Appendix 15.4

Sewer Network Flood Risk Assessment

BYRNELOOBY

Irish Water

Arklow Sewerage Scheme

Sewer Network Flooding Assessment

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1 Introduction

Arup in association with Byrne Looby was appointed by Irish Water in November 2015 to provide Engineering and Technical Consultancy Services for the Arklow Sewerage Scheme. The objective of this project is to provide a Wastewater Treatment facility that will comply with all relevant legislative requirements and will service the Arklow agglomeration over the next 20 years.

Existing hydraulic models of Arklow Sewerage Scheme built as part of Greater Dublin Strategic Drainage Study (GDSDS) were updated in accordance with Irish Water's Wastewater Network Hydraulic Model Build and Verification Standard (Document No IW-TEC-800-06, March 2018) and used as a design tool for the development of the Interceptor Sewer Scheme.

This report presents the results of various modelling scenarios undertaken for carrying out joint probabilistic flooding assessment of Arklow Sewer Network.

1.1 Background

Under the proposed Arklow Sewerage Scheme, the existing foul/combined discharges into Avoca River are to be collected by proposed interceptor sewers constructed along both banks of the Avoca River with flows conveyed to the proposed WwTW located at Ferrybank. Flows from the south of the river are to be conveyed via a proposed gravity sewer tunnel under the river bed to the proposed WwTW located at Ferrybank.

Part of the Sewerage Scheme requires the upgrade of existing sewers and a SWO located within the Alps development upstream of Arklow Bridge and adjacent the Avoca River. This overflow was found to be unsatisfactory under existing conditions, with frequent discharges into the Avoca River which was originally considered to be Contact/Recreational Waters. Hence, it was proposed to limit the number of spills via the Alps SWO to 7 per bathing season, in accordance with.

The proposed works intercepts the existing 225mm diameter combined sewer and a 1200mm diameter storm sewer, which conveys some foul connections and pass the flows through the existing SWO. The Pass Forward Flow will be conveyed to the proposed Southern Interceptor sewer and the storm flows stored in an underground on-line storage tank. An overflow from this on-line storage tank was connected to the existing storm outfall discharging to Avoca River. All screenings will be passed onto the interceptor sewer.

2 Existing Sewerage System

The existing sewerage system in Arklow town is a mixture of separate, partially separate and combined sewers. The combined sewers account for the majority of the network within the town. Partially separate systems are on the periphery of the sewer network draining into the combined sewer. More recent new developments have separate storm systems draining to the streams and foul network connecting into the existing combined sewer. New developments, which have been built close to the Avoca River, include both foul and storm systems discharging directly into the river.

The network is primarily a gravity system, with some outlying areas pumped into the main gravity system. There are four sewage pumping stations, viz. Servier, Croghan, Ballyduff and Porters Bridge.

The entire sewer network discharges directly to the Avoca River via outfalls, with no screening of the discharges. It is understood that some outfalls were constructed with flap valves but no outfalls have functioning valves at present. As the river is tidal in nature in the vicinity of all the outfalls, periods of rainfall and / or high tides can result in the backing up of flows in the sewers which results in operational deficiencies (i.e. silting) and hydraulic deficiencies where the sewers surcharge and flood due to the downstream conditions.

The sewerage catchment in Arklow is divided into following five distinct sub catchments shown below in Figure 1:

- Northern
- Southside - Western
- Southside - Central
- Southside - Southern
- Southside - Eastern

