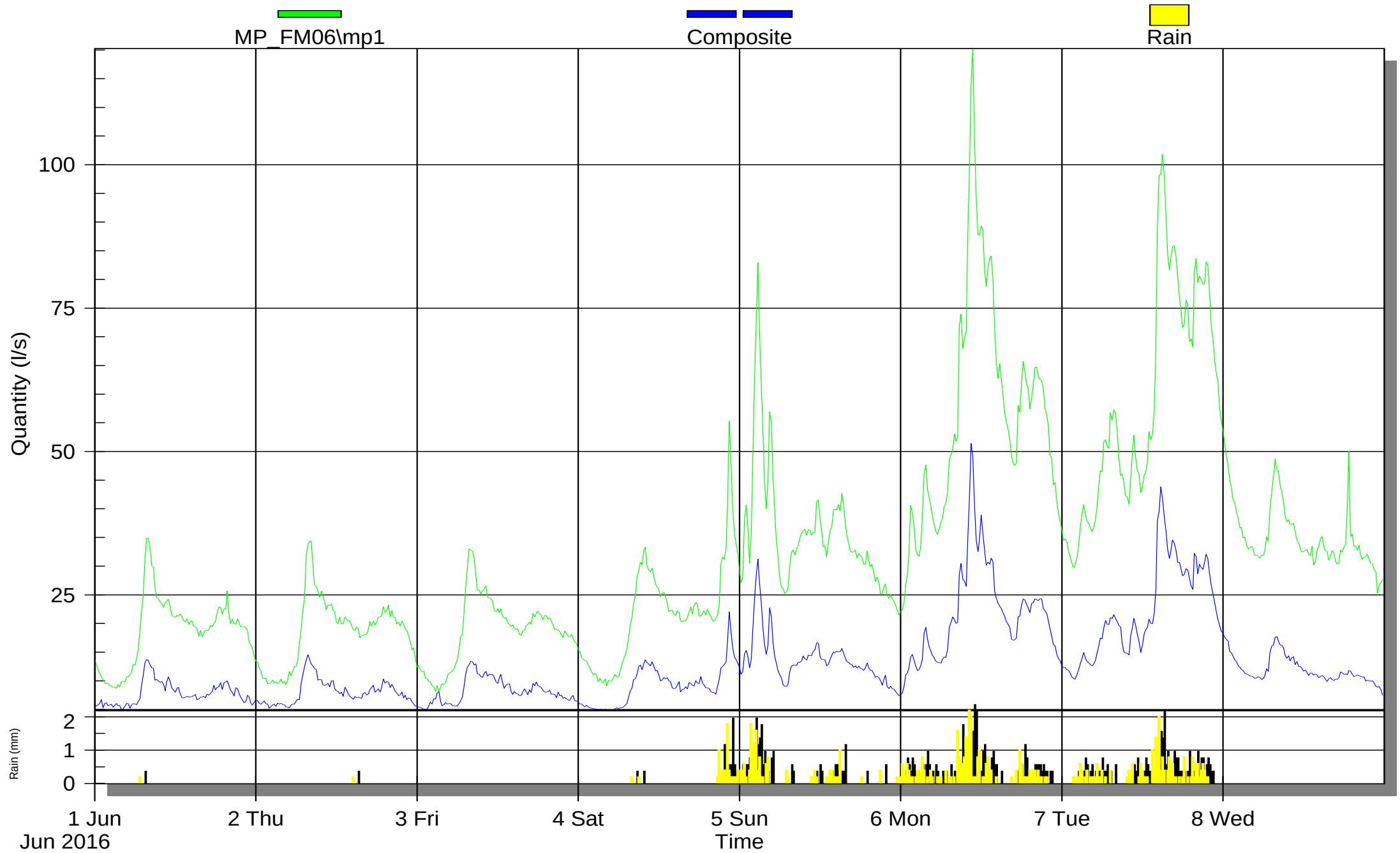
Mott MacDonald

Balance Report
Average Daily Flow



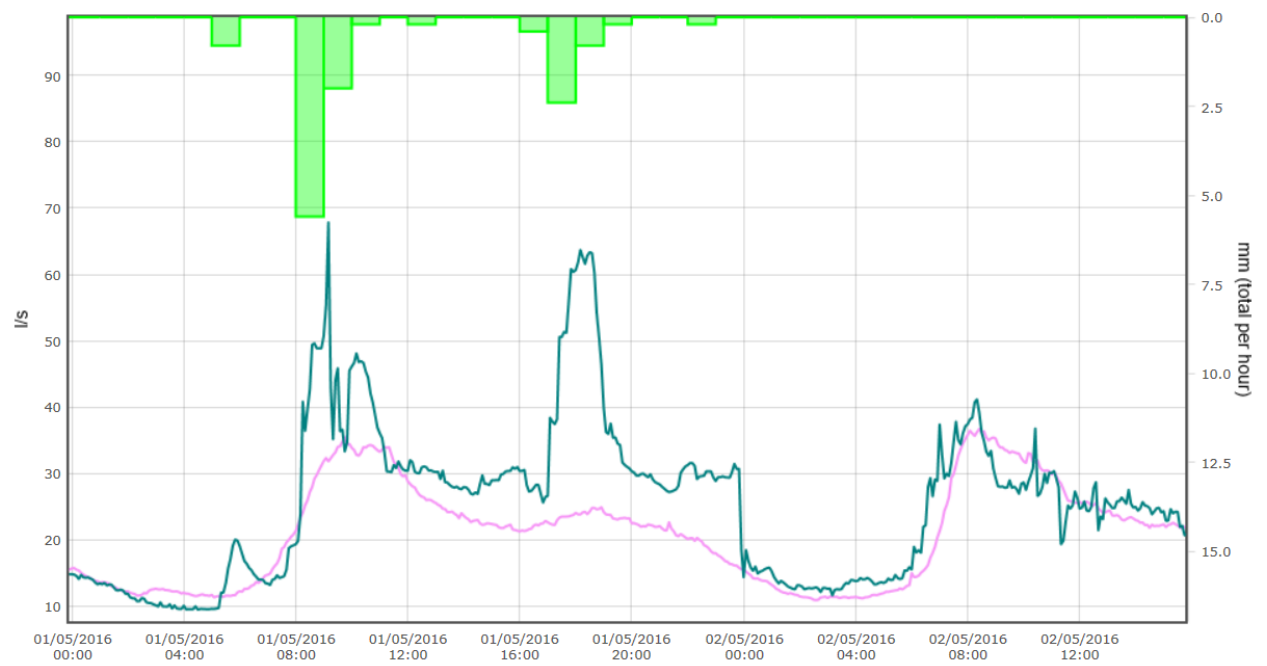
Mott MacDonald

Balance Report
Average Daily Flow

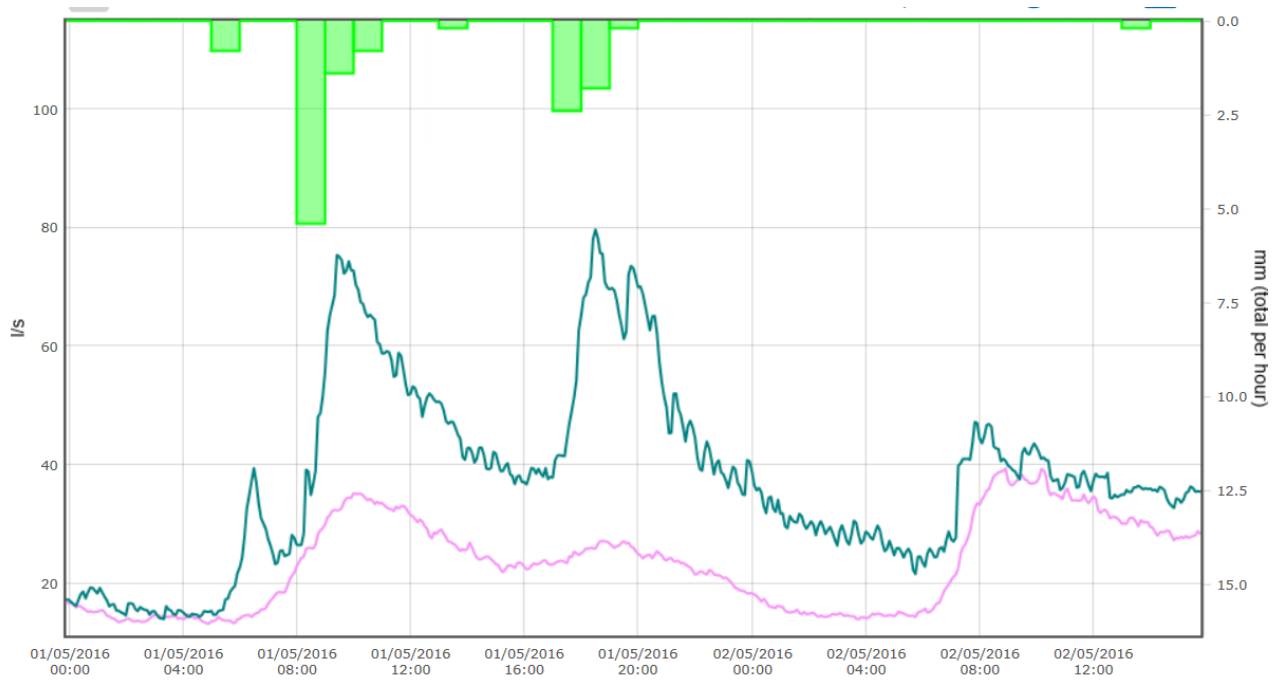


Appendix D. DWF v WWF PLOTS

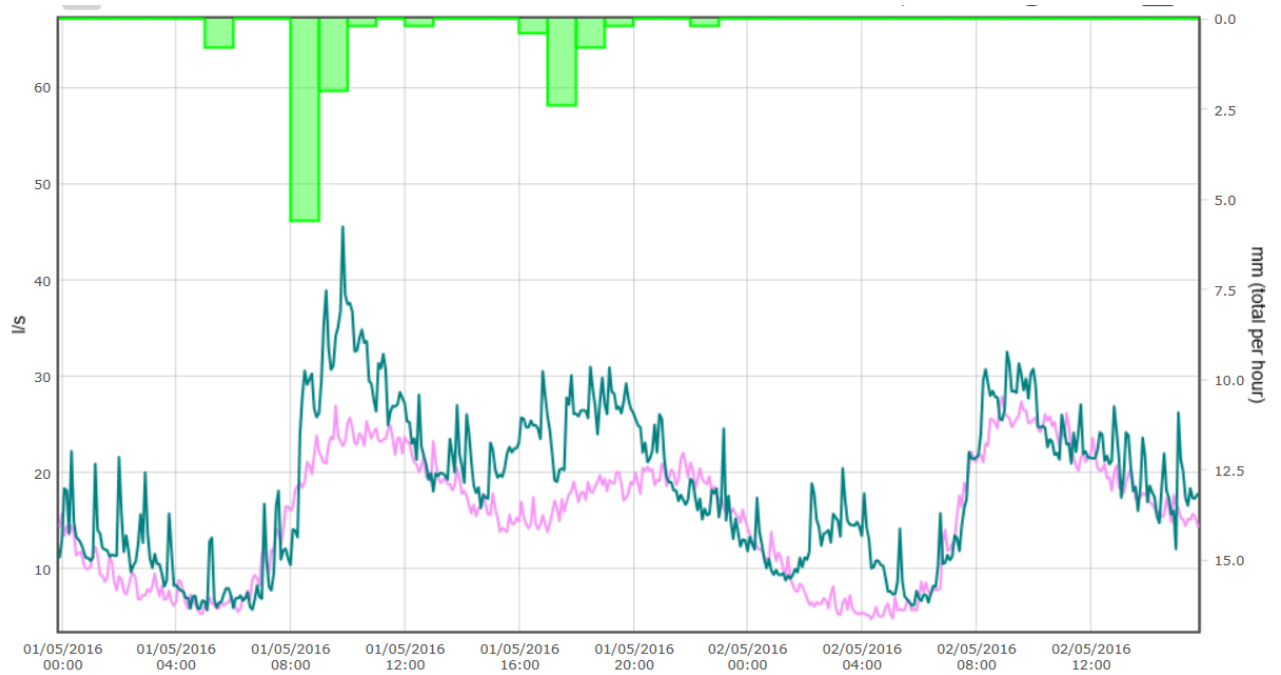
Rain Event 1: FM01



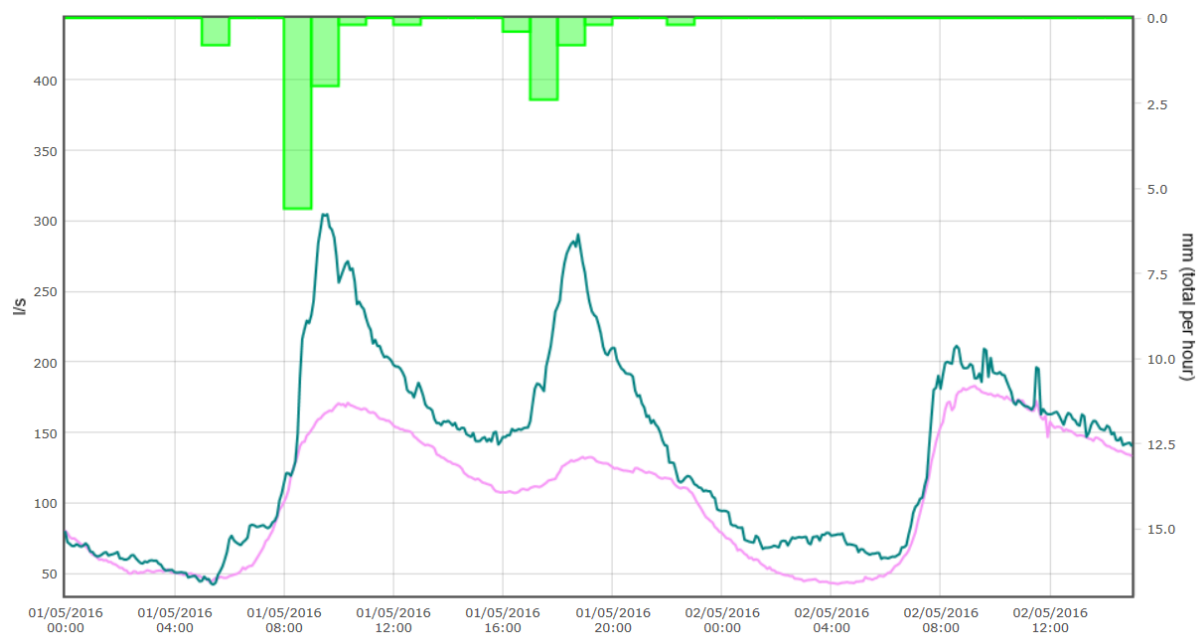
Rain Event 1: FM02



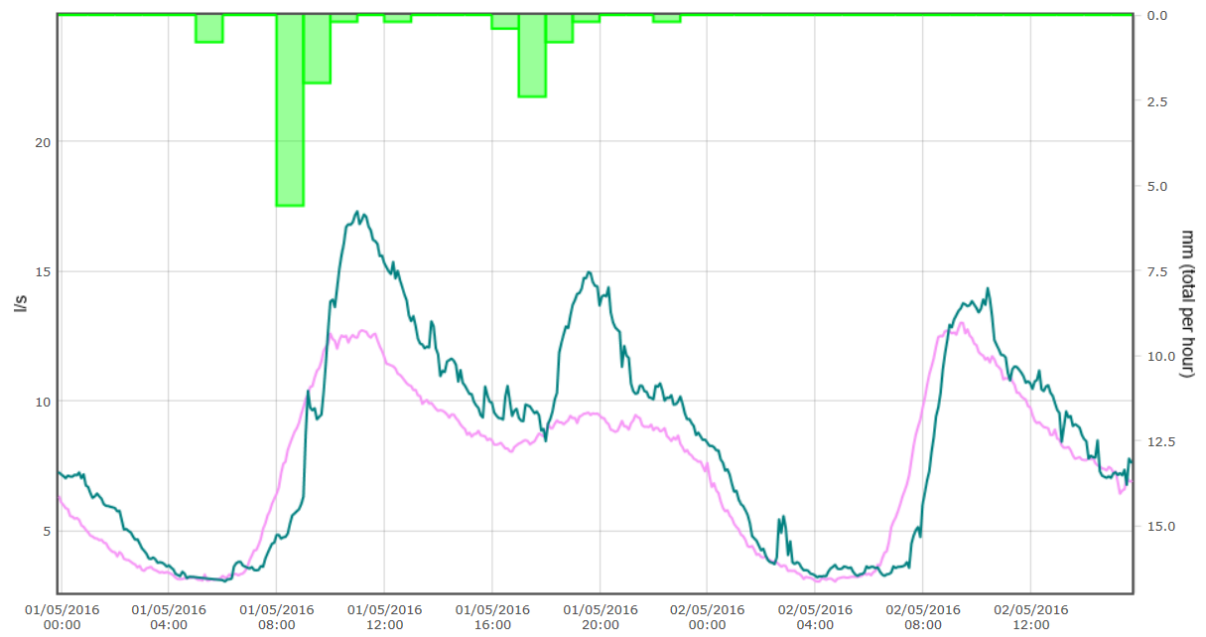
Rain Event 1: FM03



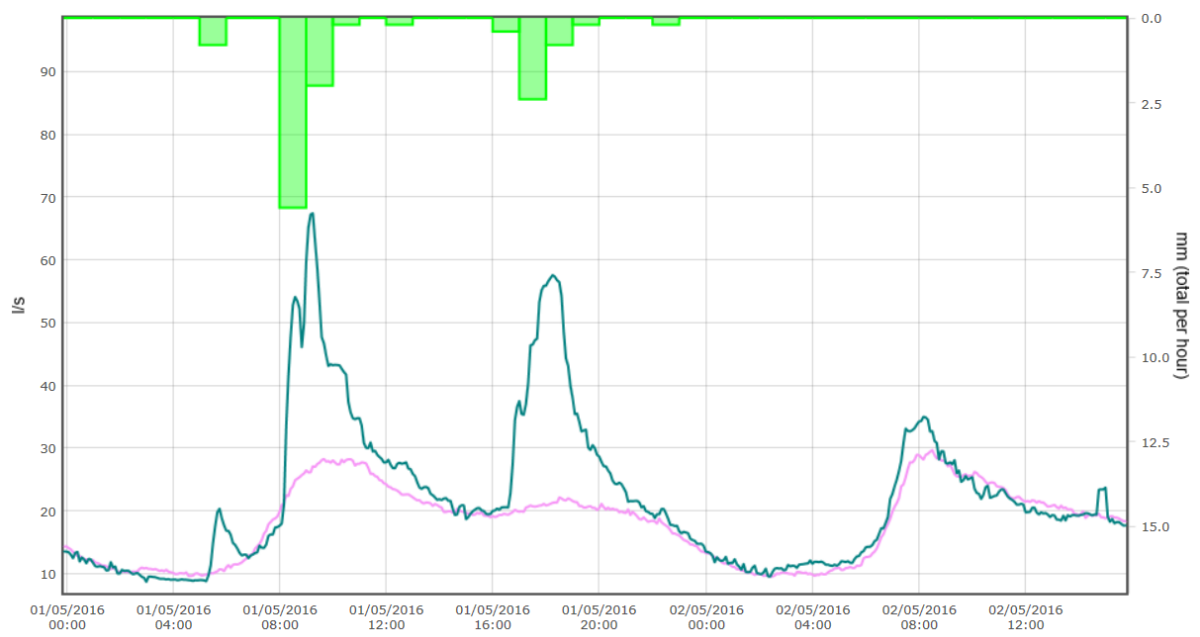
Rain Event 1: FM04



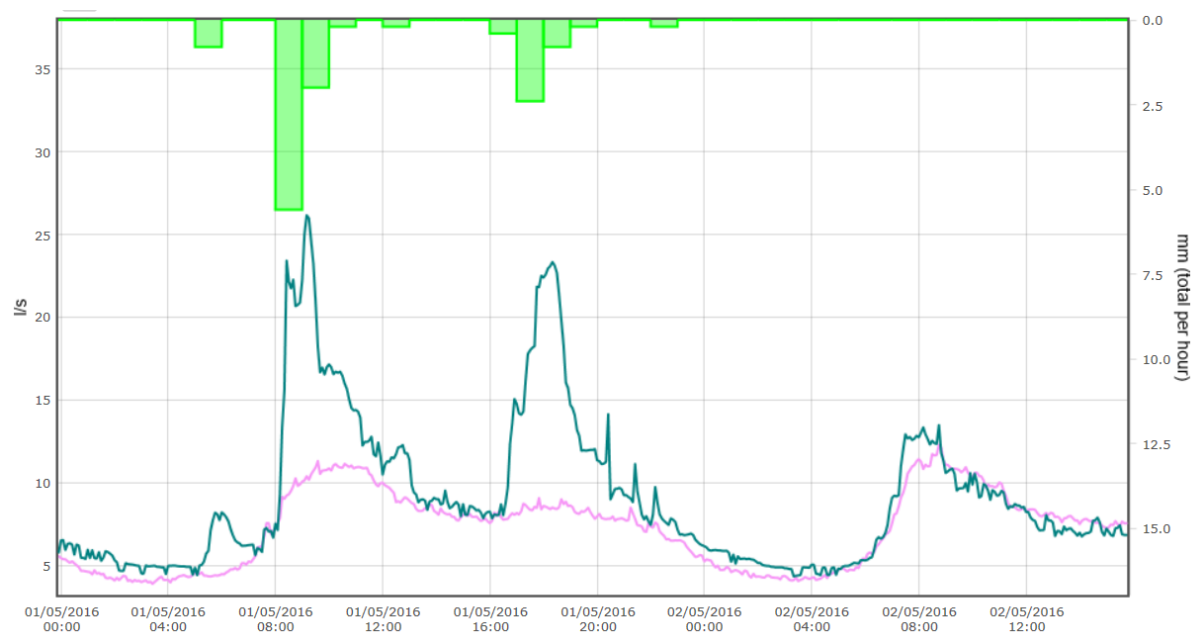
Rain Event 1: FM05



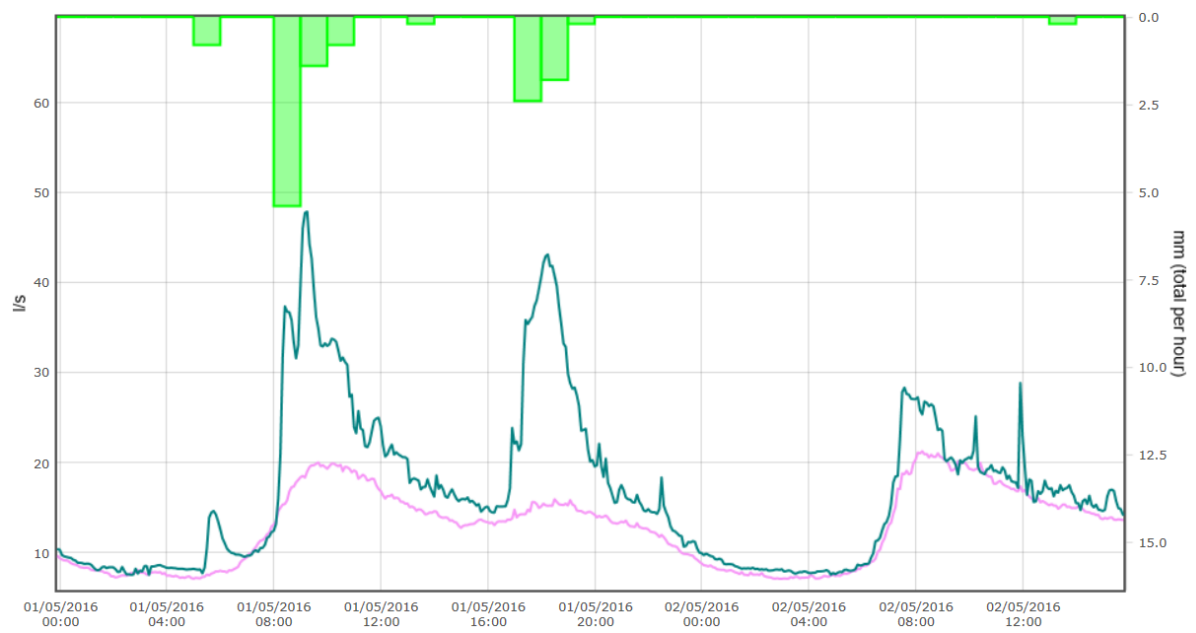
