Rhoose Point, Trem Echni
Hydraulic Modelling Asessment

016-SE156 - Trem Echni, Rhoose Point

Dŵr Cymru
Welsh Water

clear

ENVIRONMENTAL DRAINAGE FLOOD RISK ECOLOGY

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Contents

List of Tables

List of Figures

Executive Summary

Clear Environmental Consultants (Clear) was commissioned by Dŵr Cymru Welsh Water (DCWW) in December 2012 on behalf of the Developer to undertake a Hydraulic Modelling Assessment (HMA) for a proposed 90 property residential development on Trem Echni, Rhoose. This report aims to quantify the impact, if any, that the connection would have on the existing sewerage network and to identify notional solutions to any detriment that the connection may cause.

DCWW supplied a model which has been updated to reflect new GIS information and the CCTV and SPS surveys which were undertaken. The model is considered to have been verified to a standard suitable for completing the HMA and identifying detriment caused by the proposed development. The development has been modelled as two subcatchments with a total residential population of 225 and a total dry weather flow (DWF) of 0.52l/s.

The HMA was completed by comparing the Baseline model with a Development model including the two new subcatchments to represent the development. Comparisons were made to identify any detriment to the pump operation, flooding caused by a 30 year design set, CSO spills caused by a typical year and the average CSO spills in a typical year bathing season set.

The HMA has found a minor flooding detriment in the network local to the Rhoose Point SPS and using a typical year rainfall series, filtered for bathing seasons, a detriment to the spill volume and frequency was predicted for the Rhoose Main CSO. The operation of the Rhoose Main CSO was identified as being sensitive to the pump timing from Rhoose Point CSO.

In order to mitigate the impact of the development on the minor flooding an option has been proposed. This option was selected from the three options discussed below. A Sub-Option A involves up-sizing 180m of the existing sewer at the flooding location. This should be constructed in conjunction with either Option 1 or Option 2.

In order to manage the flows from the development and improve the performance of the Rhoose Main CSO, three main options have been proposed.

Option 1 involves upsizing the CSO continuation to 450mm diameter and a control device added.

Option 2 involves reconfiguration of the Rhoose Point rising main entering the Rhoose Main SPS so as to avoid any impact on the Rhoose Main CSO.

Option 3 involves the construction of a dedicated rising main from the development to the Rhoose Main SPS, also to avoid any impact on the Rhoose Main CSO

As discussed, Option 1 and Option 2 include a separate sub-option (A) to resolve reported flooding in the vicinity of the Rhoose Point SPS. This would not be required for Option 3 as this option consists of a new pumping station to pass flows directly to Rhoose Main SPS.

All options were assessed as suitable however Option 1 is considered to be the preferred option.

1. Introduction

1.1. Project Appointment

Clear Environmental Consultants (Clear) was commissioned by Dŵr Cymru Welsh Water (DCWW) in December 2012 on behalf of the Developer to undertake a Hydraulic Modelling Assessment (HMA) for a proposed development on Trem Echni, Rhoose Point of approximately 90 properties. This report aims to quantify the impact, if any, that the connection would have on the existing sewerage network and to identify notional solutions to any detriment that the connection may cause.

This report covers:

- Identification of foul flows generated from the proposed development, and hence what additional capacity would be required
- Identification of the ability of the downstream catchment to receive any additional flows via the existing gravity system (during rainfall events), without causing detriment to existing hydraulic and environmental performance
- Identification of a suitable connection point to the existing sewerage system, as long as there is available capacity, as stated above.
- Identification of options to mitigate any detriment to network performance caused by the additional development flows

1.2. Existing System

The existing Rhoose network consists of an area of 130ha discharging to several linked Pumping Stations (SPS) that pump to the Barry network and finally to the Cog Moors Waste Water Treatment Works (WwTW). Each of the SPS in the network has an emergency overflow (EO) and there are two additional combined sewer overflows (CSO). The first CSO is on Station Road and serves to limit the storm flows from the Rhoose network arriving at the Rhoose Main SPS. The second CSO is located at the Rhoose Main SPS and limits flows entering the Rhoose Main SPS wet well.

1.3. Development Site

The proposed development will be included in the Rhoose Point subcatchment. This subcatchment has separate surface and foul networks with the foul system draining to a private SPS (Rhoose Point SPS) currently maintained by the Vale of Glamorgan Council. The private SPS was adopted by DCWW in October 2012. The network layout and location of the development are outlined in Figure 1. The brown lines indicate the sewer network, the red lines indicate the rising mains and the blue hatched area identifies the development location.

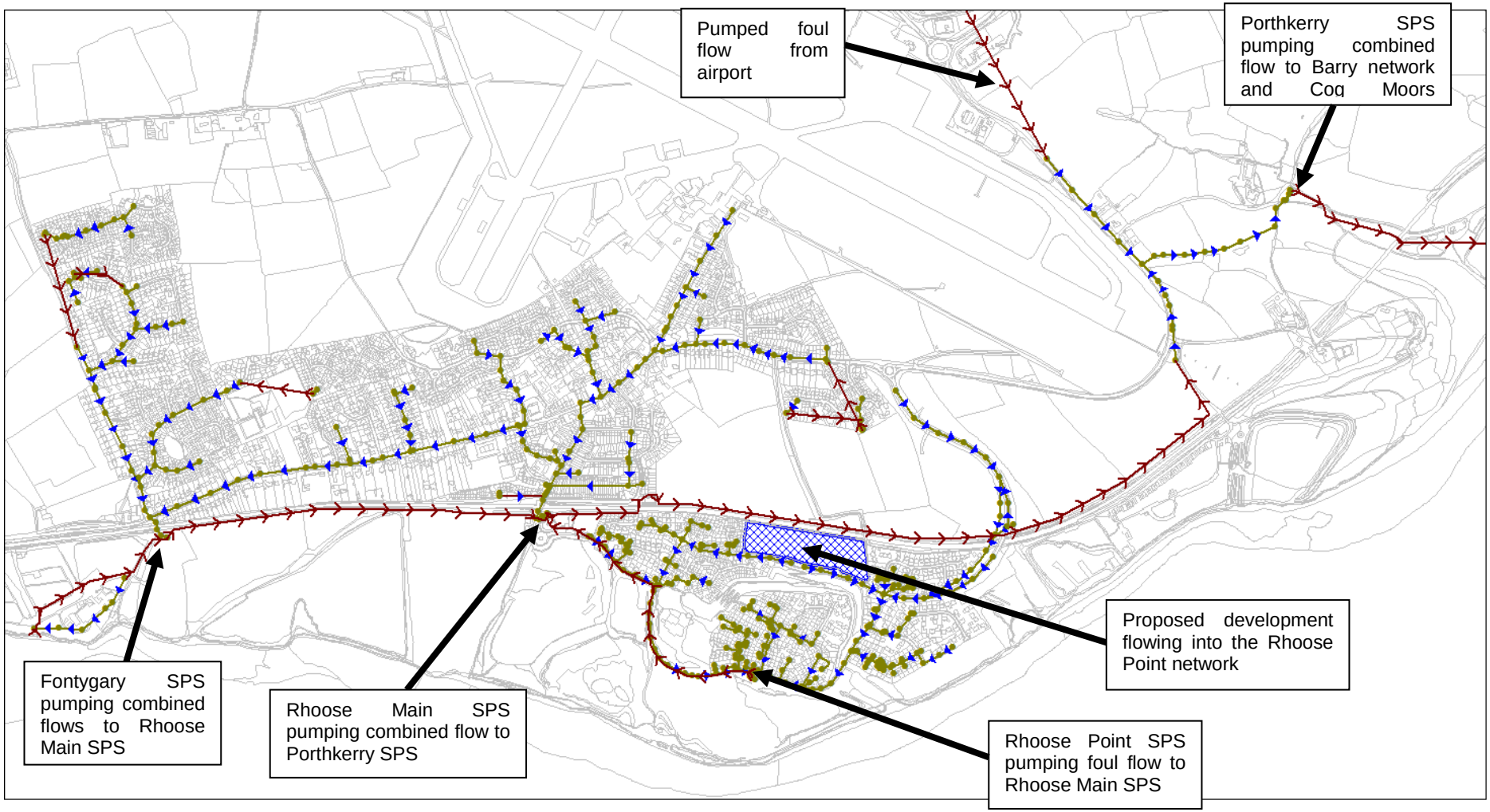


Figure 1 - Network Diagram and Development Location

2. Land Usage

2.1. Proposed Connection Details

The proposed development will consist of approximately 90 residential dwellings and is to be located at Trem Echni, Rhoose Point, Rhoose. The development located to the South of the Vale of Glamorgan railway line and is adjacent to a previous development constructed in 2001. Trem Echni currently has two 150mm diameter sewer lines at the location of the development. One sewer line passes flows to the East and one to the West. This HMA will investigate the effects of splitting the development in two and adding development flows into both manholes. Figure 2 shows the connection points.

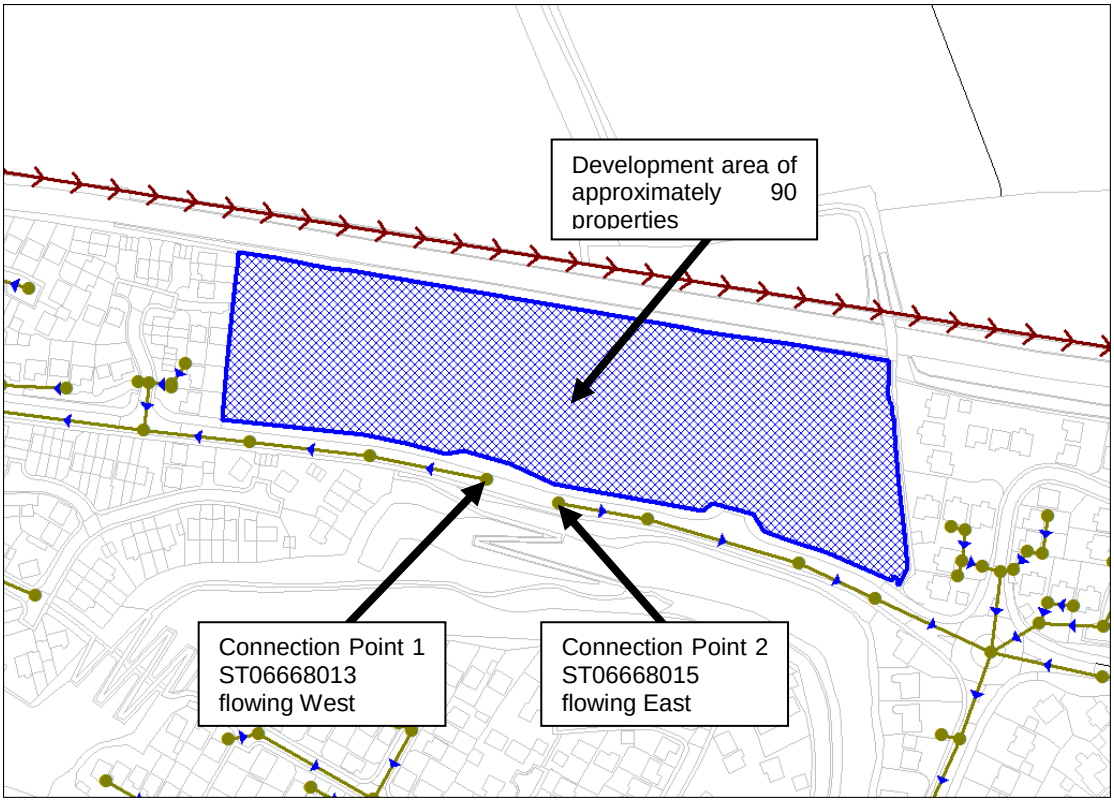


Figure 2 - Development Connection points.