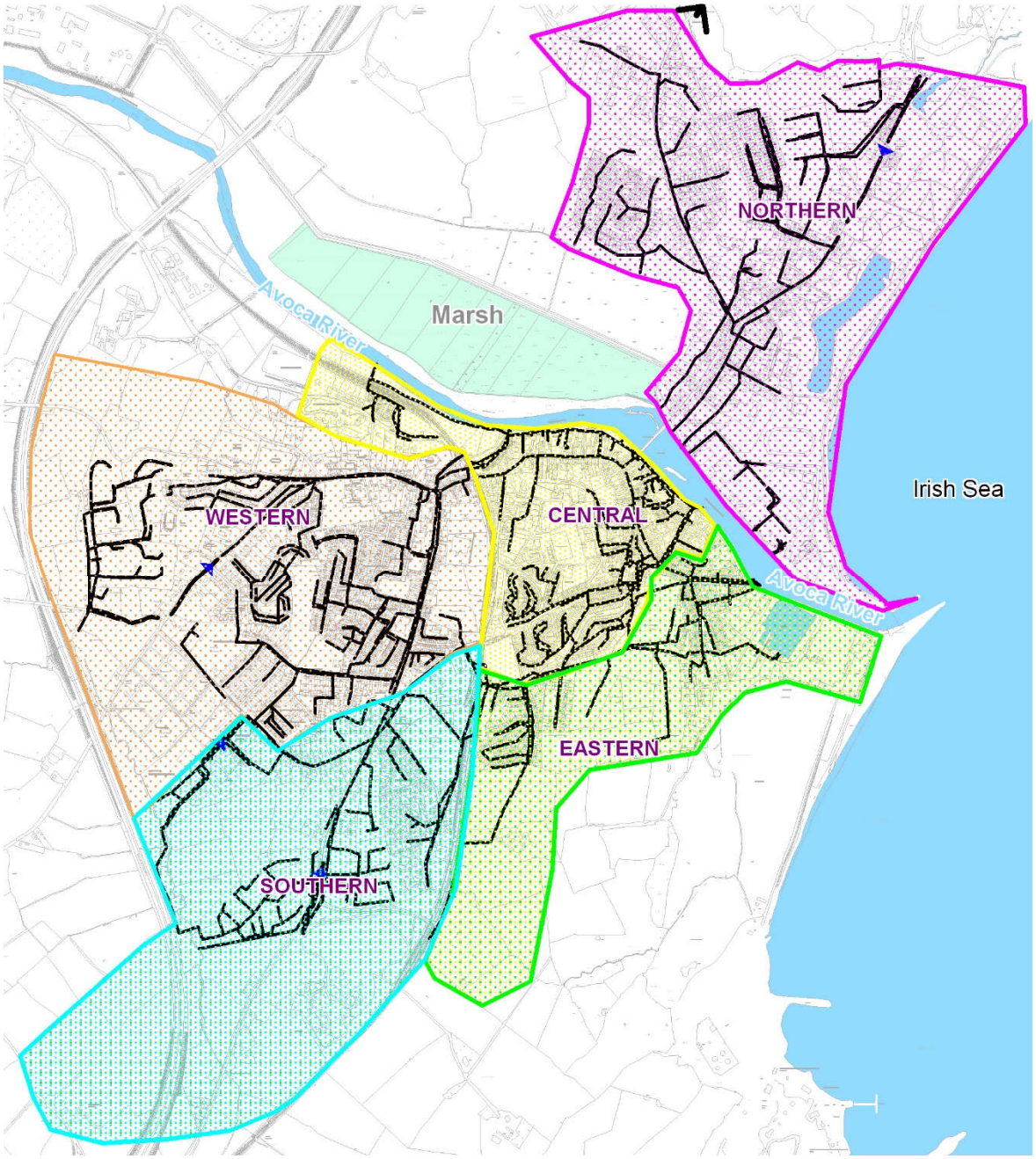

Figure 1 Arklow Sewerage Catchments

3 Hydraulic Modelling

The hydraulic modelling of the Arklow Sewerage Scheme has been undertaken in three Phases which was later updated and analysed for a 50-year design horizon in 2013 as part of the Arklow Sewerage Scheme DBO Works.

The hydraulic model of the Arklow drainage system was originally constructed using InfoWorks CS. This model was imported into InfoWorks ICM SE Version 6.5 for hydraulic assessment of the proposed Interceptor Sewers under this study.

Arklow Sewer Modelling Study (ASMS) was carried out by WYG / PH McCarthy Consulting Engineers in three Phases during GDSDS study as given in Table 1 below. Further, a hydraulic review of the model with amendments to be incorporated into the Arklow Sewerage Scheme DBO contract (2013) was carried out by Lyons Engineering Ltd.

The existing hydraulic models were used as basis for the assessment of the performance of the existing and future sewer system following a detailed review of the models to determine its suitability for use on the Arklow Sewage Scheme. The future system model was updated with proposed interceptor sewers, WwTP and proposed SWOs for the assessment of hydraulic performance of the system with regard to surcharge and flooding.

Table 1 Arklow Sewer Modelling Study Reports

Modelling Study	General Comments
Phase 1 - Data Collection and Review & Initial Planning Report, June 2004	This study involved the surveying of the manholes and sewers, carrying out of a flow and impermeable area survey and detailed loading assessment, for domestic and non-domestic loadings
Phase 2 - Model Preparation, Verification and System Performance Assessment Report, April 2007	The existing hydraulic models of Arklow Sewer System were built and verified against 3 rainfall and 2 dry weather events.
Phase 3 - Development of Needs & Identification of proposed Drainage System Development Report, October 2010	Under this phase, the verified hydraulic models were analysed against 1 in 30 year rainfall return period to identify hydraulic deficiencies in the network under existing and future loading conditions.
Wastewater Flow, Load, Tide and Rainfall Survey Report, November 2012	6 week sampling, flow, tide & rainfall monitoring programme was carried out as part of the preliminary works prior to the design of the proposed Arklow sewerage scheme.

Hydraulic Modelling Review Report, April 2013	Two hydraulic models based on the stages of construction were analysed. - Stage 1 model includes all of the DBO works and a domestic PE of 18,000, - Stage 2 model includes the DBO works, a domestic population of 36,000, as well as the Phase 3 upgrading works.

4 Methodology to assess sewer system flooding

Arklow Sewer system flooding assessment has been carried out in accordance with Greater Dublin Strategic Drainage Study's Final Strategy Report which provides the rainfall event and tide level combinations to be used for design of drainage system.

Section 3.6.2, Specific Recommendation of GDSDS Final Strategy Report provides the following combination that provides a combined return period greater than 30 years for flooding from sewerage systems affected by river or tidal levels.

- MHWS with 30-year Drainage
- 1-year tide with 1-year Drainage
- 5-year tide with 0.25-year Drainage

For the purposes of the design runs simulated for the hydraulic analysis the following tide level were used at the outfalls draining to the Avoca River. A climate change allowance of 0.5m was used in accordance with the recommendations given in Irish Coastal Protection Strategy Study - Work Package 9A Strategic Assessment of Coastal Flooding Extents – Future Scenario, South East Coast – Dalkey Island to Carnsore Point, November 2013.

- Mean High Water Spring Tide (MHWS) level of 0.49m OD Malin
- 5-year tide level of 1.15 m OD Malin
- 1-year tide level of 0.96m OD Malin

5 Existing System Hydraulic Assessment

5.1 Existing System Hydraulic Assessment (without the Interceptor Sewer & SWOs)

The hydraulic model of the existing sewer system in Arklow was run for a 30 year 60 minute critical duration event, with an allowance for climate change.