Rain Even 1: FM06



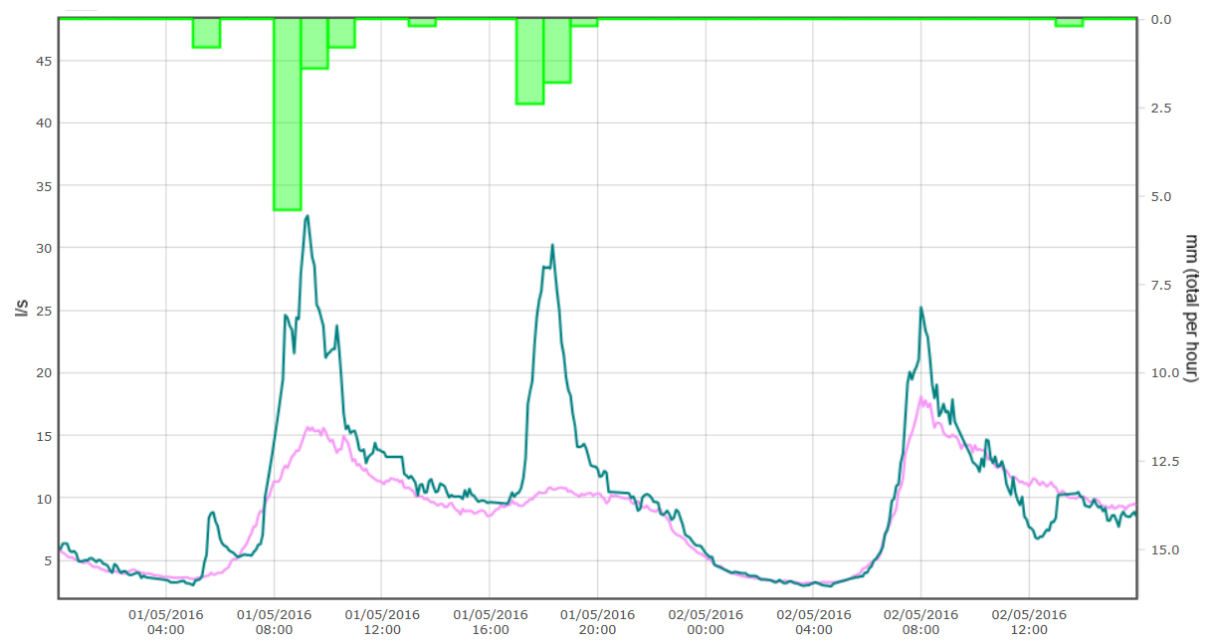
Rain Event 1: FM07



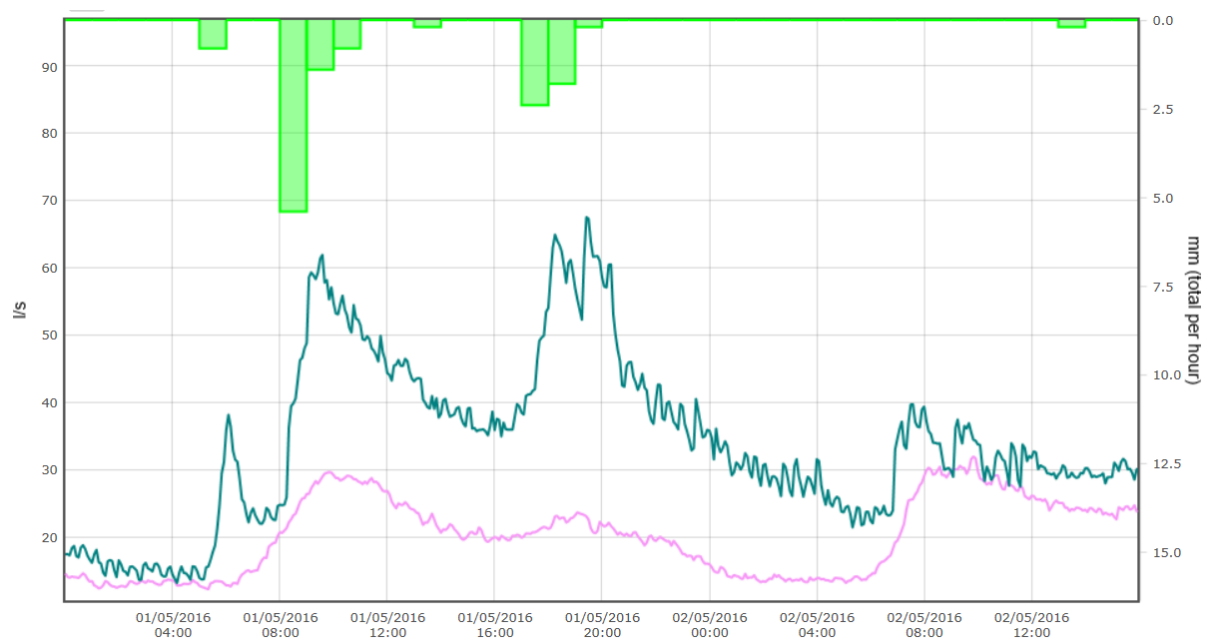
Rain Event 1: FM08



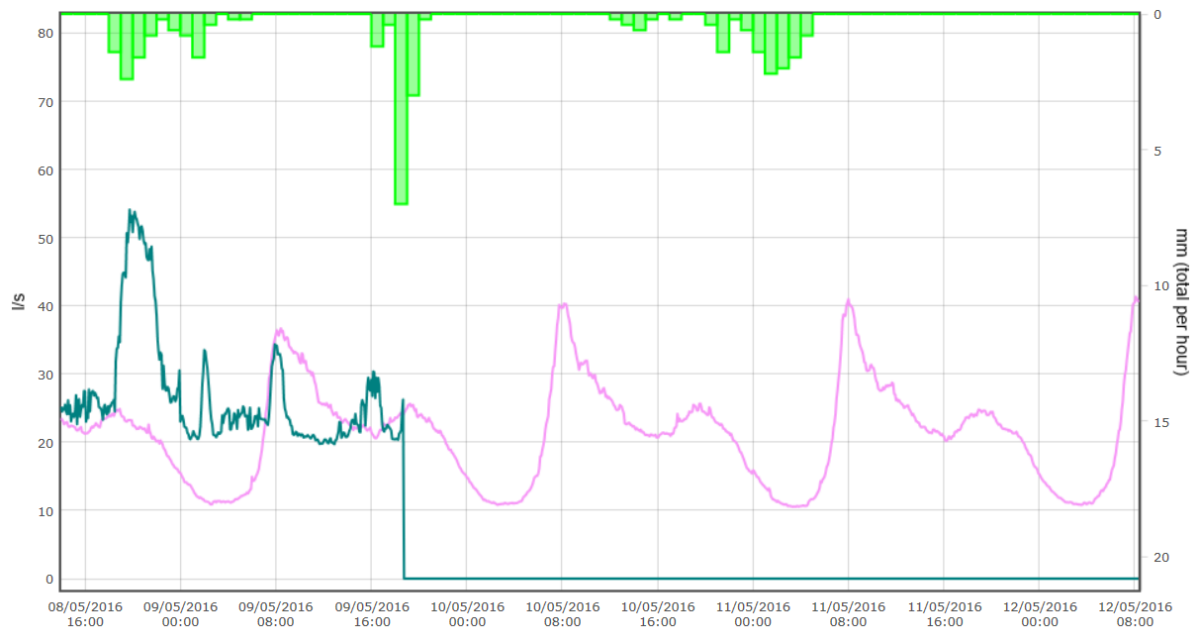
Rain Event 1: FM09



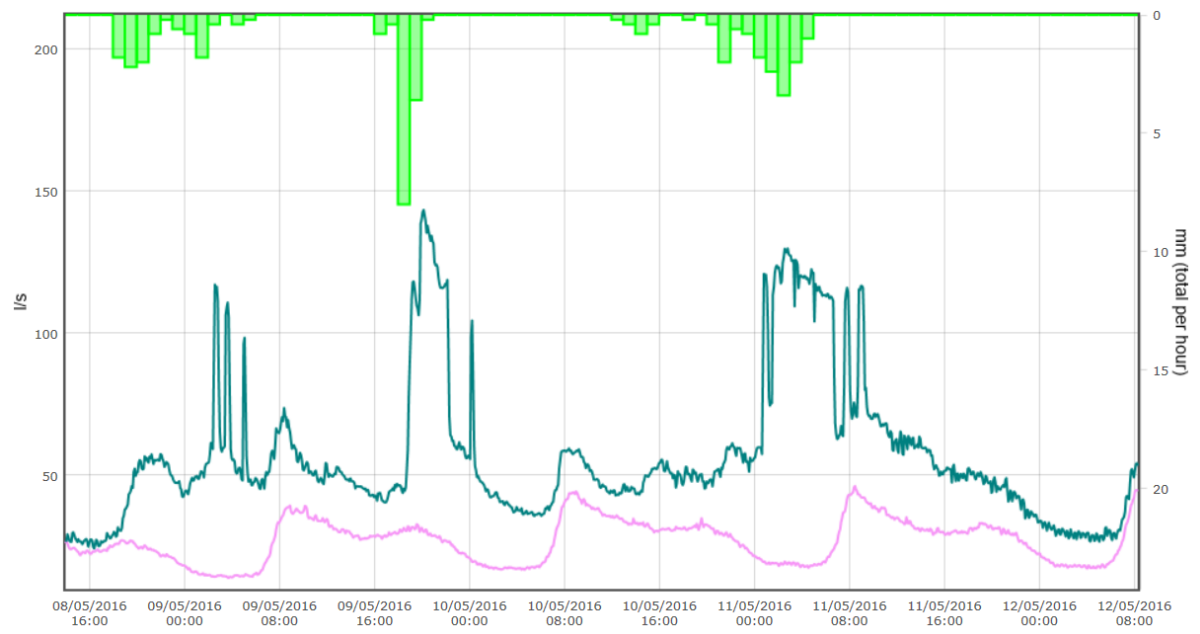
Rain Event 1: FM10



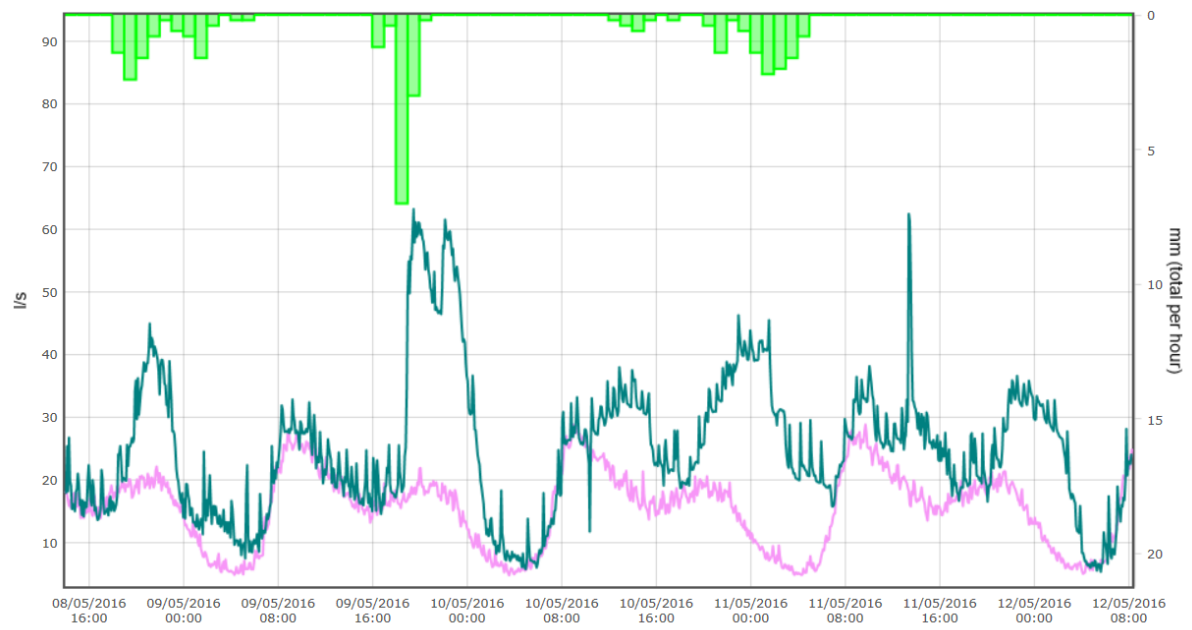
Rain Event 2: FM01



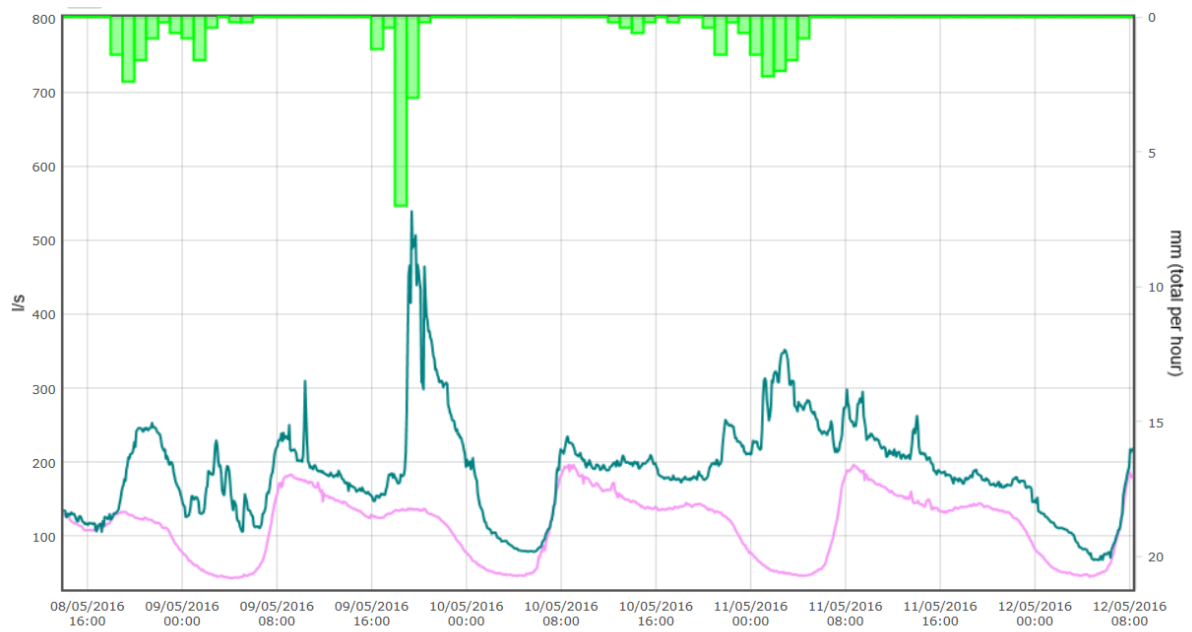
Rain Event 2: FM02



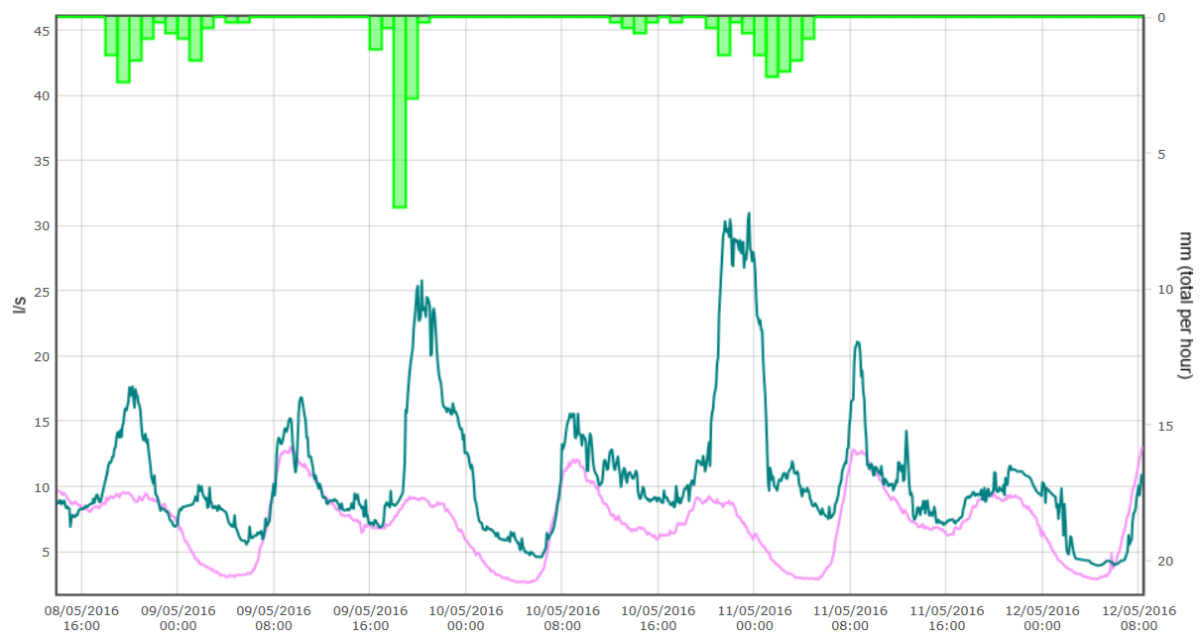
Rain Event 2: FM03



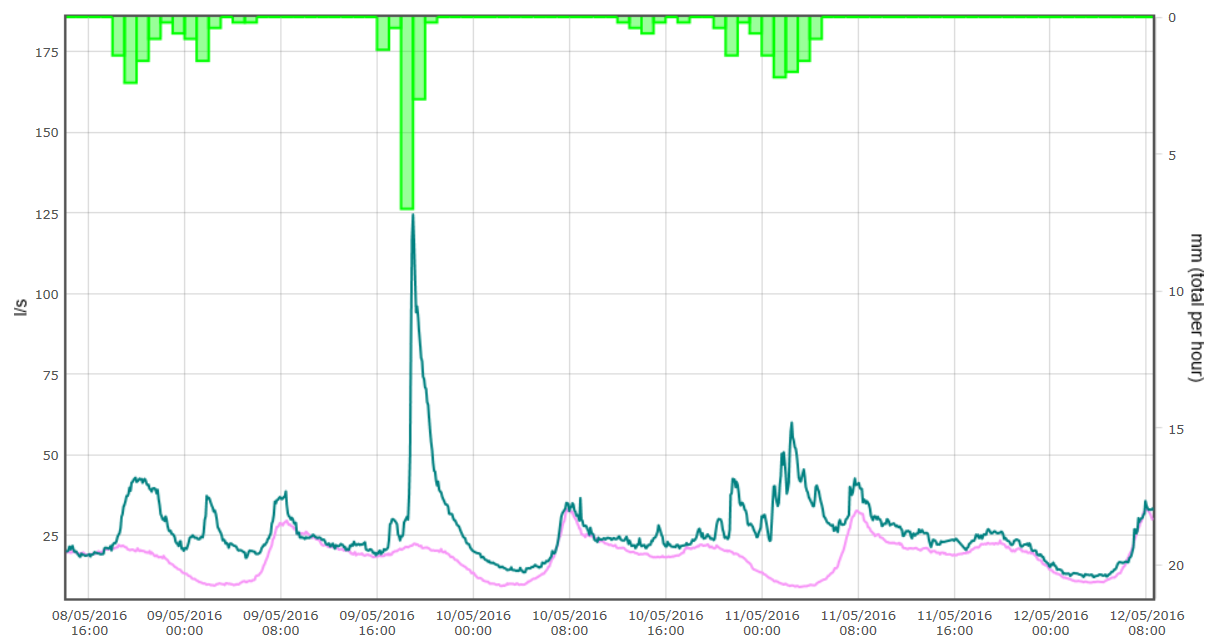
Rain Event 2: FM04



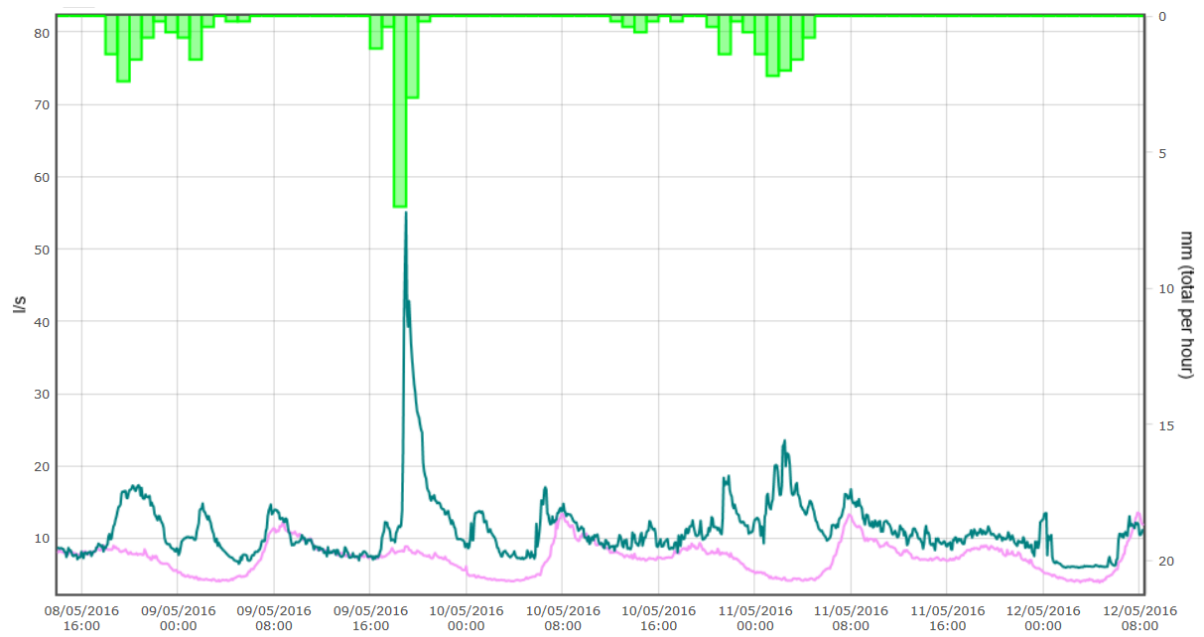
Rain Event 2: FM05