Connection Point one leads to the network which flows west along Trem Echni then down Heol Y Pentir to the Rhoose Point SPS. Connection Point two flows east along Trem Echni then down Bryn Y Gloyn to the Rhoose Point SPS. Flows are then pumped to the Rhoose Main SPS, then to the Porthkerry SPS, then finally to the Cog Moors WwTW.

3. Developed System Modelling

3.1. Background

A hydraulic model of the Cog Moors WwTW catchment was supplied as a Baseline model. This model was previously used for the Barry Bathing Beach strategy and subsequent smaller studies. An initial model review shows that the earlier 2001 Rhoose Point development is included simplistically as a sub-catchment, but does not include details of the sewer network or private SPS at Rhoose Point.

3.2. Hydraulic Model Build

No documentation was supplied with the model, and a model review was undertaken to understand any limitations or areas where caution needed to be associated with the model outputs. The review was based around the model review procedure supplied by DCWW for their Sustainable Drainage Plans, and is shown in Appendix A. The following key points should be noted:

- Model build and/or verification documentation was not available.
- There are no records to confirm how impermeable areas have been applied to the model. The areas appeared to be a mixture of assumptions for cross connection and values where an area take off exercise has been performed. A check against background GIS proved inconsistent. It was decided on the assumption that the supplied model had been correctly verified that the runoff areas would be left unaltered.

3.3. Additional Survey Data

3.3.1. Manhole Survey

No additional manhole surveys were undertaken for this model.

3.3.2. CCTV Survey

CCTV assessment was undertaken downstream of both Connection Point 1 and 2 to the Rhoose Point SPS. The results of the CCTV assessment were used to update the model. In general the CCTV survey found the sewers in Rhoose Point to be in good condition. The modelled bottom roughness coefficient was increased where the presence of grease deposits was found and the sediment depth was adjusted accordingly. The model changes made due to CCTV are summarised in Appendix B. Any CCTV survey model changes were flagged as CCTV surveyed “SC”

3.3.3. Pumping Station Survey

Three SPS directly downstream of the development were surveyed. The stations surveyed are:

- The Rhoose Point SPS on Bryn Y Gloyn
- The Rhoose Main SPS on Heol Y Pentir.
- The Porthkerry Rd SPS.

The model was updated to reflect the survey inverts, SPS layout and dimensions and the pump rates. Any SPS survey model changes were flagged as surveyed “SA”.

Operational limitations meant that pump rates and pump stop/start points were not able to be tested on all SPS. Where this is the case, values from the historical model were used and engineering judgement applied based on the data available. These have been flagged as assumed "AS".

3.3.4. Flow Survey

Depth monitors (DM) and raingauges (RG) were installed at each of the three downstream SPS within the catchment to allow model verification as part of this study. The flow survey comprised of three DMs and three RGs between the 28th June and 26th September 2013. Depth Monitor and Raingauge locations are detailed in Table 1 and Table 2.

Table 1 - Flow Monitor Locations

Reference	Model MH Ref	Location	X Co-ord	Y Co-ord	Reason for monitoring
DM001	17574968	Rhoose Point SPS on Bryn Y Gloyn	306754	165764	First SPS downstream of Development
DM002	ST06662103	Rhoose Main SPS on Heol Y Pentir.	306227	166188	Second SPS downstream of Development
DM003	ST08671005	Porthkerry Rd SPS.	308142	167025	Last SPS downstream of Development

Table 2 - Raingauge Locations

Reference	Location	X Co-ord	Y Co-ord
RG001	Rhoose Point SPS on Bryn Y Gloyn	306754	165764
RG002	Rhoose Main SPS on Heol Y Pentir.	306221	166191
RG003	Porthkerry Rd SPS.	308157	167032

3.4. Additional Updates

Sewer GIS and background mapping for the catchment were supplied by DCWW. Comparisons of this mapping with sub-catchments from the existing model identified that the new Rhoose Point development was not included in the model. Further checks for areas not included in the existing system model were made through examination of aerial photography (principally Google© Street View). This resource was also used to confirm changes identified with background mapping. These updated areas include:

- The supplied model only included a single subcatchment with a population of 1,246 for the most recent Rhoose Point development (an area south of Rhoose which encompasses the development that this HMA is being carried out for). Sewer GIS and background mapping for the catchment was supplied

by DCWW and used to build new Rhoose Point subcatchments and network. Where insufficient GIS data were available, ground levels and pipe inverts were interpolated using the InfoWorks inference tools. Additional cover levels were taken from as-built drawings supplied for the surface water network and used for interpolation of the ground level.

- Rhoose Primary School, Fontygary Road. This was already modelled by a population allowance within subcatchment ST06660301; however no trade component was included. The subcatchment was updated to include 362 pupils and staff contributing 1l/s over an eight hour educational profile.
- The Fontygary Leisure Park was not included. A new subcatchment consisting of 500 caravan sites contributing a domestic profile with a DWF of 2.6l/s was added.
- The Airport subcatchments were updated to reflect their consented discharge volumes.

3.5. Verification

The DCWW AMP4 Draft Model Build and Verification specification (2013) stipulated that hydrographs should follow each other in shape and magnitude and that the timing of peaks and troughs should be within one hour. For critical sites it states parameters to be within 10% of measured where quality data exists. This is in agreement with the Urban Drainage Group (formerly WaPUG) Code of Practice.

The majority of the predicted storm response depths deviate from measured values by more than 10%. The series of consecutive pumps in the network mean that the wet well depths are very sensitive to the state of upstream pumps and difficult to verify. Due to the lack of supporting information such as detailed flow and depth data from the upstream catchments and pumps these were not able to be fully verified.

Three raingauges were installed for this survey, however RG001 was not utilised as the response shown was inconsistent with the other two gauges.

Despite the discrepancies in verification, the model is considered suitable for this assessment of the impact of the proposed development. Details of the model alterations and the verification for each depth monitor can be found in Appendix C.

3.6. Historical Verification

Analysis of the DCWW flooding databases found several historically reported flooding locations within the area of the proposed development:

- Internal flooding at Heol y Pentir
- External flooding at junction of Bryn y Gloyn and Cilgant Y Meillion
- Other reports at Glyn y Gog, Heol Pearetree and Lon Lindys

The reported flooding on 21/05/2013 at the junction of Bryn y Gloyn and Cilgant Y Meillion has been replicated by the model. Minor flooding was predicted at MH Ref ST06659701, which is located approximately 80m east from the reported location. Table 5 details the worst case flooding volumes predicted by the model at this MH.

The reported flooding at Heol y Pentir was commented as "*No problems found, suspected groundwater issue*". The reported flooding was therefore discounted.

Also the reported flooding at Lon Lindys was commented as "*fractured, rising main*". The reported flooding was therefore discounted.

The model does not predict flooding in the area of Glyn y Gog or Heol Pearetree.

3.7. Modelling Assumptions

No supporting information was supplied with the model. For the purposes of the assessment, it was assumed that the model supplied was suitable to undertake this particular HMA when enhanced with the new data gathered.

Future model users should be aware of the issues raised by the review and verification of the existing system model outlined in the previous sections.

3.8. Development Dry Weather Flow

Dry weather flows were calculated based on the development size of 90 properties with an occupancy rate of 2.5 persons/house and a per capita return to sewer rate of 180l/person/day.

Table 3 - Development DWF Parameters

Parameter	Value	Comment
Development Size	90	
Occupancy Rate	2.5 people/household	
Population – P	225	
Per Capita Return to Sewer Flow Rate – G	180 l/person/day	As per supplied DCWW Specification v2
Total DWF Calculations		
P*G	40.5m^3/day	Population multiplied by the per capita return to sewer flow rate
DWF	0.468l/s	DWF based on 24hr CIRIA Profile
Total infiltration	0.0468 l/s	0.1 * DWF
Total DWF	0.516l/s	

3.9. Development Surface Water Runoff

Based on development drawings provided, the proposed development was assumed to be fully separately drained, with surface water discharging directly to the existing surface network. Although it was assumed that the development will have completely separate storm and foul systems, an allowance of 2% contributing impermeable area was added to the development subcatchments to account for potential cross connections and urban creep.

4. Assessment – Existing/Developed Comparison

Design rainfall events supplied by DCWW were used to predict flood volumes in the existing and developed models. The events are generated using the Flood Estimation Handbook (FEH) method. Return Periods of 30 years were selected based on the DCWW Model Build and Verification Standard Specification and return periods proposed in the project bid. Storm durations of 15, 30, 60, 120, 240, 300, 360, 480 and 720 minutes were used for both summer and winter. The M30-30 winter storm was identified as the critical event.

A full set of rainfall data from 1980 to 1990 was supplied with the model. A typical year was created using the rainfall from 1981. This year was chosen as the total rainfall of 961mm in 1981 was the close to the annual average rainfall of 950mm. The typical year was used for annual pump operation and CSO spill simulations discussed in Sections 4.3 and 4.4.

As the overflows spill into the Cold Knap Barry Bathing Water catchment, a prescriptive bathing season assessment was carried out. The rainfall data set was cut down into a bathing seasons from the 15thof May to the 30th of September. This was used to establish the bathing season average spill count for all CSOs and EOs.

Simulations were run on for 12 hours after the end of time-varying rainfall, to ensure full system drain down and so that any delayed peak flows were captured from the simulations.

4.1. Hydraulic Assessment

4.1.1. Existing Flooding

The full set of 30-year return period events were run in order to gauge a baseline level of flooding within the Rhoose area. The model predicted flooding of greater than 25m^3 at six locations. Additional flooding occurred in the parallel Barry area of the model however these have been omitted as they are hydraulically separate from the Rhoose area and the development. The six flooding manholes were located in the Fontygary and Rhoose areas which discharge separately from the proposed development into Rhoose Main SPS. The six manholes are summarised in Table 4 and detailed in Figure 3.

