RPS

IronsideFarrar
EnvironmentalConsultants

Ironside Farrar Environmental Consultants

Former Roslin Institute, Midlothian

Drainage Impact Assessment

October 2016

Document Control Sheet

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1. Executive Summary

Development	Former Roslin Institute, Midlothian DIA	**Developers**	Ironside Farrar

Development Summary	**Description**	New development of 300 residential units.
	Size	Approximately 11.9Ha in total
	Location	Roslin Village, 7km south of Edinburgh City Centre
	Previous/ Current Usage	Former Roslin Institution, Brownfield site
	Proposed Connection	Into Manhole 26639702 located to the south west of the development site

Model Utilised	STW001986_ICS_JUNE2016_TSR

Model Parameters	Development in two Phases Phase 1 – 200 houses and demolition of Logan building and Poultry centre: – Foul flow = 0.95 l/s. Creep Allowance added to base flow = 0.095 l/s. Total Area = 7.63 Ha. Contributing Area = 0.08 Ha. Connection Manhole is NT27630701 (on sewer to south west of development). Phase 2 – 300 houses (additional 100 houses and demolition of Wallace building):– Foul flow = 1.43 l/s. Creep Allowance added to base flow = 0.143 l/s. Total Area = 11.9 Ha. Contributing Area = 0.2 Ha. Connection Manhole is NT26639702 (on sewer to south west of development).
Simulation Settings	Time steps set at 20 seconds and results for 5 minutes for both design storm simulations and TSR simulations.

Stage 1 – Performance Assessment	**Flooding**	PASS
	Surcharge Level	PASS
	CSO Activations	PASS
	Formula “A”	FAIL IN BOTH PRE AND POST DEVELOPMENT SCENARIOS All CSOs with an exception of Killburn WWPS overflow are predicted to fail in both the pre-development model and the post-development model.
	Lowest level Floor	PASS
	Flooding Register Assessment	NOT PROVIDED The information about historical flooding locations has not been provided for this study.

Recommendations	**Ref**	**Description**
	1	Scottish Water and Ironside Farrar adopt the findings of this report.
	2	It is recommended that the development can go ahead without any upgrades on the network.

2. Introduction

2.1 Overview

In August 2016, RPS was commissioned to carry out a Drainage Impact Assessment to analyse the proposed discharge on a new residential development in Roslin, Midlothian; located approximately 7km to the South of Edinburgh.

The new development will comprise of 300 new residential units (to be built in two Phases) covering an area of approximately 11.9 Ha. The developer expects to discharge an average foul flow of 1.43 l/s to the Scottish water (SW) sewer network to be treated at the Edinburgh PFI Wastewater Treatment Works (WWTW).

This report outlines the findings of the Stage 1 assessment, the objectives of which are outlined in Section 2.3.

2.2 Drainage Area Study Background

The Greater Edinburgh sewered area is located on the east coast of Scotland. The Edinburgh WwTW serves a population of approximately 677,900 people.

The development is located in the village of Roslin located approximately 7km to the south of Edinburgh city centre. The village drains to a pumping station (Killburn WWPS) to the north of the village where the flow is conveyed by gravity for 13km to the terminal pumping station (WALLYFORD PFI TRANSFER SPS). This flow is then pumped into the main Edinburgh drainage network and conveyed by gravity to the Edinburgh Seafield PFI WWTW.

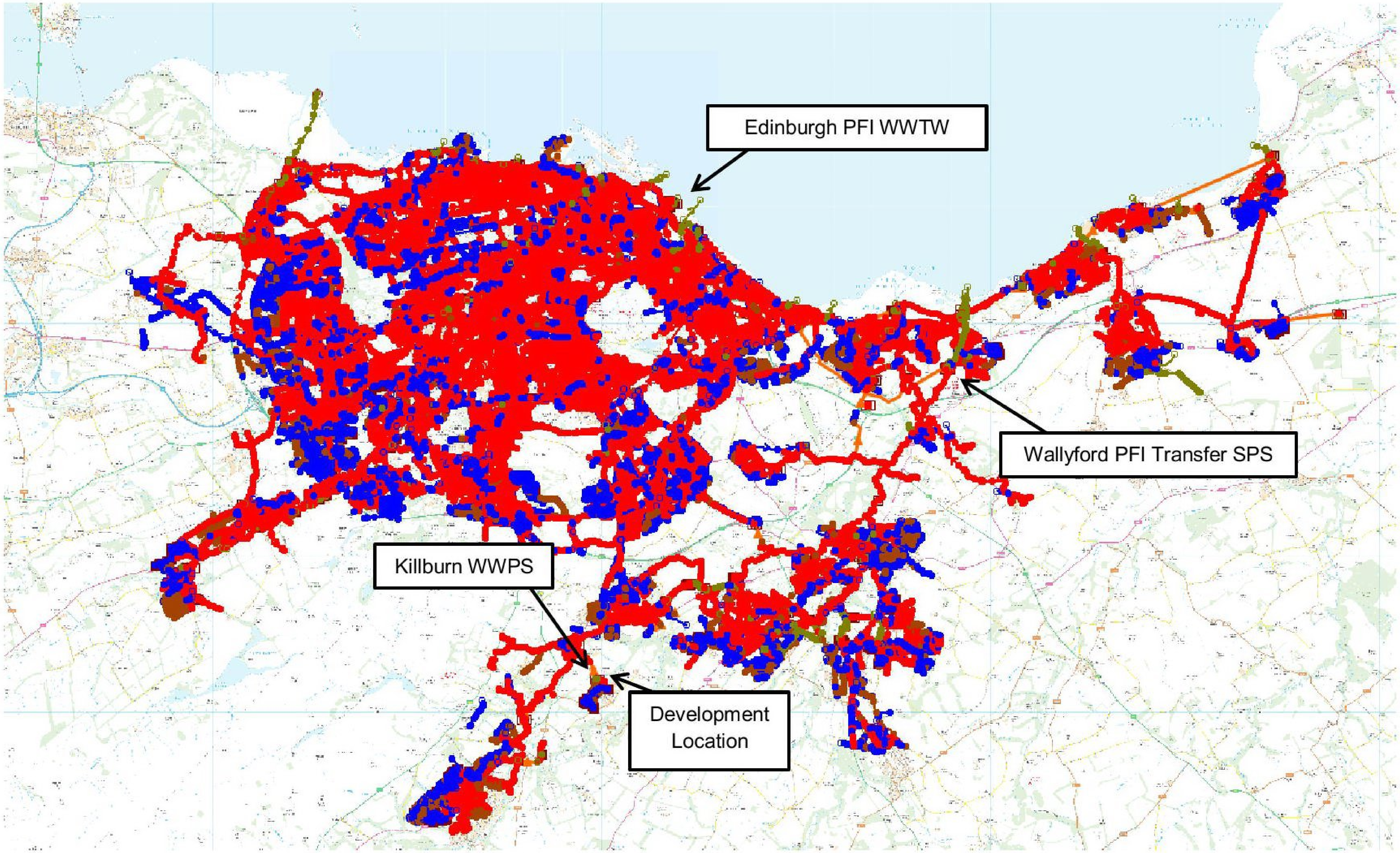

Figure 1 – Overview of the Edinburgh WWTW Model and Development Location

2.3 Study Brief and Objectives

The objectives of the study are listed below:

Stage 1

Collate Site Information

- Liaise with the developers to obtain detailed information on the proposed development.

Update Existing Model

- Incorporate the proposed connection for the development into the existing hydraulic sewerage model provided by SW.

Carry out a Development Assessment

- Investigate the impact of the foul discharge from the proposed development on the separate foul sewerage system downstream of the proposed connection points both in terms of hydraulic performance (flooding) and environmental performance (water quality impact from Combined Sewer Overflow (CSO) discharges).

Initial Solution Identification

- Where the proposed development flows are shown to cause an unacceptable detriment to the current hydraulic and/or environmental performance, identify initial potential solutions that may satisfy the requirements of the Client Brief (i.e. maintain current performance levels) for further consideration in Stage 2.
- Produce a Stage 1 Report summarising all assessment work undertaken including recommendations and conclusions.

2.4 Information Received

The following information was received and utilised during the study:

Scottish Water

- Hydraulic Model.
- SW GIS Sewer and Mapping Data.

Developer's Agent

- Drawings:

- Former Roslin Institute Demolition and Asbestos Removal Works – 8414_103 A
- Record of Indicative Development Layout – 3932/App 3a

3. Existing system

Figure 2 shows the proposed development site. The downstream route from the development to the Edinburgh PFI WwTW has also been highlighted.

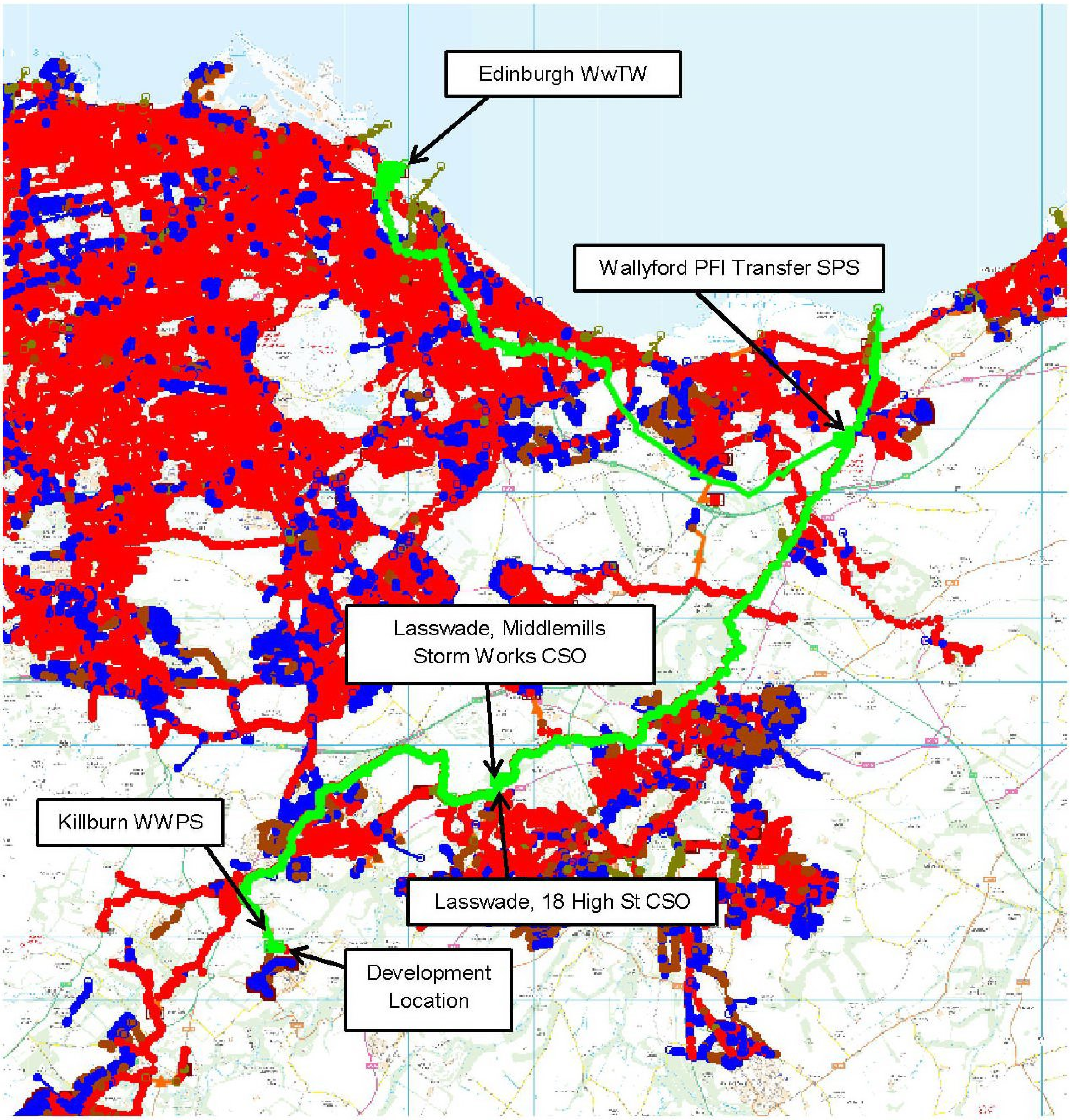

Figure 2: Proposed development location and key downstream assets to Edinburgh WwTW

3.1 Site Details

Size – Total area of 11.9 Ha.

Location – On brownfield land in the village of Roslin, 7km south of Edinburgh city centre.

Previous/ Current Usage – Brownfield.

Sewerage Details – A 225 mm diameter sewer flowing east to west from the south west boundary of the development site conveys flows away from the development site towards Killburn WWPS. On completion, 300 houses will be discharged to this sewer.

3.2 Intermittent Discharges Impacted by Proposed Development

There are five intermittent discharges located directly downstream of the development towards the Wallyford PFI Transfer WWPS (Killburn WWPS overflow, Lasswade, 18 High St CSO, Lasswade, Middlemills Storm Works CSO, Wallyford PFI Transfer CSO and Edinburgh PFI CSO), which could be impacted directly by the proposed development.

The CSO details are listed in Table 1 and their locations shown in Figure 2:

Critical Downstream CSOs in Existing System			
CSO Name	**Overflow Model ID**	**Outfall Model ID**	**Discharges to**
Killburn WWPS overflow	NT26638801_Screen	NT26638899	Kill Burn
Lasswade, 18 High St CSO	NT30662201_CSO	NT30663206	River North Esk
Lasswade, Middlemills Storm Works CSO	NT30664420	NT30664404	River North Esk
Wallyford PFI Transfer CSO	NT35718801_flume2	NT36734901	Firth of Forth Coast
Edinburgh PFI CSO	NT28768004	NT28768101	Firth of Forth Coast

Table 1: Downstream Critical CSOs in Existing System

3.3 Existing Model Update

According to the documentation, the supplied model was built using InfoWorks ICM version 6.5 and this version of ICM was also used for the modelling work on this DIA.