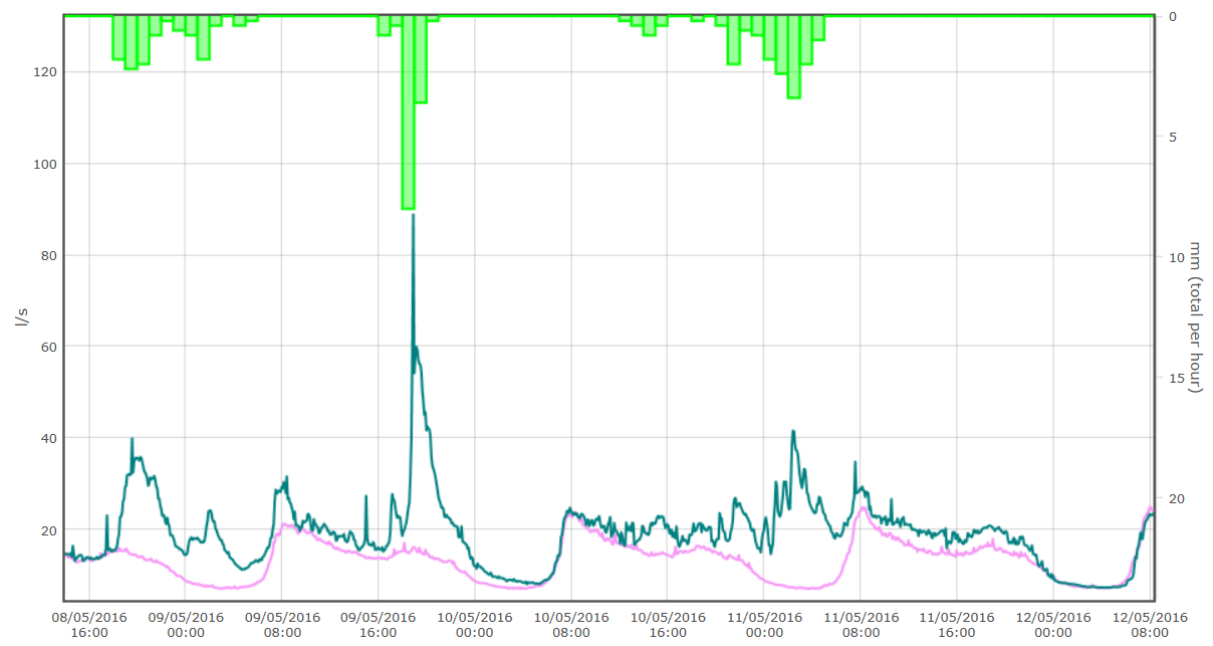
Rain Event 2: FM06



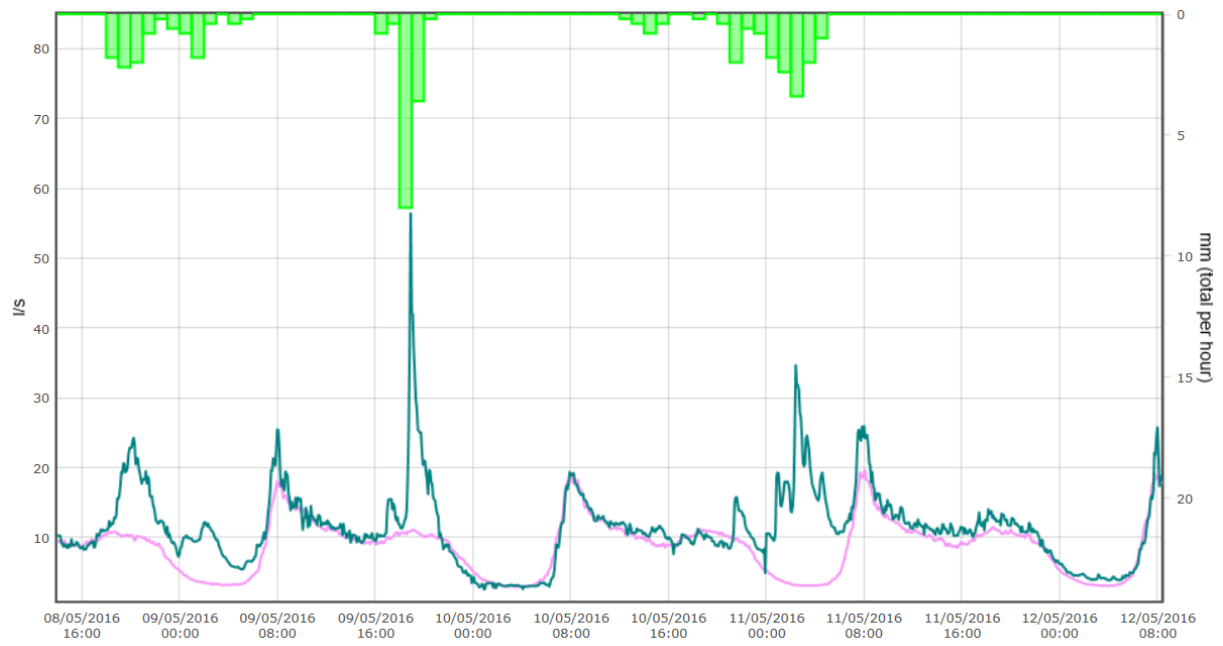
Rain Event 2: FM07



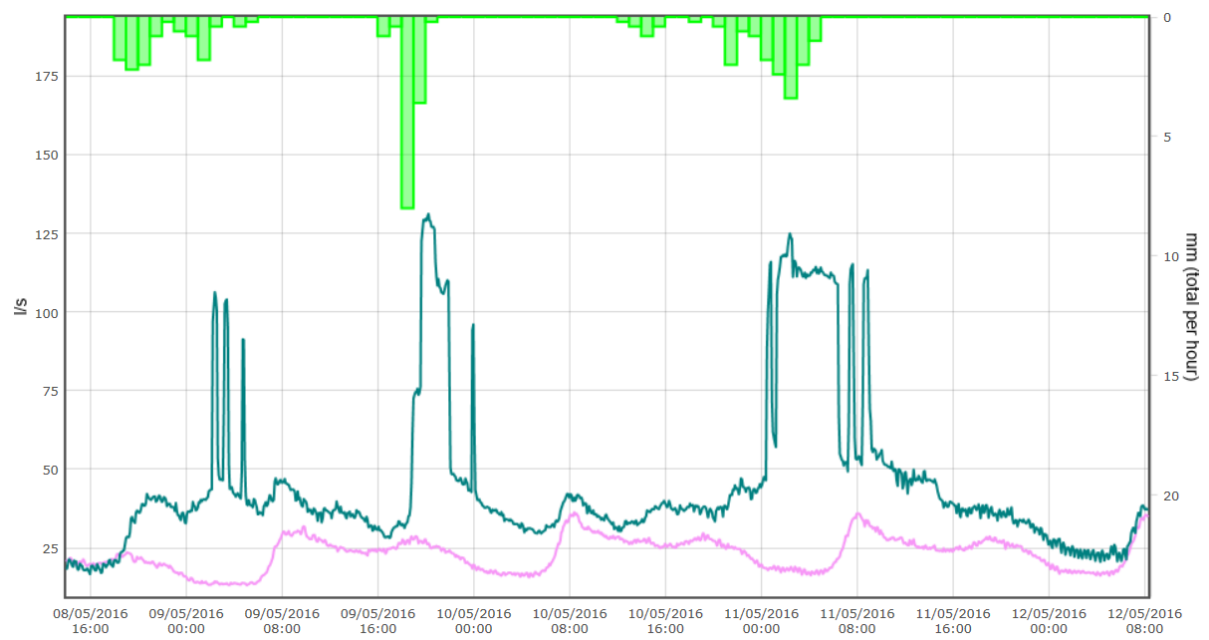
Rain Event 2: FM08



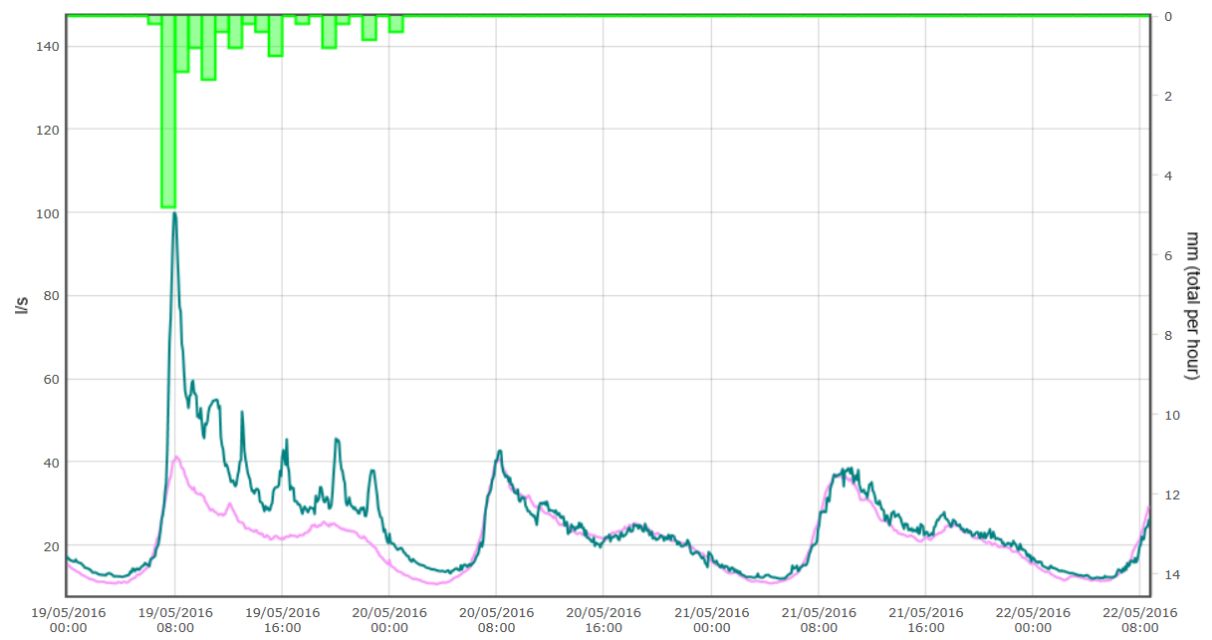
Rain Event 2: FM09



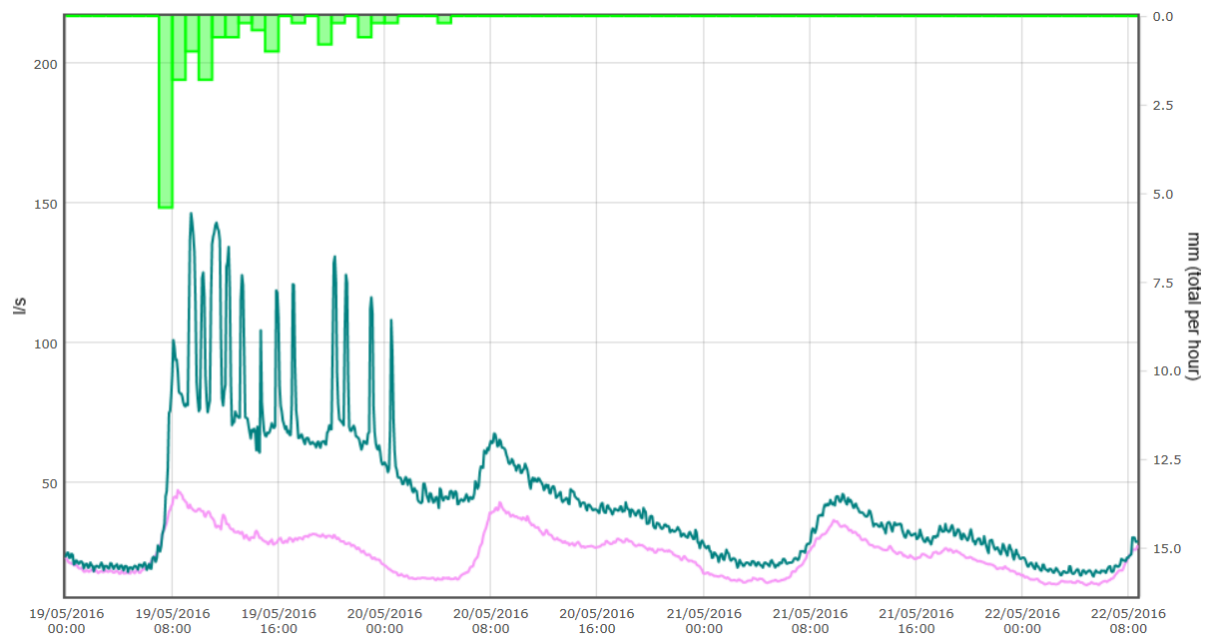
Rain Event 2: FM10



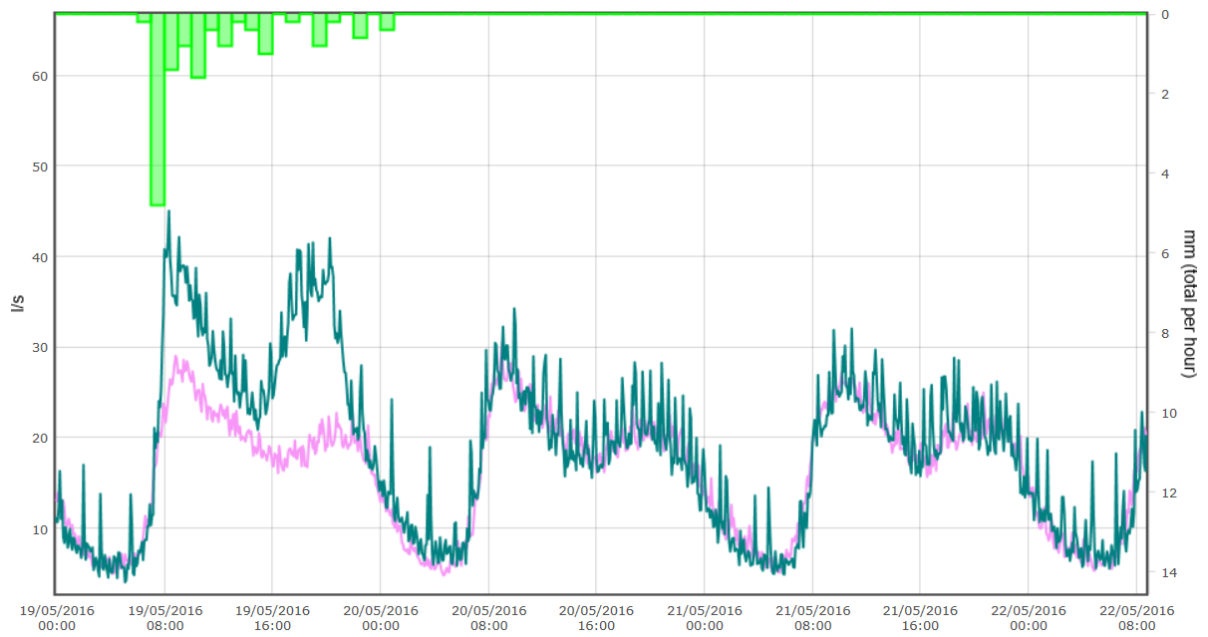
Rain Event 3: FM01



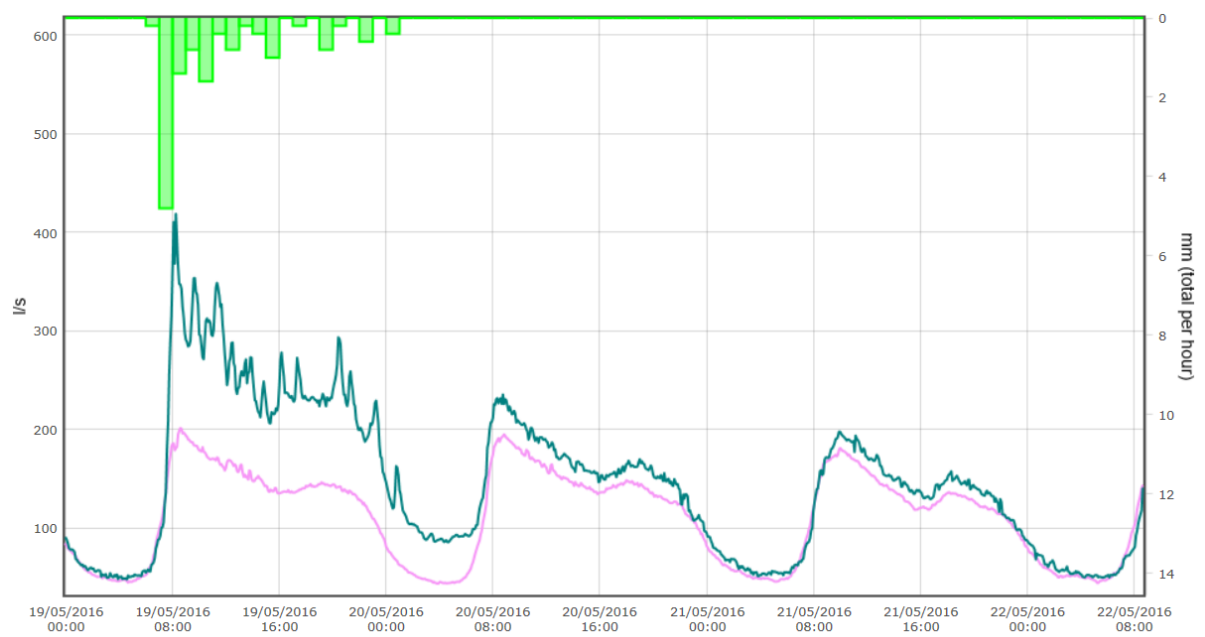
Rain Event 3: FM02



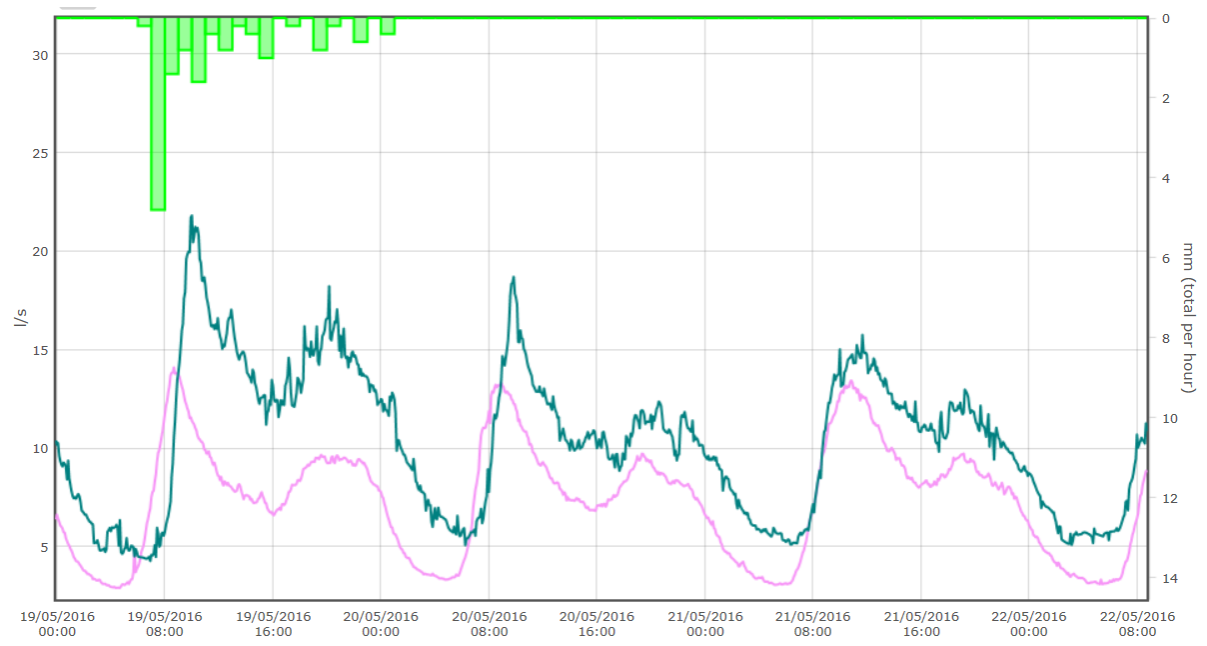
Rain Event 3: FM03



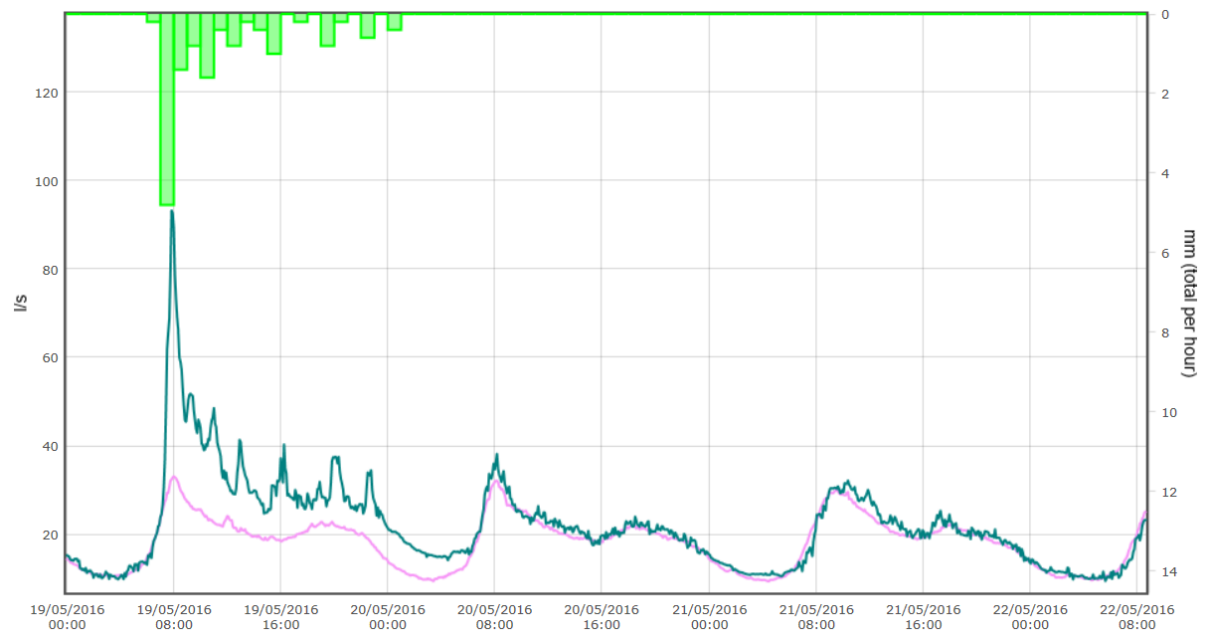
Rain Event 3: FM04



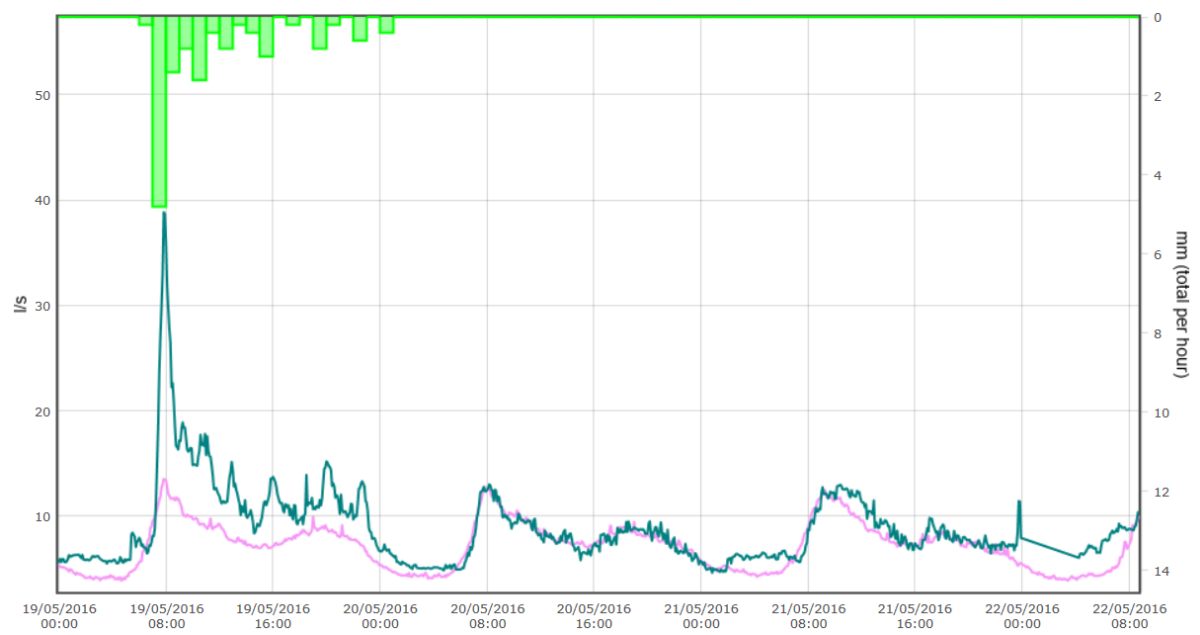
Rain Event 3: FM05