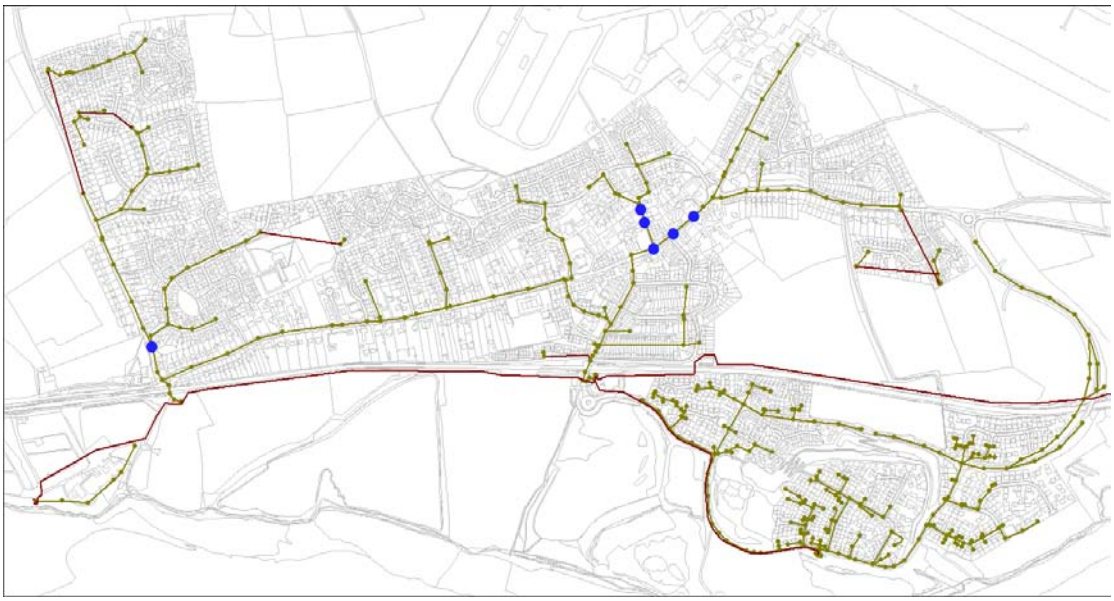


Figure 3 Existing Model flooding above 25m^3

There are reports of surface water flooding incidents in the area of the development however predictions of this nature are beyond the capability of the model. As detailed in Section 3.5 there are several historically reported flooding locations, within the development area.

Table 4 - Existing Model Flooding above 25m^3

Node ID	Critical Duration (min)	Maximum Flood Volume (m^3)
ST05661202	M30-120 Winter	48.8
ST06663403	M30-180 Winter	43.9
ST06663503	M30-300 Winter	46.8
ST06663504	M30-180 Winter	69.0
ST06664501	M30-360 Winter	40.5
ST06664504	M30-240 Winter	40.9

The longsection downstream of Connection Point 1 and 2 for the 30 Year critical 30 minute storm can be seen in Appendix D.

4.1.2. Development Model Flooding

The same set of 30 year storm events were run with the Development model to allow assessment of the change in flooding caused by the proposed development. No manholes were found to have any significant increase in flooding that could be attributed to the inclusion of the development.

One manholes showed a minor increase in the flooding in the Development model, summarised in Table 5.

Manholes directly up and downstream of the proposed connection points were assessed for increases in peak water levels due to the proposed development for the suite of design storms. Increases in level of greater than 0.1 m where the headroom

is less than 500mm during the baseline model would then be checked in greater detail. However, no locations were identified.

Table 5 - Changes in worst-case predicted flood volumes relative to Baseline Model.

Node ID	Worst Case Flood Volume		Change in Flood Volume		
	Baseline Model (m^3)	Development Model (m^3)	(m^3)	%	
ST06659701	3.5	5.5	2.0	57%	Minor increase in flooding volume, requires to be mitigated.

4.2. Combined Sewer Overflow Assessment

4.2.1. Spill Frequency & Volume Assessment

The bathing season rainfall set discussed in Section 4 was used to asses any change between the CSO spilling in the Baseline model and the Development model between 15th May and the 30th September. The SPS overflows from all SPS in the model were gauged for any change. As shown in Table 7 and Table 8, in both the Baseline and Development model runs, only the Rhoose Main SPS overflow spills during this assessment.

Table 6 - Changes to CSO Annual Bathing Season Spill Volume relative to Baseline Model

CSO Name	Existing Model Spill Vol. (m^3)	Development Model Spill Vol. (m^3)	Absolute Difference (m^3)	% Difference
Rhoose Point SPS EO	0	0	0	0%
Rhoose Main SPS CSO	2,159	2245	86	4%
Porthkerry SPS EO	0	0	0	0%
Fontygary Coastal CSO	0	0	0	0%
Airport SPS EO	0	0	0	0%
Station Rd CSO	0	0	0	0%

Table 7 - Changes to CSO Annual Bathing Season Spill Frequency relative to Baseline Model

CSO Name	Existing Model Spill Frequency	Development Model Spill Frequency	Absolute Difference	% Difference
Rhoose Point SPS EO	0	0	0	0%
Rhoose Main SPS CSO	14	16	2	14%
Porthkerry SPS EO	0	0	0	0%
Fontygary Coastal CSO	0	0	0	0%
Airport SPS EO	0	0	0	0%
Station Rd CSO	0	0	0	0%

A detriment to spill volume was noted at the Rhoose Main CSO. The Rhoose Main CSO will also spill when the pumps in the SPS wet well (82l/s for duty and 10l/s for assist) are beaten and the wet well and storage overflows directly from the wet well to the screening chamber. This does not occur during the TSR set and only operates during high return period events.

4.3. Pump Operation Assessment

To assess the effect of the development on the downstream SPS, a volume balance was performed for each of the three SPS downstream of the development. The SPS inflow and outflow for the Baseline and Development model were compared to indicate the increases in volume expected due to the development

4.3.1. Wet Well Inflow

The annual increase in volume inflow passing into each SPS downstream of the development can be seen in Table 9. An increase of approximately 16,000m^3 per annum is seen across all the SPS which can be attributed to the inclusion of the development.

Table 8 - Change in modelled pumping station annual inflow due to development

Pumping Station	Baseline Model Inflow (m^3)	Development Model Inflow (m^3)	Change In Inflow (m^3)
Rhoose Point SPS	94,162	110,073	15,911
Rhoose Main SPS	621,090	637,176	16,086
Porthkerry SPS	641,054	657,144	16,089

4.3.2. Pumping Volume and Hours

Annual pumping volumes and hours correspond to the increased inflow at each SPS. The detriment to the annual pumped volume and annual pumping hours can be seen in Table 10 and Table 11.

Table 9 - Change in modelled annual pumped volume due to development

Pump	Baseline Model Pumped Volume (m3)	Development Model Pumped Volume (m3)	Change In Pumped Volume	
			(m3)	(%)
Rhoose Point	94,161	110,065	15,904	16.9%
Rhoose Main Assist	5,916	6,856	939	15.9%
Rhoose Main Duty	615,512	630,676	15,465	2.5%
Porthkerry	641,662	657,782	16,120	2.5%

Table 10 - Change in modelled annual pumping hours due to development

Pump	Baseline Model Pumped hours (hr.)	Development Model Pumped hours (hr.)	Change In Pumped hours	
			(hr.)	(%)
Rhoose Point	2,212	2,583	371	16.8%
Rhoose Main Assist	200	231	32	15.9%
Rhoose Main Duty	2,714	2,775	61	2.2%
Porthkerry	2,387	2,440	53	2.2%

4.4. Hydraulic Analysis Results Summary

As a result of comparison of the hydraulic assessment between the Baseline model and Development model performance it can be seen that:

- There are some existing areas of flooding reported in the Rhoose area. The model predicts an increase in flooding volume (increase from 3.5m^3 to 5.5m^3) at a reported historical flooding location on Bryn y Gloyn. This manhole is located in the vicinity of the Rhoose Point SPS.
- With the exception of Rhoose Main CSO, none of the CSOs or EOs spill in the typical year Bathing Season in either the Baseline or Development model. The Rhoose Main CSO spills between the Baseline and Development model. A detriment was observed in the spill volume in the Development model. This is considered to be attributed to the inclusion of the development.
- A detriment was also predicted in the Rhoose Main CSO bathing season spill frequency
- An increase of inflow and pumped volume of approximately 16,000m^3 per year is noted at all SPS downstream of the development.

As a result of the HMA, it is concluded that the model predicts a detriment to the network as a result of the development. The detriment at the Rhoose Main CSO also means that additional flows should not be added from the development without mitigation. This has resulted in an optioneering stage being undertaken to improve the operation of the Rhoose Main CSO, or relocate the development flows to prevent any interaction with this CSO.

5. Notional Solution Development

Options have been developed to mitigate the sensitivity of Rhoose Main CSO to the Rhoose Point pump timing issue and resolve the detriment at the CSO.

5.1. Initial Solution Development & Discounted Options

Initial solutions considered to mitigate the development detriment include:

- The construction of a SPS dedicated to pumping the new development flows to Rhoose Main SPS was investigated. This solution was deemed feasible and is discussed further as Option 3 in Section 5.5. This option will have the same effect on the network as Option 2 and hence individual modelling has not been completed for this option.
- Separation of storm water from combined areas upstream of Rhoose Point was assessed. While storm water separation is a desirable network improvement; in this case it has been discounted as an unsuitable solution. Only one potential area along the northern end of Rhoose Road was identified as suitable for separation. This was investigated further and found to only marginally mitigate any detriment caused by the development.
- It had been suggested that the Rhoose Point SPS is under capacity and in poor condition and a full upgrade of the Rhoose Point SPS in needed. This option has been investigated in part by increasing the Rhoose Point storage. The option was deemed feasible however no survey or flow data collected showed any sign of an under capacity SPS. The pump rate and storage volumes were both in excess of a typical design specification. Further investigation suggests the electrical controls are in poor condition and prone to failure however the SPS itself was designed and sized with the correct capacity.

5.2. Option A – Upsize 180m of sewer along Bryn Y Gloyn from 150mm to 225mm diameter

This option offers a solution to the small increase in flooding predicted at MH Ref ST06659701 on Bryn Y Gloyn.

Option A requires to be incorporated into Options 1 and 2; however the option has been described separately should there be a desire to resolve the flooding independently.

5.2.1. Option Description

The flooding in manhole ST06659701 is caused by the 150mm sewer along the south eastern corner of Bryn Y Gloyn being under capacity. During storm events the flow is restricted and backs up to the intersection with Nyth-Yr-Eos. This option proposes to upgrade 180m of the existing sewer from 150mm to 225mm between Cilgant Y Meillion and Nyth-Yr-Eos. This is shown in Figure 4.