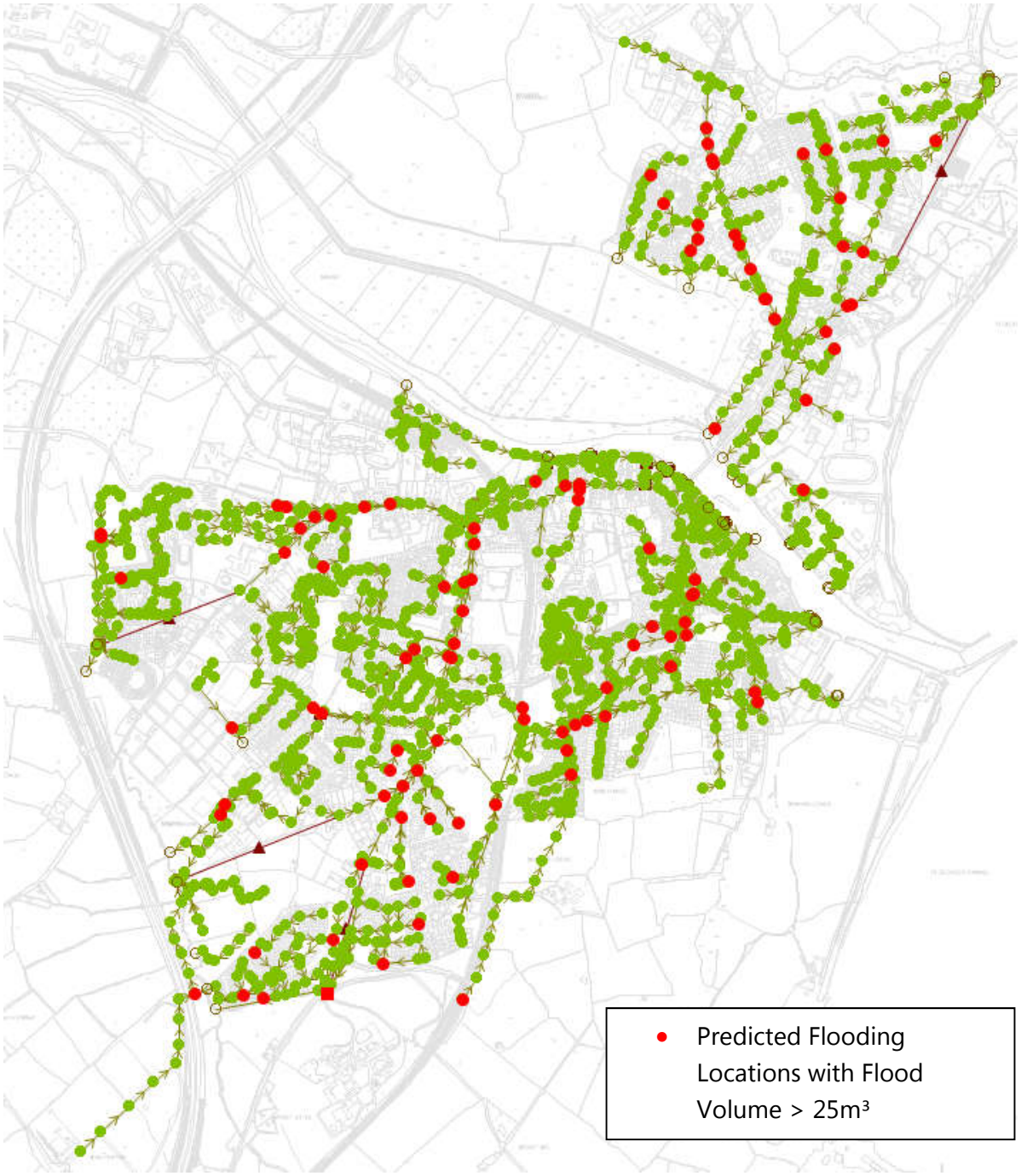

Figure 2: Existing System - Predicted flooding location > 25m3 for M30_60 & MHWS with CC

Figure 2 above shows the extent of predicted flooding of the existing system for a 30 year 60-minute critical duration storm which indicates that the existing drainage system is already under capacity in design storm conditions. A total of 106 location are predicted to flood with a flood volume greater than 25 m^3 (refer to Appendix 1). Significant flooding is predicted to occur in both Arklow north and south catchments with total flood volume of 8,104 m^3.

The assessment of the spill volumes shows that 7,566m^3 of raw sewage is predicted to spill via the existing outfalls into Avoca River during Dry Weather Flow (DWF). Further, the sewer system is predicted to spill 15,100m^3 & 21,484m^3 through outfalls into Avoca River for 5 year and 30 year critical duration storm events, respectively.

5.2 Existing System Hydraulic Assessment (with Interceptor Sewers & SWOs)

The hydraulic model of the existing sewer system with the proposed interceptor sewer and the SWOs in Arklow was also run for a 30-year 60 minute critical duration event, with an allowance for climate change to assess the flooding within the catchment.

Figure 3 below shows the extent of predicted flooding of the existing system with the proposed interceptor sewer which indicates that the existing drainage system still floods significantly under design storm conditions without the implementation of all other upgrades proposed in Phase 3 GDSDS Study.