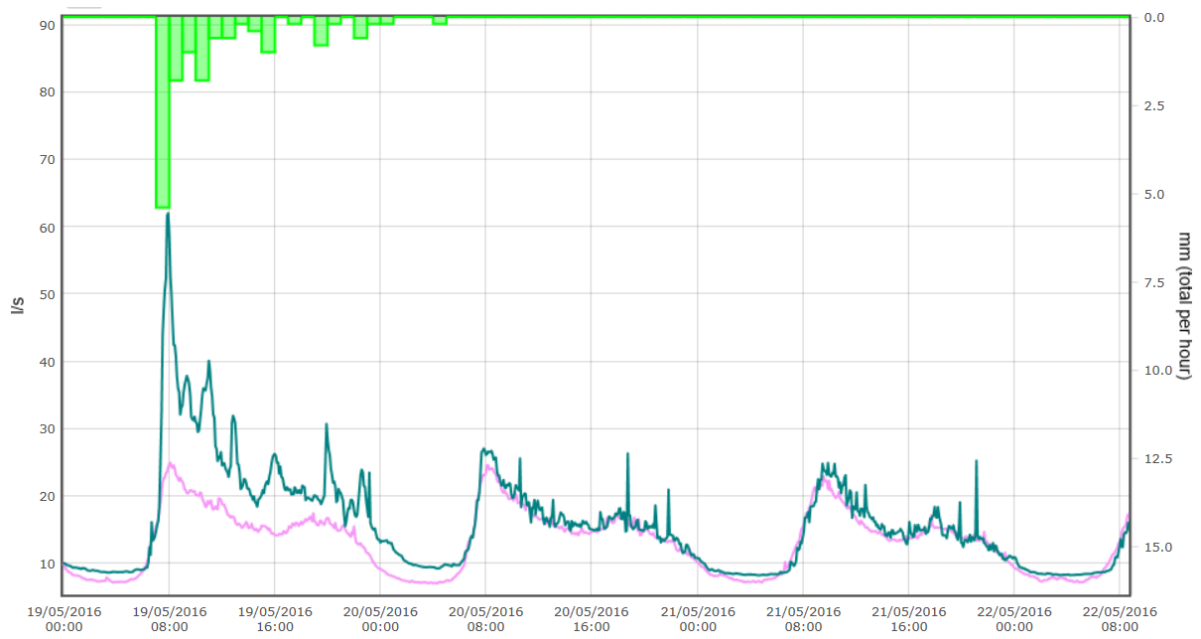
Rain Event 3: FM06



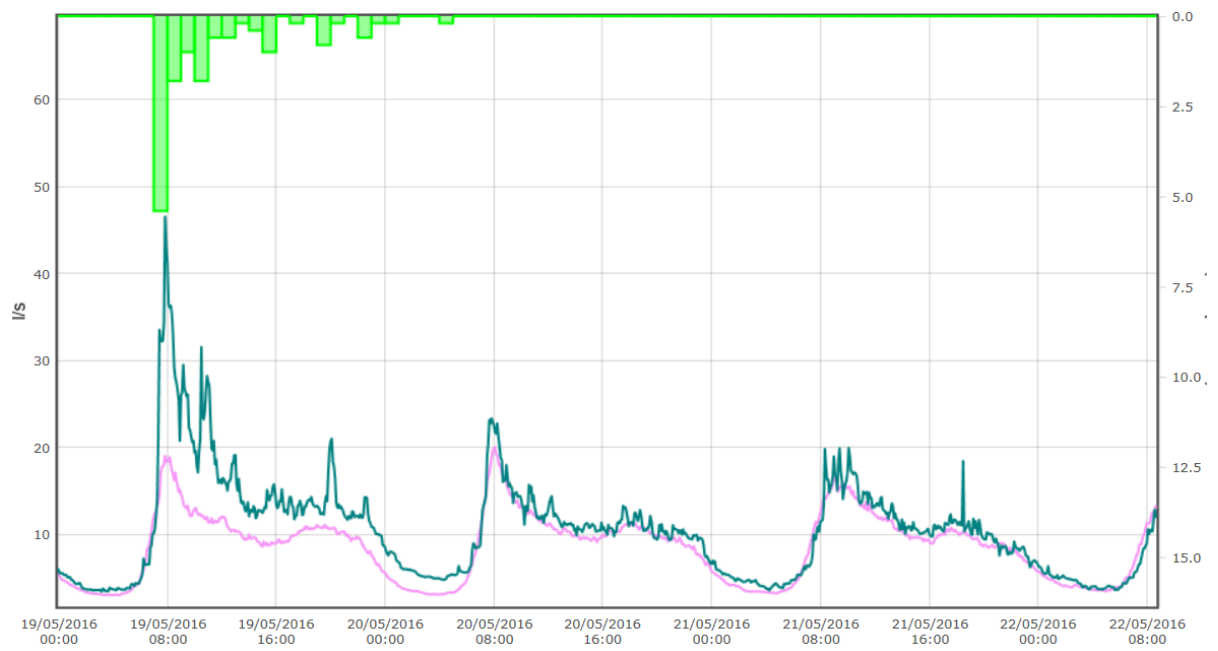
Rain Event 3: FM07



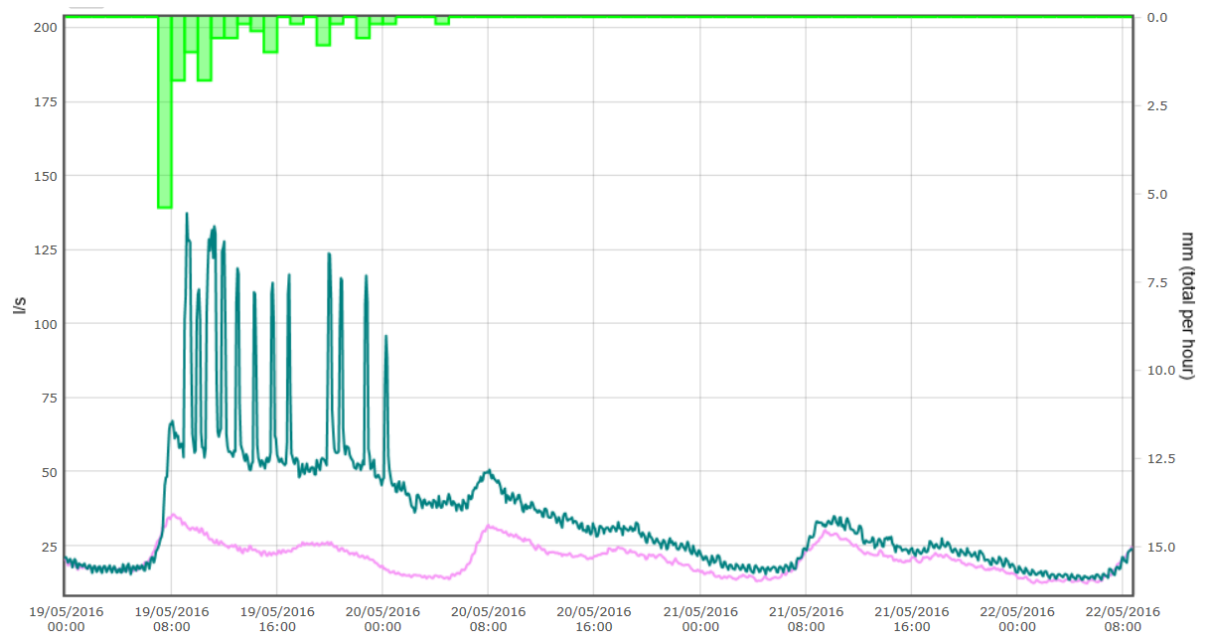
Rain Event 3: FM08



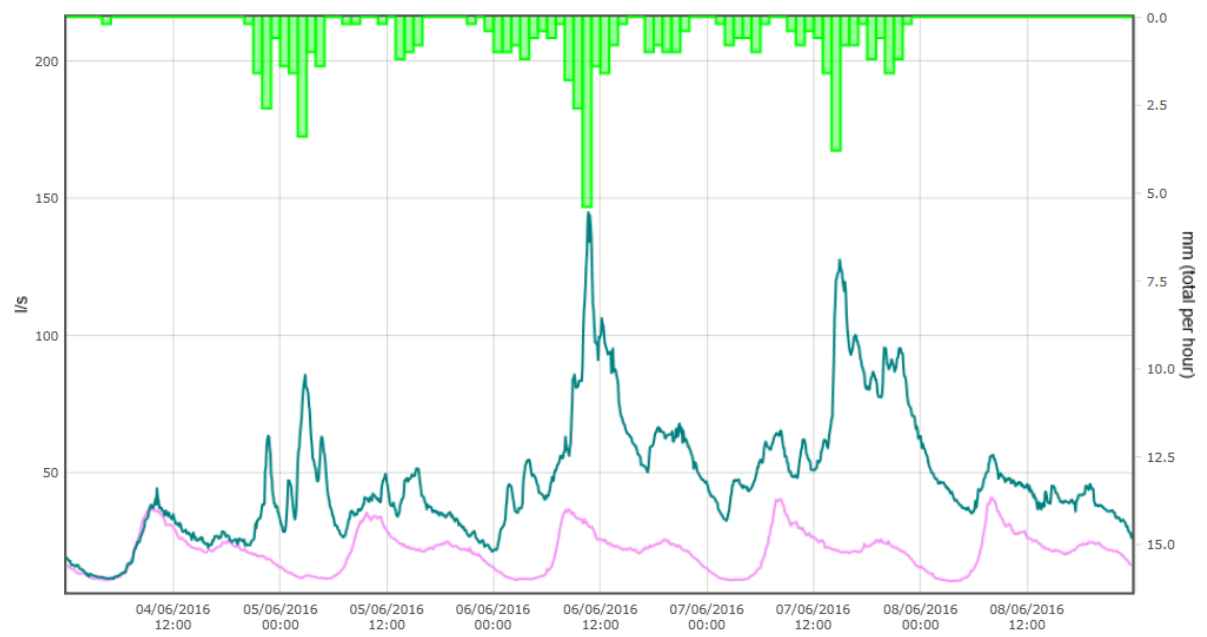
Rain Event 3: FM09



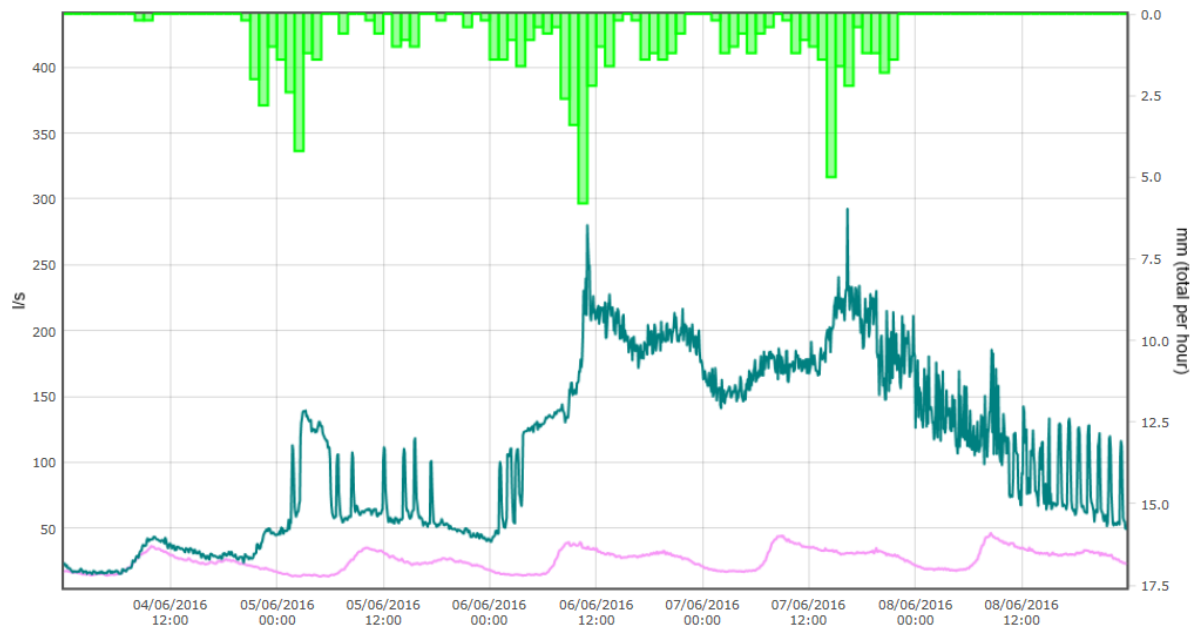
Rain Event 3: FM10



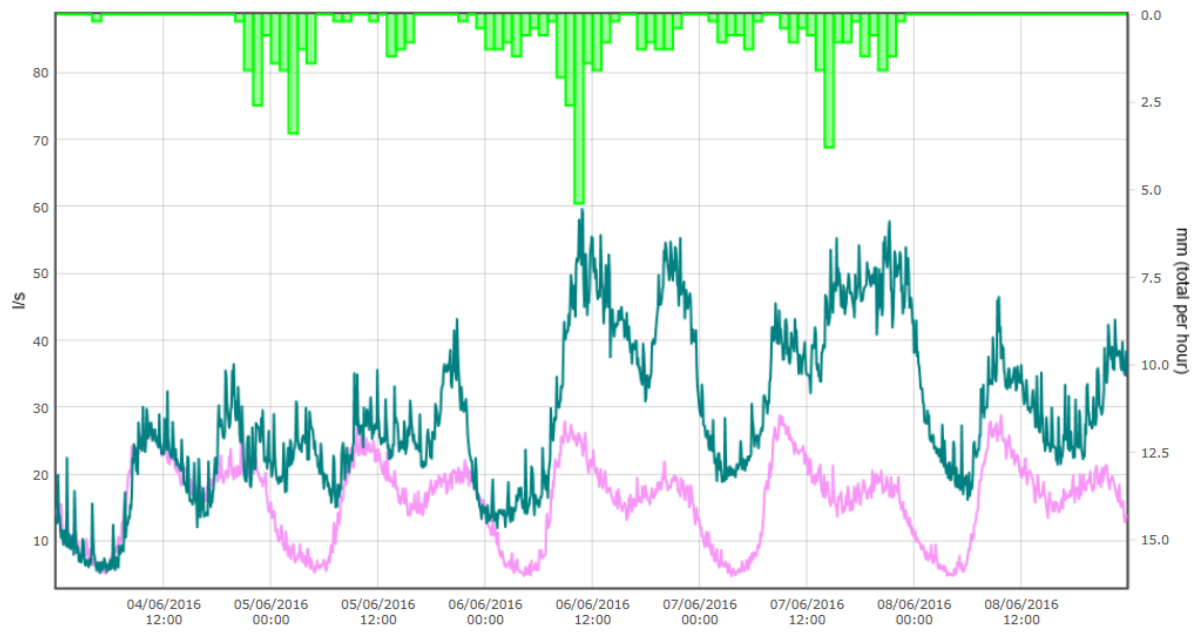
Rain Event 4: F1



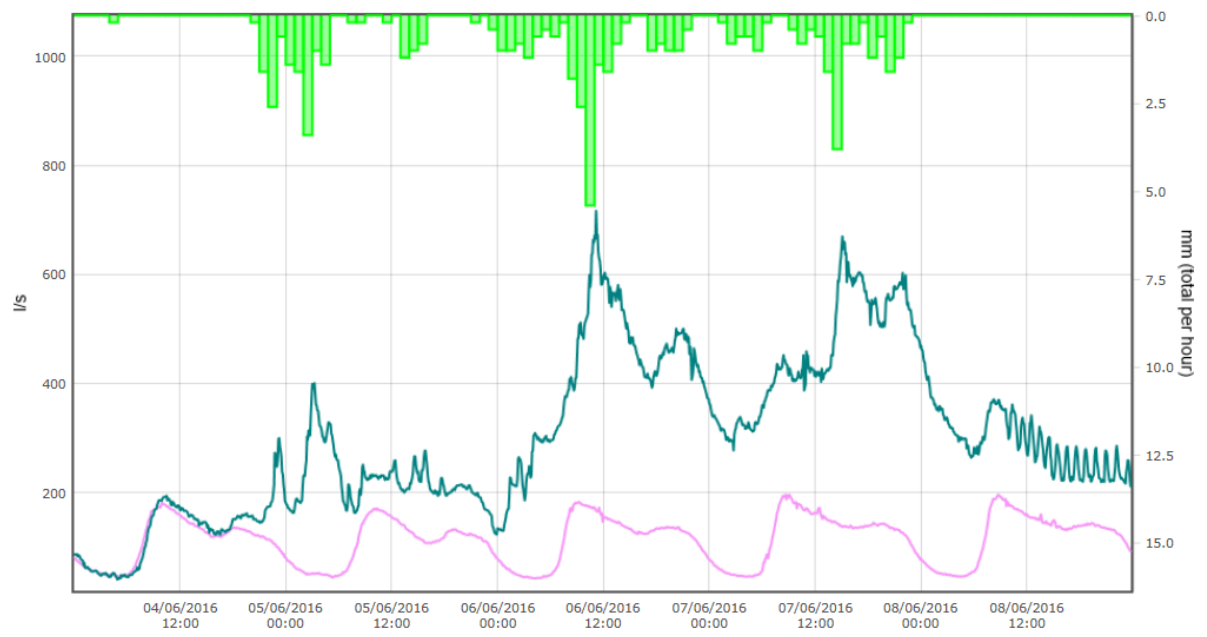
Rain Event 4: F2



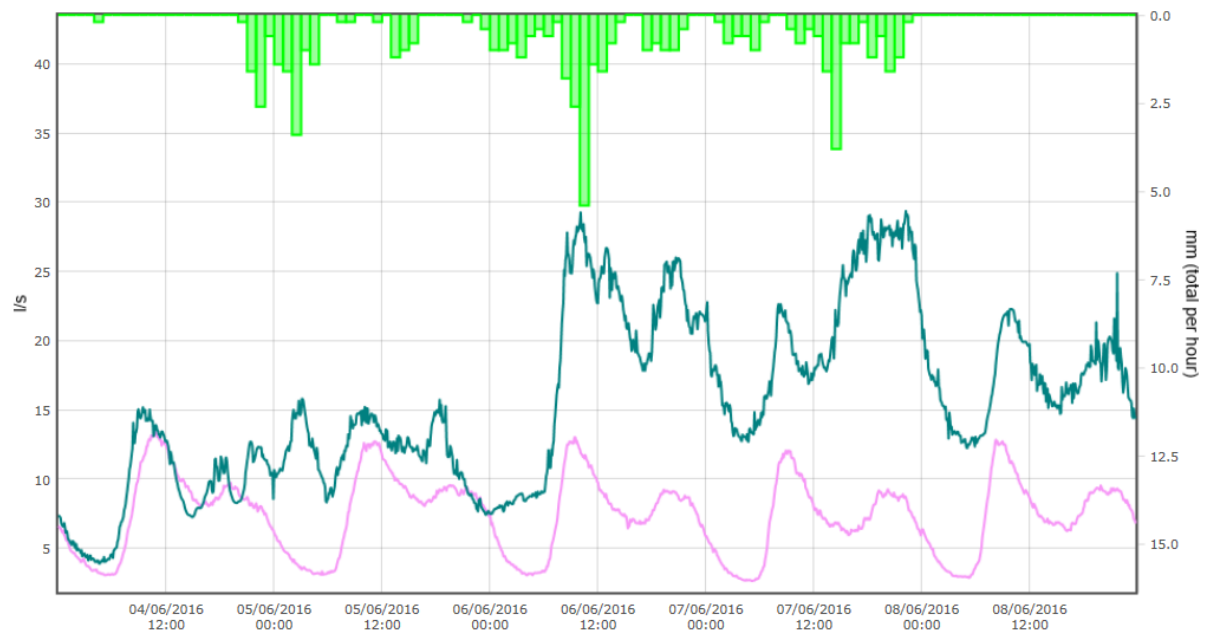
Rain Event 4: F3



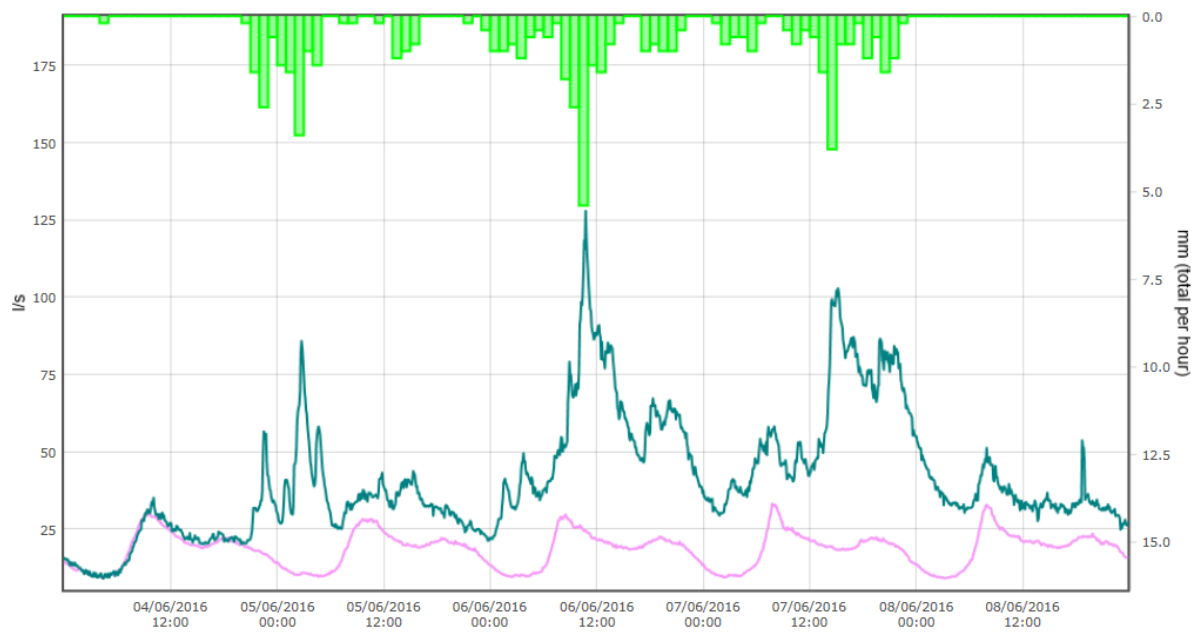
Rain Event 4: F4



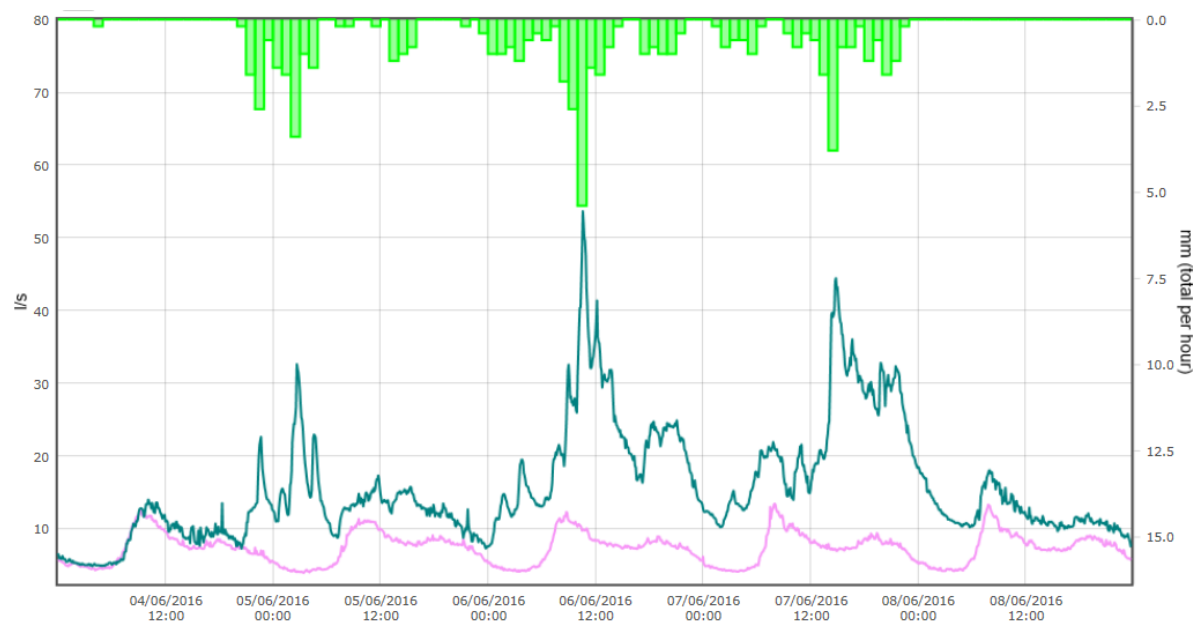
