N4 Collooney to Castlebaldwin, *Proposed Road Development*

APPENDIX NO. 4.1

Operation Stage Drainage Information

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TABLE OF CONTENTS

Tables

1 Introduction

1.1 Introduction

This appendix to the EIS provides a general overview of the drainage design for the *Proposed Road Development* including information on:

- Design Flows;
- Drainage Catchments and Outfalls;
- Outfall Capacities;
- Constructed Wetland/Attenuation Pond design; and
- Culvert sizes for what are considered to be the main crossing points on the *Proposed Road Development.*

The information contained herein has been extracted and summarised from the detailed information contained within the design report.

2 Design Flows

2.1 Return Period Rainfall depths for Sliding durations

Return Period Rainfall Depths for sliding Durations

Site Location: Easting: 171052 Northing: 319356

Average Annual Rainfall (1961-1990) for Collooney: 1182mm

Table 2-1: Return Period Rainfall Depths

Average Recurrence	Return Period														
Interval	Years														
DURATION	6months	1	2	3	4	5	10	20	30	50	75	100	150	200	250
5 mins	2.5	3.5	4	4.8	5.4	5.8	7.2	8.8	9.8	11.2	12.5	**13.5**	15.1	16.2	17.2
10 mins	3.5	4.9	5.6	6.7	7.5	8.1	10	12.2	13.6	15.7	17.4	**18.8**	21	22.6	24
15 mins	4.1	5.7	6.6	7.9	8.8	9.5	11.8	14.4	16	18.4	20.5	**22.2**	24.7	26.6	28.2
30 mins	5.4	7.5	8.6	10.2	11.3	12.2	14.9	18.1	20.1	22.9	25.5	**27.4**	30.4	32.7	34.6
1 hours	7.1	9.8	11.1	13.2	14.5	15.6	18.9	22.7	25.2	28.6	31.6	33.9	37.4	40.1	42.4
2 hours	9.4	12.7	14.4	16.9	18.6	19.9	24	28.6	31.5	35.6	39.1	**41.9**	46	49.2	51.9
3 hours	11.1	14.9	16.8	19.6	21.5	23	27.6	32.7	35.9	40.5	44.4	**47.4**	52	55.5	58.4
4 hours	12.5	16.6	18.7	21.8	23.9	25.4	30.4	35.9	39.4	44.3	48.5	**51.8**	56.7	60.4	63.5
6 hours	14.7	19.4	21.8	25.3	27.6	29.4	35	41.1	45	50.4	55.1	**58.6**	64	68.1	71.5
9 hours	17.3	22.6	25.4	29.3	31.9	33.9	40.2	47	51.3	57.3	62.4	**66.4**	72.3	76.8	80.5
12 hours	19.4	25.3	28.3	32.6	35.4	37.5	44.3	51.7	56.3	62.7	68.3	**72.5**	78.8	83.6	87.6
18 hours	22.8	29.5	32.9	37.8	40.9	43.3	50.9	59.1	64.3	71.3	77.4	**82**	89	94.3	98.6
24 hours	25.6	33	36.6	41.9	45.4	48	56.2	65	70.6	78.1	84.7	**89.6**	97	102.6	107.2
2 days	34.1	42.4	46.4	52.2	55.9	58.7	67.3	76.4	82	89.6	96.1	**100.9**	108.1	113.6	117.9
3 days	41.3	50.4	54.8	60.9	64.9	67.8	76.8	86.2	92	99.7	106.2	**111.1**	118.3	123.7	128
4 days	47.9	57.7	62.3	68.8	72.9	76	85.4	95	100.9	108.8	115.4	**120.3**	127.6	133	137.3

NOTES:

- These values are derived from a Depth Duration Frequency (DDF) Model;
- For frequencies less than two years Average Recurrence Intervals (ARI) are used;
- For details refer to:
    - Fitzgerald D. L. (2007) Estimates of Point Rainfall Frequencies Technical Note No. 61 Met Eireann Dublin
- Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf.

2.2 Design Surface Water Flow

Table 2-2: Rainfall Events for Design Surface Water Flow

Rainfall Events For Design Surface Water Flow		
From Table 3.2 - 100 year 1hr event	33.9	mm/hr
Including Climate Change	**40.68**	**mm/hr**
From Table 3.2 - 10 year 1hr event	18.9	mm/hr
Including Climate Change	**22.68**	**mm/hr**
NOTES: Apply 20% for Climate Change		

3 Drainage Catchments & Outfalls

The *Proposed Road Development* is located wholly with the Western River Basin District (WRBD), which is a largely rural area with many high quality waters and protected sites that depend on water. The WRBD is defined as the physiographical region within hydrometric areas 29-35 that drain in to the Atlantic Ocean, covers an area of 12,193km^2, comprises 89 river catchments with over 14,200km of river and contains the sub-catchments of Unshin River, its sub-catchments and Lough Arrow. The *Proposed Road Development* is entirely located in Hydrometric Area 35 and crosses drains and streams which discharge to the Unshin River and Lough Arrow.