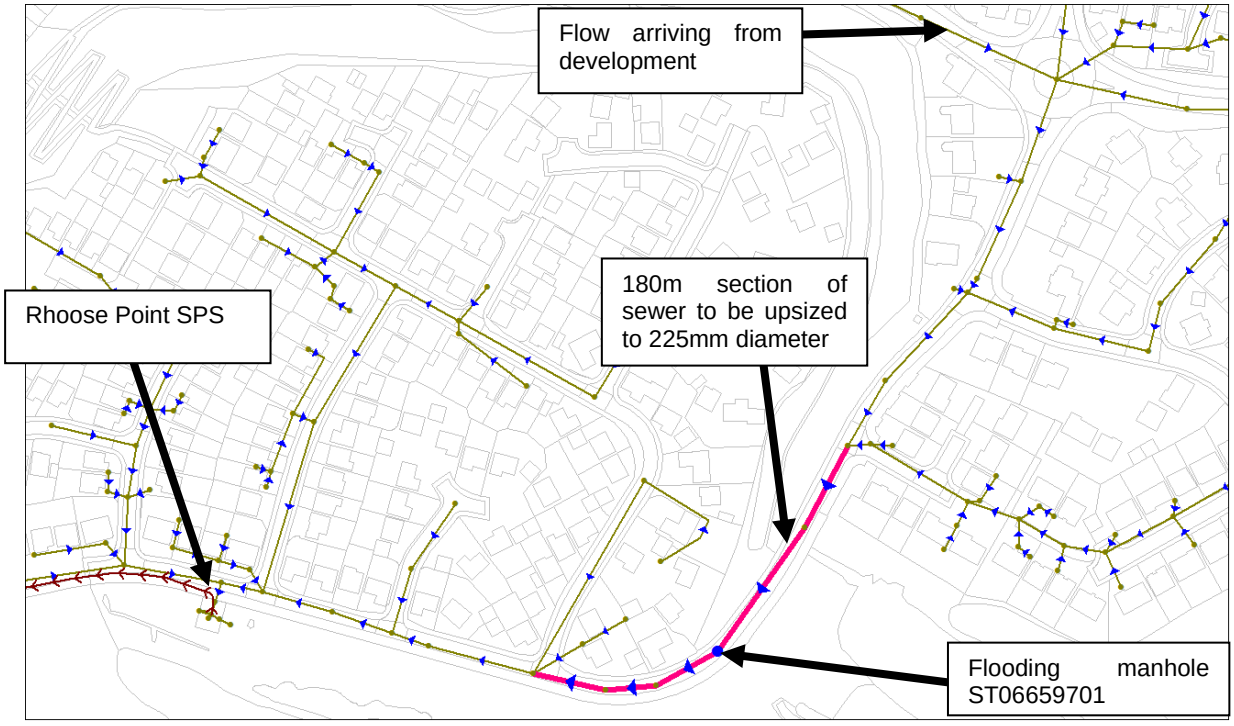


Figure 4 - Option A; Upsizing 180m section of sewer on Bryn Y Gloyn

5.3. Option 1 – Refurbish Rhoose Main SPS CSO

This option would include Option A.

As the Rhoose Main CSO was identified as the main area of detriment, this option offers a solution to the detriment at the Rhoose Main CSO.

5.3.1. Option Description

Refurbishing the Rhoose Main CSO by upsizing the continuation pipe and adding a flow control to the continuation so that the CSO spills at the consented rate. Approximately 13m of the continuation would be upgraded from 225mm diameter to 450mm diameter.

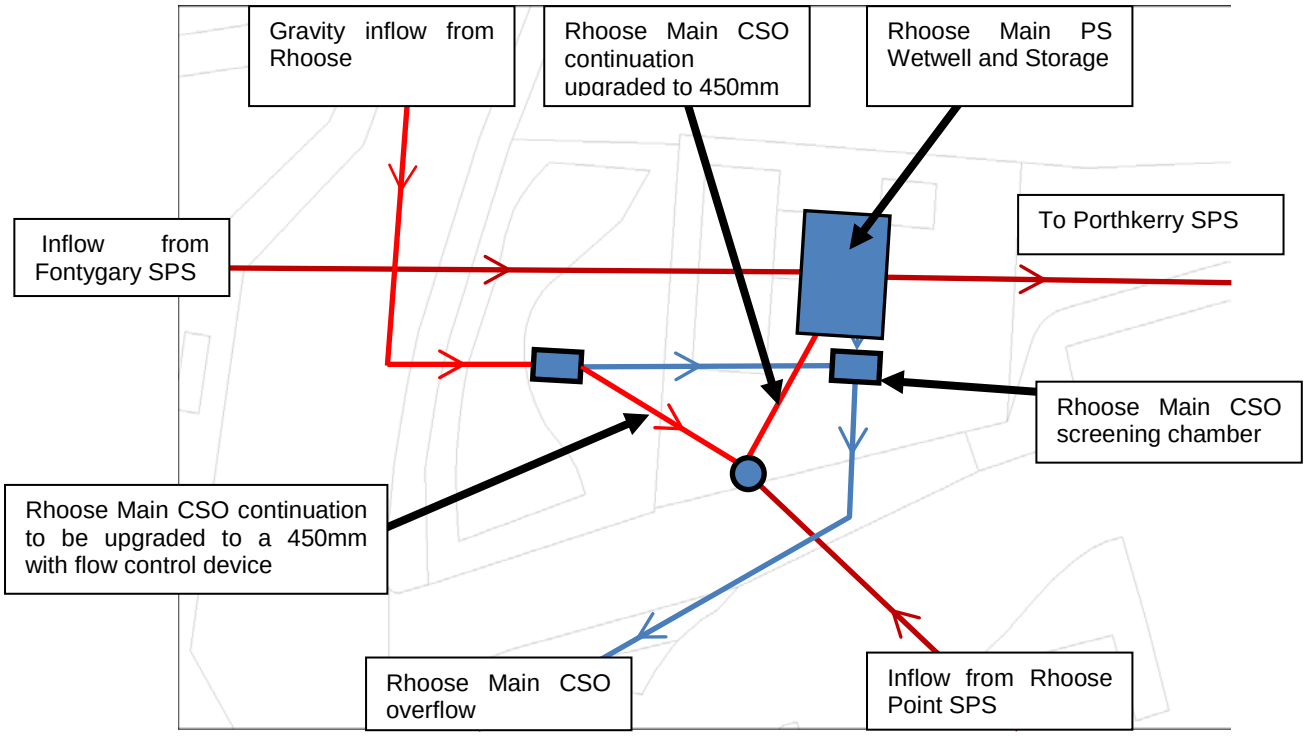


Figure 5 - Option 1; Refurbish Rhoose Main SPS CSO schematic

In order to model the refurbishment, the two continuation pipes have been upsized to 450mm and an orifice with a limiting discharge of the consent pass forward value included. This orifice control is a means of modelling the refurbishment and detailed design would be necessary to determine the best means of controlling the continuation flows in the CSO. This is shown in Figure 5.

As this option would require overpumping of the continuation flows to allow for construction, a new control could potentially be constructed offline and then connected in place of the existing control. This would minimise the amount of overpumping required. This would be assessed during a detailed design phase.

This solution considerably reduces the volume and frequency of spills from the Rhoose Main CSO. A summary of this can be seen in Table 12. This option model shows no changes to the other spill volumes or frequencies or the flood volumes other than model instabilities. This option will not have a significant impact on the

assets downstream from Rhoose Main SPS, although more flow will be passed down to the WwTW. The downstream Porthkerry EO does not spill with this option in place.

Table 11 - Option 1; Rhoose Main CSO and Rhoose Point EO spill comparison

Model	Rhoose Main CSO
	Annual bathing period spill count
Baseline Model	14
Development Model	16
Option 1 Model	3

5.3.2. Option Considerations

Option A would be constructed in conjunction with this option to resolve the flooding in the vicinity of the Rhoose Point SPS.

5.4. Option 2 – Reconfigure Rhoose Main SPS CSO

This option would include Option A.

This option offers a solution to the detriment at the Rhoose Main CSO.

5.4.1. Option Description

Reconfigurations of the inflow from Rhoose Point so that flows are passed directly into the Rhoose Main SPS instead of manhole ST06662104. This reconfiguration means that the inflow is not being carried by the pipe ST06662104.1 and hence Rhoose Point will no longer influence the CSO operation. This is shown in Figure 6.

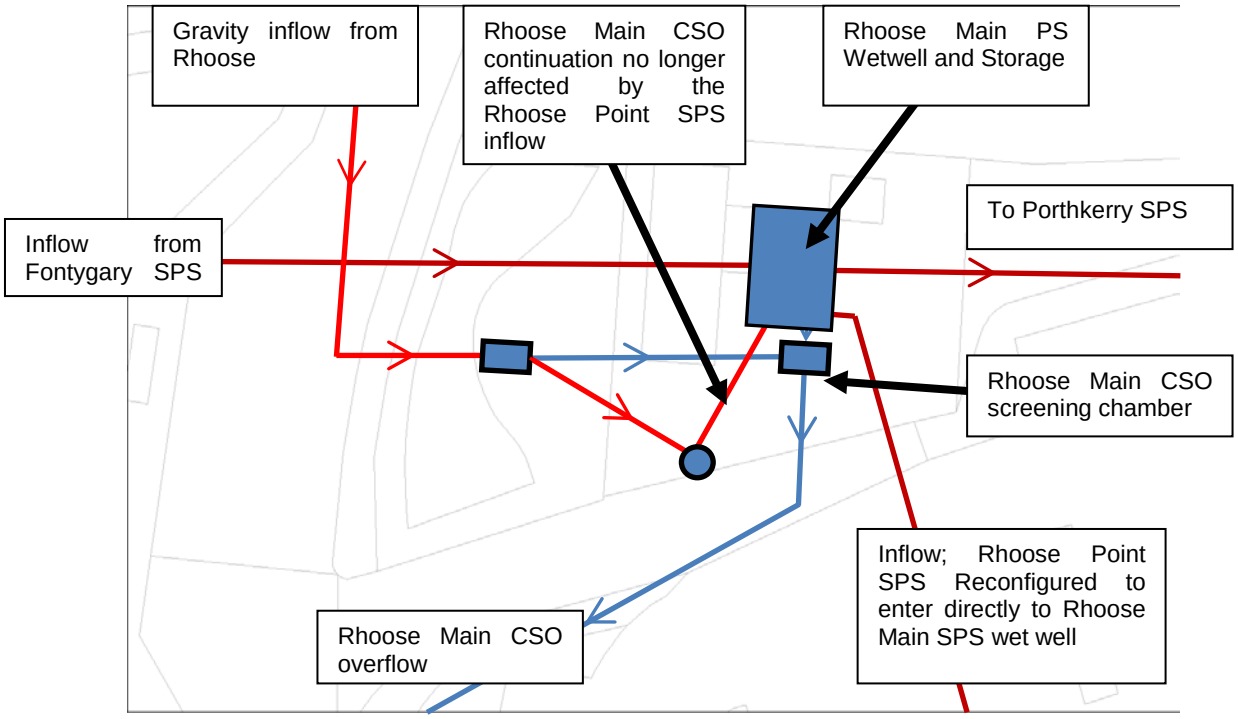


Figure 6 - Option 2; Reconfigure Rhoose Point pumped inflow into Rhoose Main schematic

This solution reduces the volume and frequency of spills from the Rhoose Main CSO. A summary of this can be seen in Table 13. The option model shows no changes to the other spill volumes or frequencies or the flood volumes other than model instabilities. This option will not have a significant impact on the assets downstream from Rhoose Main SPS although more flow will be passed down to the WwTW. The downstream Porthkerry EO does not spill with this option in place.