Rain Event 4: F5



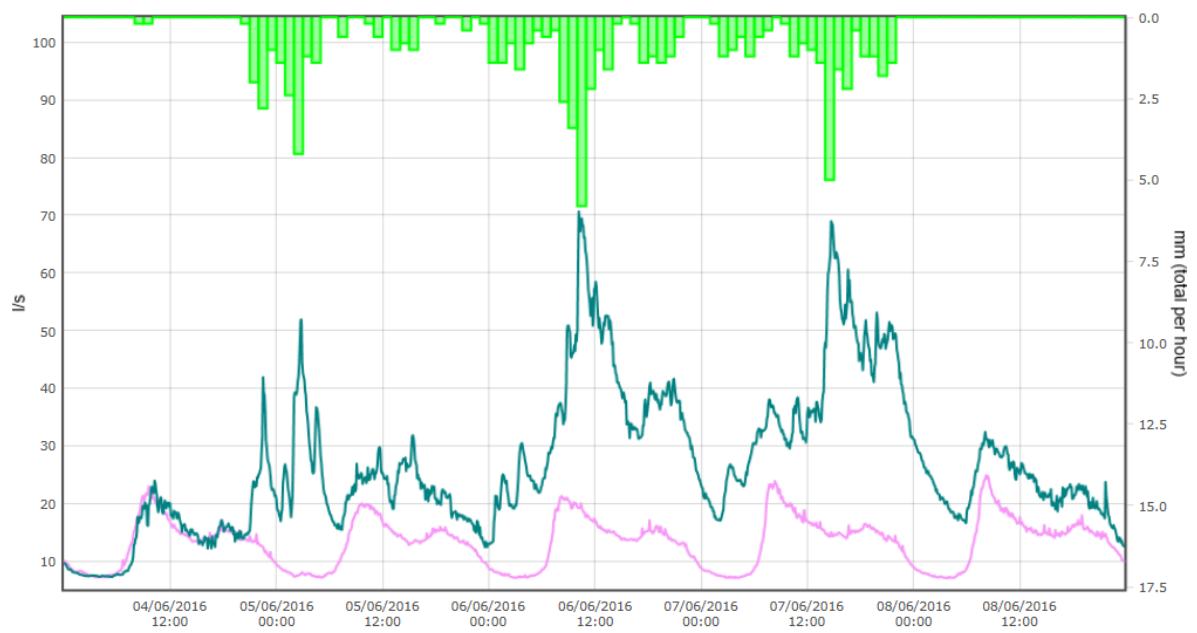
Rain Event 4: F6



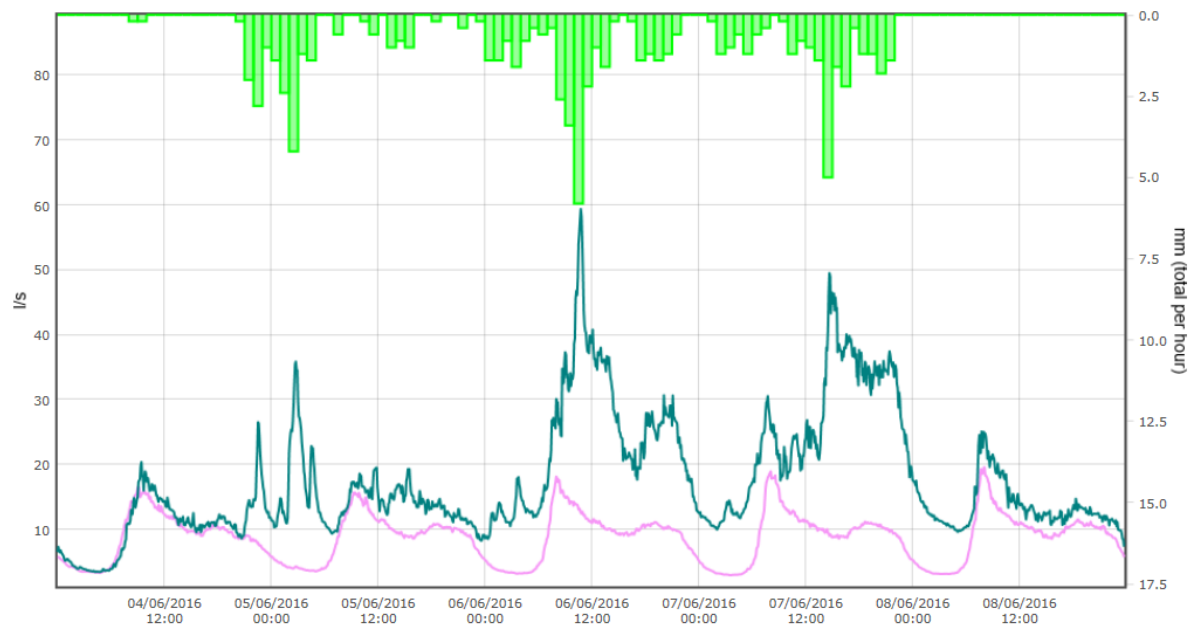
Rain Event 4: F7



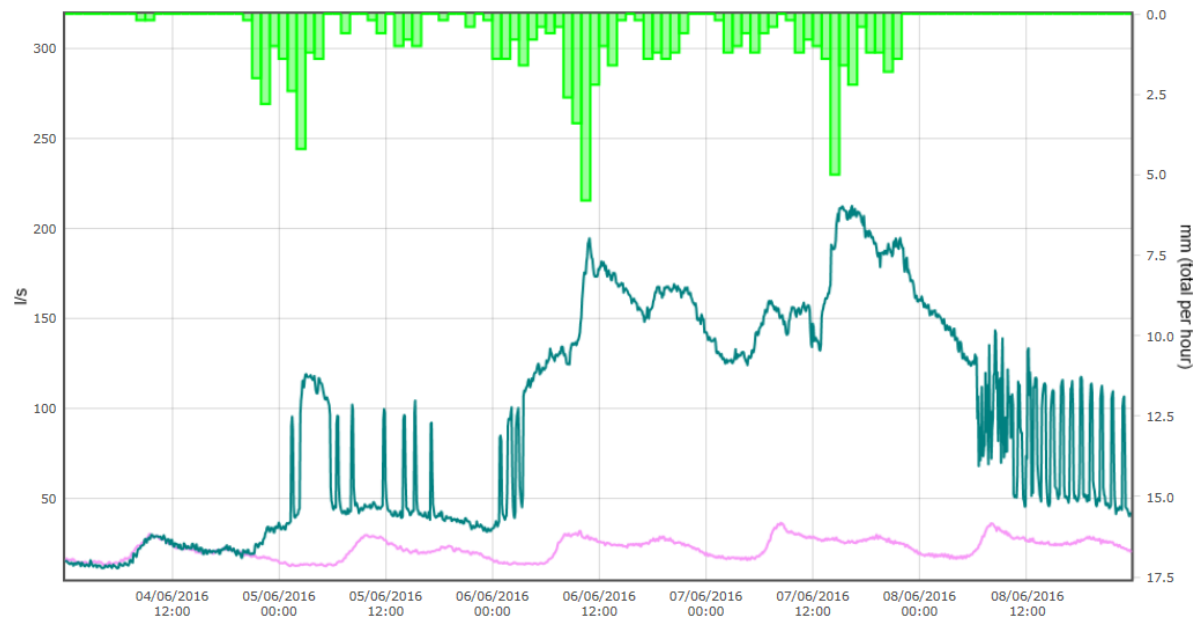
Rain Event 4: F8



Rain Event 4: F9



Rain Event 4: F10



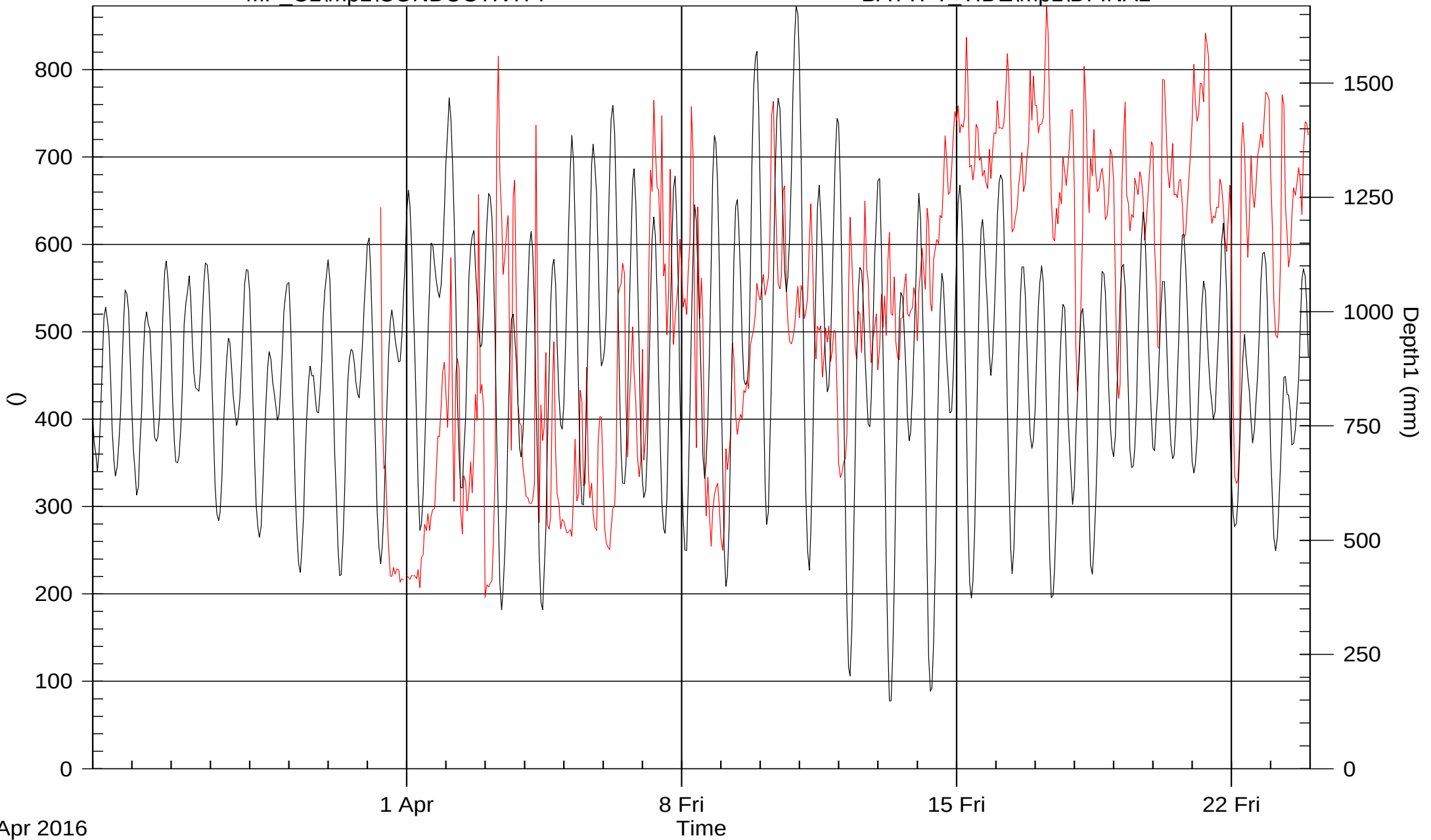
Appendix E. CONDUCTIVITY PLOTS

Mott MacDonald

Pipe Height: 0.00

MP_C1\mp1\CONDUCTIVITY

BATTPT_TIDE\mp1\DFINAL

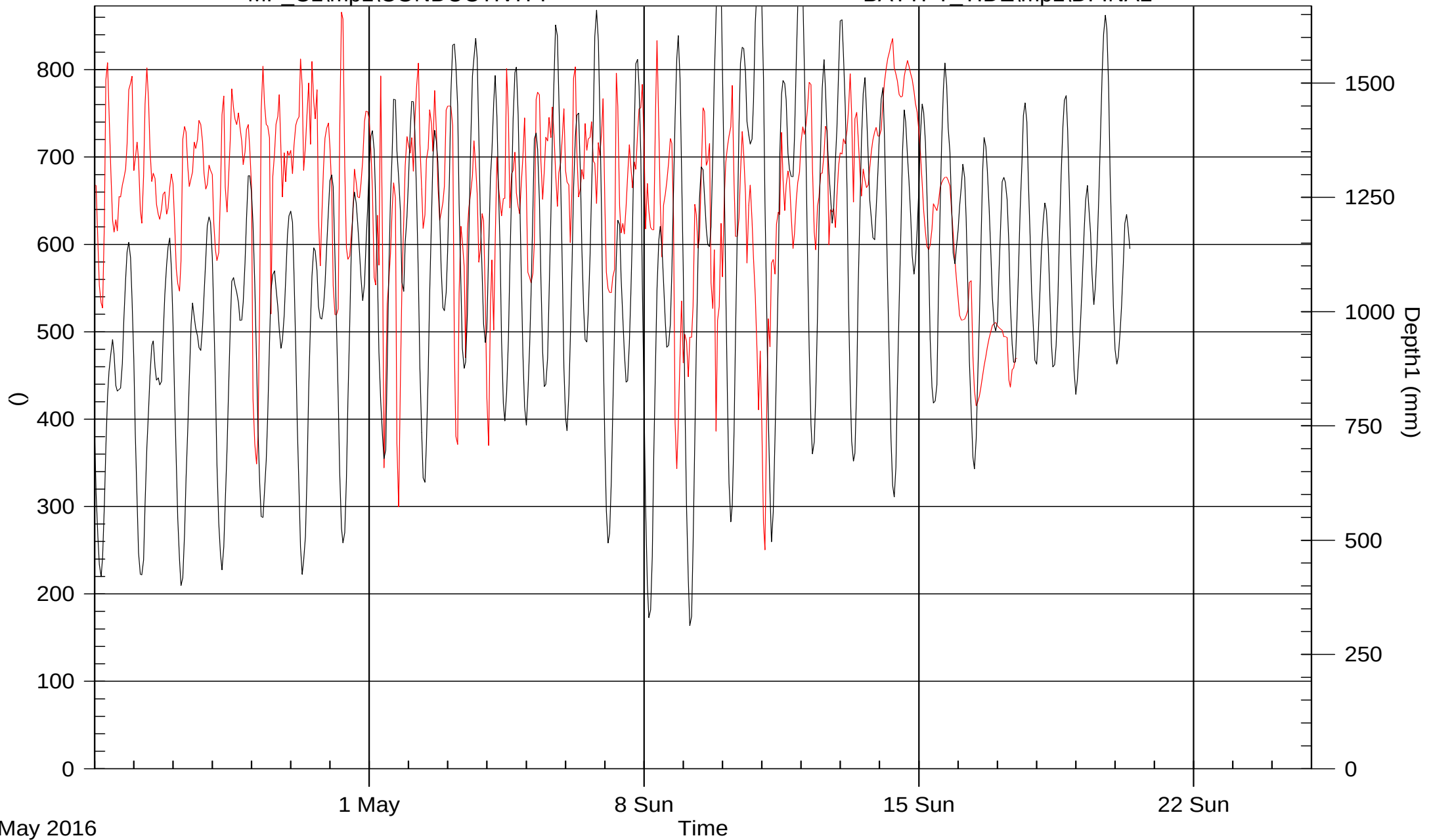


Mott MacDonald

Pipe Height: 0.00

MP_C1\mp1\CONDUCTIVITY

BATTPT_TIDE\mp1\DFINAL

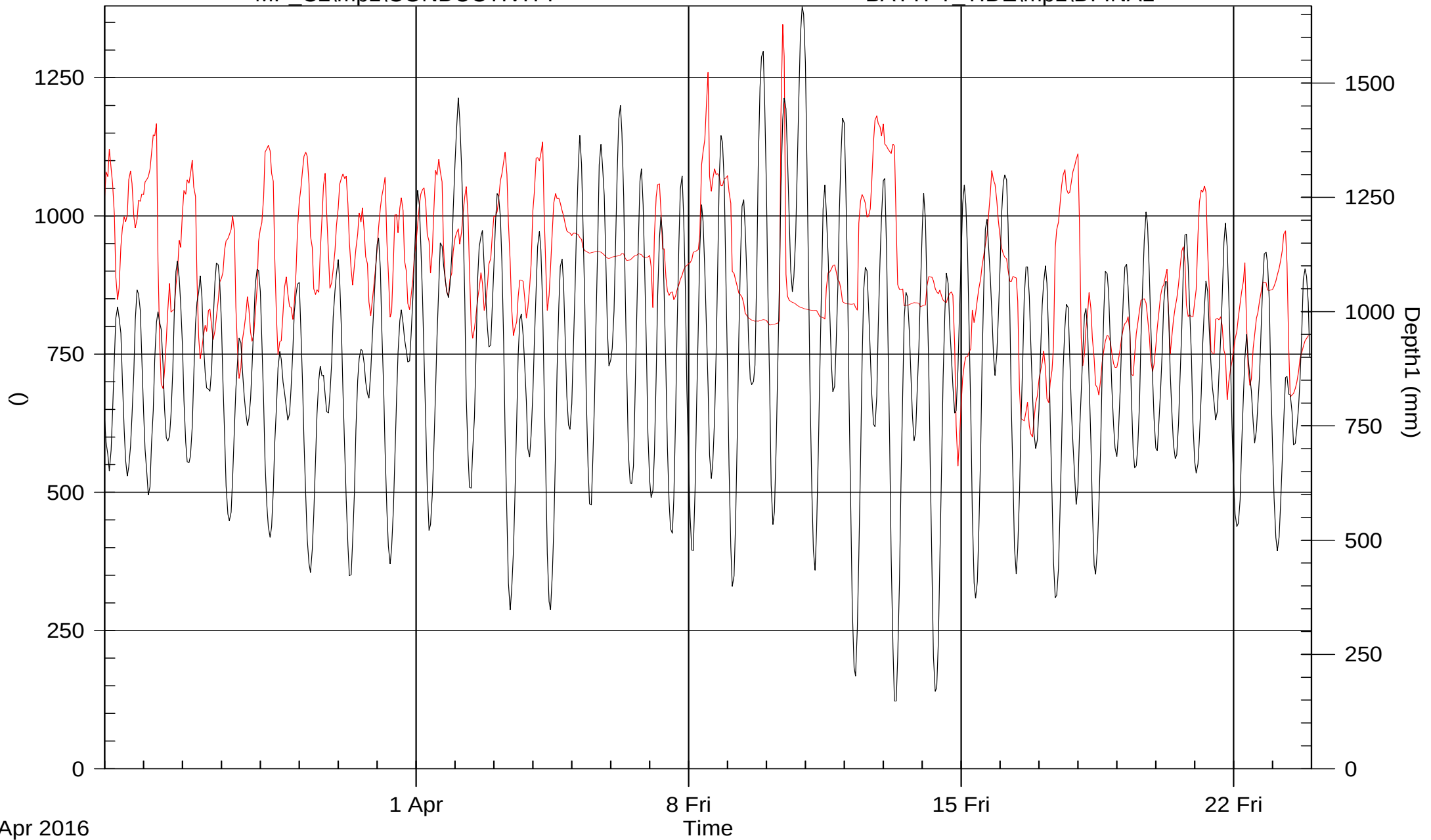


Mott MacDonald

Pipe Height: 0.00

MP_C2\mp1\CONDUCTIVITY