The former Roslin Institute development is proposed by the developer to be built in two Phases. The first Phase would consist in demolish the existing Poultry Centre and Logan Building whilst retaining the existing Wallace Building and constructing 200 houses. For the second Phase it is then proposed to demolish this remaining building and construct a further 100 dwellings. As such, subcatchment NT27630701 will be deleted on the model for the Phase 1 scenario removing the associated discharging foul flow of 1.67 l/s. Afterwards, for the Phase 2 scenario; subcatchment NT26639702 was deleted removing the associated trade flow of 0.05 l/s and additional residential flow of 0.34 l/s.

No updates were applied to the baseline model. Figure 3 shows the sewer network at the development site in the baseline model.

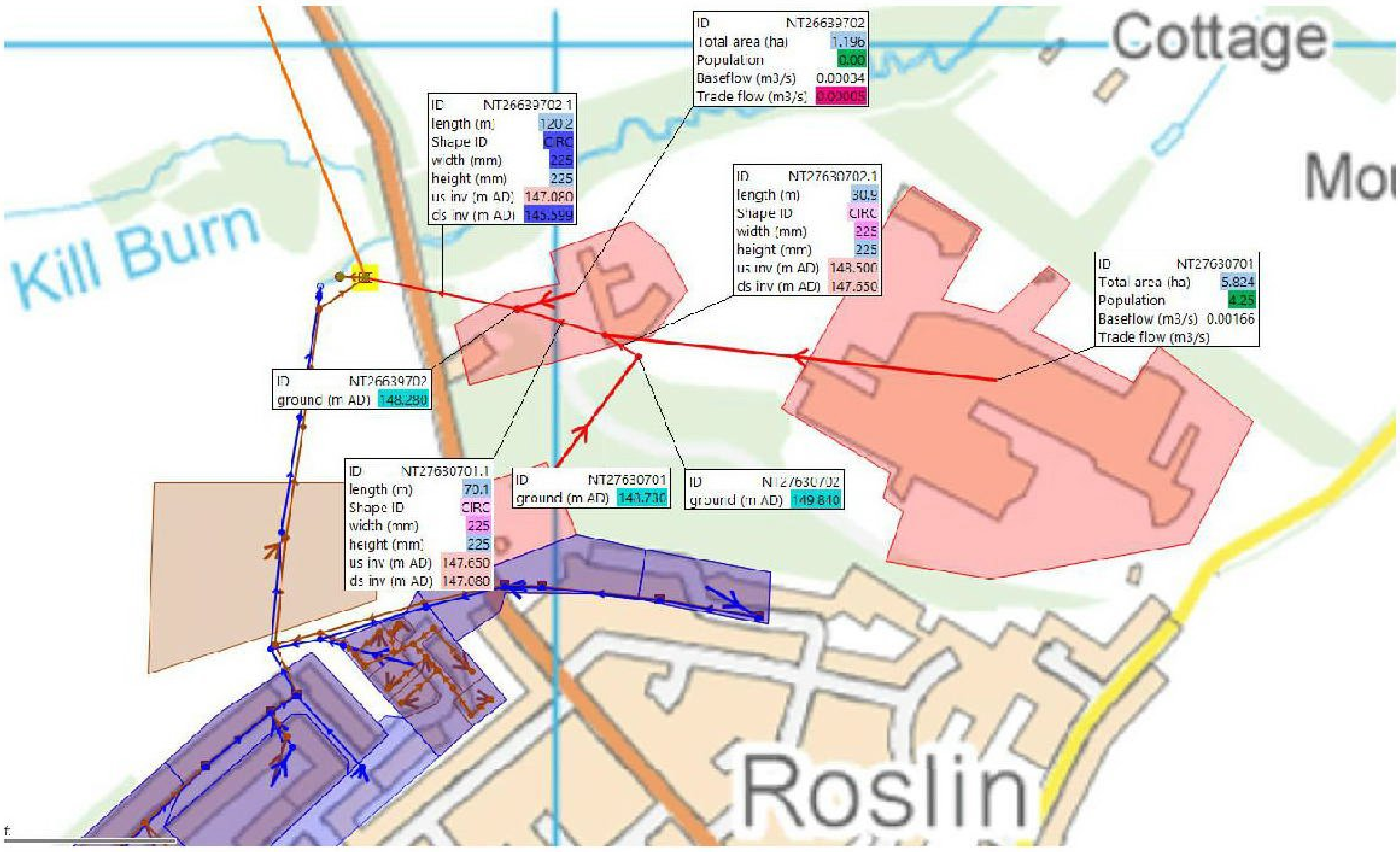

Figure 3: Model at Former Roslin Institute Development Site

4. Proposed Development & developed system amendments

Brief Requirement	"Calculate flows for the proposed development. Input additional flow into the model."

4.1 Proposed Land Usage

The former Roslin Institute development site will consist of 300 residential units upon completion within an area of 11.9 Ha. It is highlighted that it is proposed by the developer to build the new dwellings in two Phases. The first Phase would consist of 200 houses being developed and the existing Wallace Building initially retained. For the second Phase it is then proposed to demolish this remaining building and construct a further 100 dwellings. Full modelling parameters can be seen in Appendix 1.

4.2 Proposed Connection Details

It is proposed for the whole development to be connected to a 225 mm diameter sewer at the south-west boundary of the development site through manhole NT26639702, which conveys flows to Killburn WWPS to the north-west. The first Phase of the development will be connected to manhole NT27630701 (as the Wallace building is retained) and Phase 2 will be connected to manhole NT26639702 which is the proposed connection point for the whole development. Details of the estimated discharge rates for each Phase of the proposed development are detailed in Table 2 which also includes a summary of the estimated discharge rates. Note that there is a reduction in foul flow in the Phase 2 of the development due to the removal of the remaining offices at the Wallace Building.

Connection Point Details						
Development Section	**Proposed Connection Point**	**No Of Houses**	**Total Area of Section (Ha)**	**Assumed Contributing Area (Ha)**	**Foul Flow (l/s)**	**Future Infiltration (l/s)**
Phase 1	NT27630701	200	7.93	7.93	0.95	0.095
Phase 2	NT26639702	100	3.97	3.97	0.48	0.048
Whole Development	**NT26639702**	**300**	**11.9**	**11.9**	**1.43**	**0.143**

Table 2: Connection Points and Estimated Discharge Rates from Phase of development

4.3 Dry Weather Flow

It is proposed by the developer to complete the re-development of the site in two Phases. Phase 1 would provide 200 residential units whilst maintaining use of the Wallace Building on the site, discharging an average foul flow of 0.95 l/s. At a later date, Phase 2 would involve the demolition of the Wallace Building and the construction of an additional 100 properties. The associated removal of trade flows and additional residential flows are expected to give a final dry weather flow discharge rate of 1.43 l/s following completion of both phases of the development.

The foul flow was calculated assuming an occupancy rate of 2.5 people per household and assuming a discharge rate of 165 litres per capita per day.

System flows are scaled by a peaking factor of 2.5 for flooding and surcharge level assessment whereas a factor of 1 has been applied for time series analysis.

4.4 Surface Water Runoff

The surface water from the development will be discharged into a nearby watercourse and controlled via a SUDs scheme and will not be included in this assessment.

4.5 Future Misconnections & Infiltration

Table 2 shows how much contributing area and future infiltration was added to each section of the development. An allowance of 1% of the total contributing area was applied to represent runoff from future cross connections into consideration. This is standard industry practice and gives a small factor of safety. An additional nominal allowance of 10% foul flow was added to the base flow to take into consideration any future infiltration which may occur as the development drainage network ages and deteriorates.

5. Stage 1 Assessment – Existing / Developed Comparisons

Brief Requirement	"Determine existing / developed system flood volumes, spill volumes and frequency for CSOs, in locations impacted upon by the development."

5.1 Hydraulic Assessment

Brief Requirement	"Compare analysis of the existing model to the developed model in terms of flood volumes and surcharge levels."

Investigations to determine the effect of the proposed development upon the existing downstream network have been undertaken using 30 year return period rainfall events of 30, 60, 120, 240, 360, 600, 720 and 1440 minute durations, for both summer and winter FEH rainfall profiles. The analysis has been undertaken to determine the potential flooding detriment throughout the complete catchment area.

5.1.1 Flooding Assessment

The comparative analysis showed that adding the proposed development to the network would not cause an increase in flooding on the existing network in either Phase 1 or Phase 2.

The assessment predicted a decrease in flow in the catchment when the proposed development was added to the network, based on the completed simulations. Table 3 shows the total flow volume obtained on simulations on sewer link NT26639702.1 which is directly downstream of the development.The proposed development will produce smaller flow and the Kilburn PS, located directly downstream from the new development, will control the incoming flow to the sewer system.

Total Flow Volume on NT26639702.1 (DS of Development)				
Event		Baseline	Development Phase 1 (m^3)	Development Phase 2 (m^3)
Summer	M30-30	208.975	169.434	191.42
	M30-60	260.903	186.935	205.129
	M30-120	342.566	220.566	230.26
	M30-240	460.955	270.316	272.676
	M30-360	563.203	315.801	311.705
	M30-600	740.794	400.422	386.512
	M30-720	819.009	437.268	420.419
	M30-1440	1256.837	656.981	624.208
Winter	M30-30	213.058	171.14	194.273
	M30-60	268.643	191.38	208.93
	M30-120	349.69	224.063	233.971

Total Flow Volume on NT26639702.1 (DS of Development)				
Event		Baseline	Development Phase 1 (m^3)	Development Phase 2 (m^3)
	M30-240	478.089	276.621	276.835
	M30-360	583.096	321.833	314.947
	M30-600	770.683	407.317	389.381
	M30-720	852.749	446.472	424.935
	M30-1440	1319.633	673.659	631.227

Table 3: Flow Volume Comparison downstream the Proposed Development

A comparison of inflow results for different duration events at Kilburn PS can be found in Appendix 2.

5.1.2 Surcharge levels

A comparative analysis of the level increase at manholes with less than 0.5 m freeboard was undertaken for the Phase 1 and Phases 2 post-development scenarios.

The comparative analysis showed that adding the proposed development to the network would cause a minimal impact on surcharge level to the manholes located directly downstream of the development. Although those manholes had more than 0.5m freeboard, an assessment of the manhole levels was undertook showing an increase of 0.006 m found on manhole NT27630701 during the M30-30 summer storm event on Phase 1 scenario and an increase of 0.017m found on manhole NT26639702 during the M30-30 summer storm event on Phase 2 Scenario. The results of maximum increases are listed in Table 4. The locations of the affected manholes are shown in Figure 4.

PHASE 1 - Reduction in available freeboard					
Node ID	Storm	Season	Available Freeboard (m)		
			Base Model Freeboard	Development Phase 1 Freeboard	Change in Freeboard
NT27630702	Development Phase 1 M30-1440	Summer	-1.313	-1.313	0
NT27630701	**Development Phase 1 M30-30**	**Summer**	**-0.989**	**-0.983**	**0.006**
NT26639702	Development Phase 1 M30-30	Summer	-1.109	-1.11	-0.001
NT26638802	Development Phase 1 M30-240	Summer	-1.044	-1.048	-0.004

PHASE 2 - Reduction in available freeboard					
Node ID	Storm	Season	Available Freeboard (m)		
			Base Model Freeboard	Development Phase 2 Freeboard	Change in Freeboard
NT27630702	Development Phase 2 M30-1440	Summer	-1.313	-1.313	0

NT27630701	Development Phase 2 M30-1440	Winter	-0.989	-1.051	-0.062
PHASE 2 - Reduction in available freeboard					
NT26639702	**Development Phase 2 M30-30**	**Summer**	**-1.109**	**-1.092**	**0.017**
NT26638802	Development Phase 2 M30-240	Summer	-1.044	-1.047	-0.003

Table 4: Predicted change in freeboard at manholes downstream the proposed development