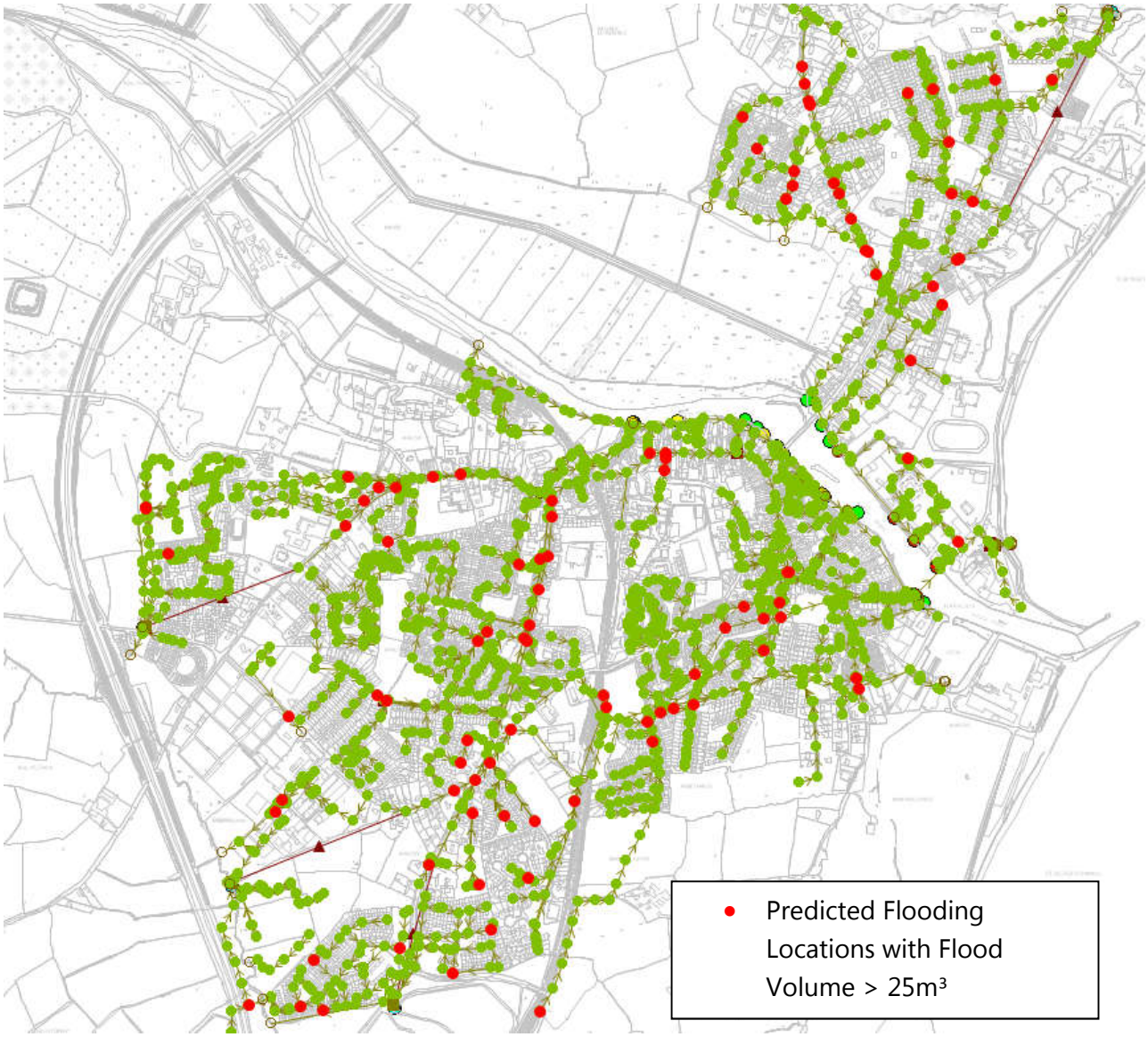

Figure 2: Existing System with Interceptor Sewer - Predicted flooding location > 25m3 for M30_60 & MHWS with CC

Appendix 2 shows a total of 100 location that are predicted to flood with a total flood volume of 7562 m³.

6 Future System Hydraulic Assessment with Interceptor Sewers and SWOs without

The hydraulic model of the future sewer system incorporating all developments up to a 50 year design horizon including all proposed GDSDS Phase 3 upgrades, proposed interceptor sewers and the SWOs was run for various modelling scenarios as described in Section 4 for carrying out joint probabilistic flooding assessment of Arklow Sewer Network.

6.1 Scenario 1 – M30_60 Storm & MWHS with Climate Change (0.99 mOD)

The hydraulic model of the future system was run for a 30-year 60minute critical duration storm event and MWHS tide level of 0.99m OD Malin (with climate change). Figure 3 below shows 3 predicted flooding locations with flood volume greater than 25 m³ for this scenario.

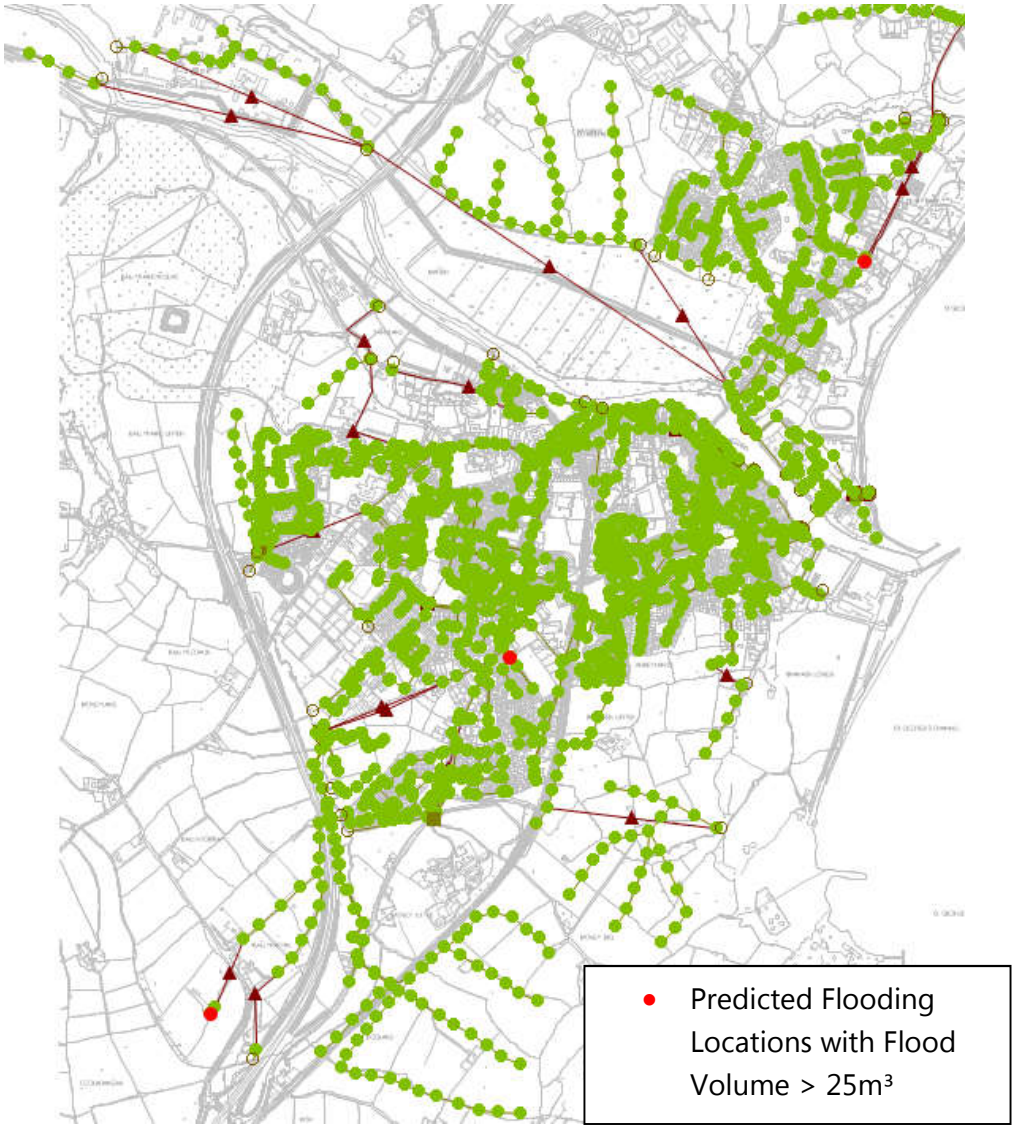

Figure 3 Scenario 1 - Predicted flooding locations with flood volume > 25 m³

Table 4 and 5 below shows the predicted flood volumes and overflow spill volumes on the overflows discharging directly into Avoca River/Irish Sea. The total volume of flooding from 3 predicted flooding locations within the catchment was found to be 134 m³. It was noted that only Alps SWO spills into Avoca River in Scenario 1.