BATTPT_TIDE\mp1\DFINAL

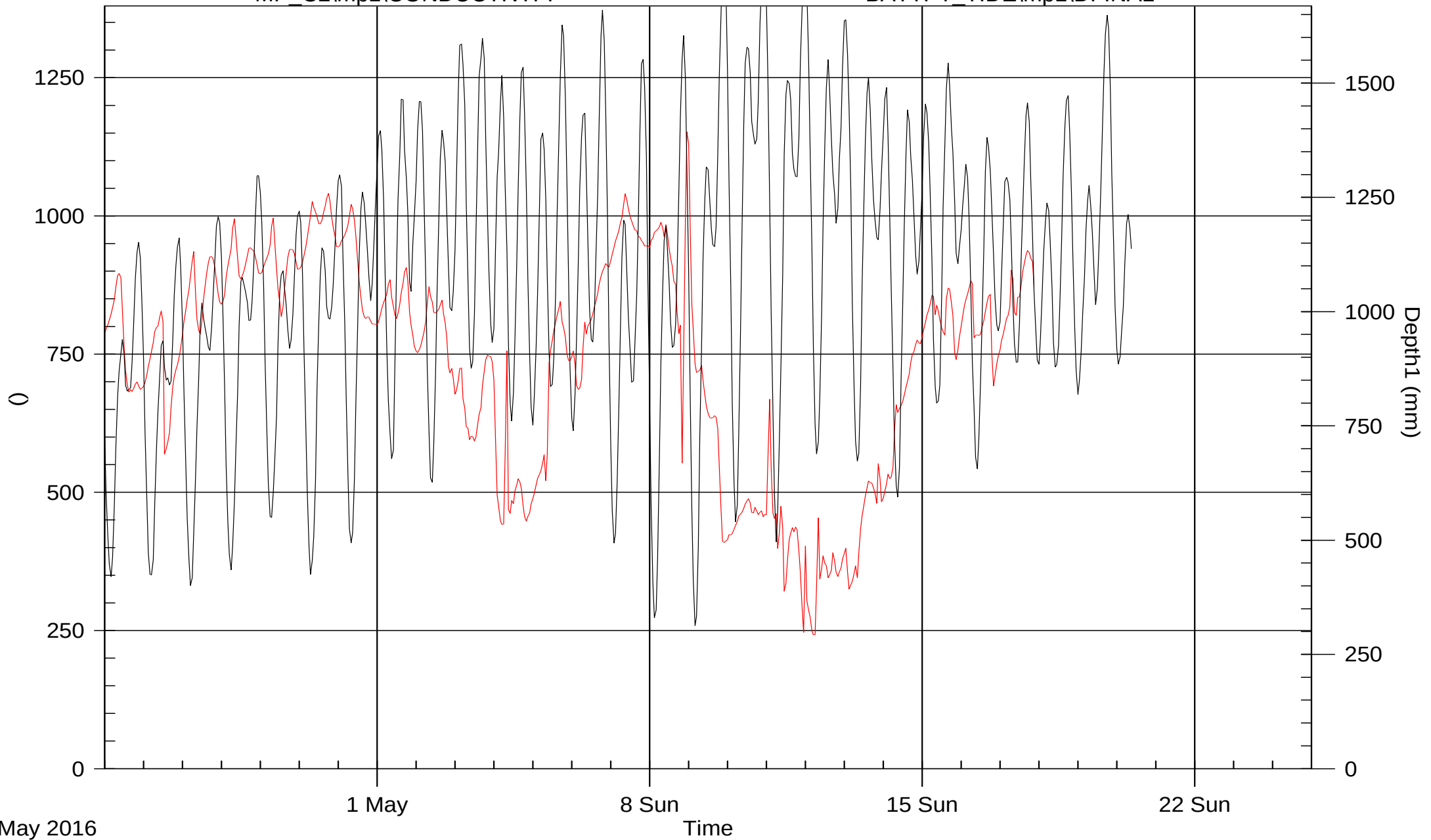


Mott MacDonald

Pipe Height: 0.00

MP_C2\mp1\CONDUCTIVITY

BATTPT_TIDE\mp1\DFINAL

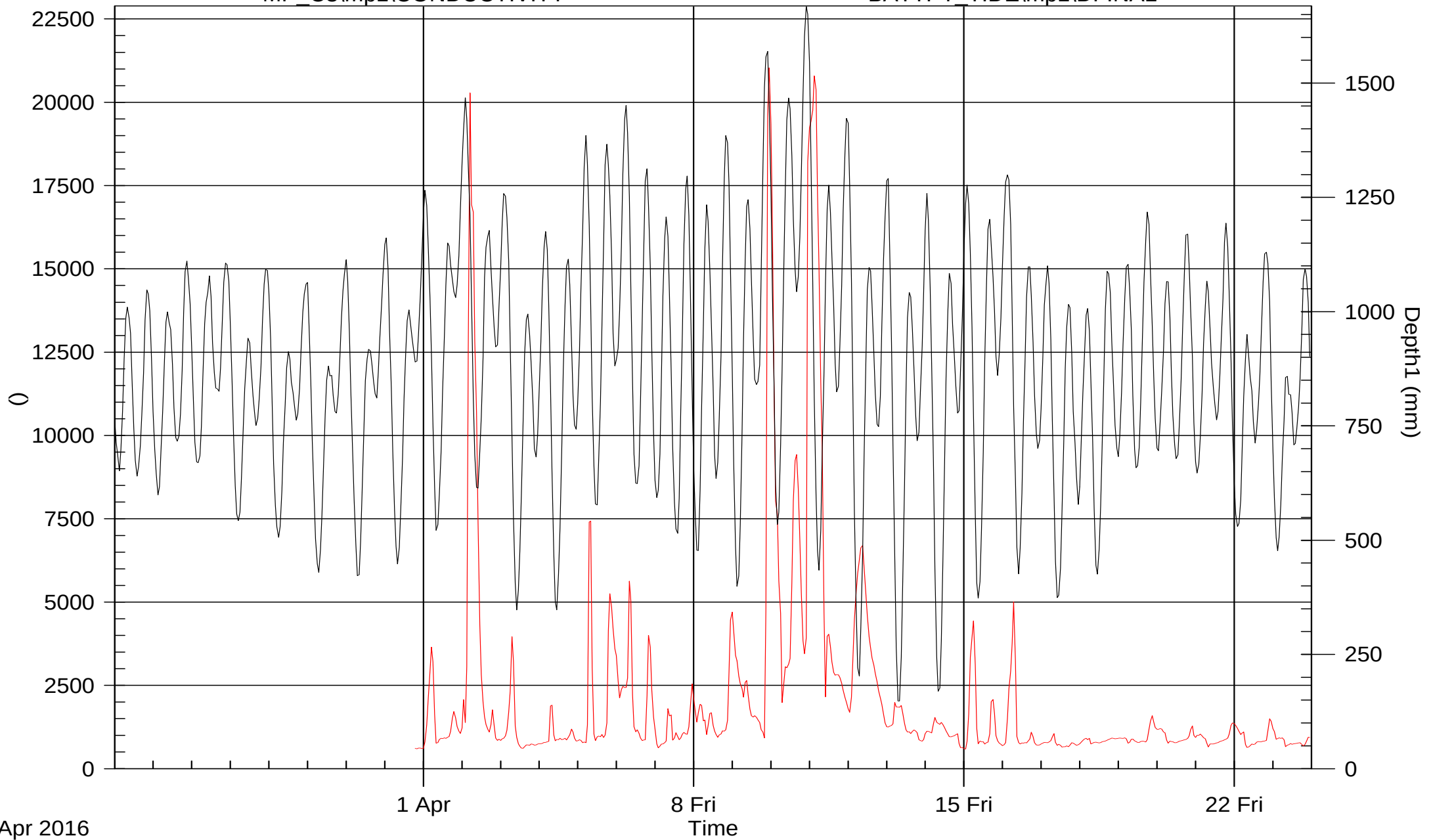


Mott MacDonald

Pipe Height: 0.00

MP_C3\mp1\CONDUCTIVITY

BATTPT_TIDE\mp1\DFINAL

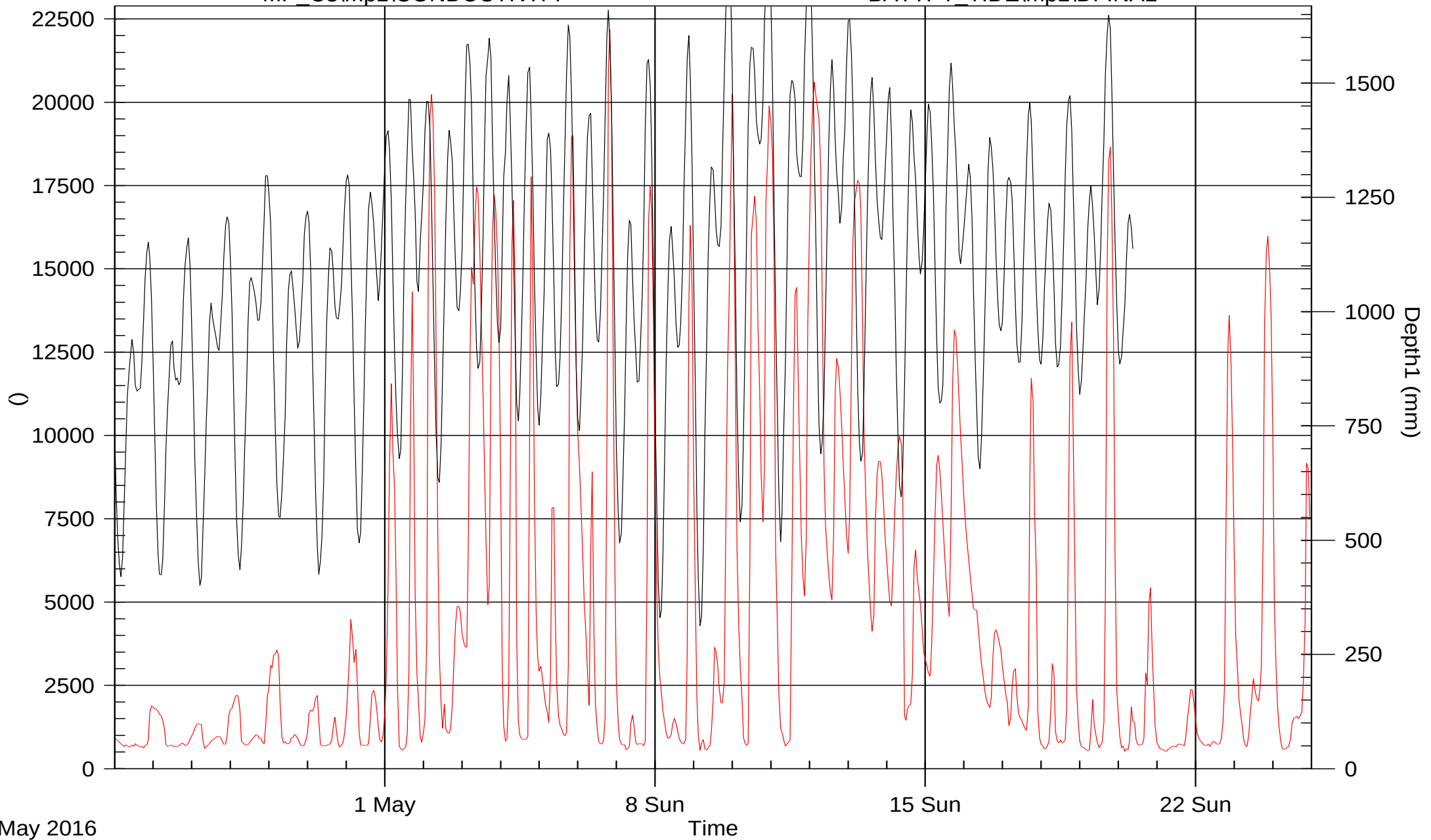


Mott MacDonald

Pipe Height: 0.00

MP_C3\mp1\CONDUCTIVITY

BATTPT_TIDE\mp1\DFINAL

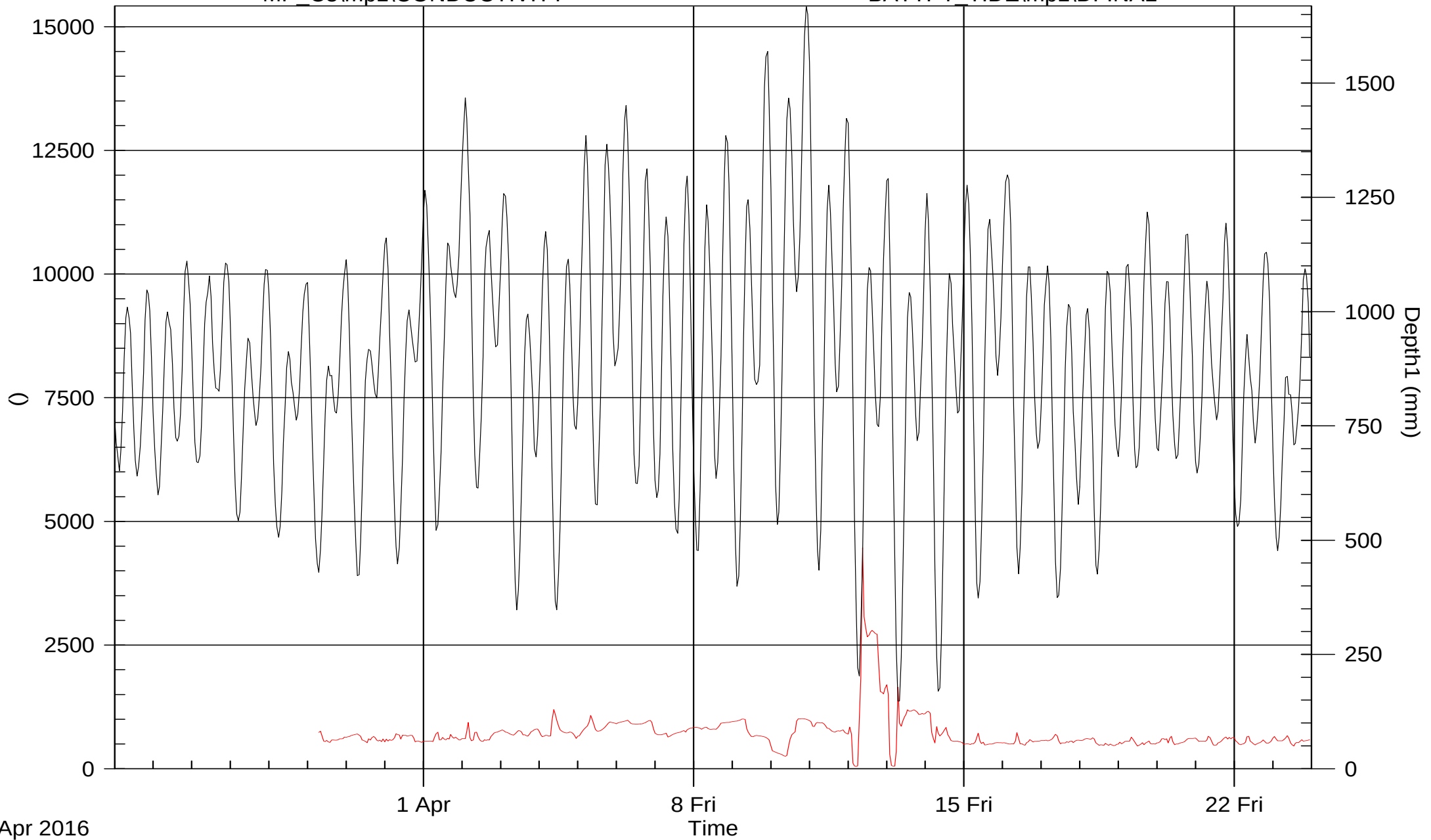


Mott MacDonald

Pipe Height: 0.00

MP_C5\mp1\CONDUCTIVITY

BATTPT_TIDE\mp1\DFINAL

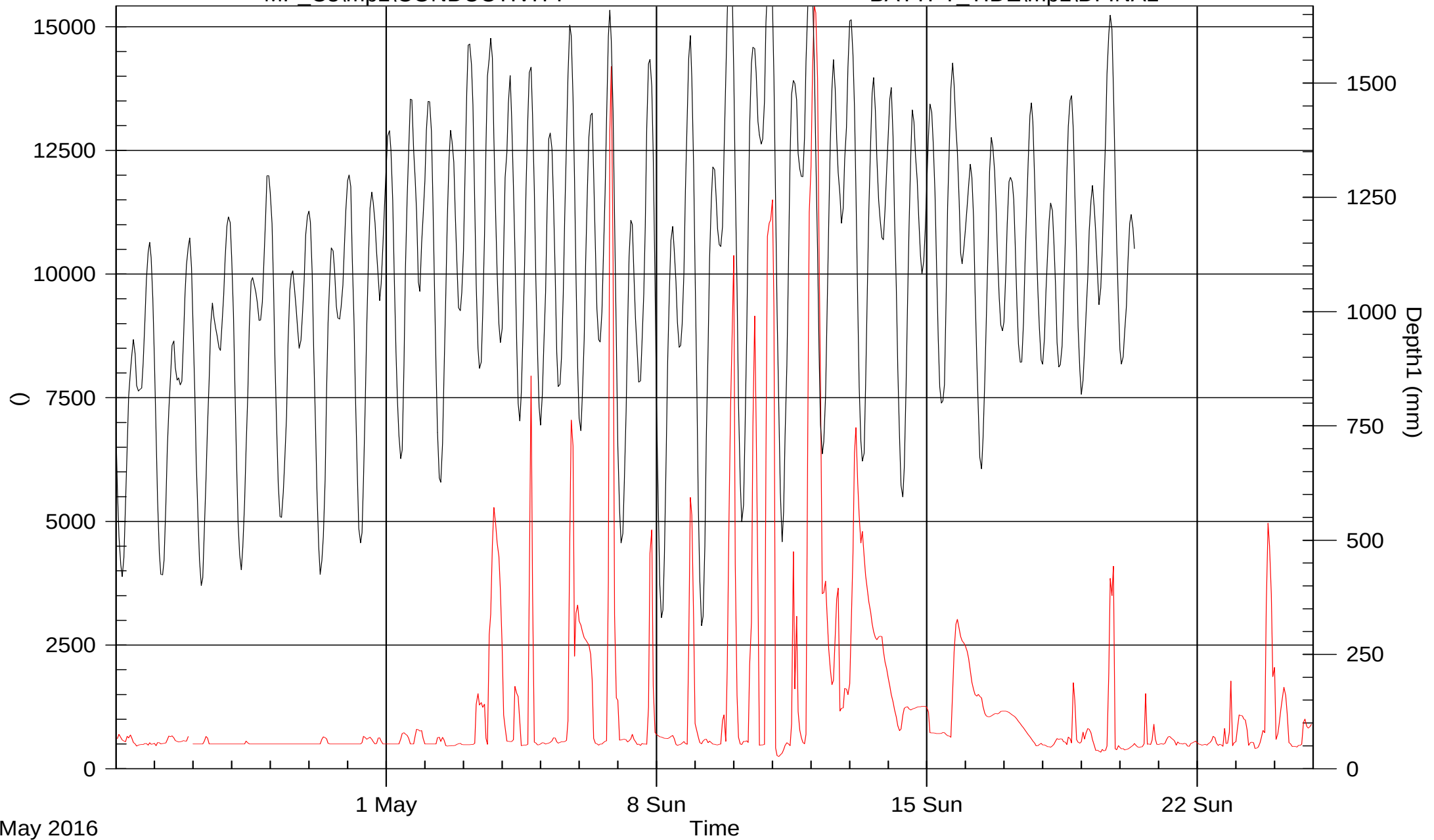


Mott MacDonald

Pipe Height: 0.00