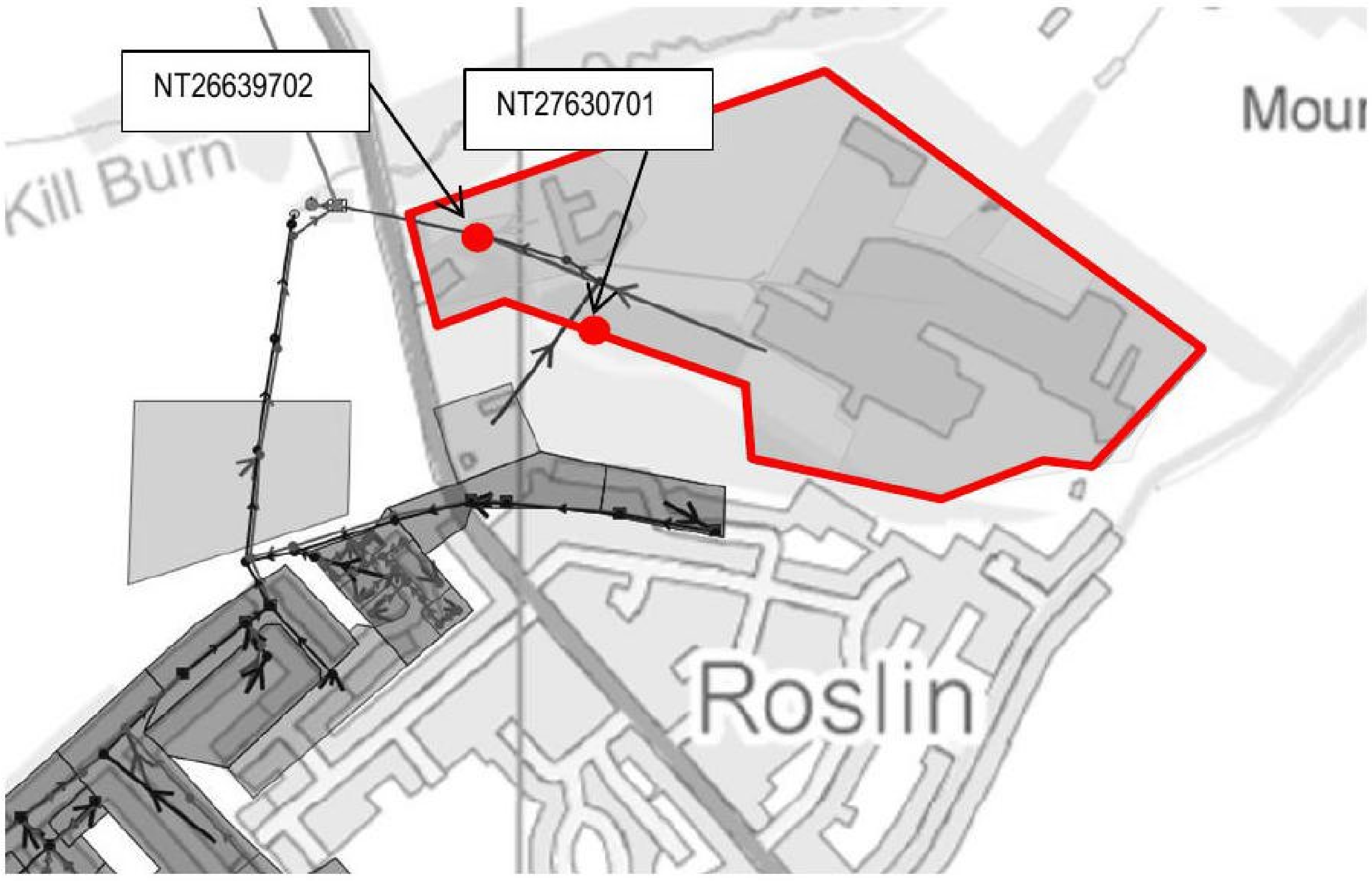

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Figure 4: Location of Manholes downstream the proposed development with Increased Surcharge Levels

5.2 CSO Assessment

Brief Requirement	Compare analysis of the existing model to the developed model in terms of spill volumes and number of activations from CSOs affected by the development. Calculate Formula "A" for existing and proposed flows at CSOs affected by the development. Calculate CSO settings in multiples of Dry Weather Flow."

5.2.1 CSO Spill Frequency and Volume Assessment

Brief Requirement	"Compare analysis of the existing model to the developed model in terms of spill volumes and number of activations from CSOs affected by the development."

In accordance with the Scottish Water Development Brief, an analysis of spill volumes during TSR events has been conducted to assess the performance of the downstream CSOs. The typical year TSR data set for the Edinburgh WWTW catchment area which was provided by Scottish Water (261 separate rainfall events) was used for this assessment.

The five CSOs mentioned in Section 3.2 located on the downstream route of the development were analysed in both Phase 1 and Phase 2 of the development to assess the impact on the network. A summary of the outfall activations for the three scenarios can be seen in Table 5 and a summary of the overall spill volumes for each CSO can be seen in Table 6. From these results none of the assessed CSO is predicted to increase the number of spills per annum under post-development scenario Phase 1 and the Wallyford PFI Transfer CSO is predicted to increase by two spills per annum under post-development scenario Phase 2. Annual spill volumes are generally predicted to decrease, with a significant reduction (59.57% at Phase 1 and 65.68% at Phase 2) predicted at Killburn WWPS overflow, located directly downstream the development. However, the Wallyford PFI Transfer CSO is predicted to increase in annual spill volume (1.35% at Phase 1 and 0.91% at Phase 2). The assessment has been revaluated and this increase has been considered to be associated with model instabilities rather than as a detriment due to the inclusion of the development.

CSO Spill Frequency					
CSO Name	**Overflow Model ID**	**Existing Network Spills**	**Developed Phase 1 Network with Mitigation Network Spills**	**Developed Phase 2 Network with Mitigation Network Spills**	**Comments**
Killburn WWPS overflow	NT26638801_Screen	1	1	1	No additional spills
Lasswade, 18 High St CSO	NT30662201_CSO	52	52	52	No additional spills
Lasswade, Middlemills Storm Works CSO	NT30664420	54	54	54	No additional spills
Wallyford PFI Transfer CSO	NT35718801_flume2	32	32	34	2 additional spills at Phase 2
Edinburgh PFI CSO	NT28768004	88	88	88	No additional spills

Table 5: CSO Spill Frequency

CSO Overall Spill Volumes Comparison								
CSO Name	Overflow Model ID	Existing Network Spill Volume (TSR Series) (m³)	Developed Phase 1 Network Spill Volume (TSR Series) (m³)	Developed Phase 2 Network Spill Volume (TSR Series) (m³)	Increase In Volume (m³) Phase 1	% Increase In Volume Phase 1	Increase In Volume (m³) Phase 2	% Increase In Volume Phase 2
Killburn WWPS overflow	NT26638801_ Screen	169	68	58	-101	-59.57%	-111	-65.68%
Lasswade, 18 High St CSO	NT30662201_ CSO	44606	43479	43385	-1127	-2.53%	-1222	-2.81%
Lasswade, Middlemills Storm Works CSO	NT30664420	197307	192695	192399	-4613	-2.34%	-4908	-2.55%
Wallyford PFI Transfer CSO	NT35718801_ flume2	316543	320804	319476	4262	1.35%	2933	0.91%
Edinburgh PFI CSO	NT28768004	61528	61525	61530	-3	-0.01%	2	0.00%

Table 6: CSO Overall Spill Volumes Comparison

5.2.2 Formula "A" Assessment

There are five CSOs located directly on the downstream route from the development towards WwTW. The calculated Formula "A" values for each of these are shown in Table 7 for both pre- and post-development scenarios. From these results it is highlighted that all CSOs with an exception of Killburn WWPS overflow are predicted to fail on the baseline scenario. However, there is an overall improvement at all the CSOs in predicting to pass Formula A under either the post-development Phase 1 or Phase 2.

As all these CSOs with the exception of Killburn WWPS are predicted to fail in the pre-development scenario, it would be recommended that these overflows are further investigated by Scottish Water. Full results of the Formula 'A' assessment can be seen in Appendix 3.

Formula "A" Results							
CSO Name	CSO Setting (m³/s)	Formula 'A' (l/s)			Passes Formula 'A' Baseline	Passes Formula 'A' Phase 1	Passes Formula 'A' Phase 2
		Existing	Developed Phase 1	Developed Phase 2			
Killburn WWPS overflow	0.027	7	9	10	Yes	Yes	Yes
Edgefield Industrial Estate CSO	0.190	193	195	197	No	No	No
Lasswade, 18 High St CSO	0.105	206	208	209	No	No	No
Lasswade, Middlemills Storm Works CSO	0.609	944	946	947	No	No	No
Wallyford PFI Transfer CSO	0.000	9936	9938	9940	No	No	No

Table 7: Formula "A" Assessment

5.3 Lowest Floor Level Assessment

Brief Requirement	"Final check on the lowest floor level must be made against the hydraulic gradient for the connecting sewer. The floor level must be above the hydraulic gradient for a 1-in-30 year critical storm duration."

It is proposed for the whole development to be connected to a 225 mm diameter sewer at manhole NT26639702. The first Phase of the development will be connected to manhole NT27630701 (as the Wallace building is retained) and Phase 2 will be connected to manhole NT26639702 which is the proposed connection point for the whole development.

An analysis of the proposed connection NT26639702 for Phase 2 and NT27630701 for Phase 1 was carried out to determine difference in TWL for both the baseline and development model and highlight any detriment. The analysis results are detailed in Table 5.

	MH Ref	Floor Level (mAOD)	Max Flood Depth at Critical Duration M30-30 Summer	TWL at Critical duration (mAOD)
Baseline Model	NT27630701	140.15	-1.025	139.125
	NT26639702	140.15	-1.144	139.006
Phase 1	NT27630701	140.15	-0.983	139.167
Phase 2	NT26639702	140.15	-1.092	139.058

Table 8 – Freeboard at connection manholes

The model predicts there will be an increase in TWL at manhole NT27630701 on Phase 1 of 0.042m, which gives a freeboard of 0.983m with the Phase 1 development connected during the critical duration event (M30-30S). For Phase 2, the model predicts an increase in TWL at manhole NT26639702 of 0.052m, which gives a freeboard of 1.092 during the critical duration event (M30-30S). In both phases the lowest floor of the development is high than the maximum surcharge level.

6. Conclusions and Recommendations

6.1 Stage 1 Conclusion

From the hydraulic analysis undertaken it is predicted by the model that the addition of the proposed development in either Phase 1 or Phase 2 would be beneficial in reducing the overall flooding and pollution risk within the catchment. As such no increases in flooding volume due to the addition of the development or surcharge level increase to within 0.5m of cover level are predicted at individual nodes in the catchment in the post-development scenario.

Comparatively, the model predicts an overall reduction in the post-development Phase 1 scenario in spill volumes at downstream CSOs, with a reduction (59.57% at Phase 1 and 65.68% at Phase 2) predicted at Killburn WWPS overflow, located directly downstream from the development. However, the Wallyford PFI Transfer CSO is predicted to increase in annual spill volume (1.35% at Phase 1 and 0.91% at Phase 2). The assessment has been revaluated and this increase has been considered to be associated with model instabilities rather than as a detriment due to the inclusion of the development.

It is highlighted that all CSOs with an exception of Killburn WWPS overflow are predicted to fail on the baseline scenario. However, there is an overall improvement at all the CSOs in predicting to pass Formula A under either the post-development Phase 1 or Phase 2.

As all these CSOs with the exception of Killburn WWPS are predicted to fail the Formula 'A' in the pre-development scenario, it would be recommended that these overflows are further investigated by Scottish Water.

The large reductions in the CSO annual discharge is due to the removal of a significant foul flow discharge that was present on site during its previous usage. This existing foul flow was found to be greater than the future foul flows that the site that were implemented in the analysis; even taking into account the additional 10% infiltration base flow and 1% impermeable area runoff values.

6.2 Recommendations

As the development causes no detriment on the network, there is no need for any network upgrades to be installed therefore the Stage 2 assessment for this DIA has not been undertaken.

In can be concluded that both of the Phases of the Former Roslin Institute DIA which total 300 residential units can be connected to the network with no additional network upgrades required.

Appendix 1 Development Site Layout Model Parameters

Model Parameters Added to represent Development Site and Proposed Diversion Sewer.		
Object In Model	**Object Type**	**Description of Changes**
Roslin_MH	Subcatchment	Subcatchment added to represent 200 houses in Phase 1 and office trade flows and 300 houses in Phase 2. Connects to manhole NT27630701 at Phase 1 and to manhole NT26639702 at Phase 2 for the whole development. Phase 1 Population = 500. Total area = 7.93 Ha. Contributing Area = 0.08 Ha. Base flow = 0.000095 m^3/s Phase 2 Population = 750. Total area = 11.9 Ha. Contributing Area = 0.2 Ha. Base flow = 0.000143 m^3/s

Appendix 2 Stage 1 Flow Volume Decrease Results

Flow volume decreases due to the addition of the proposed development in the network (and demolition of the previous offices at Roslin Institute). A comparison of inflow results for different duration events at Kilburn PS (located directly downstream the proposed development) are shown below.

Kilburn PS (NT26638802.1)				
Event		Baseline	Development Phase 1 (m^3)	Development Phase 2 (m^3)
Summer	M30-30	698.882	674.192	662.998
	M30-60	897.619	824.536	885.221
	M30-120	1138.836	1009.915	1026.597
	M30-240	1373.7396	1301.886	1321.878
	M30-360	1560.675	1495.745	1511.683
	M30-600	1892.303	1835.556	1869.933
	M30-720	2006.635	2030.865	1998.798
	M30-1440	2937.569	2844.388	2903.875
Winter	M30-30	738.745	678.256	718.786
	M30-60	902.078	825.200	901.135
	M30-120	1146.936	1050.957	1066.495
	M30-240	1406.136	1334.408	1317.283
	M30-360	1592.436	1519.656	1537.242
	M30-600	1893.331	1892.256	1902.021
	M30-720	2094.940	2055.168	2047.377
	M30-1440	3031.081	3002.490	2962.845