Table 2 Scenario 1 - Predicted Flooding Volume > 25m3

Node ID	System Type	Location	GL mOD	Flood Volume > 25m3
Leis_Bal	Combined	Assumed Golf Course	51.3	81.2
ST25743102	Combined	Junction of Woodbine Rd/Sea Road	15.722	27.1
ST23728502	Foul	Knockenrahan	38.349	25.9
Total				**134.2**

Table 3 Scenario 1 - Predicted Overflow Spill Volumes

SWO Location	Ground Level (mOD)	Invert Level (mOD)	Pipe Diameter (mm)	Spill Volume (m3)
The Alps	4.0	3.0	900mm	1,289
Shaft TSS3 - u/s of River Crossing	1.746	0.0	1200mm	0
WWTP Inlet PS	1.788	-0.3	1200mm	0

6.2 Scenario 2 – M1_60 Storm & 1 Year Tide level with Climate Change (1.4585 mOD - Interpolated)

For Scenario 2, the hydraulic model of the future system was run for a 1-year 60minute critical duration storm event and 1-year tide level of 1.4585 m OD Malin (with climate change). Figure 4 below shows 4 predicted flooding locations with flood volume greater than 25 m³ for this Scenario.

Figure 4 Scenario 2 - Predicted flooding locations with flood volume > 25 m³

Table 6 below shows the predicted flood volumes greater than 25 m³. The total volume of flooding from 4 predicted storm water flooding locations along Harbour Road was found to be 139 m³. The flooding was primarily due to surcharge caused by high tide levels in the Avoca River that prevents storm water discharge into the river. It was noted that for Scenario 2, none of the existing and proposed SWO spills into Avoca River/Irish Sea .

Table 4 Scenario 2 - Predicted Flooding Volume > 25m³

Node ID	System Type	Location	GL mOD	Flood Volume > 25m3
MHS34	Storm	Harbour Road	1.167	49.7
MHS30	Storm	Harbour Road	1.285	28.1
ST24739005	Storm	Harbour Road	1.118	35.8
ST24739004	Storm	Harbour Road	1.21	25.7
	Total			**139.3**

6.3 Scenario 3 – 0.25 Year Storm & 5 Year Tide level with Climate Change (1.65 mOD)

In Scenario 3, the hydraulic model of the future system was run for a 0.25 Year 60minute critical duration storm event and 5-year tide level of 1.65 m OD Malin (with climate change). Figure 5 below shows 10 predicted flooding locations with flood volume greater than 25 m³.

Figure 5 Scenario 3 - Predicted flooding locations with flood volume > 25 m³

Table 7 below shows the predicted flood volumes greater than 25 m³. The total volume of flooding from 10 predicted storm water flooding locations with Arklow South found to be 580 m³. The flooding at these locations were also primarily due to surcharging caused by high tide levels in Avoca River that prevents storm water discharge into the river. Again for Scenario 2, none of the existing and proposed SWO spills into Avoca River/Irish.

Table 5 Scenario 3 - Predicted Flooding Volume > 25m³

Node ID	System Type	Location	GL mOD	Flood Volume > 25m3
MHS34	Storm	Harbour Road	1.167	122.9
MHS30	Storm	Harbour Road	1.285	88
ST24739005	Storm	Harbour Road	1.118	84.3
ST24739004	Storm	Harbour Road	1.21	73.8
ST24739003	Storm	Harbour Road	1.31	44.8
ST25730003	Storm	Harbour Road	1.284	36.3
ST24737325	Storm	Off Doyle's Lane, S Quay	1.351	36.2
ST24738004	Storm	Harbour Road	1.403	36
ST24737395	Storm	The Brook, S Quay	1.373	30
ST24737313	Storm	Off Doyle's Lane, S Quay	1.338	27.7
Total				**580**

7 Future System Hydraulic Assessment with all Pumps down at WWTP

7.1 30-year 60minute storm event and MWHS tide level (with CC) and all pumps down

The hydraulic model of the future system was run for a 30-year 60minute critical duration storm event and MWHS tide level of 0.99m OD Malin (with climate change) with all the pumps shut down at the WwTP to assess catchment flooding due to the pumping station failure. Figure 6 below shows 3 predicted flooding locations with flood volume greater than 25 m³.

Figure 6 Predicted flooding locations with flood volume > 25 m³ with all pumps down for M30_60 & MHWS with CC

Table 8 below shows the predicted flood volumes greater than 25 m³. A total of 37 locations are predicted to flood with a flood volume greater than 25 m³. The total volume of flooding from predicted flooding locations within Arklow was found to be 2,358 m³ with majority of the flooding locations observed in Arklow South particularly along Southgreen Road.

Table 6 Predicted Flooding Volume > 25m³ (all pumps down)

Node ID	Flood Volume > 25m3
ST25730703	192.9
ST25730702	183.7
MHS08	181.7
ST24739601	178.4
ST24738106	108.8
ST24737301	94.7
ST24737410	81.4
Leis_Bal	81.3
MHS10A	75.8
ST25730704	74.8
ST24739906	66.7
ST25720901	63.9
ST24738267	60.4
ST24736337	59.9
ST24736424	58.3
ST24738702	53.7
ST24737335	51.3
ST25731903	47.8
MHS06	43.5
MHS07	43.2
ST24739901	42.3
ST24729902	41.6
ST24729950	41.3
ST24738101	39.6
ST25731901	38.2
ST24729901	38
ST24729904	34.5
ST24737105	33.4
ST24738204	31.6
ST24738601	30
ST25720902	29.2
ST25731803	27.4
ST25743102	27.1
ST24736020	25.7
ST24729704	25.5

Node ID	Flood Volume > 25m3
ST23728502	25.3
ST24737002	25
Total	**2357.9**

7.2 30-year 60minute storm event (with CC) but no tide and all pumps down

The hydraulic model of the future system was also run for a 30-year 60minute critical duration storm event without tide levels applied at the outfalls that discharge into Avoca River with all the pumps shut down at the WwTP to assess flooding due to pumping station failure during low tide conditions. Figure 7 below shows 3 predicted flooding locations with flood volume greater than 25 m³ for this scenario.