MP_C5\mp1\CONDUCTIVITY

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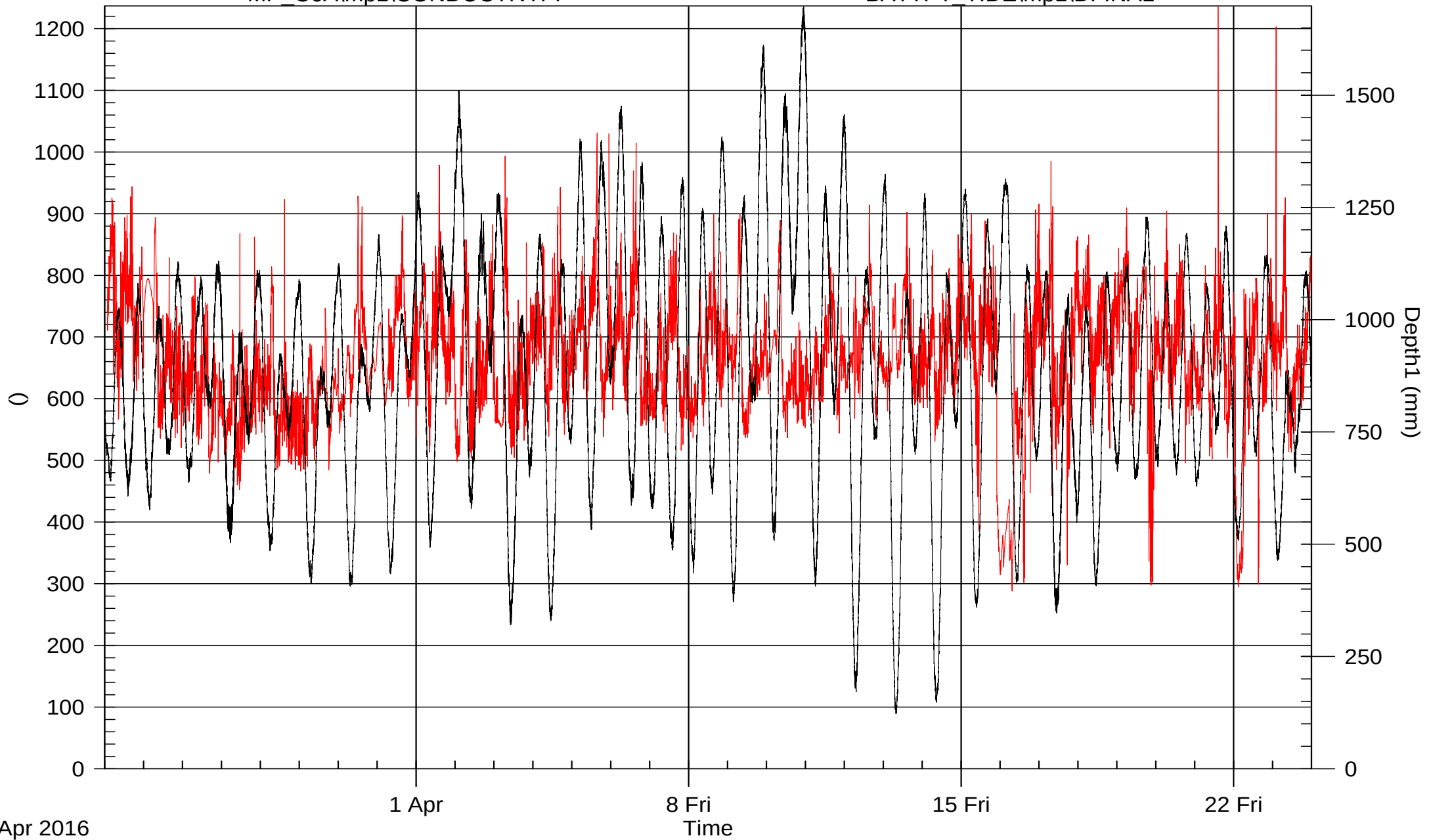


Mott MacDonald

Pipe Height: 0.00

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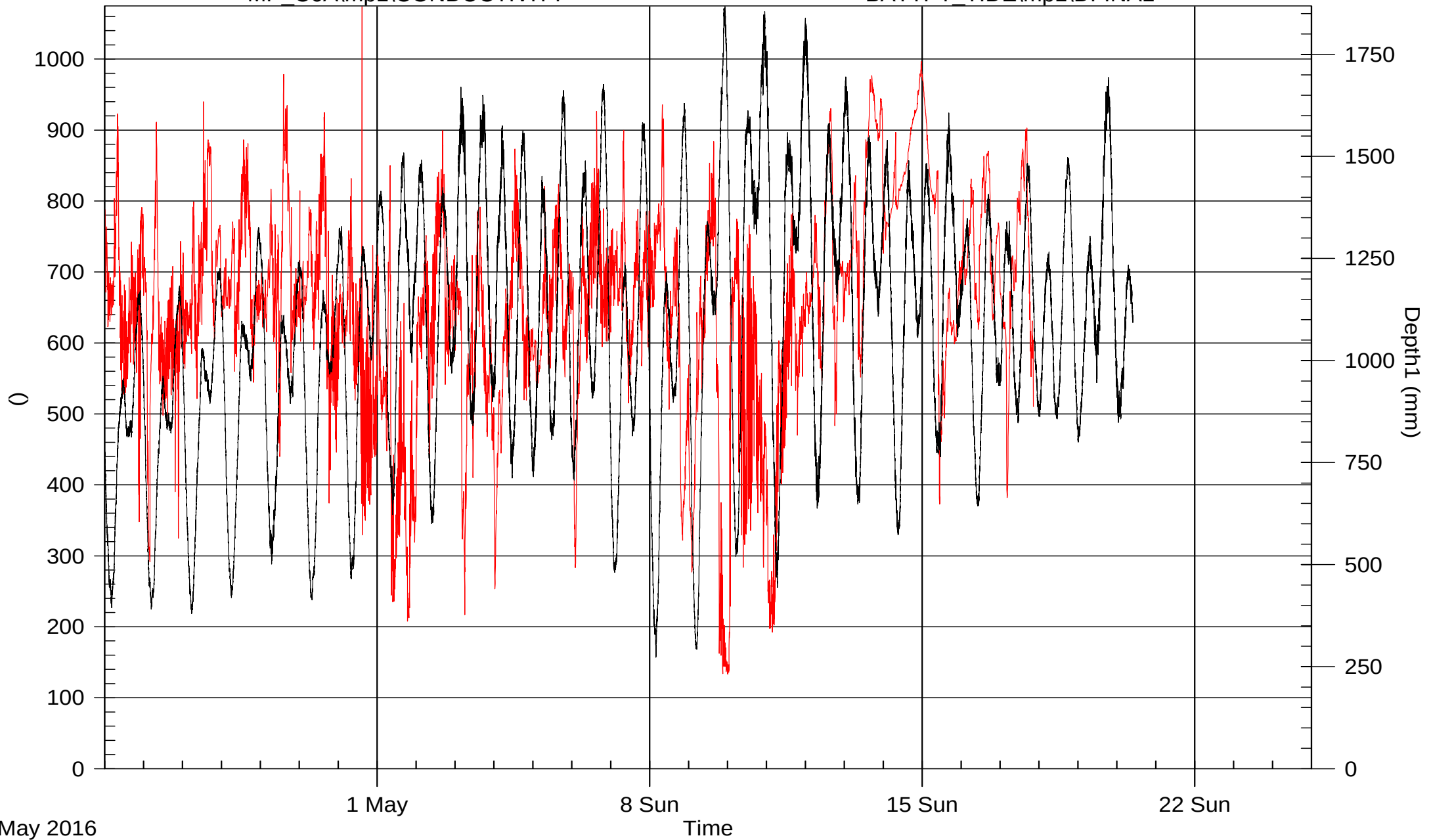


Mott MacDonald

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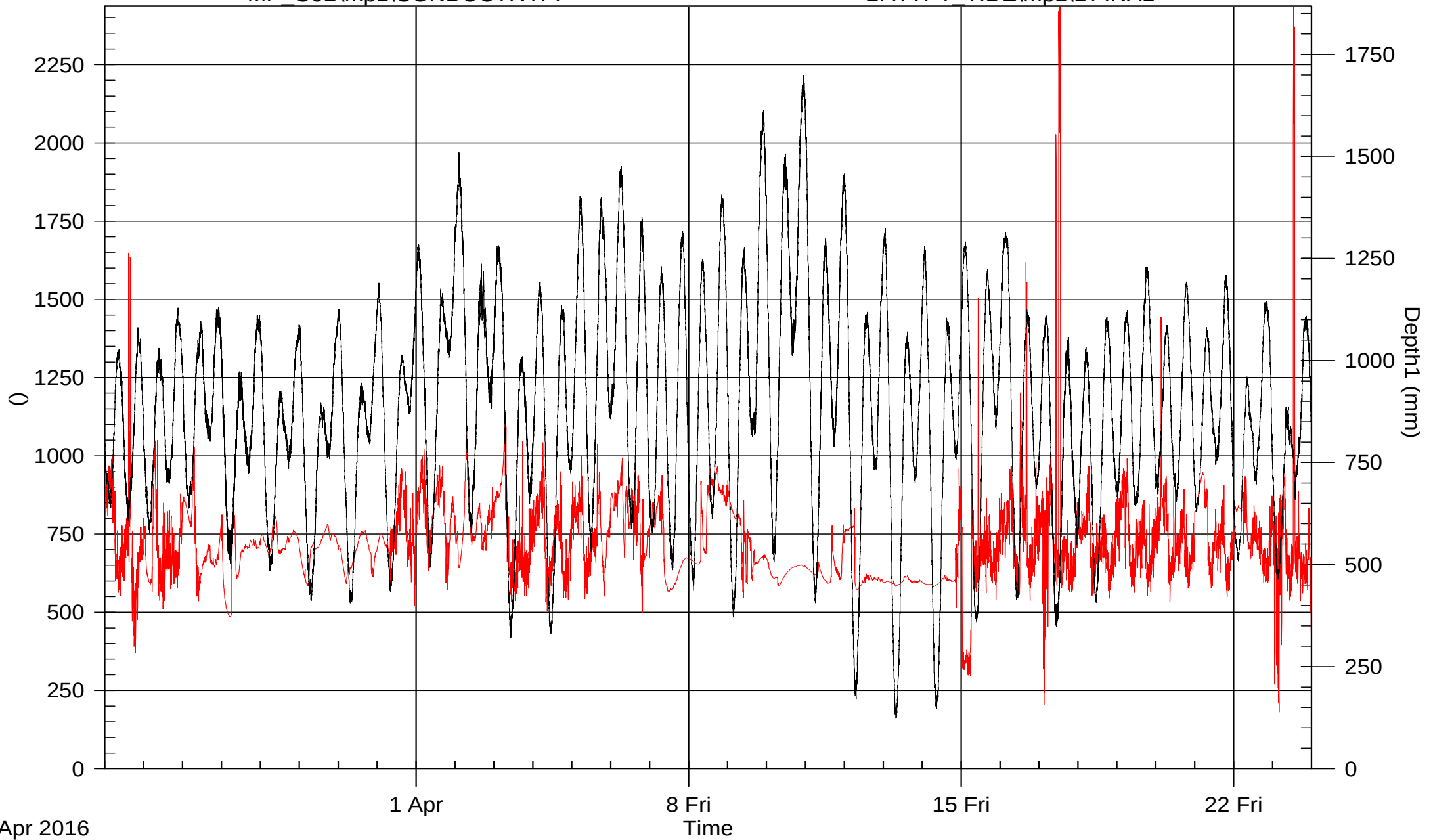


Mott MacDonald

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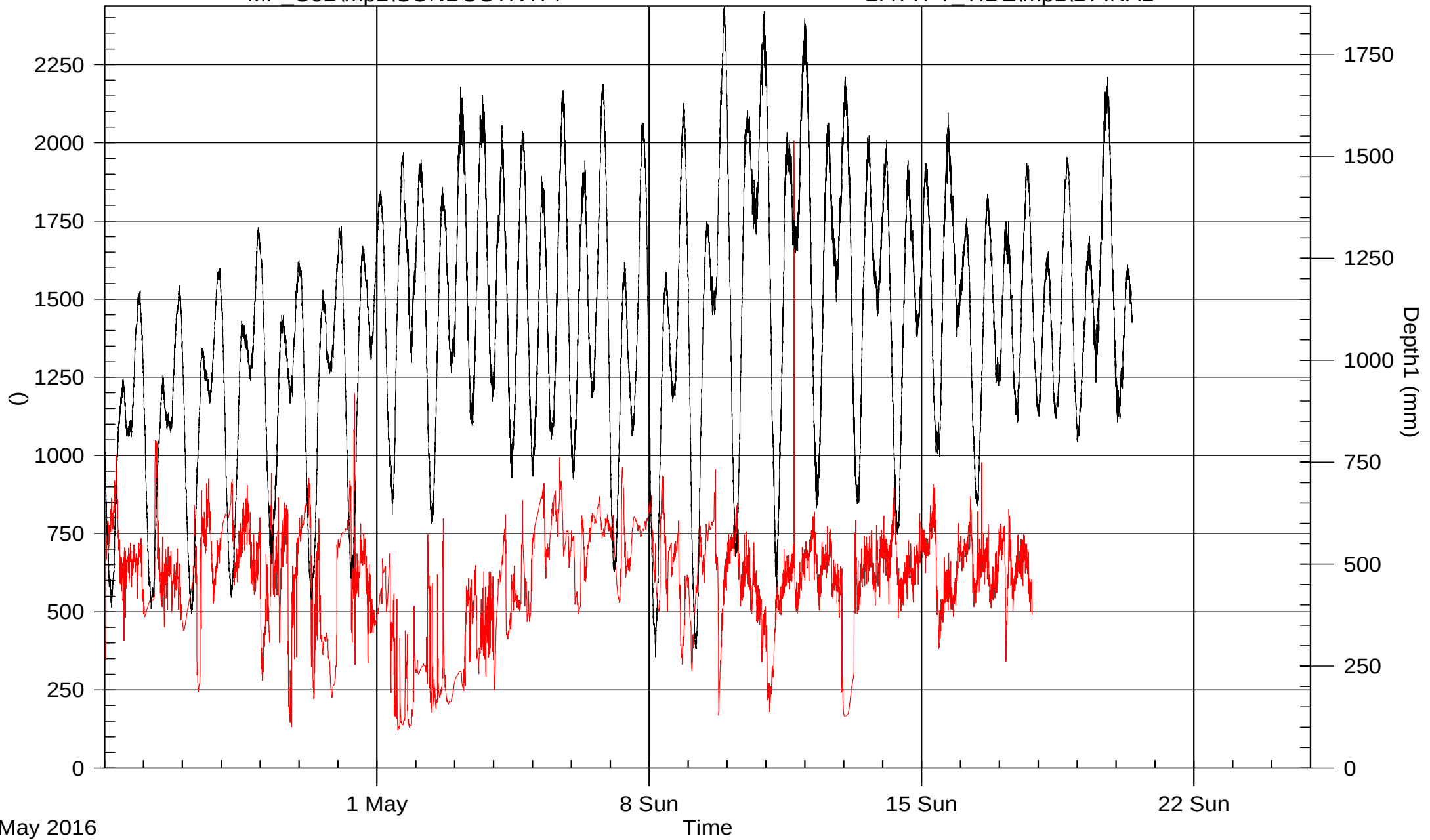


Mott MacDonald

Pipe Height: 0.00

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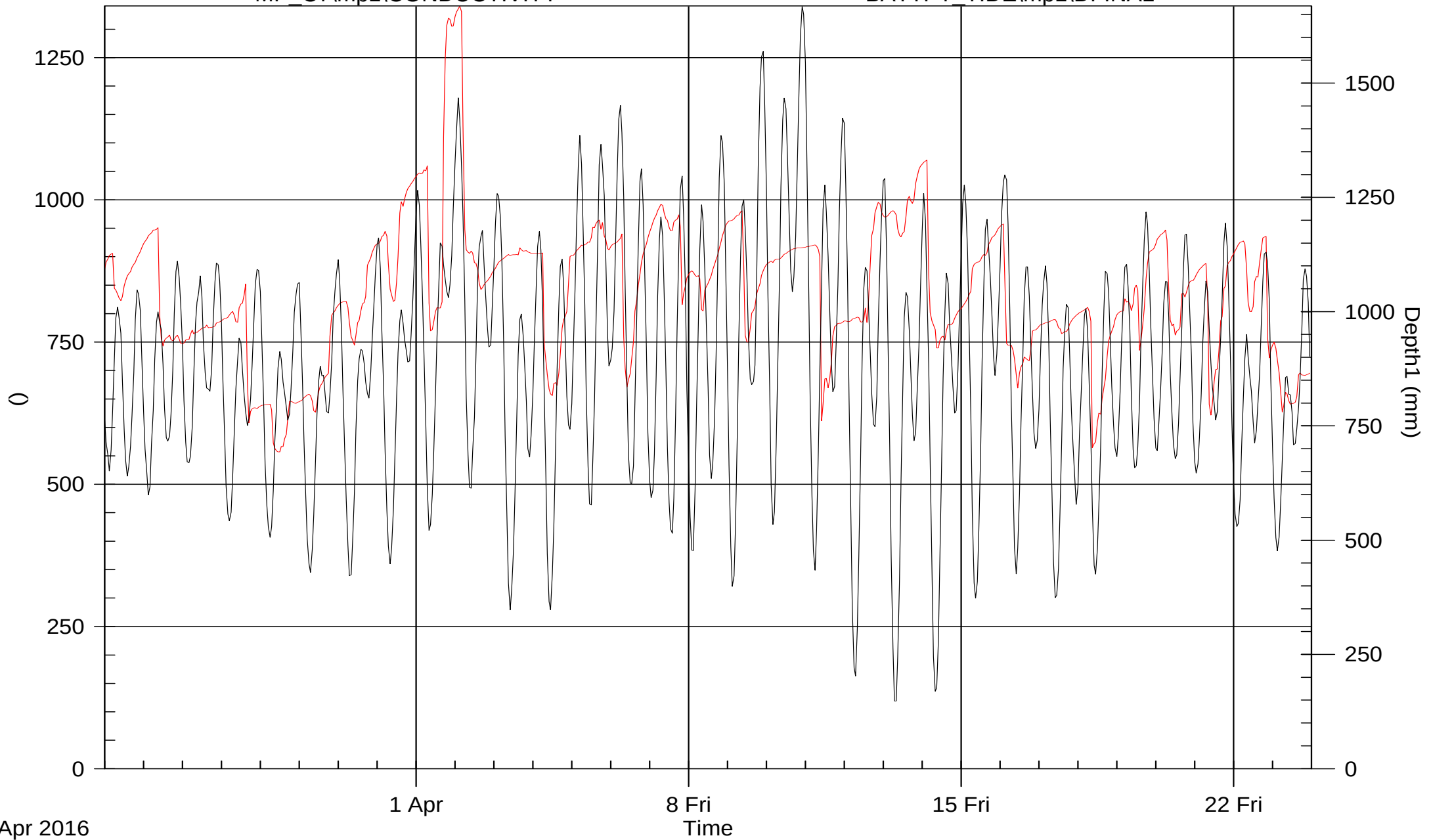