Summer – M30-30

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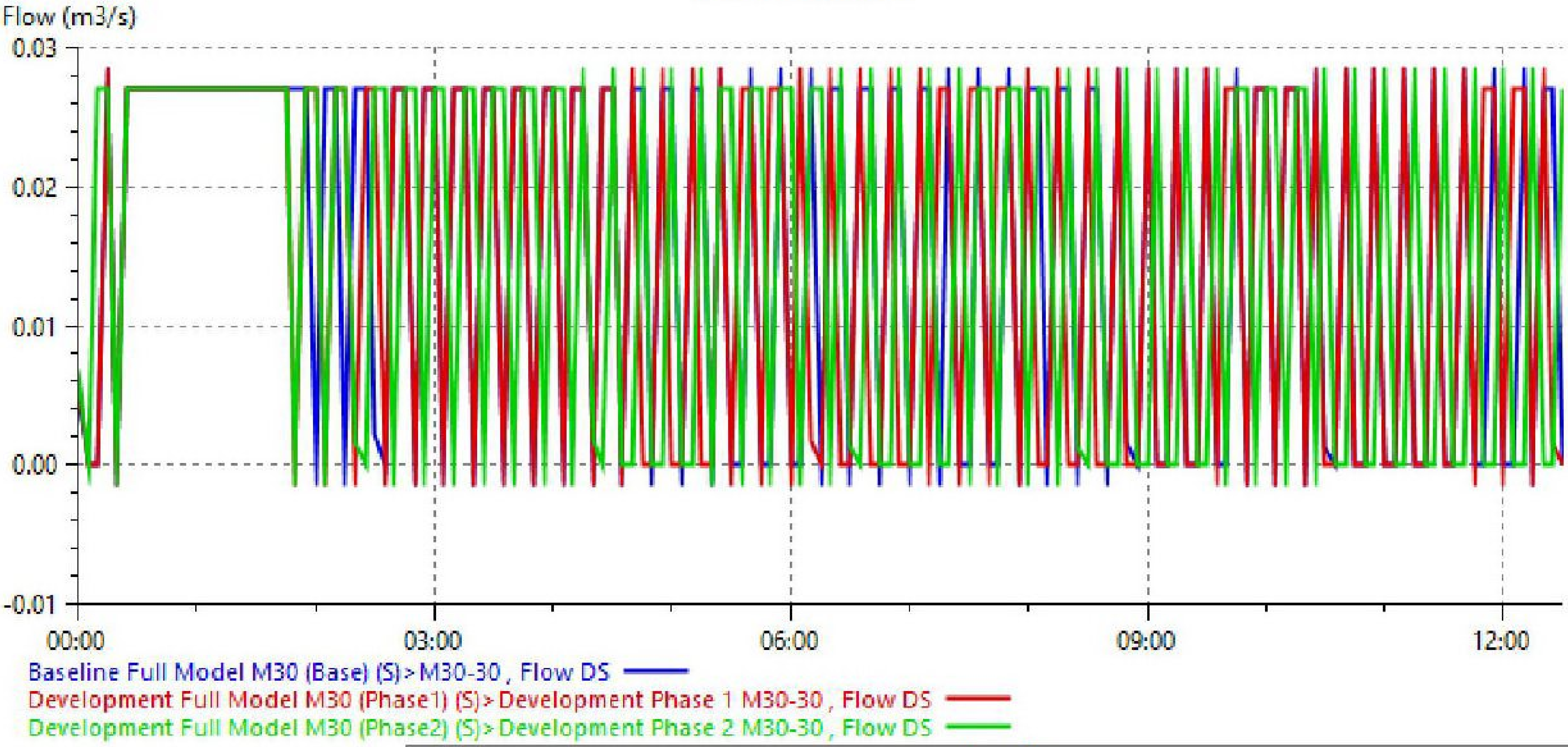

	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
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...)>Development Phase 1 M30-30	-0.000	0.027	674.192
...)>Development Phase 2 M30-30	-0.000	0.027	662.998

Summer – M30-60

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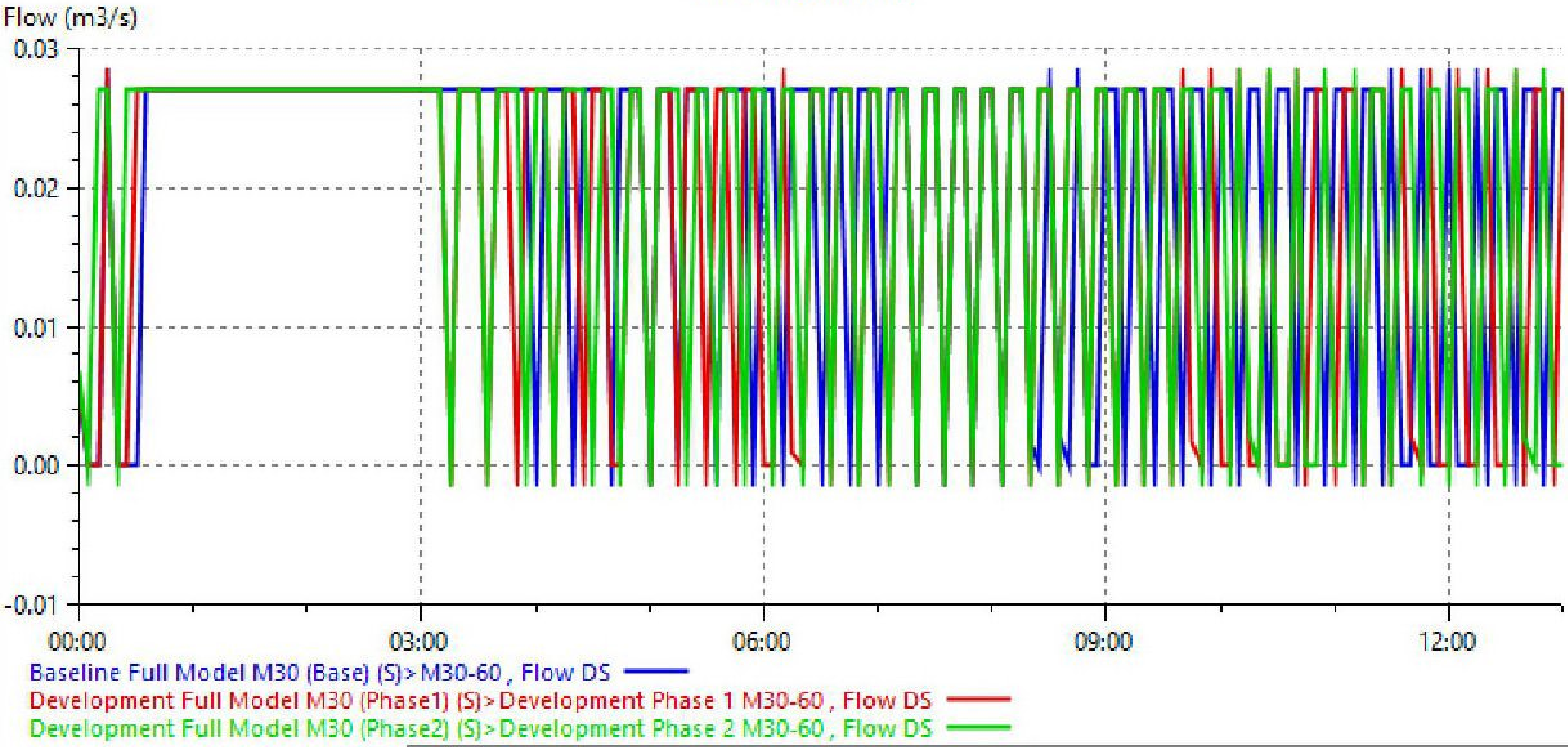
Link : NT26638802.1

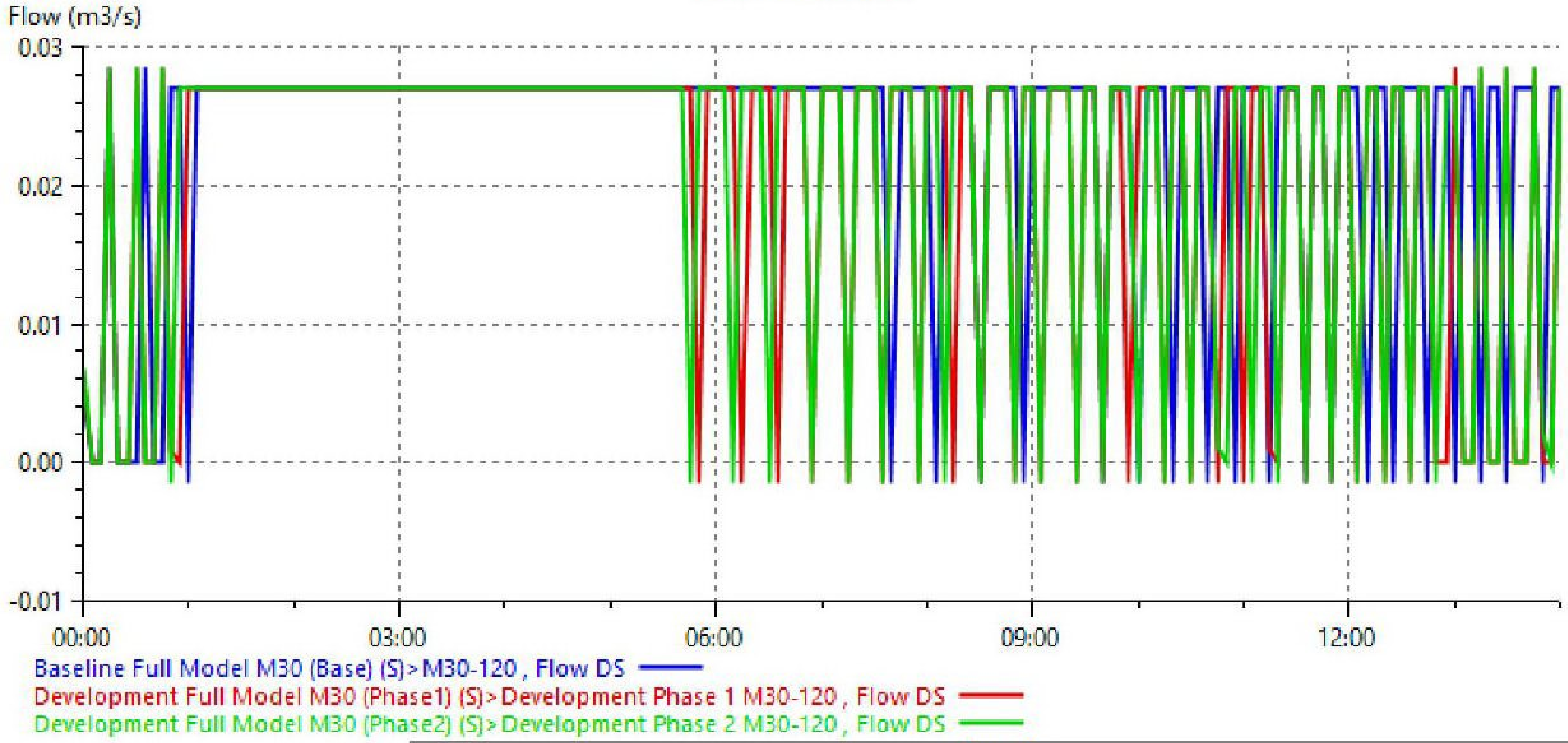


	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
...ll Model M30 (Base) (S)>M30-60	-0.000	0.027	897.619
...)>Development Phase 1 M30-60	-0.000	0.027	824.536
...)>Development Phase 2 M30-60	0.000	0.027	885.221

Summer – M30-120

Object Per Page Report Produced by Pilar.Laguia (04/10/2016 13:53:59) Page 1 of 1
Sim: >STW001986_ICS_RAA>Full Model Runs>Baseline>Baseline Full Model M30 (Base) (S)>M30-120 (28/09/2016 12:22:28)
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 1>Development Full Model M30 (Phase1) (S)>Development Phase 1 M30-120 (28/09/...
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 2>Development Full Model M30 (Phase2) (S)>Development Phase 2 M30-120 (28/09/...

Link : NT26638802.1

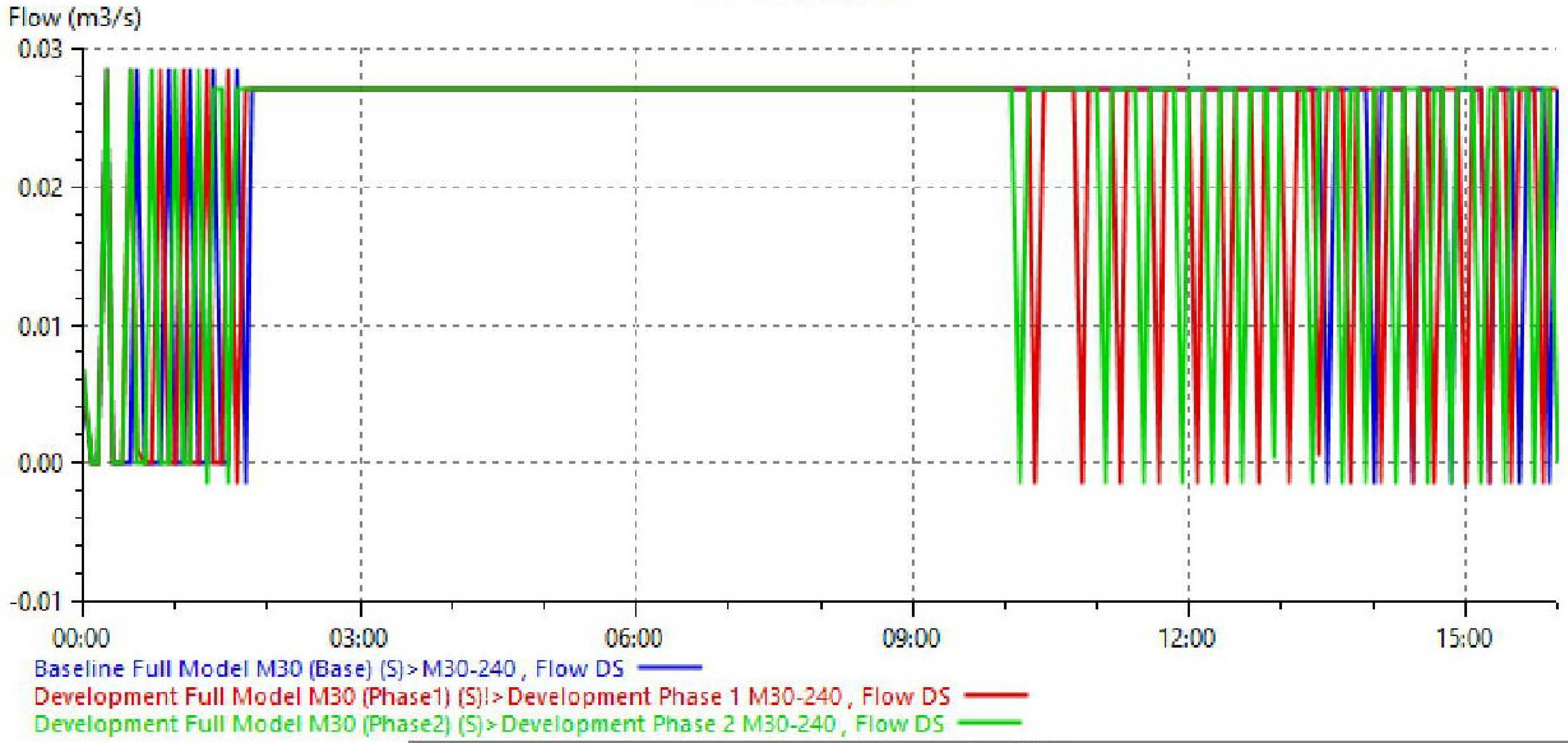


	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
...l Model M30 (Base) (S)>M30-120	-0.000	0.027	1138.836
...>Development Phase 1 M30-120	-0.000	0.027	1009.915
...>Development Phase 2 M30-120	-0.000	0.027	1026.597

Summer – M30-240

Object Per Page Report Produced by Pilar.Laguia (04/10/2016 13:55:51) Page 1 of 1
Sim: >STW001986_ICS_RAA>Full Model Runs>Baseline>Baseline Full Model M30 (Base) (S)>M30-240 (28/09/2016 12:22:28)
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 1>Development Full Model M30 (Phase1) (S)!>Development Phase 1 M30-240 (28/09/...
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 2>Development Full Model M30 (Phase2) (S)>Development Phase 2 M30-240 (28/09/...