Figure 7 Predicted flooding locations with flood volume > 25 m³ with all pumps down for M30_60 & No tide

Table 9 below shows the predicted flood volumes greater than 25 m³. Nine locations are predicted to flood with a flood volume greater than 25 m³. The total volume of flooding from predicted flooding locations within Arklow catchment was found to be 435 m³ with majority of the flooding locations observed in Arklow North.

Table 7 Predicted Flooding Volume > 25m³ (all pumps down without tide)

Node ID	Flood Volume > 25m3
Leis_Bal	81.3
ST25730702	74.2
ST24739601	68.7
ST25730703	54
ST24739906	43.3
ST24736424	33.5
ST25743102	27
ST25731903	27
ST23728502	25.9
Total	**434.9**

It should be noted that no significant flooding was predicted for a 1 in 5 year event with all pumps down and the SWOs that discharge into Avoca River did not spill for a 1 in 5 year critical duration event.

8 Future System - SWO Assessment

SWO performance assessment was carried out to assess its impact on Avoca River in accordance with the requirements given in IW Storm Water Overflow Technical Standard Document (IW-TEC-800-03). Avoca River has been categorised as contact/recreational use waters. Therefore, in accordance with Section 8.3.2 of the above IW Technical Standard all discharges to contact/recreational waters via SWOs are limited to 7 spills/bathing season.

The hydraulic model of the future system incorporating the proposed interceptor sewers, SWOs and the WwTP was run with Time Series Rainfall (TSR) event for assessment of spill frequency and volume of discharge via the proposed SWOs at the WwTP, Shaft TSS3 on Southern Interceptor Sewer, and existing SWO at the Alps. The results of spill frequency analysis of the future system as shown in Tables 10, 11 and 12 indicates that proposed SWOs spill on average less than once during bathing season which is well below the permitted 7 spills/bathing season.

Table 8 Spill Frequency Analysis – Alps SWO

SWO Ref	**ST24732508.2 - The Alps**		
	Total No of Spills	**Total Volume of Spills (m^3)**	**Total No of Spills/Bathing Season**
Year 1	2	451.07	2
Year 2	2	2,988.42	0
Year 3	3	66,708.30	1
Year 4	0	0.00	0
Year 5	0	0.00	0
Year 6	1	334.90	1
Year 7	1	1,018.82	1
Year 8	0	0	0
Year 9	0	0	0
Year 10	0	0	0
Average No of Spills	**0.90**		**0.50**

Table 9 Spill Frequency Analysis – WwTP SWO

SWO Ref	ST25733201.2 - WwTP SWO		
	Total No of Spills	**Total Volume of Spills (m^3)**	**Total No of Spills/Bathing Season**
Year 1	0	0.00	0
Year 2	0	0.00	0
Year 3	2	5,690.72	0
Year 4	0	0.00	0
Year 5	0	0.00	0
Year 6	1	63.66	1
Year 7	0	0.00	0
Year 8	0	0.00	0
Year 9	0	0.00	0
Year 10	0	0.00	0
Average No of Spills	**0.30**		**0.10**

Table 10 Spill Frequency Analysis – SI SWO

SWO Ref	TSS3.2 - Southern Interceptor SWO		
	Total No of Spills	**Total Volume of Spills (m^3)**	**Total No of Spills/Bathing Season**
Year 1	0	0.00	0
Year 2	0	0.00	0
Year 3	2	52,407.60	0
Year 4	0	0.00	0
Year 5	0	0.00	0
Year 6	1	313.47	1
Year 7	2	0.00	0
Year 8	0	0.00	0
Year 9	0	0.00	0
Year 10	0	0.00	0
Average No of Spills	**0.50**		**0.10**

9 Summary of Modelled Scenarios

Scenario	Combined Sewer Overflow Locations	Total No. of Flooding Locations with Flood Volume > 25m3	Total Flood Volume (m^3) > 25m3	Spill Volumes at Alps (m^3)	Comments
Existing System Hydraulic Assessment without Interceptor Sewers and SWOs					
M30_60 min storm event & MWHS tide level with Climate Change (0.99 mOD)	➢ Ø900mm overflow at The Alps, IL – 3.0m OD ➢ Ø1200mm overflow at TSS3 on Southern Interceptor Sewer to Avoca River, IL – 0.0m OD ➢ Ø1200mm overflow at WWTP Inlet PS to Arklow Bay, IL – 0.3m OD	106	8,103.7	The Alps SWO – 859m^3	➢ Significant flooding predicted within the catchment without implementation of upgrades proposed in Phase 3 GDSDS Study ➢ Northern and Southern Interceptor sewers surcharged under peak flow conditions

Scenario	Combined Sewer Overflow Locations	Total No. of Flooding Locations with Flood Volume > 25m3	Total Flood Volume (m^3) > 25m3	Spill Volumes at Alps (m^3)	Comments
Existing System Hydraulic Assessment with Interceptor Sewers and SWOs					
M30_60 min storm event & MWHS tide level with Climate Change (0.99 mOD)	➢ Ø900mm overflow at The Alps, IL – 3.0m OD ➢ Ø1200mm overflow at TSS3 on Southern Interceptor Sewer to Avoca River, IL – 0.0m OD ➢ Ø1200mm overflow at WWTP Inlet PS to Arklow Bay, IL – 0.3m OD	100	7,562	The Alps SWO – 1,458m^3 Southern Interceptor SWO – 0 m^3 WWTP SWO – 0m^3	➢ Significant flooding predicted within the catchment without implementation of upgrades proposed in Phase 3 GDSDS Study