Table 12 - Option 2; Rhoose Main CSO and Rhoose Point EO spill comparison

Model	Rhoose Main CSO
	Annual bathing period spill count
Baseline Model	14
Development Model	16
Option 2 Model	14

5.4.2. Option Considerations

The reconfiguration will allow an extra 12l/s leeway in the Rhoose Main CSO and the flows from the development will no longer influence the spills.

The suitability of the upgrade would require to be investigated including whether there is the available space for the new rising main into the wet well.

Option A would be constructed in conjunction with this option to resolve the flooding in the vicinity of the Rhoose Point SPS.

5.5. Option 3 – Pump directly to Rhoose Main SPS

This option offers a solution to the detriment at the Rhoose Main CSO.

5.5.1. Option Description

The construction of a dedicated main pumping the development flows along Trem Echni directly to the Rhoose Main SPS wet well. This option is intended to bypass Rhoose Point SPS and avoid any detriment to the Rhoose Main CSO. This is shown in Figure 7.

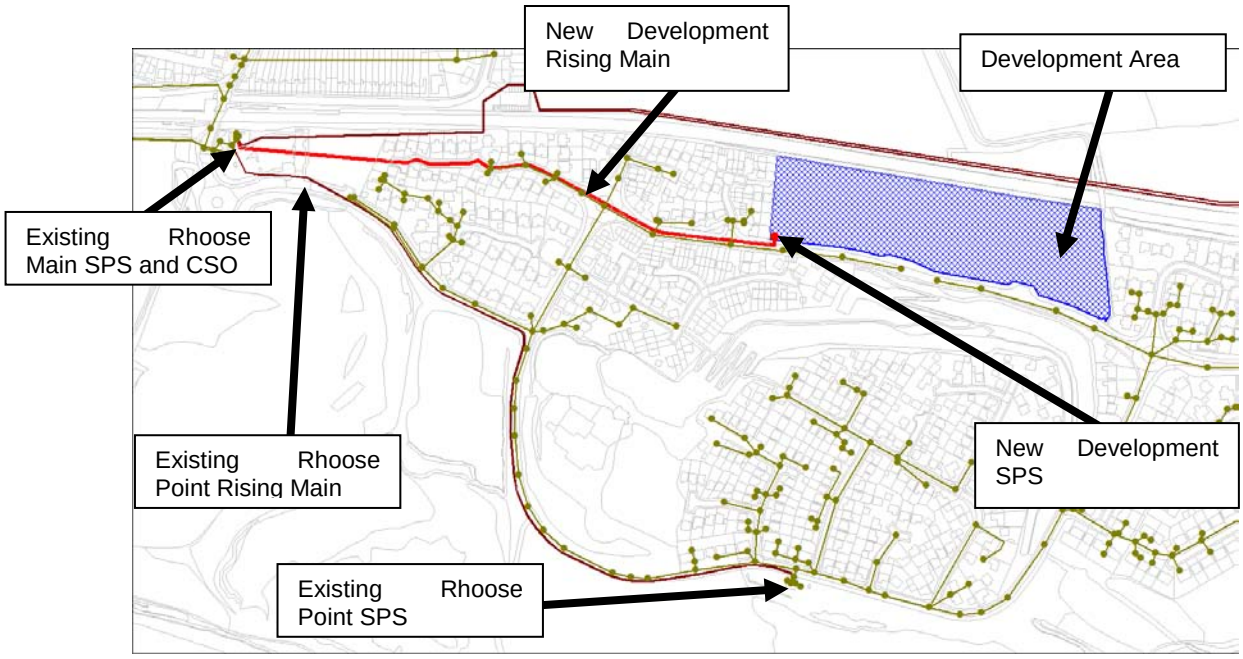


Figure 7 - Option 3; Pump directly to Rhoose Main SPS schematic

This option has the same effect as Option 2, except with two rising mains entering Rhoose Main SPS rather than the single existing Rhoose Point rising main. Additional modelling has not been performed and it is concluded to have a similar effect as Option 2, however a flow control may be required to prevent both SPSs discharging peak flows simultaneously. As with Option 2, this will not have a significant impact on the assets downstream from Rhoose Main SPS and Porthkerry EO does not spill with this option in place.

5.5.2. Option Considerations

This option removes the flows that will affect the Rhoose Main CSO performance.

Foul and storm networks are already in place to serve the development (presumably because the original Rhoose Point development was anticipated to have further development in that location) and no detriment is identified between the development and the Rhoose Point SPS. A new development SPS is concluded to not use the network as effectively as possible and will result in an inefficient doubling up of the operational cost by having two Rhoose Point pumping stations.

The feasibility of the upgrade would require to be investigated including whether there is the available space for the new rising main into the wet well. In addition consideration should be given to the OPEX costs associated with the operation of two pumping stations.

This option does not require Option A to be constructed as flows would be pumped directly to Rhoose Main SPS, avoiding the flooding location.

6. Budget Capital Cost Estimates

The costs for Option A, 1, 2 and 3 have been estimated using the DCWW Cost Database. Note that the costing estimates for Options 1 and 2 include the cost for Option A as the upsizing is required as part of the overall solution. It would not be required for Option 3 as the development flows would be pumped directly to Rhoose Main SPS.

It is important to note that these costs were completed at a desktop level and should not be taken as actual detailed costs. These costs would be subject to change depending on-site conditions.

The total option costs are shown in Table 14.

Table 13 - Option Cost Summary

Option	Total Cost Estimate	Comments
Option 1 – Refurbish Rhoose Main SPS CSO	£327,808	Cost estimate is for the initial survey cost, over-pumping during construction (estimated 16 weeks), pipe upgrade and flow control device. Also included is the cost of up-sizing 180m of 150mm to 225mm diameter sewer.
Option 2 – Reconfigure Rhoose Point Rising Main	£348,046	Cost estimate based on the DCWW cost model. No allowance for design or investigation included. Also included is the cost of up-sizing 180m of 150mm to 225mm diameter sewer.
Option 3 – Pump directly to Rhoose Main SPS	£363,291	Cost estimate for simple SPS and rising main to Rhoose Main SPS.

7. Conclusions and Recommendations

The HMA has identified a minor flooding detriment in the network in the vicinity of the Rhoose Point SPS and using a typical year, filtered for a bathing seasons, a detriment to the spill volume and frequency was noted at the Rhoose Main CSO.

In order to mitigate the effects of the development of the reported flooding at Bryn Y Gloyn, one sub-option has been proposed:

- Option A involves upgrading 180m of the existing sewer from 150mm to 225mm between Cilgant Y Meillion and Nyth-Yr-Eos on Bryn Y Gloyn. This option removes the model predicted flooding which replicates the reported external flooding at the junction of Bryn Y Gloyn and Cilgant Y Meillion.

Although Option A has been reported separately, it should be constructed along with either Option 1 or Option 2.

In order to mitigate the effects of the development on the performance of the Rhoose Main CSO, three options have been proposed:

- Option 1 involves further investigation of the Rhoose Main CSO. Once this has been carried out, the CSO continuation should be upsized to 450mm diameter and a control device added.
- Option 2 involves reconfiguration of the Rhoose Point rising main to directly connect it to the Rhoose Main SPS. This avoids any effects on the Rhoose Main CSO.
- Option 3 involves the construction of a dedicated rising main from the development to the Rhoose Main SPS.

All of the above options were identified as removing the impact of the development on the reported flooding at Bryn Y Gloyn and the impact at Rhoose Main CSO.

Following our Peer Review on 14th January 2014 it was agreed that Option 1 is considered to be the preferred option as it addresses the underlying issue at the Rhoose Main CSO and removes the flooding at Bryn Y Gloyn.

Option 2 would also be suitable as it directly removes the impact of the development on Rhoose Main CSO.

Option 3 is not considered to be as cost effective as either Option 1 or Option 2 as a new SPS would be required and the flooding at Bryn Y Gloyn would not be resolved.

Appendix A – Brief Review of Existing System Model

Check	Comment
Possible to trace model build and verification history?	No history or reporting provided with the model. Unable to trace the model history.
Confirm flagging process	Two flags used - #I – model import and IN – inferred. With no model history the confidence in either flag is unknown.
Compare connectivity of model to asset data	Model connectivity matches the asset data well however the location of assets are inconsistently offset – looks to have been built using a slightly different GIS or an old design drawing perhaps. Model deemed acceptable for the purpose of this HMA.
Review level of simplification is acceptable.	Storm network has been cut back however the foul network has not. Storm network is not considered in this HMA so deemed acceptable.
Confirm presence of all major ancillaries.	All major ancillaries have been included in the model
Confirm STW inlet/FFT inclusion and general suitability.	WwTW included in the supplied model however this was cut down as it is independent of the area of interest of this HMA.
Confirm model extents cover all flooding locations.	Model extends greatly beyond the area of assessment for this HMA
Confirm all recent developments are included.	Rhoose Point development is not included. Model updated based on GIS supplied.
Confirm all recent capital schemes since model construction are included.	No capital Schemes identified. Model updated to include Rhoose Point development.
Confirm all significant traders are included and how they have been modelled.	Not all traders included. Added Rhws Primary School on Fontygary Road, the Fontygary Leisure Park and updated the airport to specification.
Highlight any sections of network not represented/represented by inflows/dummy flows.	New storm flow network not modelled however no areas where foul flow is not modelled.
Check level of detail at known problems.	No known issues
Percentage of manhole survey data included in model.	Unclear flagging in supplied model. No additional manhole surveys included. 39/689 (5%) of cutdown model links CCTV'd
Confirm size and resolution of subcatchments. Confirm subcatchments digitised to property boundaries.	Several large subcatchments used for groundwater infiltration removed. Foul subcatchments ranging from 3.7ha - 0.13ha and 822 – 2 people per ha. Subcatchments generally match the property boundaries however seem to be digitised with a slightly different set of GIS.
Comment on how impermeable areas have been applied.	Very unclear how impermeable areas have been applied. Seemingly random mixture of assumed areas as a percent and very specific percentages that do not correlate to current GIS supplied.
Check application of stored, lost and sealed manhole flood types.	Dummy nodes correctly set to sealed and all others set to lost except 7 storm nodes set to stored. Updated based on impermeable areas in GIS.

Examine model population.	Model population corresponds to the property seed count
Check wastewater flow profile ordinates.	CIRIA profile used in model.
Check infiltration applied to model.	Infiltration predominantly applied to large areas added for slow response. No flow survey taken so infiltration unchanged
Check headloss application is sensible.	Headloss revised to Infoworks standard and all pipes with headloss of 8 were reviewed and changed if necessary.
Confirm how storage compensation applied.	Unknown. Updated with InfoWorks numerical correction and storage compensation tools.
Runoff model used suitable?	Fairly large percentages used for runoff surfaces however still within expected range.
Confirm if the New UK runoff model or SCS model has been used to represent slow response runoff. Any issues with slow response predictions?	New UK model. Very large percentage percolation infiltration used (90%) this was reduced to 60% in verification.
Sample check key ancillaries to confirm accuracy of modelling.	No data available to perform check.
Check pipe roughness values.	90% set to default 3mm top 3mm bottom. Remainder set higher but still to a reasonable value. Updated the cutdown model to Specification.
Check sediment depths.	Only a small number of pipes have sediment included. All are reasonable values.
Identify any amendments to represent operational issues (inclusion of orifices or short sections of small diameter pipe to represent partial obstructions).	No operational issues included in supplied model
Seasonal variation likely?	Seasonal variation in the Fontygary Leisure Park accounted for.