Link : NT26638802.1

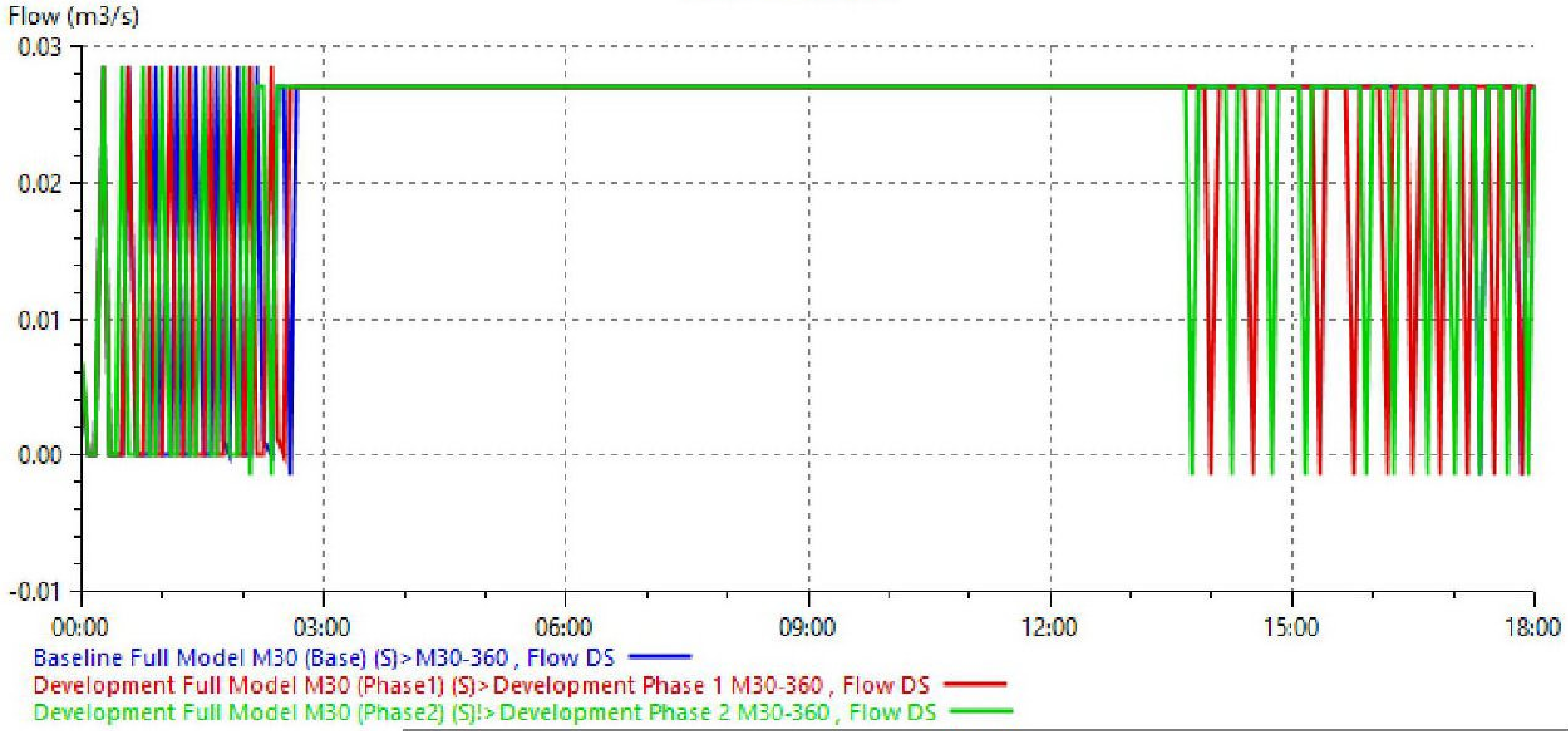


	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
...l Model M30 (Base) (S)>M30-240	-0.000	0.027	1373.736
...!>Development Phase 1 M30-240	-0.000	0.027	1301.886
...>Development Phase 2 M30-240	-0.000	0.027	1321.878

Summer – M30-360

Object Per Page Report Produced by Pilar.Laguia (04/10/2016 13:56:00) Page 1 of 1
Sim: >STW001986_ICS_RAA>Full Model Runs>Baseline>Baseline Full Model M30 (Base) (S)>M30-360 (28/09/2016 12:22:28)
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 1>Development Full Model M30 (Phase1) (S)>Development Phase 1 M30-360 (28/09/...
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 2>Development Full Model M30 (Phase2) (S)!>Development Phase 2 M30-360 (03/10/...

Link : NT26638802.1



	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
...l Model M30 (Base) (S)>M30-360	-0.000	0.027	1560.675
...>Development Phase 1 M30-360	-0.000	0.027	1495.745
...!>Development Phase 2 M30-360	-0.000	0.027	1511.683

Summer – M30-600

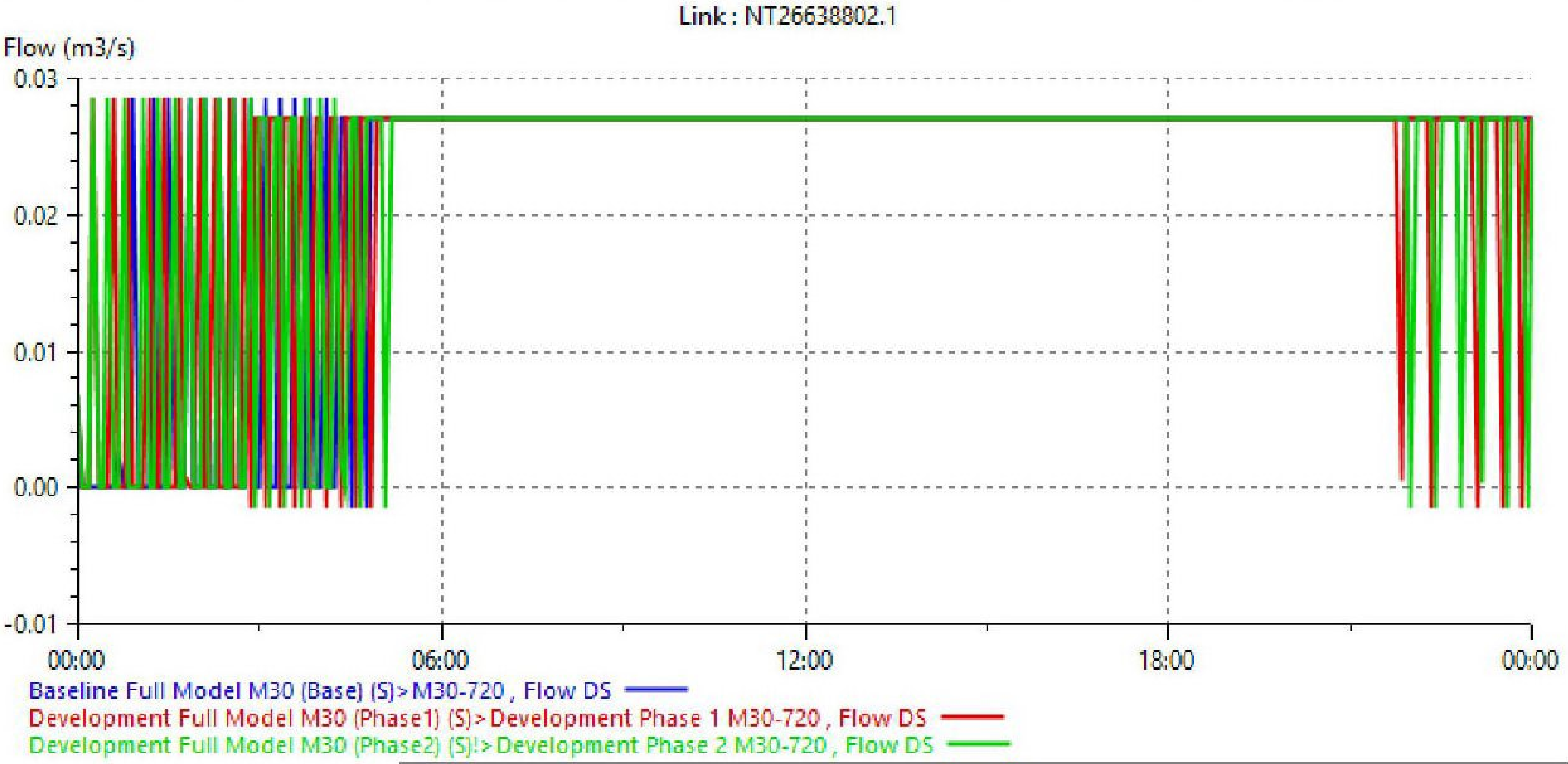
Object Per Page Report Produced by Pilar.Laguia (04/10/2016 13:57:12) Page 1 of 1
Sim: >STW001986_ICS_RAA>Full Model Runs>Baseline>Baseline Full Model M30 (Base) (S)>M30-600 (28/09/2016 12:22:28)
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 1>Development Full Model M30 (Phase1) (S)>Development Phase 1 M30-600 (28/09/...
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 2>Development Full Model M30 (Phase2) (S)!>Development Phase 2 M30-600 (03/10/...

Link : NT26638802.1

	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
...l Model M30 (Base) (S)>M30-600	-0.000	0.027	1892.303
...>Development Phase 1 M30-600	-0.000	0.027	1835.556
...!>Development Phase 2 M30-600	-0.000	0.027	1869.933

Summer – M30-720

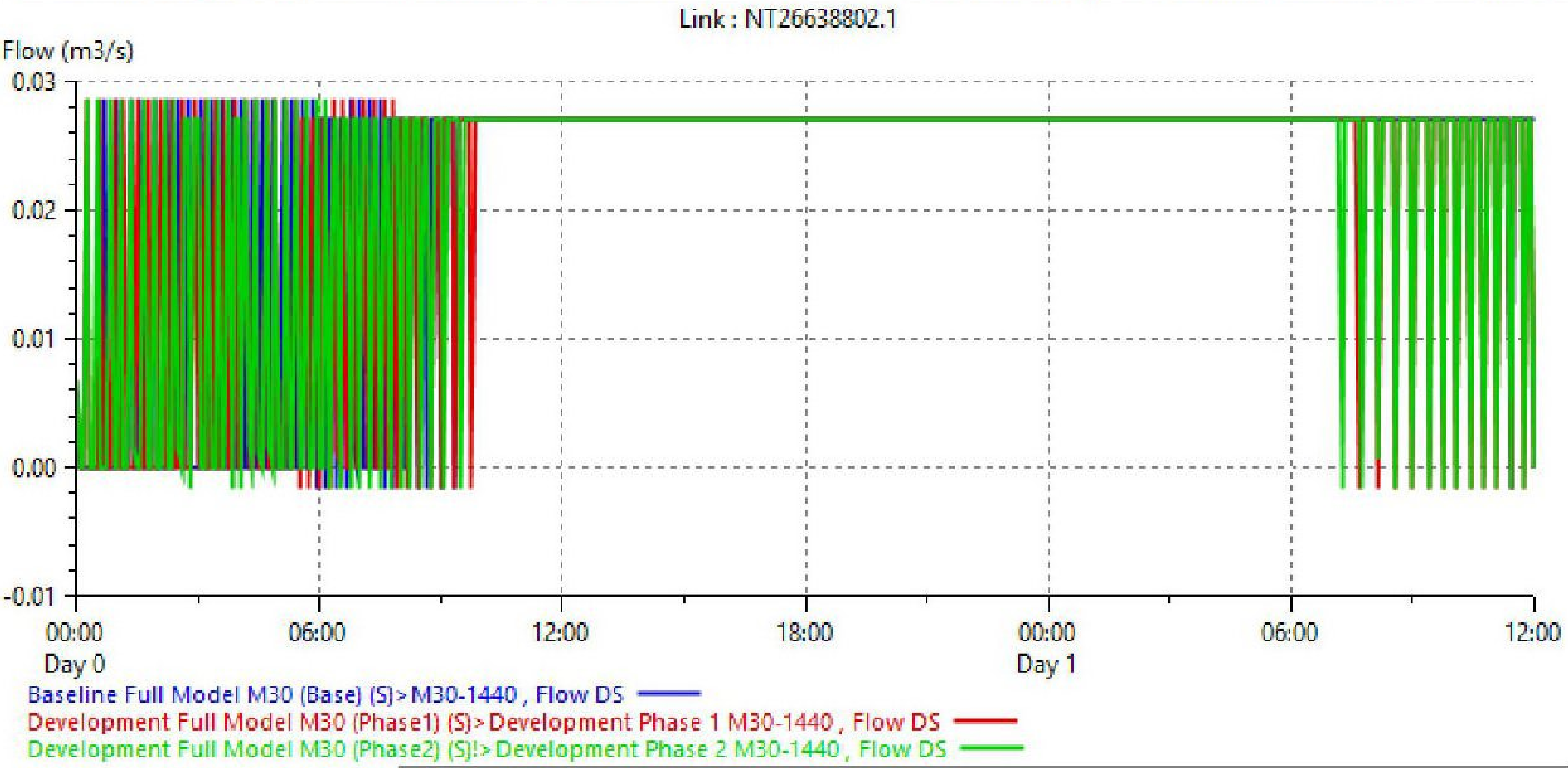
Object Per Page Report Produced by Pilar.Laguia (04/10/2016 13:57:16) Page 1 of 1
Sim: >STW001986_ICS_RAA>Full Model Runs>Baseline>Baseline Full Model M30 (Base) (S)>M30-720 (28/09/2016 12:22:28)
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 1>Development Full Model M30 (Phase1) (S)>Development Phase 1 M30-720 (28/09/...
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 2>Development Full Model M30 (Phase2) (S)!>Development Phase 2 M30-720 (03/10/...