Scenario	Combined Sewer Overflow Locations	Total No. of Flooding Locations with Flood Volume > 25m3	Total Flood Volume (m^3) > 25m3	Spill Volumes (m^3)	Comments
Future System Hydraulic Assessment with Interceptor Sewers and SWOs					
M30_60 min storm event & MWHS tide level with Climate Change (0.99 mOD)	Ø900mm overflow at The Alps, IL – 3.0m OD Ø1200mm overflow at TSS3 on Southern Interceptor Sewer to Avoca River, IL – 0.0m OD Ø1200mm overflow at WWTP Inlet PS to Arklow Bay, IL – 0.3m OD	3 (2Foul/Combined, 1 Storm)	134.2	The Alps SWO - 1,289m^3 Southern Interceptor SWO - 0^3 WWTP SWO - $0m^3$	3 no location of foul flooding Northern and Southern Interceptor sewer remains surcharged for no of days
M1_60 min storm event & 1-year tide level with Climate Change (Tide Level – 1.4585 mOD)	➢ Ø900mm overflow at The Alps, IL – 3.0m OD ➢ Ø1200mm overflow at TSS3 on Southern Interceptor Sewer to Avoca River, IL – 0.0m OD ➢ Ø1200mm overflow at	4 (Storm)	139.3	No Spills predicted at any SWO	➢ No foul/combined sewer flooding predicted ➢ Increase in tide levels predicts storm flooding at Harbour Road

Scenario	Combined Sewer Overflow Locations	Total No. of Flooding Locations with Flood Volume > 25m3	Total Flood Volume (m^3) > 25m3	Spill Volumes (m^3)	Comments
Future System Hydraulic Assessment with Interceptor Sewers and SWOs					
	WWTP Inlet PS to Arklow Bay, IL – 0.3m OD				
4M_60 min storm event & 5-year tide level with Climate Change (Tide Level – 1.65 mOD)	➢ Ø900mm overflow at The Alps, IL – 3.0m OD ➢ Ø1200mm overflow at TSS3 on Southern Interceptor Sewer to Avoca River, IL – 0.0m OD ➢ Ø1200mm overflow at WWTP Inlet PS to Arklow Bay, IL – 0.3m OD	10 (Storm)	580	No Spills predicted at any SWO	➢ No foul/combined sewer flooding predicted ➢ Increase in tide levels predicts storm flooding particularly at Harbour Road

Scenario	Combined Sewer Overflow Locations	Total No. of Flooding Locations with Flood Volume > 25m3	Total Flood Volume (m^3) > 25m3	Spill Volumes (m^3)	Comments
Future System Hydraulic Assessment with all Pumps down at WWTP					
M30_60 min storm event & MWHS tide level with Climate Change (0.99 mOD)	➢ Ø900mm overflow at The Alps, IL – 3.0m OD ➢ Ø1200mm overflow at TSS3 on Southern Interceptor Sewer to Avoca River, IL – 0.0m OD ➢ Ø1200mm overflow at WWTP Inlet PS to Arklow Bay, IL – 0.3m OD	37	2,358	The Alps SWO - 1,803m^3 Southern Interceptor SWO - 10,935m^3 WWTP SWO – 7,416m^3	➢ 37 locations predicted to flood despite significant spills at the SWO
M30_60 min storm event with Climate Change & No tide	➢ Ø900mm overflow at The Alps, IL – 3.0m OD ➢ Ø1200mm overflow at TSS3 on Southern Interceptor Sewer to Avoca River, IL – 0.0m OD ➢ Ø1200mm overflow at	9	435	The Alps SWO - 1,533m^3 Southern Interceptor SWO – 8,007m^3 WWTP SWO – 10,581m^3	➢ 9 locations predicted to flood despite significant spills at the SWO

Scenario	Combined Sewer Overflow Locations	Total No. of Flooding Locations with Flood Volume > 25m3	Total Flood Volume (m^3) > 25m3	Spill Volumes (m^3)	Comments
Future System Hydraulic Assessment with all Pumps down at WWTP					
	WWTP Inlet PS to Arklow Bay, IL – 0.3m OD				
M5_60 min storm event & No tide	➢ Ø900mm overflow at The Alps, IL – 3.0m OD ➢ Ø1200mm overflow at TSS3 on Southern Interceptor Sewer to Avoca River, IL – 0.0m OD ➢ Ø1200mm overflow at WWTP Inlet PS to Arklow Bay, IL – 0.3m OD	-	-	The Alps SWO - 578m^3 Southern Interceptor SWO - 5,147m^3 WWTP SWO – 9,419m^3	➢ No flooding predicted

10 Conclusions

The hydraulic assessment of the existing and future sewer system of Arklow was carried out to assess risk of flooding from the sewers. The hydraulic model of the future sewer was run for various modelling scenarios as per specific recommendations given in GDSDS Final Strategy Report for carrying out joint probabilistic flooding assessment of Arklow Sewer Network.

The hydraulic assessment results indicate that the existing sewerage system in Arklow is significantly under capacity and is predicted to flood at more than 100 locations with flood volume greater than 25m³ for a 1 in 30-year storm event. The assessment of the spill volumes shows that 7,566m³ of raw sewage is predicted to spill via the existing outfalls into Avoca River during Dry Weather Flow (DWF). Further, the sewer system is predicted to spill 15,100m³ and 21,484m³ of combined sewage into Avoca River for a 5 year and 30-year return period critical duration events.

Hydraulic assessment of the existing system incorporating the proposed interceptor sewer, and SWOs shows that the total flooding within Arklow sewerage catchment is only marginally reduced without implementation of all other upgrades proposed in Phase 3 of the GDSDS Study. Further, all the flows from the Arklow catchment will be conveyed to the proposed WwTP at Ferrybank. Hence, there will not be any discharge of raw sewage into Avoca River following the construction of the Interceptor Sewers and the WwTP which will the improve the existing water quality in the Avoca River/Estuary.

The result of the hydraulic assessment of the future sewer system which incorporates all upgrades proposed in Phase 3 of the GDSDS, the proposed interceptor sewer, proposed SWOs and WwTP indicates very minor flooding within the catchment for a 1 in 30-year critical duration storm event with MHWS including allowance of climate change. In total just 3 locations are predicted to flood marginally above 25 m³ in a 30-year return period event.