Appendix B - Survey data added to the model.

Sewer Model Reference	Width (mm)	Bottom Roughness Colebrook-White (mm)	Sediment Depth (mm)
18612137.1	150	6	
18613465.1	150	6	
18613476.1	150	6	
18614784.1	150	6	
18614792.1	150	6	
18614808.1	150	6	8
18617199.1	150	6	8
18617214.1	150	6	8
18617236.1	150	6	7
18617269.1	150	6	6
18617301.1	150	6	30
18617354.1	150	12	
18617371.1	150	6	
18617383.1	150	6	
18617388.1	150	6	
18617390.1	150	6	
18617392.1	150	6	
18617398.1	150	6	
18617420.1	150	6	8
18617428.1	150	6	8
18617430.1	150	6	
18617443.1	225	6	
18617447.1	225	6	
18617452.1	225	6	56
18617454.1	225	6	
18617459.1	225	6	
18617463.1	225	6	
18617695.1	225	6	
18617696.1	150	6	
18617698.1	150	6	
18617699.1	150	6	
18617702.1	150	6	
18617705.1	150	6	

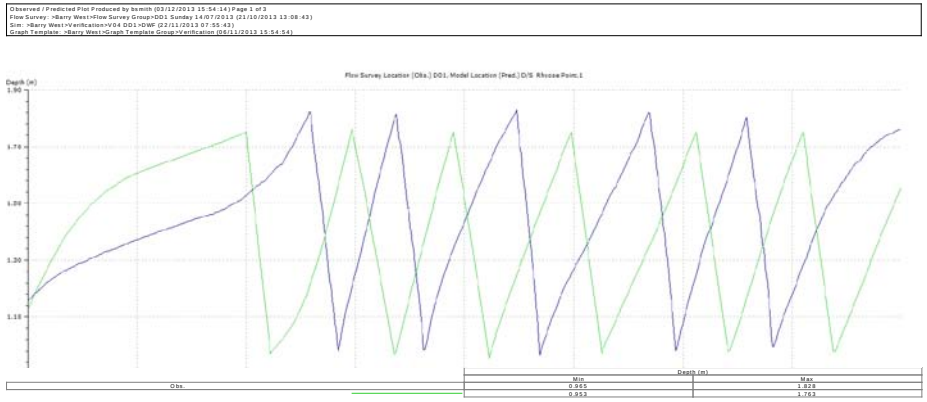
Sewer Model Reference	Width (mm)	Bottom Roughness Colebrook-White (mm)	Sediment Depth (mm)
18617709.1	150	6	
18617712.1	150	6	
18617715.1	150	6	
18617721.1	150	6	
18617724.1	150	6	
18617726.1	150	6	

Appendix C – Existing System Model Verification

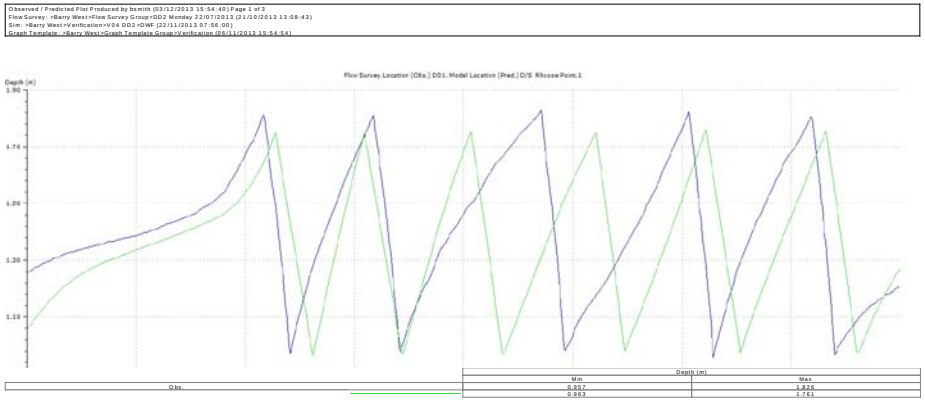
DM001

- No pump start/stop or rate data supplied so the start/stop was extracted from the observed data. Rate was first taken using the depth data at the time of the SPS test as the test is obvious in the record. This rate was clearly incorrect so a rate of 12l/s was used to best fit the data.
- New subdivision with separate storm water. Cross connection assumption of 2% fits well.
- RG001 was removed as it seems to have an inconsistent peak with RG002 and RG003

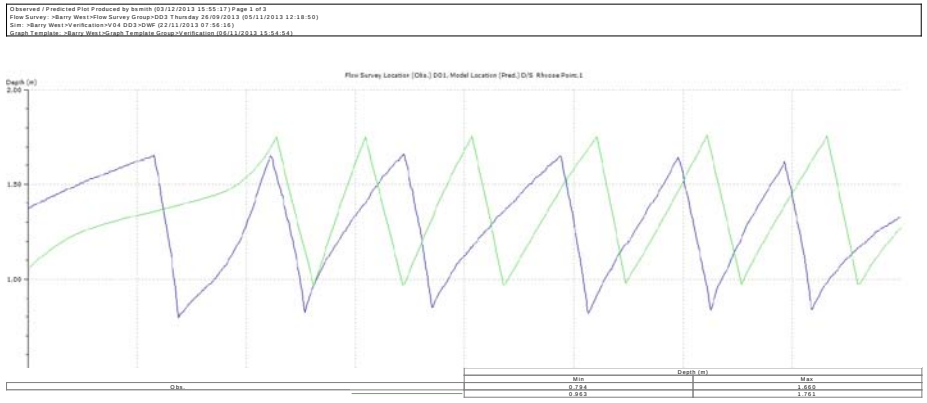
DWF 1



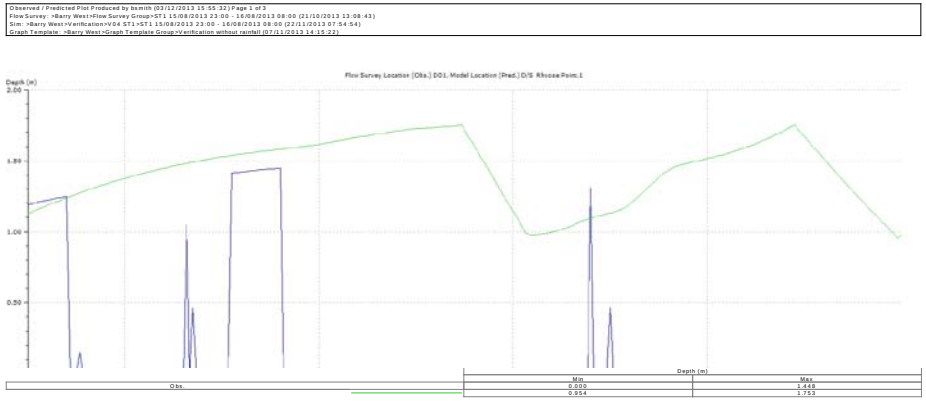
DWF 2



DWF 3



Storm 1



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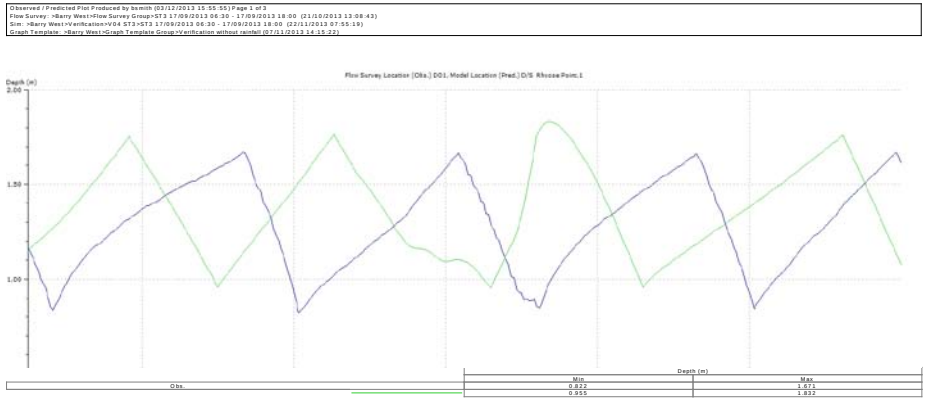
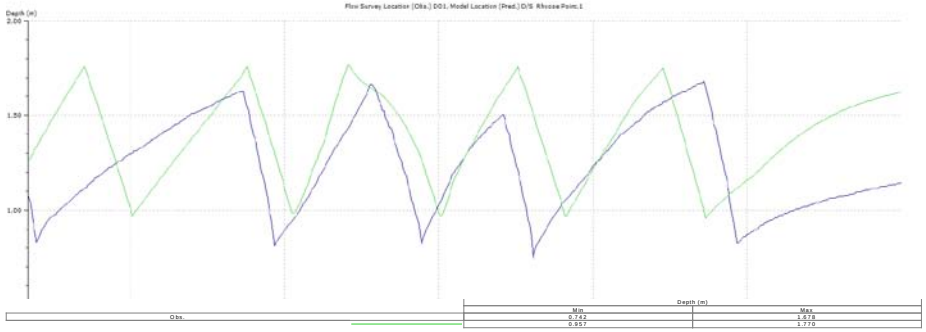