3.1 Outfall Locations

The following outlines the approx. location of the proposed drainage outfalls. Chapter 14 of this EIS assesses the impacts which the provision of the *Proposed Road Development* will have on these outfalls.

Outfall No. 01

Outfall number 01 is located within the townland of Rathrippin. The outfall accepts treated and attenuated road runoff from an existing attenuation pond in the townland of Toberbride, it consists of a storm water pipe which occurs 950m up-gradient of its discharge to the Owenmore River. The pipe ranges in diameter from 600mm at the inlet point to 1050mm at the outfall point to the Owenmore.

The outfall point occurs circa 950m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 02

Outfall number 02 is located within the townland of Ardcurley. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- The Markree Demesne Stream (which is on average 3.m wide (top width) and 1m deep) over circa 575m to the Unshin River.

The outfall point occurs circa 490m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 03

Outfall number 03 is located within the townland of Ardcurley. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- An existing open drain (which is on average 4.5m wide (top width) and 1m deep) over circa 280m to the Unshin River.

The outfall point occurs circa 130m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 04

Outfall number 04 is located within the townland of Doorly. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- An existing open drain (which is on average 3.2m wide (top width) and 1m deep) over circa 660m to the Turnalaydan Stream.

The outfall point occurs circa 660m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 05

Outfall number 05 is located within the townland of Knocknagroagh. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- An existing open drain (which is on average 1.7m wide (top width) and 0.7m deep) over circa 170m to the Turnalaydan Stream.

The outfall point occurs circa 170m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 06

Outfall number 06 is located within the townland of Knocknagroagh. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges directly to the:

- Turnalaydan Stream (which is on average 10m wide (top width) and 2m deep).

The outfall point occurs circa 300m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 07

Outfall number 07 is located within the townland of Drumfin. The outfall occurs in a proposed new open drain circa 280m downstream of the discharge of treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges directly to the:

- The Turnalaydan Stream (which is on average 10m wide (top width) and 2m deep).

The outfall point occurs circa 600m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 08

Outfall number 08 is located within the townland of Drumfin. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- An existing open drain (which is on average 4m wide (top width) and 1.4m deep) over circa 650m to the Turnalaydan Stream before discharging to Lough Corran which a further circa 1,130m downstream.

The outfall point occurs circa 3120m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 09

Outfall number 09 is located within the townland of Carrownagark. The outfall occurs in a proposed new open drain circa 175m downstream of the discharge of treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges directly to the:

- Drumfin River (which is on average 6m wide (top width) and 1.7m deep).

The outfall point occurs circa 1400m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 10

Outfall number 10 is located within the townland of Carrownagark. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- An existing open drain (which is on average 4.5m wide (top width) and 1.0m deep) over circa 225m; to a tributary of the Unshin River at a point which is a further distance of c. 2215m upstream from the Unshin River.

The outfall point occurs circa 2120m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 11

Outfall number 11 is located within the townland of Kingsbrook. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- An existing open drain (which is on average 3.1m wide (top width) and 0.7m deep) over circa 250m; to a tributary of the Unshin at a point which is a further distance circa c. 2920m upstream from the Unshin River.

The outfall point occurs circa 2550m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 12

Outfall number 12 is located within the townland of Aghalenane. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via:

- An existing open drain (which is on average 2.8m wide (top width) and 1.2m deep) over circa 22m to the Ardloy Loughs (2 existing ponds in sequence). It then discharges to the Aghalenane Lough (215m

between both Loughs). The outflow from this lough discharges to a tributary of the Unshin which is circa 2700m from the Unshin River.

The outfall point occurs circa 2720m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 13

Outfall number 13 is located within the townland of Springfield. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges directly to the

- The Springfield Stream (which is on average 3.8m wide (top width) and 2m deep) which then discharges to the Swallow Hole/Turlough Complex at Tawnagh townland.