	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
...l Model M30 (Base) (S)>M30-720	-0.000	0.027	2006.635
...>Development Phase 1 M30-720	-0.000	0.027	2030.865
...!>Development Phase 2 M30-720	-0.000	0.027	1998.798

Summer – M30-1440

Object Per Page Report Produced by Pilar.Laguia (04/10/2016 13:58:26) Page 1 of 1
Sim: >STW001986_ICS_RAA>Full Model Runs>Baseline>Baseline Full Model M30 (Base) (S)>M30-1440 (28/09/2016 12:22:28)
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 1>Development Full Model M30 (Phase1) (S)>Development Phase 1 M30-1440 (28/09...
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 2>Development Full Model M30 (Phase2) (S)!>Development Phase 2 M30-1440 (03/1...

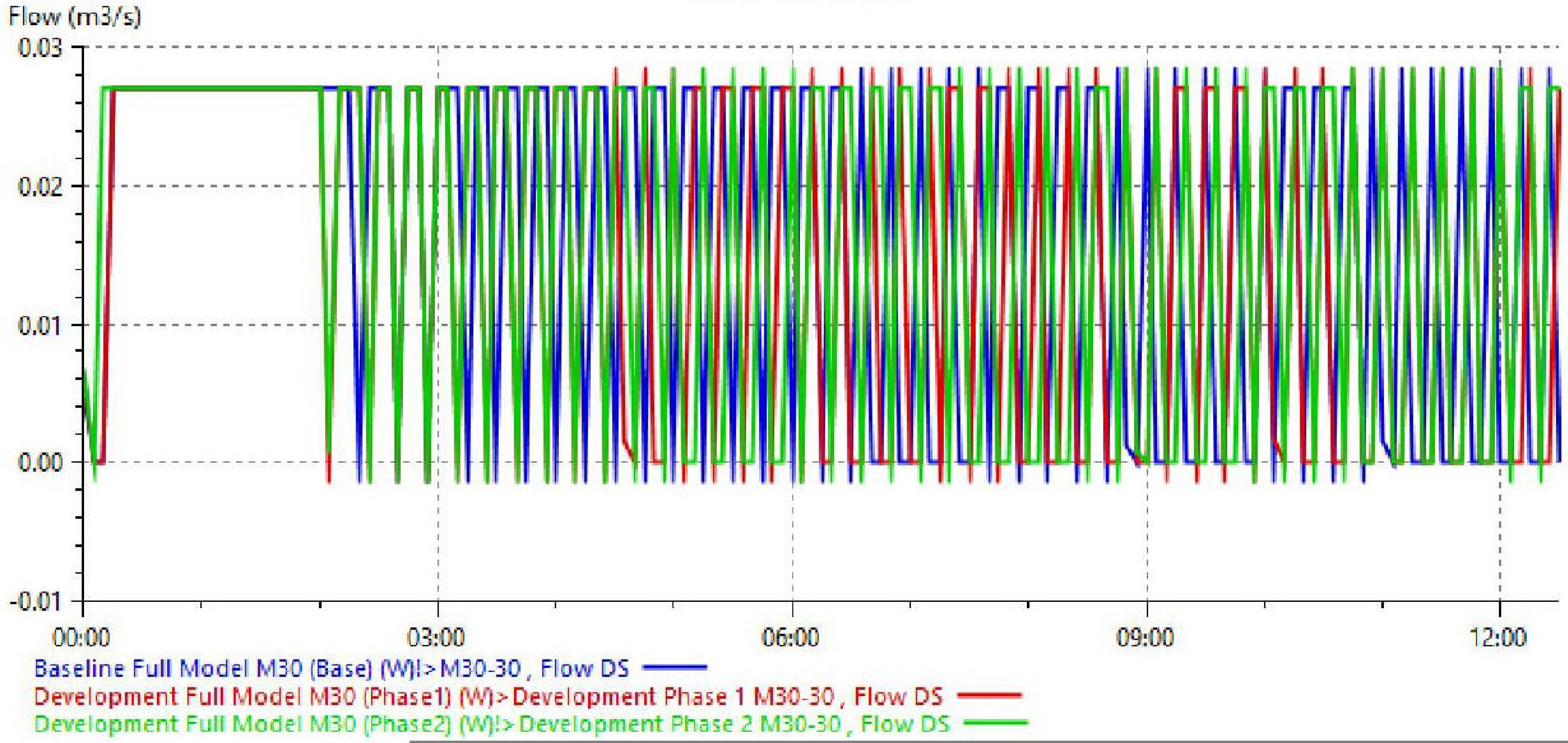


	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
...Model M30 (Base) (S)>M30-1440	-0.000	0.027	2937.569
...Development Phase 1 M30-1440	-0.000	0.027	2844.388
...Development Phase 2 M30-1440	-0.000	0.027	2903.875

Winter – M30-30

Object Per Page Report Produced by Pilar.Laguia (04/10/2016 14:00:22) Page 1 of 1
Sim: >STW001986_ICS_RAA>Full Model Runs>Baseline>Baseline Full Model M30 (Base) (W)!>M30-30 (29/09/2016 08:30:59)
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 1>Development Full Model M30 (Phase1) (W)>Development Phase 1 M30-30 (28/09/...
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 2>Development Full Model M30 (Phase2) (W)!>Development Phase 2 M30-30 (28/09/...

Link : NT26638802.1

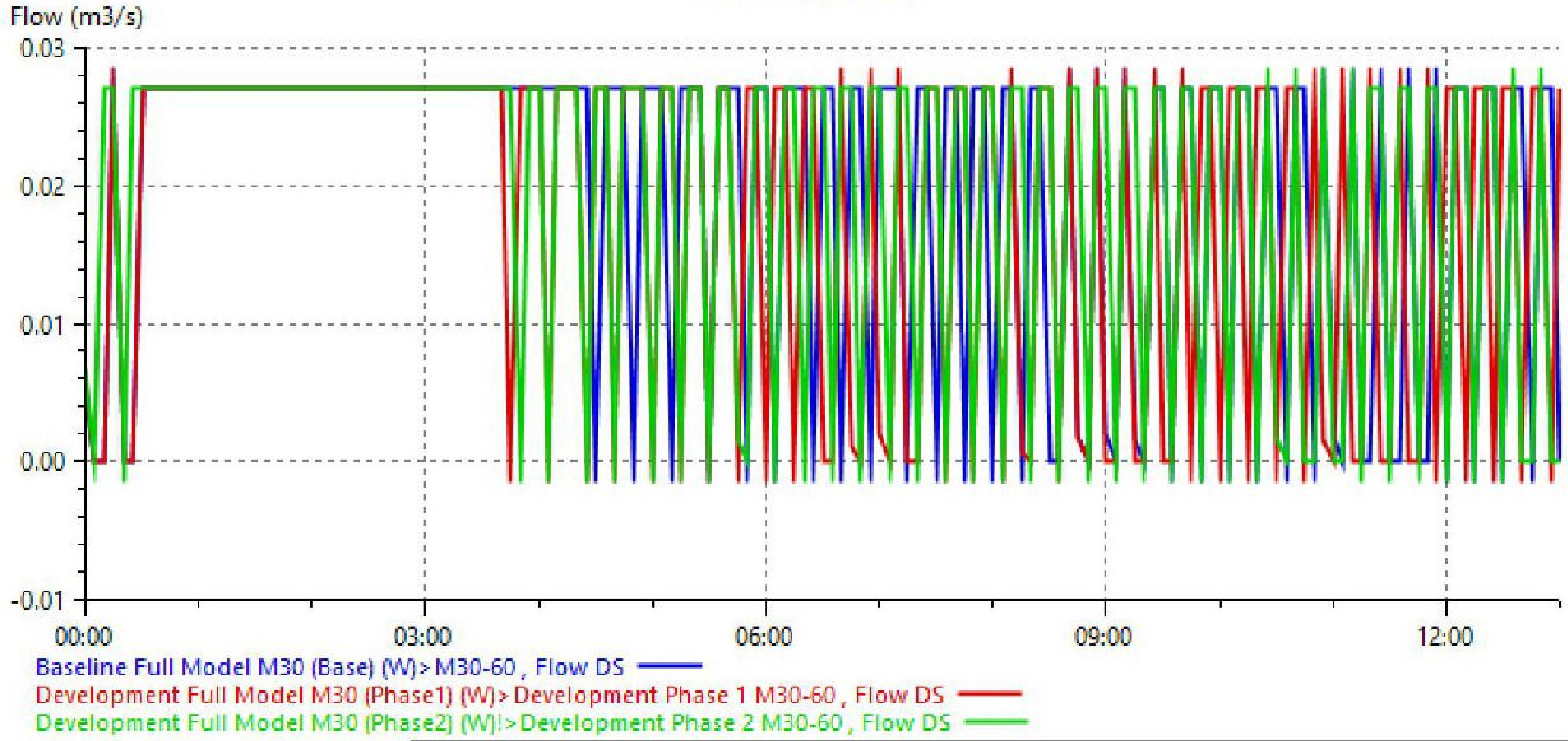


	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
...l Model M30 (Base) (W)!>M30-30	-0.000	0.027	738.745
...)>Development Phase 1 M30-30	-0.000	0.027	678.256
...)!>Development Phase 2 M30-30	-0.000	0.027	718.786

Winter – M30-60

Object Per Page Report Produced by Pilar.Laguia (04/10/2016 14:00:27) Page 1 of 1
Sim: >STW001986_ICS_RAA>Full Model Runs>Baseline>Baseline Full Model M30 (Base) (W)>M30-60 (28/09/2016 12:25:16)
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 1>Development Full Model M30 (Phase1) (W)>Development Phase 1 M30-60 (28/09/...
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 2>Development Full Model M30 (Phase2) (W)!>Development Phase 2 M30-60 (28/09/...

Link : NT26638802.1

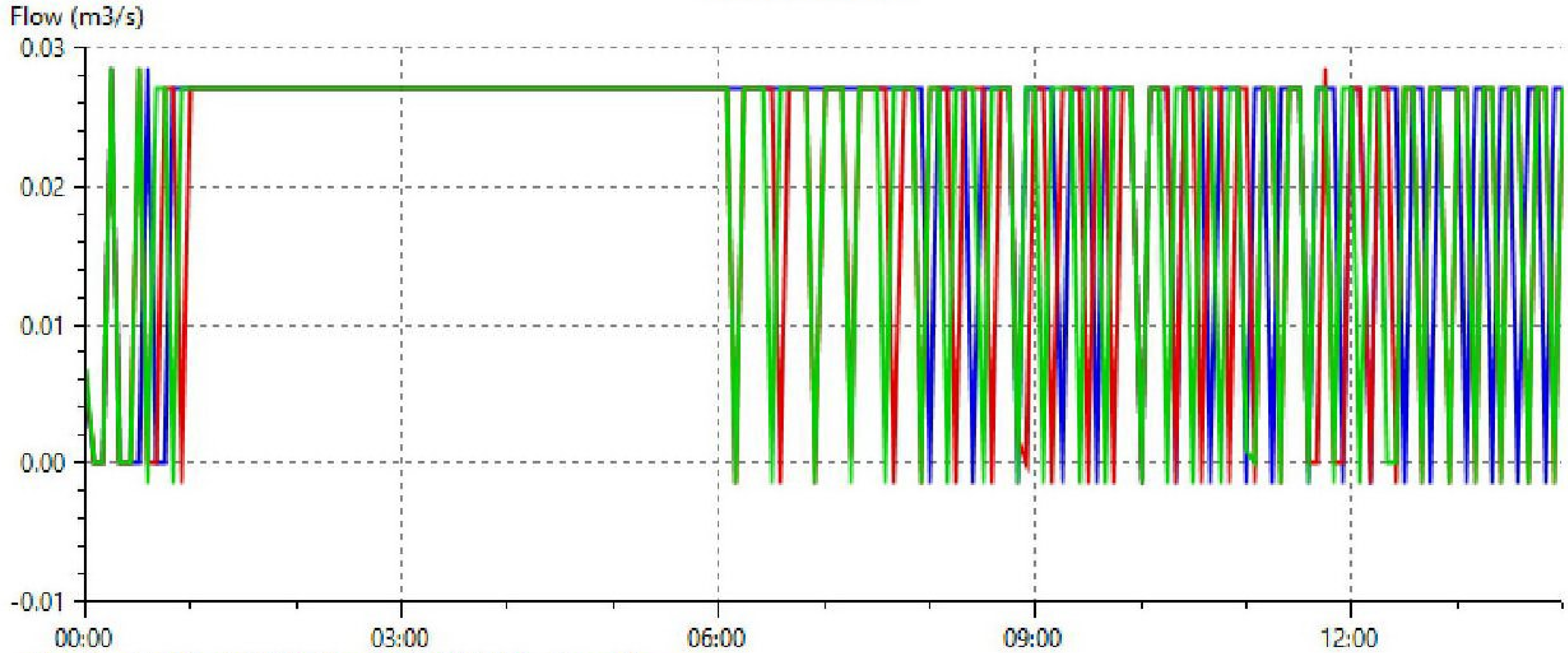


	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
...ll Model M30 (Base) (W)>M30-60	-0.000	0.027	902.078
...)>Development Phase 1 M30-60	-0.000	0.027	825.200
...)!>Development Phase 2 M30-60	0.000	0.027	901.135

Winter – M30-120

Object Per Page Report Produced by Pilar.Laguia (04/10/2016 14:01:34) Page 1 of 1
Sim: >STW001986_ICS_RAA>Full Model Runs>Baseline>Baseline Full Model M30 (Base) (W)>M30-120 (28/09/2016 12:25:16)
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 1>Development Full Model M30 (Phase1) (W)>Development Phase 1 M30-120 (28/09...
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 2>Development Full Model M30 (Phase2) (W)!>Development Phase 2 M30-120 (28/09...