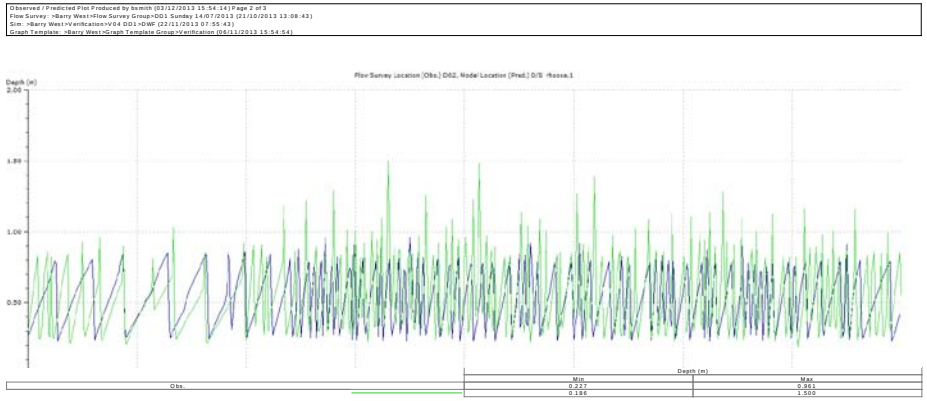
Storm 3



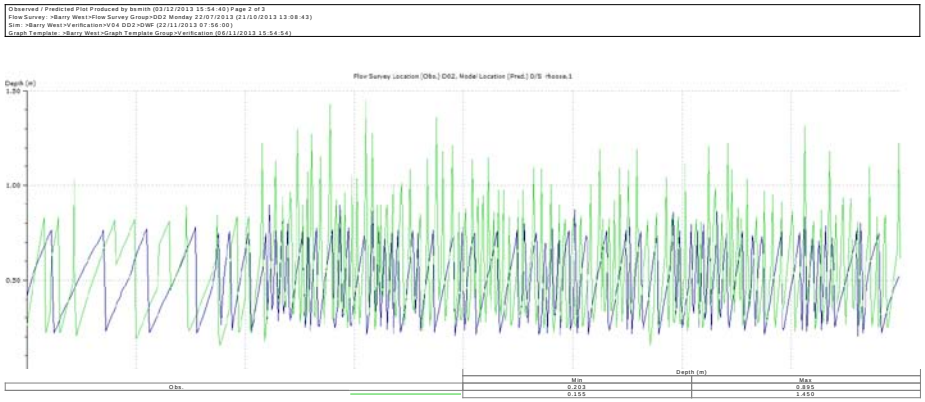
DM002

- Pump test start are on average 0.41mm above observed.
- Difficult to verify without any flow data. Suitably verified for the small development in this HMA.
- Reintroduced the groundwater infiltration from the supplied model with a lower rate of 60%. Decreased the standby pump at Rhoose Main to 35l/s to represent both pumps running in conjunction

DWF 1



DWF 2



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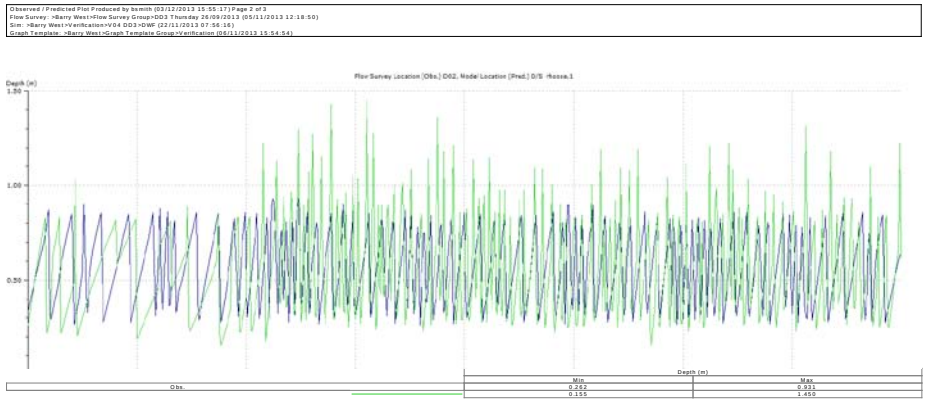
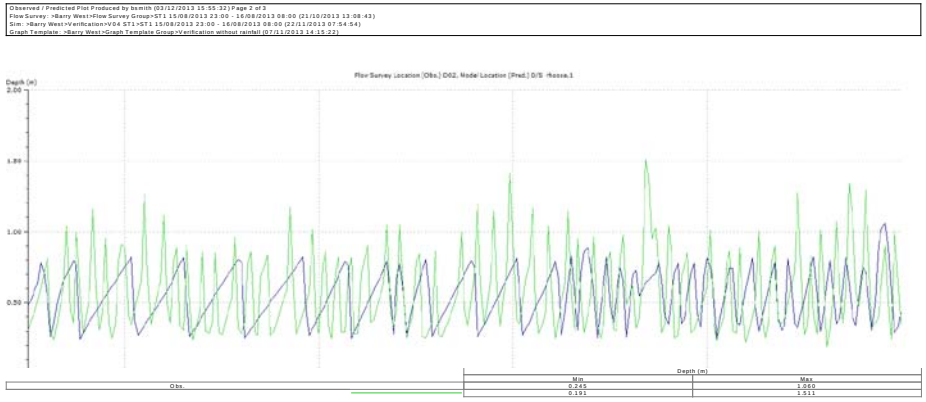
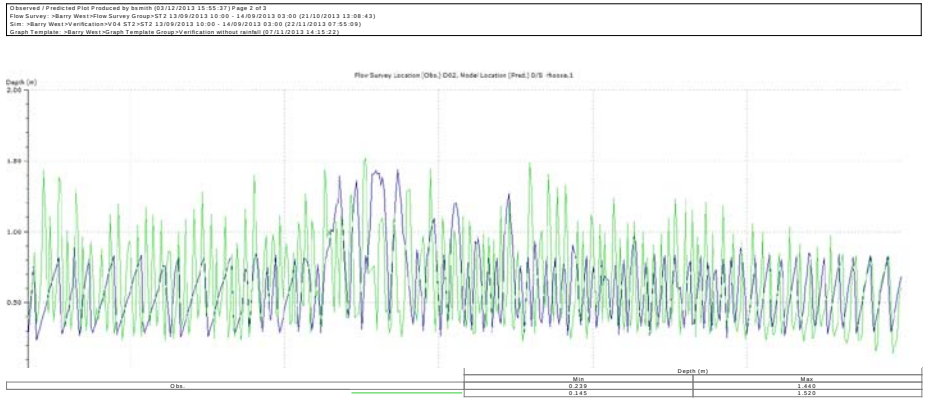


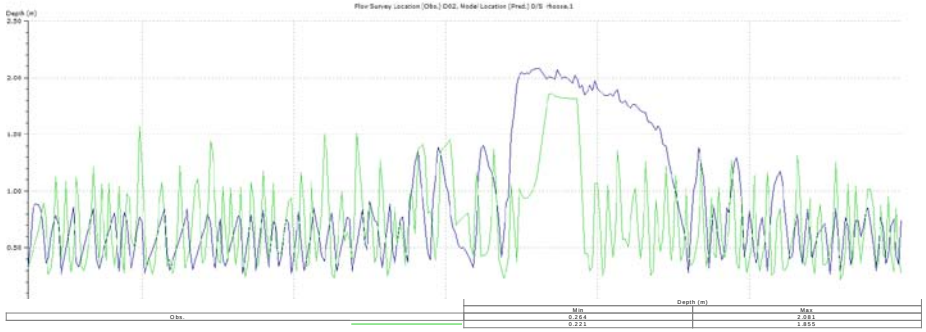
Storm 1



Storm 2



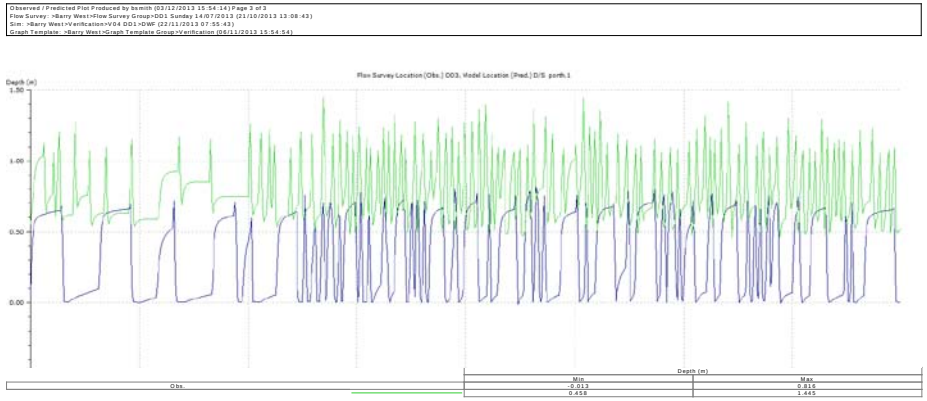
Storm 3



DM003

- An obvious step change can be seen in the observed data on the 30/08/13. DD1 and DD2 and ST1 are before this step so are about 500mm offset. DD3 does not fully fit criteria as there was small rainfall in the preceding days however a third day was needed to verify DM003 correctly.
- Increased the standby pump at Porthkerry to 40l/s

DWF 1



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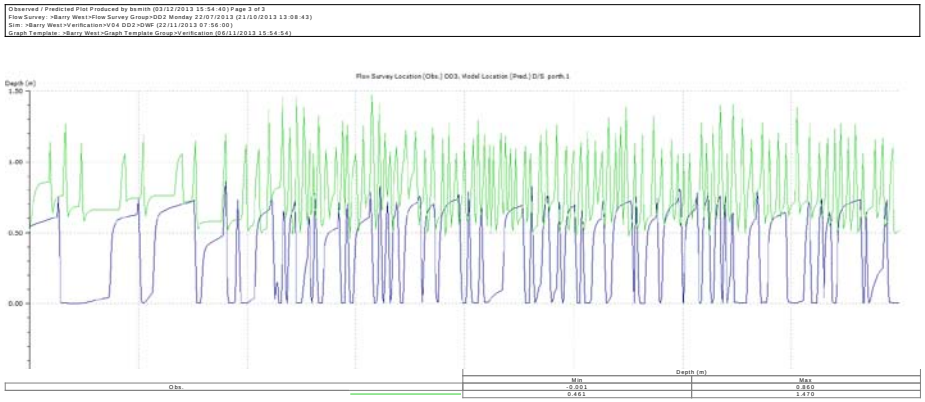
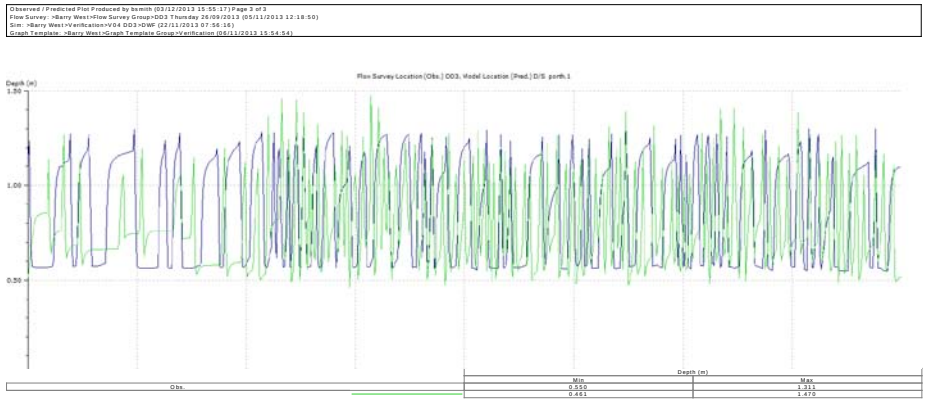
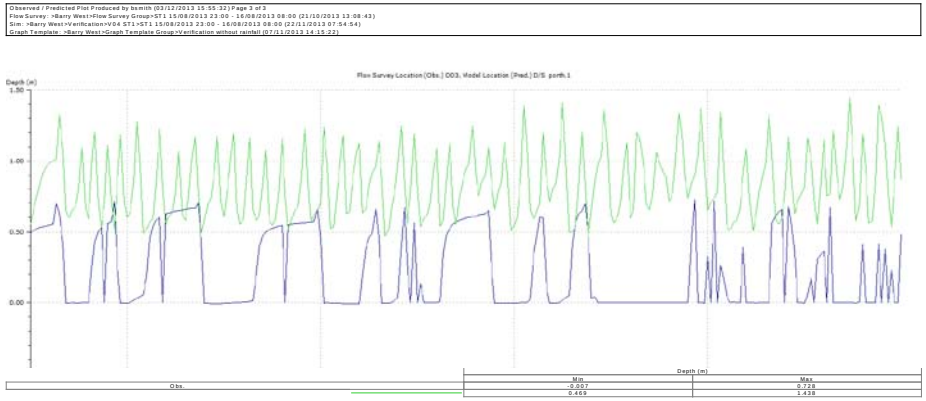