It should be noted that storm water flooding is predicted in Arklow South particularly along the Harbour Road and South Green Road Areas for both 1 year drainage with 1 year tide level and 0.25 year drainage with 5 year tide level combination events due to surcharging of Storm water sewers caused by high tide conditions in Avoca River.

The results of spill frequency analysis of the future system indicate that proposed SWOs spill on average less than once during bathing season which is well below the permitted 7 spills/bathing season. Therefore, the proposed development would remove the need to discharge untreated wastewater into the Avoca River excluding discharges via SWOs which are compliant with IW standards.

Appendix

1. Existing System - Predicted Flooding Locations
2. Existing System with Interceptor Sewers - Predicted Flooding Volumes

1. Existing System - Predicted Flooding Locations

Node ID	Flood Volume > 25m3
ST24747202	457.7
ST24736020	409.5
ST24730101	335.5
ST23727407	295.8
ST25744501	250.3
ST23729699	216.4
ST25742003	202
ST25742202	192.1
ST23739003	182.6
ST23728911	160.7
ST23729909	142.6
ST25741303	141.2
ST24722601	133
ST24721797	128.4
ST23729903	123.2
ST24733498	120.6
ST24737003	105.5
ST24748104	103
ST23735310	100.6
ST24720401	98
ST24729802	98
ST24749004	97.8
ST24730201	97.1
ST23728503	87.8
ST24721796	84.6
ST24724704	84
ST23735202	78.4
ST24733499	78
ST23725002	76.1
ST25741202	75.5
ST24724804	73.6
ST24747201	72.1
ST24737103	71
ST25731902	69.6
ST23717901	67.5
ST24747402	66.9

Node ID	Flood Volume > 25m3
ST24747501	66.1
ST23737401	65.3
ST23711805	64.4
ST24737101	63.6
ST24733405	62.7
ST24748203	61.8
ST24748208	61.3
ST25743502	60.6
ST25730704	60.1
ST23739107	59
ST23734204	57.2
ST24749003	56.3
ST25742001	55.8
ST23729202	55.3
ST24723701	54.7
ST22738109	54.6
ST23712801	54.3
ST23727602	54
ST23727502	50.1
ST23729302	50.1
ST25740502	49.3
ST23713804	49.1
ST24723702	47.8
ST23719801	47.8
ST24745403	47.2
ST24737602	47.1
ST24747502	46.6
ST24747601	44.6
ST25741510	43.4
ST24749001	42.9
ST23729908	42.1
ST24726899	41.9
ST24735005	41.4
ST25730404	41
ST23727504	40.6
ST24746303	40
ST23722401	38.6
ST24730303	37.4
ST24733406	36.8
ST24729704	36.4

Node ID	Flood Volume > 25m3
ST23713902	35.8
ST23728906	34.6
ST25731901	34.6
ST24732402	33.3
ST24723601	33
ST23728403	32.9
ST23725705	32.7
ST23726203	32.4
ST24747203	32
ST24731101	31.5
ST237353D1	31.4
ST24725901	31.3
ST24726901	30.1
ST23722701	29.8
ST23734402	29.5
ST24737114	29.4
ST23736401	29.1
ST23728201	28.8
ST22738303	28.6
ST23734306	28.4
ST23728003	27.9
ST23725709	27.8
ST23722407	27.8
ST23727401	27.5
ST22738301	27.3
ST24733497	26.6
ST23715805	26.3
ST24735203	26.1
ST23733402	26
ST24723505	25.2
Total	**8103.7**

2. Existing System with Interceptor Sewers - Predicted Flooding Volumes

Node ID	Flood Volume > 25m3
ST24747202	451
ST24736020	381
ST24730101	327.5
ST23727407	288.9
ST25744501	245.7
ST23729699	210.3
ST25742003	193.8
ST25742202	187.3
ST23739003	178
ST23728911	155
ST23729909	138
ST25741303	137.5
ST24722601	130.2
ST24721797	125.2
ST24737003	122.7
ST23729903	120.3
ST24733498	116.2
ST23735310	97.5
ST24730201	95.1
ST24720401	94.9
ST24748104	94.5
ST24729802	94
ST23728503	86.3
ST24724704	83.4
ST24721796	82.1
ST24733499	75.8
ST23735202	75.2
ST25741202	73.5
ST23725002	73.4
ST24724804	71.3
ST24747201	69.1
ST24749004	67.3
ST24747402	64.8
ST23717901	64
ST24747501	64
ST23737401	63
ST24733405	60.8
ST23711805	59.8

Node ID	Flood Volume > 25m3
ST24748208	59.7
ST24748203	59.5
ST25743502	58.5
ST23739107	56.7
ST23734204	54.6
ST24723701	53.2
ST22738109	53
ST23727602	52.7
ST25742001	52.6
ST23729202	52.5
ST23712801	52
ST24737103	51.4
ST25731902	51.4
ST24737101	49.7
ST23727502	48.4
ST23729302	48.1
ST25730704	47.7
ST23713804	47.1
ST25740502	46.7
ST24723702	46.6
ST24745403	45.5
ST24747502	44.8
ST25730404	44.3
ST23719801	44.1
ST24747601	42.3
ST24749003	41.8
ST25741510	41.7
ST24726899	40.4
ST23727504	39.6
ST23729908	39.5
ST24735005	38.4
ST24746303	37.9
ST23722401	37.6
ST24730303	36.5
ST24733406	35
ST24729704	34.2
ST23713902	34
ST24749001	33.2
ST23728906	33.1
ST24723601	31.9
ST23726203	31.7

Node ID	Flood Volume > 25m3
ST23728403	31.5
ST23725705	31
ST24747203	30.9
ST24731101	30.7
ST237353D1	30.2
ST24725901	29.6
ST25731901	29.5
ST23722701	28.8
ST23734402	28.5
ST24726901	28.4
ST23736401	27.8
ST23728201	27.8
ST22738303	27.4
ST23722407	27.1
ST23725709	27.1
ST23734306	27
ST23728003	26.5
ST23727401	26.4
ST22738301	26.2
ST25732201	25.9
ST24733497	25.5
Total	**7561.8**