Mott MacDonald

Pipe Height: 0.00

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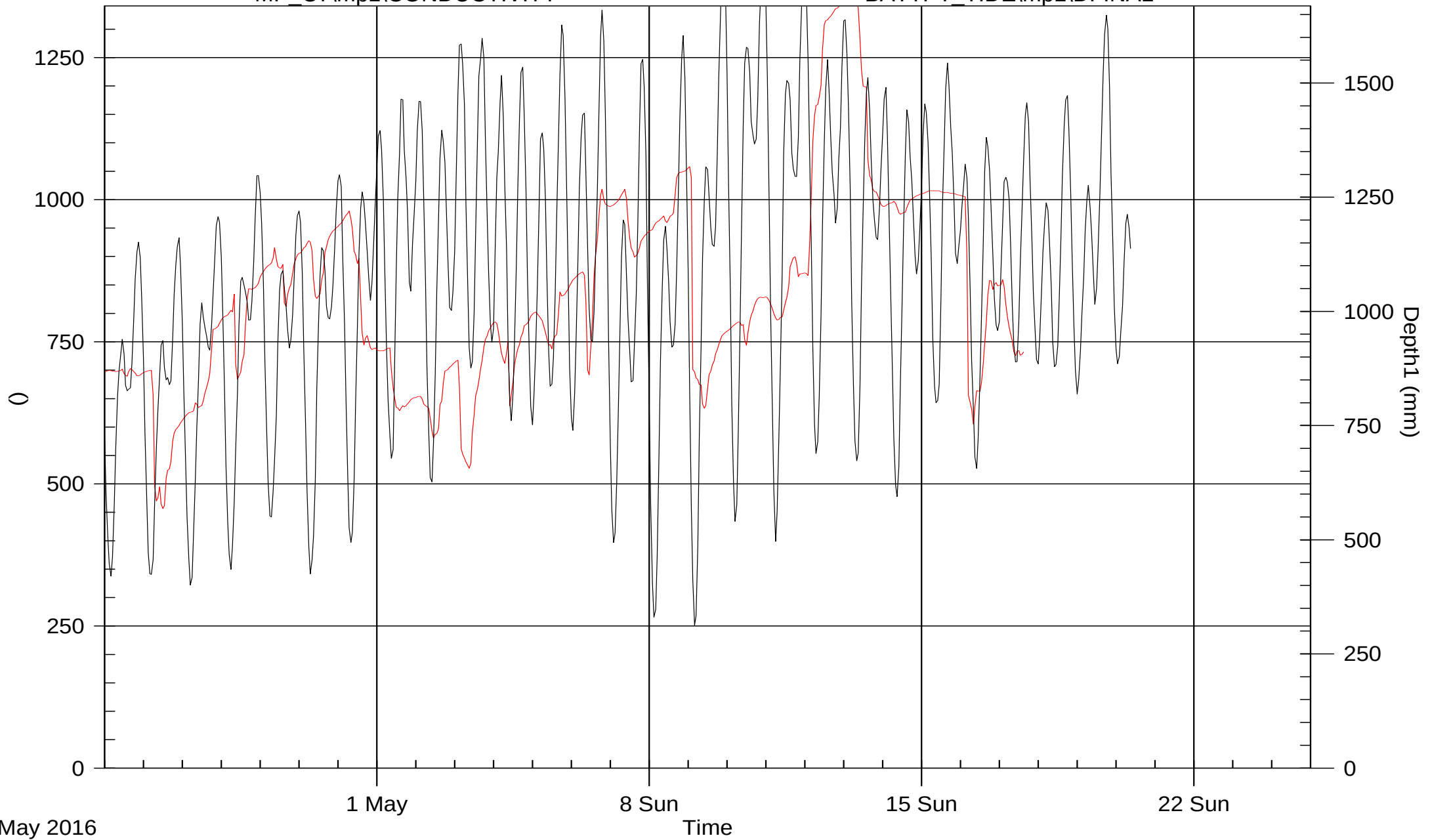


Mott MacDonald

Pipe Height: 0.00

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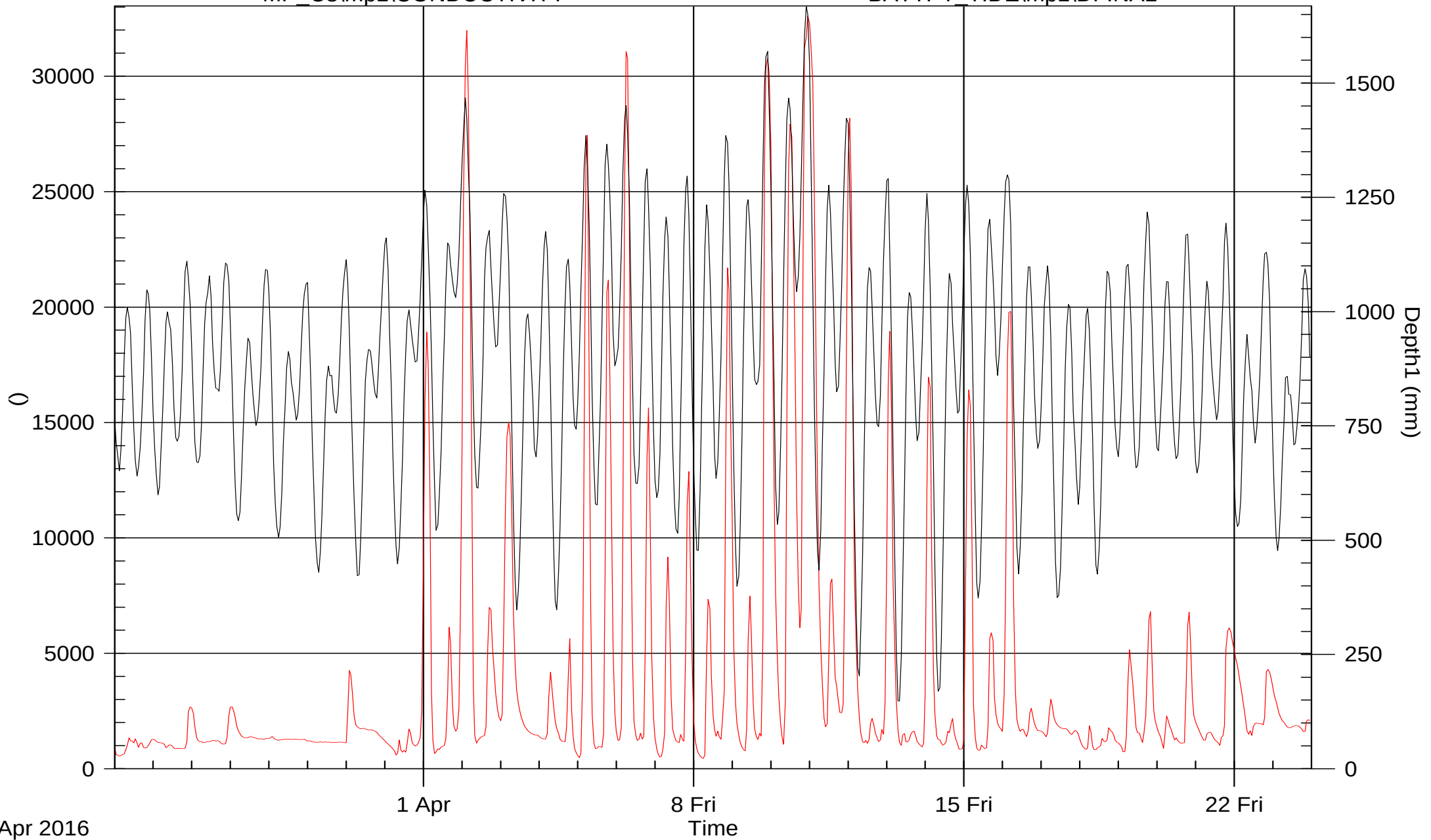


Mott MacDonald

Pipe Height: 0.00

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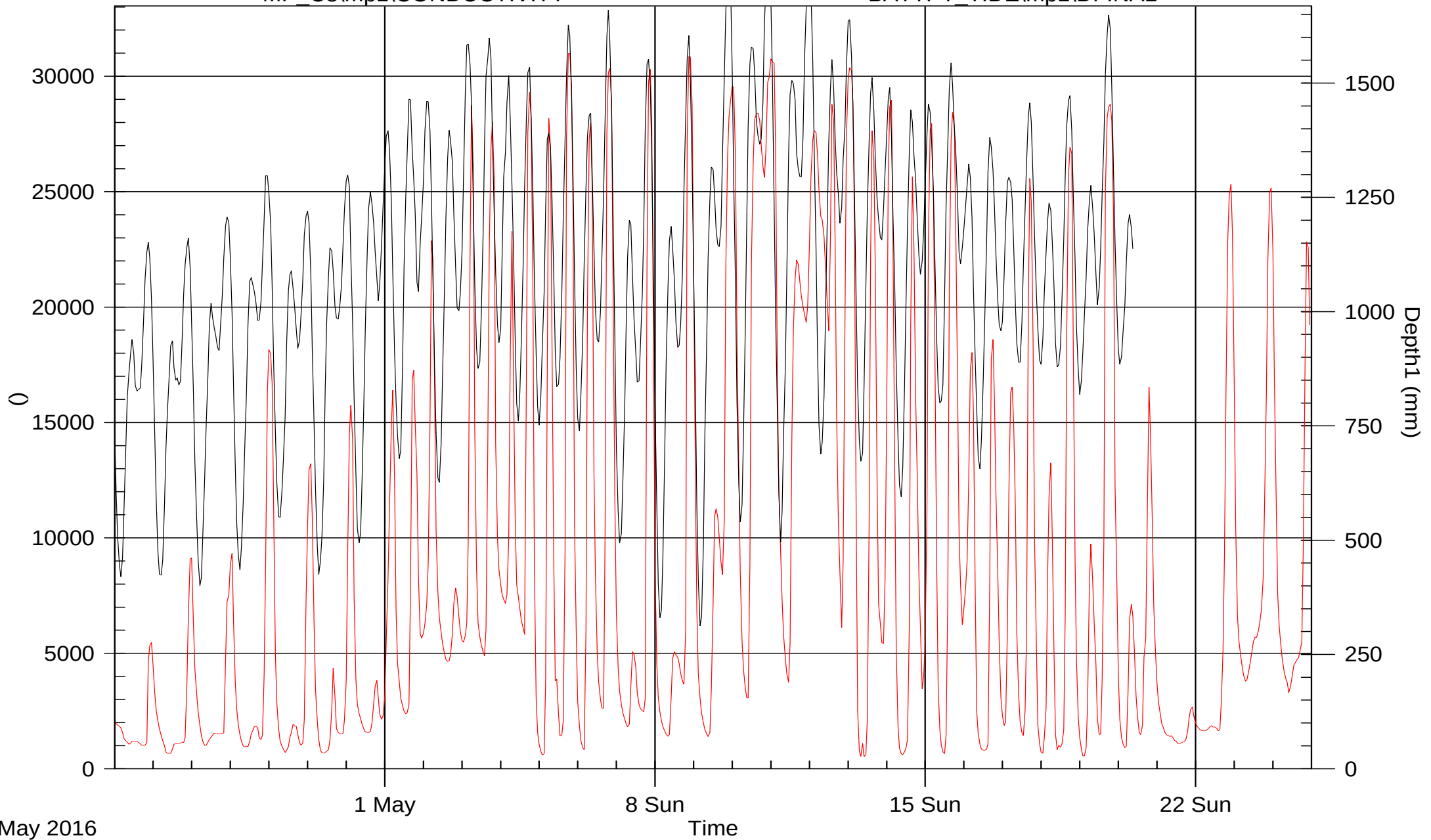


Mott MacDonald

Pipe Height: 0.00

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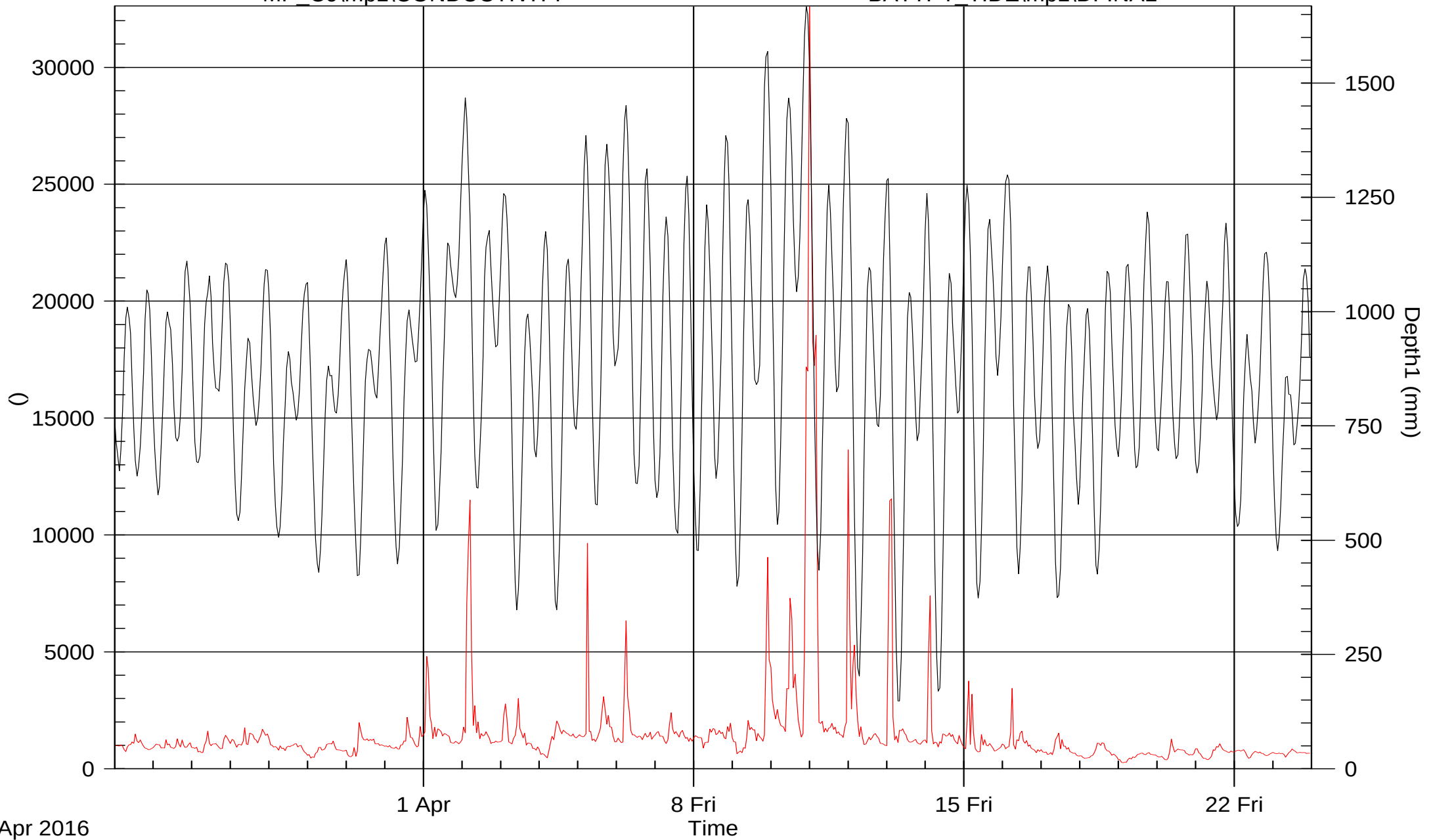


Mott MacDonald

Pipe Height: 0.00

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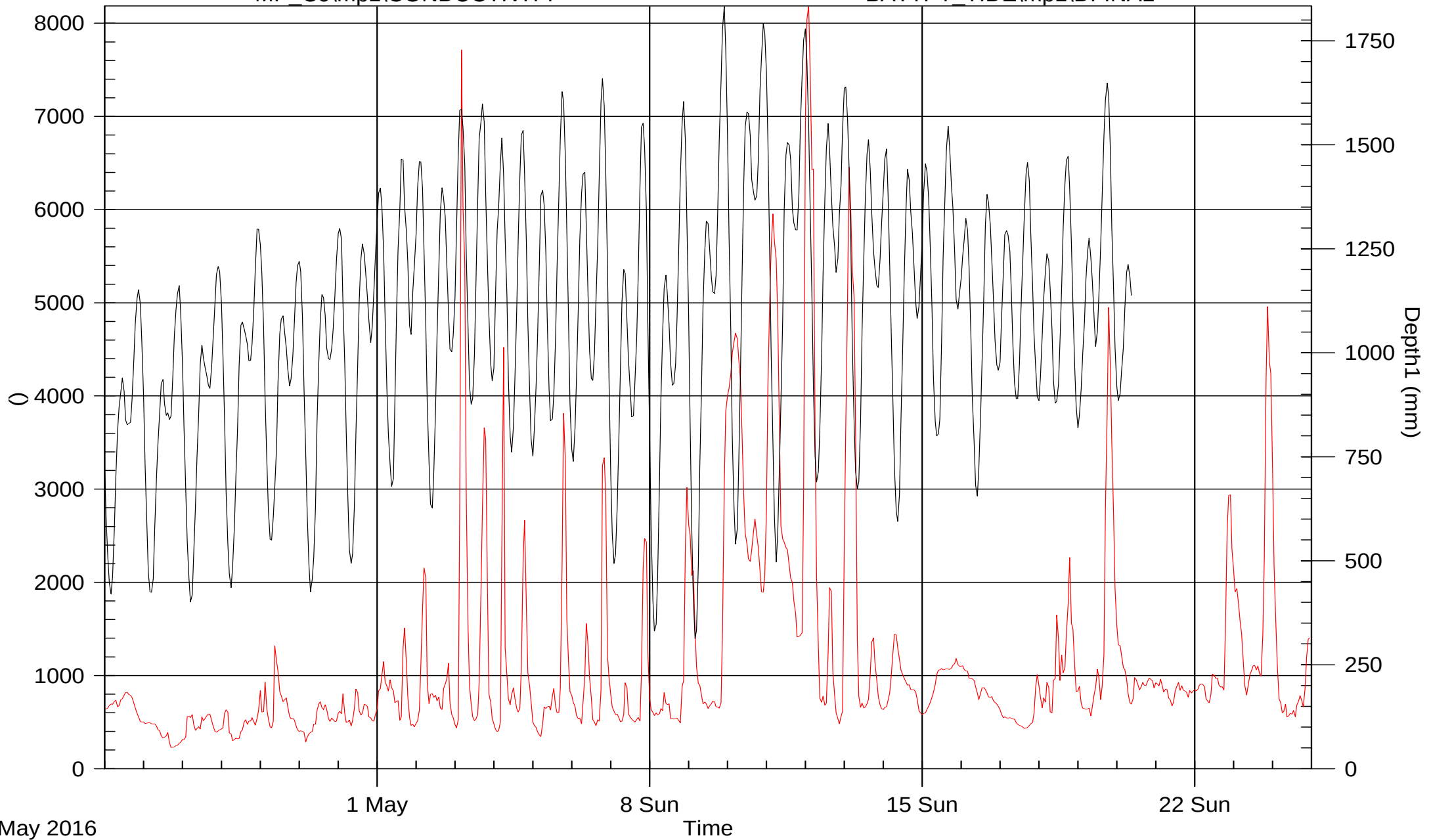


Mott MacDonald

Pipe Height: 0.00

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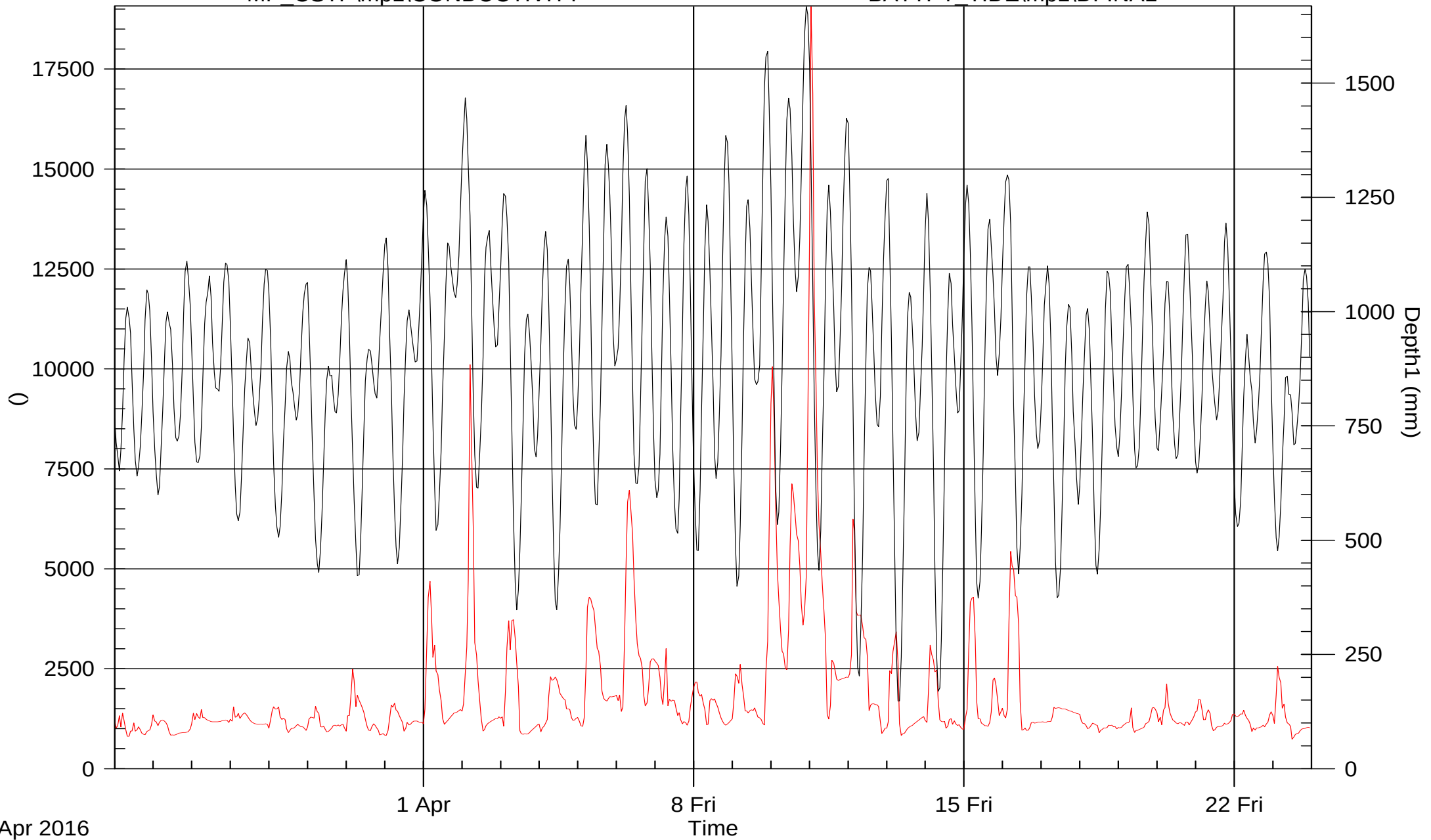


Mott MacDonald

Pipe Height: 0.00

MP_CSTP\mp1\CONDUCTIVITY

BATTPT_TIDE\mp1\DFINAL



Mott MacDonald

Pipe Height: 0.00

MP_CSTP\mp1\CONDUCTIVITY

BATTPT_TIDE\mp1\DFINAL