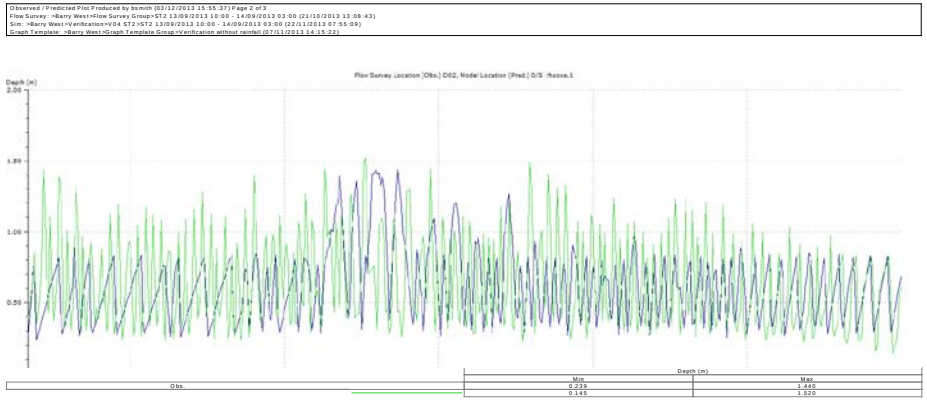
DWF 3



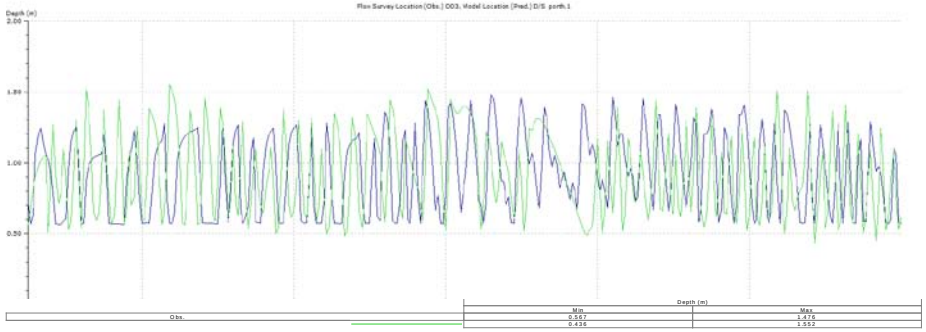
Storm 1



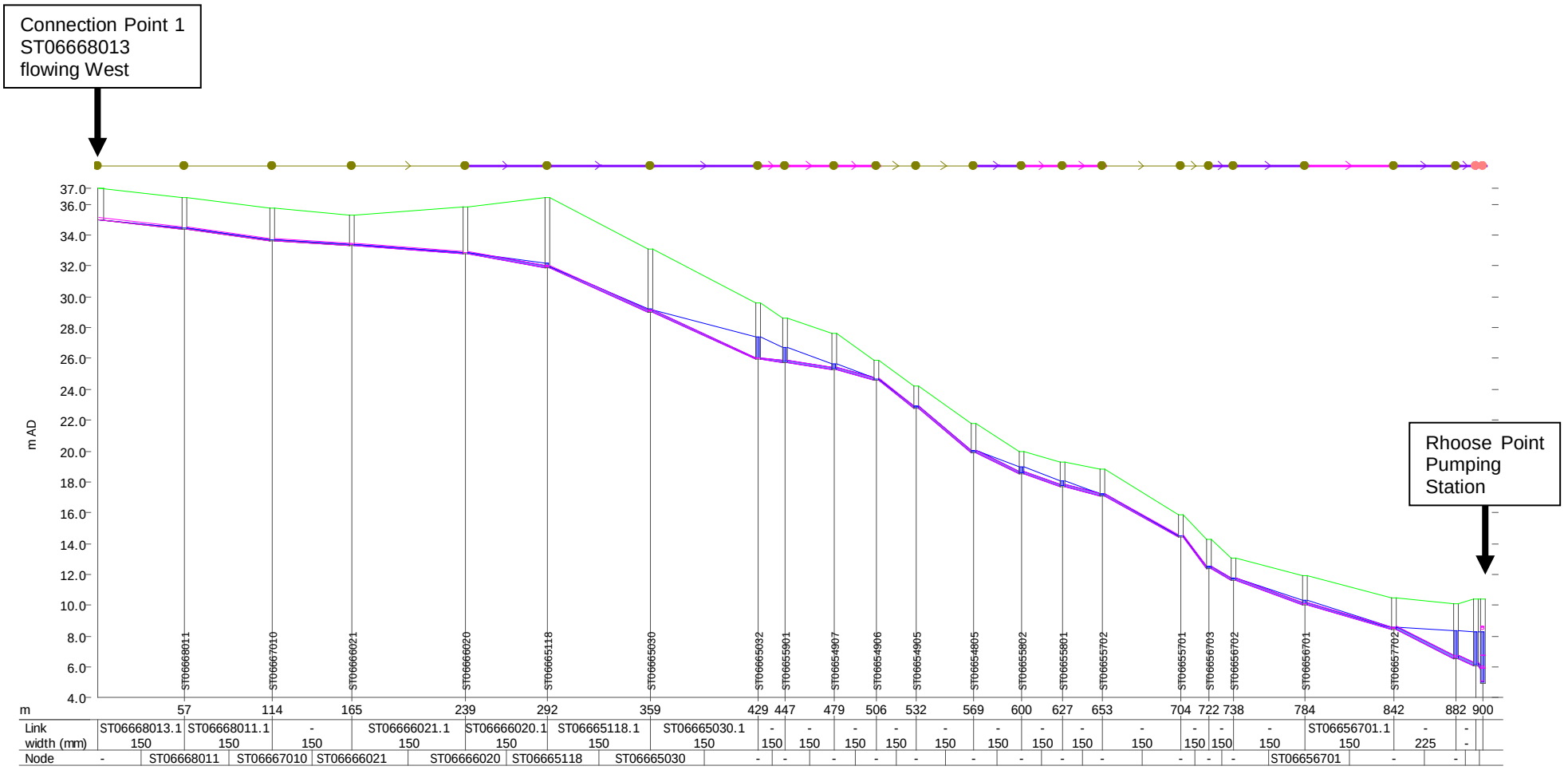
Storm 2



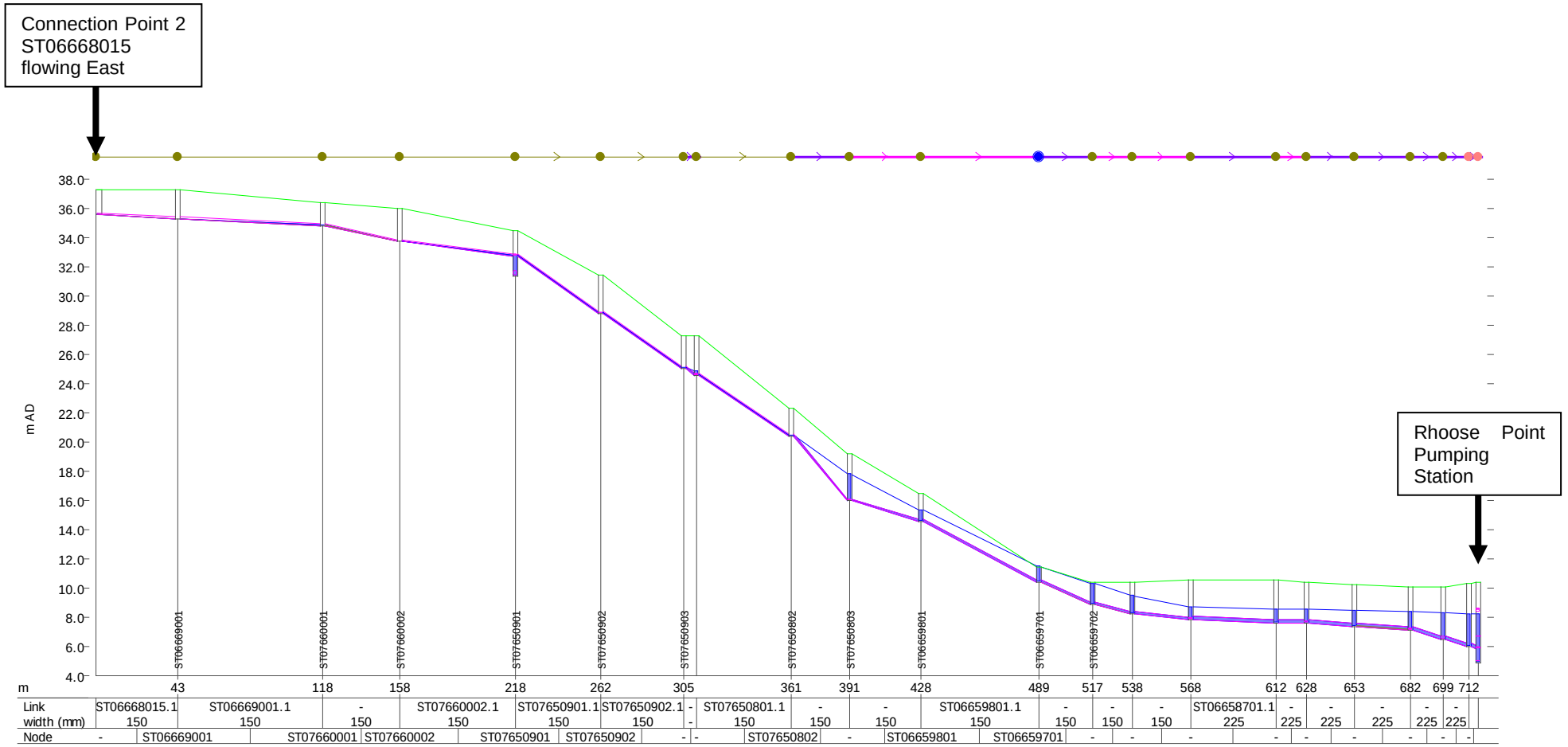
Storm 3



Appendix D – Baseline Model Longsections



Baseline model performance for critical design storm for flood volume downstream of the proposed development Connection 1 (M30-30 Winter).



Baseline model performance for critical design storm for flood volume downstream of the proposed development Connection 2 (M30-30 Winter).