Link : NT26638802.1



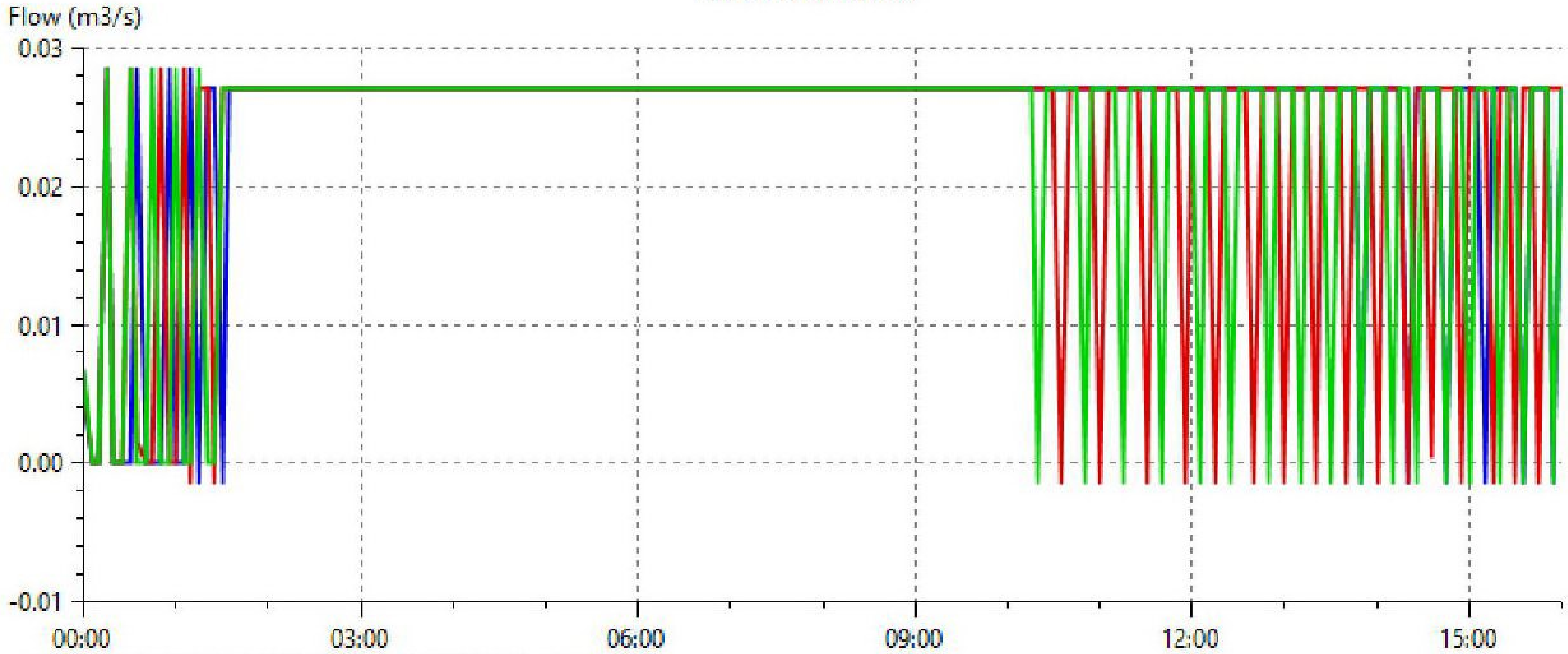
Baseline Full Model M30 (Base) (W)>M30-120 , Flow DS
Development Full Model M30 (Phase1) (W)>Development Phase 1 M30-120 , Flow DS
Development Full Model M30 (Phase2) (W)!>Development Phase 2 M30-120 , Flow DS

	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
... Model M30 (Base) (W)>M30-120	-0.000	0.027	1146.936
...>Development Phase 1 M30-120	-0.000	0.027	1050.957
...!>Development Phase 2 M30-120	-0.000	0.027	1066.495

Winter – M30-240

Object Per Page Report Produced by Pilar.Laguia (04/10/2016 14:01:40) Page 1 of 1
Sim: >STW001986_ICS_RAA>Full Model Runs>Baseline>Baseline Full Model M30 (Base) (W)>M30-240 (28/09/2016 12:25:16)
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 1>Development Full Model M30 (Phase1) (W)>Development Phase 1 M30-240 (28/09...
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 2>Development Full Model M30 (Phase2) (W)!>Development Phase 2 M30-240 (28/09...

Link : NT26638802.1



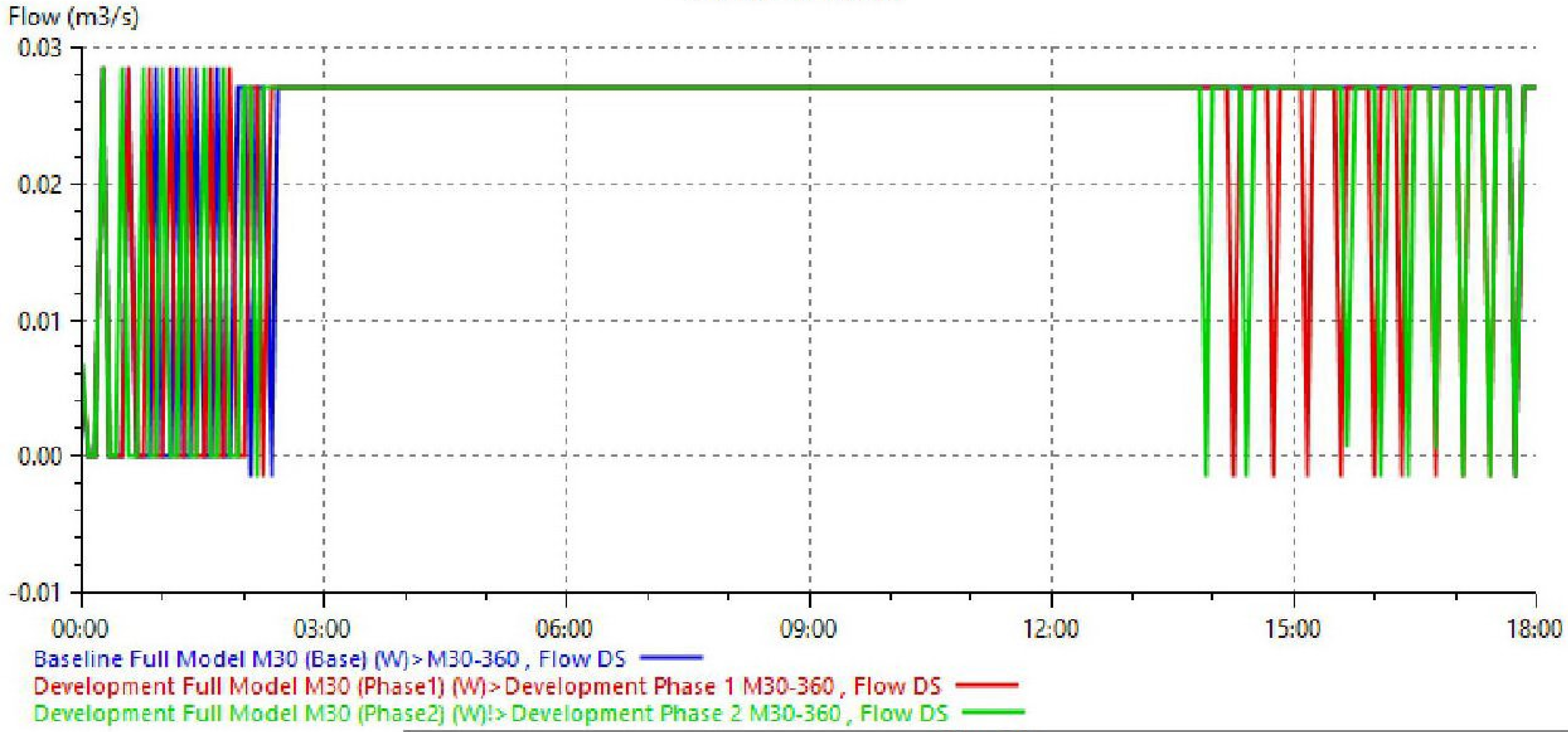
Baseline Full Model M30 (Base) (W)>M30-240 , Flow DS
Development Full Model M30 (Phase1) (W)>Development Phase 1 M30-240 , Flow DS
Development Full Model M30 (Phase2) (W)!>Development Phase 2 M30-240 , Flow DS

	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
... Model M30 (Base) (W)>M30-240	-0.000	0.027	1406.136
...>Development Phase 1 M30-240	-0.000	0.027	1334.408
...!>Development Phase 2 M30-240	-0.000	0.027	1317.283

Winter – M30-360

Object Per Page Report Produced by Pilar.Laguia (04/10/2016 14:02:35) Page 1 of 1
Sim: >STW001986_ICS_RAA>Full Model Runs>Baseline>Baseline Full Model M30 (Base) (W)>M30-360 (28/09/2016 12:25:16)
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 1>Development Full Model M30 (Phase1) (W)>Development Phase 1 M30-360 (28/09...
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 2>Development Full Model M30 (Phase2) (W)!>Development Phase 2 M30-360 (28/09...

Link : NT26638802.1

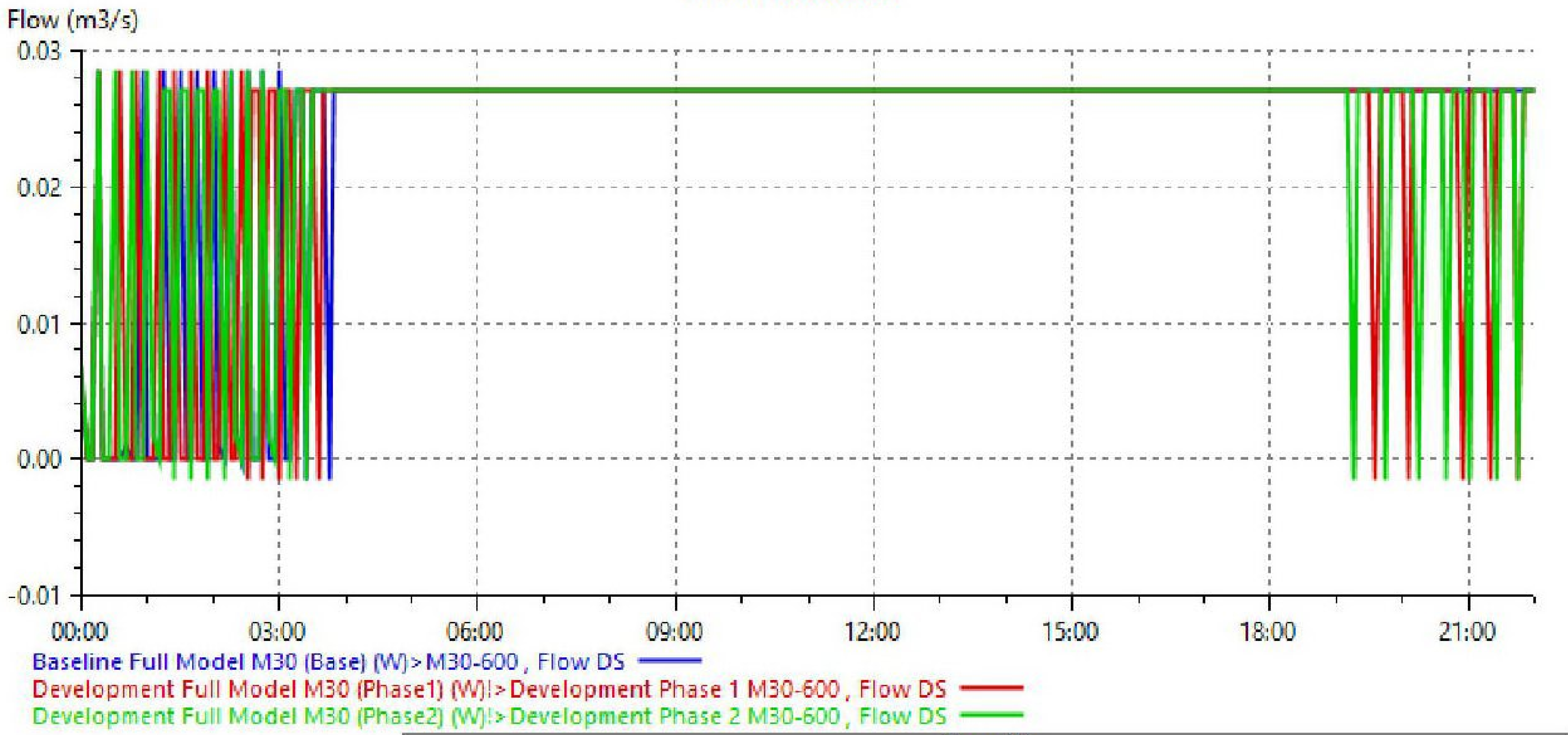


	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
... Model M30 (Base) (W)>M30-360	-0.000	0.027	1592.436
...>Development Phase 1 M30-360	-0.000	0.027	1519.656
...!>Development Phase 2 M30-360	-0.000	0.027	1537.242

Winter – M30-600

Object Per Page Report Produced by Pilar.Laguia (04/10/2016 14:02:39) Page 1 of 1
Sim: >STW001986_ICS_RAA>Full Model Runs>Baseline>Baseline Full Model M30 (Base) (W)>M30-600 (28/09/2016 12:25:16)
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 1>Development Full Model M30 (Phase1) (W)!>Development Phase 1 M30-600 (29/09...
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 2>Development Full Model M30 (Phase2) (W)!>Development Phase 2 M30-600 (28/09...

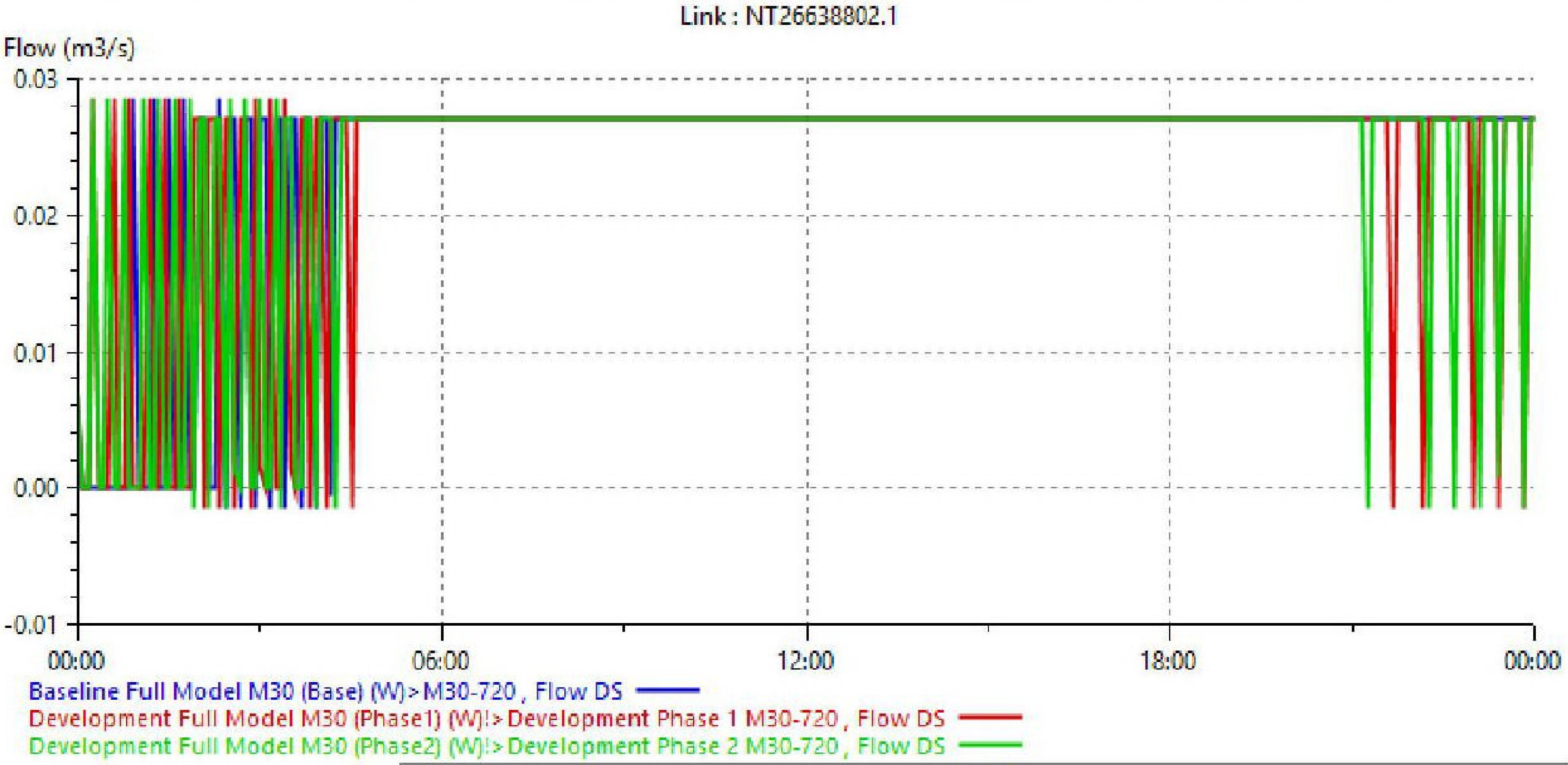
Link : NT26638802.1



	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
... Model M30 (Base) (W)>M30-600	-0.000	0.027	1893.331
...!>Development Phase 1 M30-600	-0.000	0.027	1892.256
...!>Development Phase 2 M30-600	-0.000	0.027	1902.021

Winter – M30-720

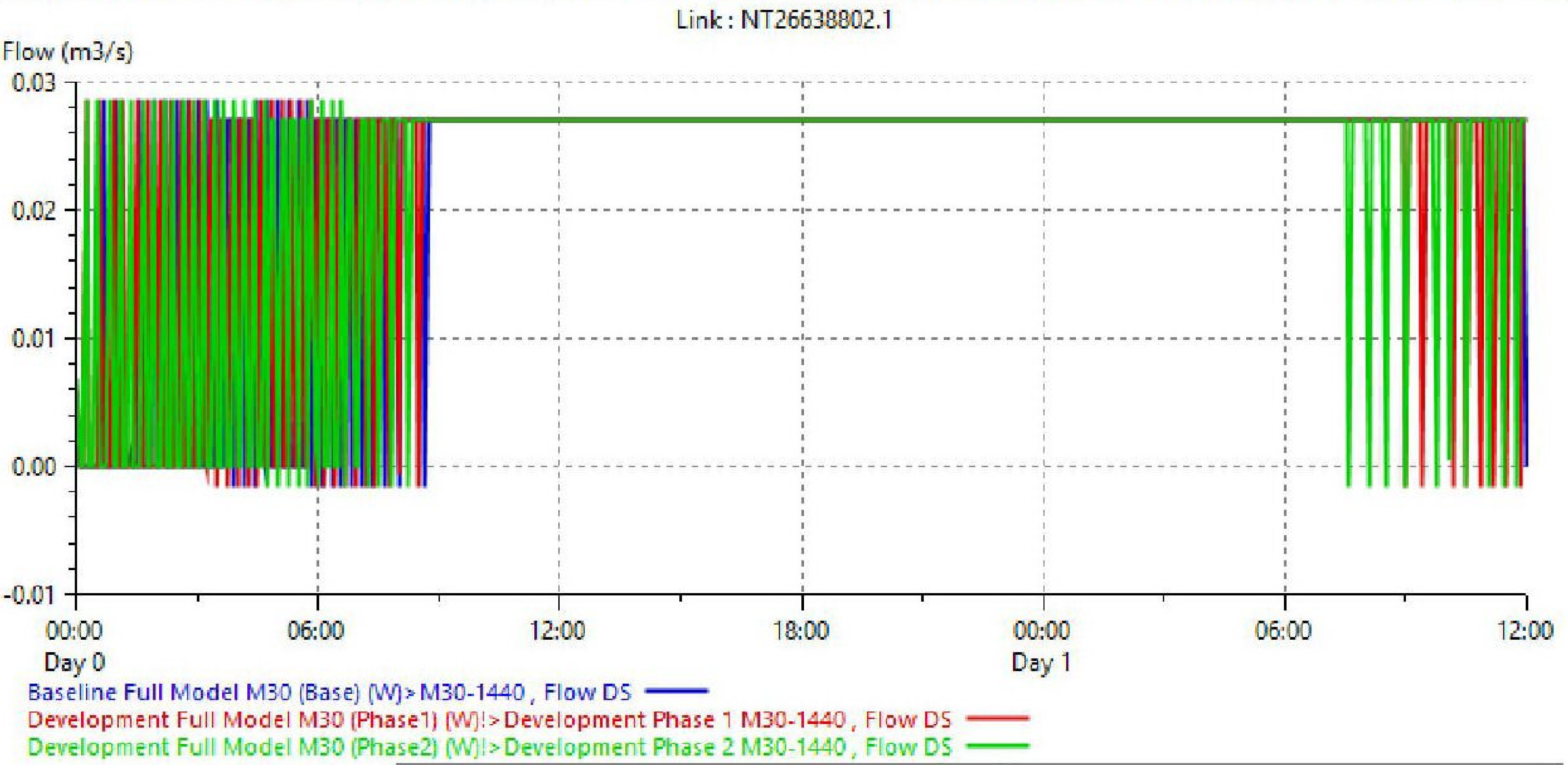
Object Per Page Report Produced by Pilar.Laguia (04/10/2016 14:03:19) Page 1 of 1
Sim: >STW001986_ICS_RAA>Full Model Runs>Baseline>Baseline Full Model M30 (Base) (W)>M30-720 (28/09/2016 12:25:16)
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 1>Development Full Model M30 (Phase1) (W)!>Development Phase 1 M30-720 (29/09...
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 2>Development Full Model M30 (Phase2) (W)!>Development Phase 2 M30-720 (28/09...



	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
... Model M30 (Base) (W)>M30-720	-0.000	0.027	2094.940
...!>Development Phase 1 M30-720	-0.000	0.027	2055.168
...!>Development Phase 2 M30-720	-0.000	0.027	2047.377

Winter – M30-1440

Object Per Page Report Produced by Pilar.Laguia (04/10/2016 14:03:24) Page 1 of 1
Sim: >STW001986_ICS_RAA>Full Model Runs>Baseline>Baseline Full Model M30 (Base) (W)>M30-1440 (28/09/2016 12:25:16)
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 1>Development Full Model M30 (Phase1) (W)!>Development Phase 1 M30-1440 (29/0...
Sim: >STW001986_ICS_RAA>Full Model Runs>Phase 2>Development Full Model M30 (Phase2) (W)!>Development Phase 2 M30-1440 (28/0...



	Flow DS		
	Min (m3/s)	Max (m3/s)	Volume (m3)
...odel M30 (Base) (W)>M30-1440	-0.000	0.027	3031.081
...Development Phase 1 M30-1440	-0.000	0.027	3002.490
...Development Phase 2 M30-1440	-0.000	0.027	2962.845

Appendix 3 Formula 'A' Results

Baseline

Overflow ID	CSO Name	Catchment	Node Number	Total Population	Separate Population	Combined Population	Commercial + Trade Flows (l/day)	l/s	Infiltration (l/sec)	Dry Weather Flow (l/sec) - 165 cons. rate	Combined Formula A (l/sec) - 165 cons. rate	Flow at First Spill	Pass Formula A	3DWF
NT26638801_Screen.2	Killburn WWPS overflow	STW001986	-	589	572	16	4320.00	0.05	2.12	3.3	7	27.0	PASS	10
NT30662201_CSO.1	Lasswade, 18 High St CSO	STW001986	-	11300	5355	5945	436320.00	5.05	34.09	60.7	193	190.0	FAIL	182
NT30664420.1	Lasswade, Middlemills Storm Works CSO	STW001986	-	11995	5540	6455	436320.00	5.05	36.06	64.0	206	103.9	FAIL	192
NT35718801_flume2.1	Wallyford PFI Transfer CSO	STW001986	-	56567	19956	36611	770688.00	8.92	125.27	242.2	944	609.9	FAIL	727
NT28768004.1	Edinburgh PFI CSO	STW001986	-	512562	86321	426241	20278080.00	234.70	1078.41	2292.0	9936	0.0	FAIL	6,876

Development Phase 1

Overflow ID	CSO Name	Catchment	Node Number	Total Population	Separate Population	Combined Population	Commercial + Trade Flows (l/day)	l/s	Infiltration (l/sec)	Dry Weather Flow (l/sec) - 165 cons. rate	Combined Formula A (l/sec) - 165 cons. rate	Flow at First Spill	Pass Formula A	3DWF
NT26638801_Screen.2	Killburn WWPS overflow	STW001986	-	1,085	1,072	12	4,320	0.05	0.56	2.7	9	27.0	PASS	8
NT30662201_CSO.1	Lasswade, 18 High St CSO	STW001986	-	11,796	5,855	5,940	436,320	5.05	32.53	60.1	195	190.4	FAIL	180
NT30664420.1	Lasswade, Middlemills Storm Works CSO	STW001986	-	12,491	6,040	6,451	436,320	5.05	34.5	63.4	208	105.6	FAIL	190
NT35718801_flume2.1	Wallyford PFI Transfer CSO	STW001986	-	57,062	20,456	36,607	770,688	8.92	123.71	241.6	946	608.8	FAIL	725
NT28768004.1	Edinburgh PFI CSO	STW001986	-	513,057	86,821	426,236	20,278,080	234.70	1076.85	2291.3	9938	0.0	FAIL	6,874

Development Phase 2

Overflow ID	CSO Name	Catchment	Node Number	Total Population	Separate Population	Combined Population	Commercial + Trade Flows (l/day)	l/s	Infiltration (l/sec)	Dry Weather Flow (l/sec) - 165 cons. rate	Combined Formula A (l/sec) - 165 cons. rate	Flow at First Spill	Pass Formula A	3DWF
NT26638801_Screen.2	Killburn WWPS overflow	STW001986	-	1,335	1,322	12	0	0.00	0.26	2.8	10	27.0	PASS	8
NT30662201_CSO.1	Lasswade, 18 High St CSO	STW001986	-	12,046	6,105	5,940	432,000	5.00	32.23	60.2	197	190.8	FAIL	181
NT30664420.1	Lasswade, Middlemills Storm Works CSO	STW001986	-	12,741	6,290	6,451	432,000	5.00	34.2	63.5	209	105.7	FAIL	191
NT35718801_flume2.1	Wallyford PFI Transfer CSO	STW001986	-	57,312	20,706	36,607	766,368	8.87	123.41	241.7	947	609.3	FAIL	725
NT28768004.1	Edinburgh PFI CSO	STW001986	-	513,307	87,071	426,236	20,273,760	234.65	1076.55	2291.5	9940	0.0	FAIL	6,874