Outfall No. 14

Outfall number 14 is located within the townland of Sheerevagh. The outfall occurs in a proposed new open drain circa 160m downstream of the discharge of treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It then discharges to the:

- Lissycoyne Stream (which is on average 4.5m wide (top width) and 1.8m deep) at a point which is circa c. 1755m upstream from the Unshin River.

The outfall point occurs circa 1540m upstream from the boundary of the Unshin River cSAC/pNHA.

Outfall No. 15

Outfall number 15 is located within the townland of Castlebaldwin. The outfall accepts treated and attenuated road runoff from a proposed Constructed Wetland/Attenuation Pond facility. It discharges via the:

- Drumderry Stream (which is on average 3.3m wide (top width) and 2m deep) at a point which is circa c. 2400m upstream from Lough Arrow.

The outfall point occurs circa 780m upstream from the boundary of the Lough Arrow cSAC/pNHA.

4 Outfall Capacities

4.1 Outfall Capacities

The following table demonstrates the effect which the provision of the Proposed Road Development will have on receiving watercourses. This table is also reproduced in Chapter 14 of the EIS where the effects of same are considered. Additionally; the Flood Risk Assessment contained within Appendix 4.2 (volume 4) of this EIS considers the Flood Risk associated with the Proposed Road Development on receiving watercourses.

Table 4-1: Existing and required outfall capacities

Without Attenuation							
Outfall ID	Existing Capacity	Existing Flow Calculated (1 in 100 Year Event)	Catchment Flow Post Road Construction	Flow From Proposed Road Surface (1 in 100 Year Event)	Required Capacity	Difference	Increase in peak flood
	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
1	0.729	0.721	0	0.425	1.146	0.425	0.425
2	3.028	1.62	2.12	0.961	3.081	1.461	1.461
3	4.567	1.807	1.807	0.418	2.225	0.418	0.418
4	0.698	0.916	0.916	0.179	1.095	0.179	0.179
5	0.509	0.118	0.118	0.013	0.131	0.013	0.013
6	40.894	18.167	18.095	1.144	19.239	1.072	1.072
7	5.055	17.833	17.752	0.575	18.327	0.494	0.494
8	4.560	1.685	1.500	0.381	1.881	0.196	0.196
9	2.824	24.940	24.940	0.174	25.114	0.174	0.174
10	0.358	0.747	0.634	0.334	0.968	0.221	0.221
11	0.742	0.924	0.885	0.193	1.078	0.154	0.154
12	2.097	1.232	1.232	0.043	1.275	0.043	0.043
13	3.062	4.700	4.619	0.079	4.697	-0.003	-0.003
14	3.083	4.129	4.056	0.675	4.731	0.602	0.602
15	2.193	4.903	4.806	0.423	5.229	0.326	0.326

With Attenuation							
Outfall ID	Existing Capacity	Existing Flow Calculated (1 in 100 Year Event)	Catchment Flow Post Road Construction	Attenuated Flow From Proposed Road Surface (1 in 100 Year Event)	Required Capacity	Difference	Increase in peak flood
	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)
1	0.729	0.721	0	0.024	0.024	-0.705	-0.705
2	3.028	1.620	2.120	0.193	2.313	0.693	0.693
3	4.567	1.807	1.807	0.082	1.888	0.082	0.082
4	0.698	0.916	0.916	0.032	0.948	0.032	0.032
5	0.509	0.118	0.118	0.002	0.120	0.002	0.002
6	40.894	18.167	18.095	0.222	18.317	0.150	0.150
7	5.055	17.833	17.752	0.115	17.867	0.033	0.033
8	4.560	1.685	1.500	0.073	1.573	-0.112	-0.112
9	2.824	24.940	24.940	0.030	24.970	0.030	0.030
10	0.358	0.747	0.634	0.066	0.700	-0.047	-0.047
11	0.742	0.924	0.885	0.033	0.918	-0.006	-0.006
12	2.097	1.232	1.232	0.018	1.249	0.018	0.018
13	3.062	4.700	4.619	0.014	4.633	-0.067	-0.067
14	3.083	4.129	4.056	0.137	4.193	0.064	0.064
15	2.193	4.903	4.806	0.085	4.891	-0.012	-0.012

5 Constructed Wetlands/Attenuation Ponds Sizing

5.1 Introduction

The following is a brief overview of the design characteristics[1] of the various Constructed Wetlands/Attenuation Ponds proposed along the route of the Proposed Road Development. This overview is a summary of design calculations contained within the design report for the *Proposed Road Development*.

In general the ponds have been designed in accordance with the criteria set out in section 4.8.2.2.2.3 of Chapter 4 of the EIS (volume 2). That is with the exception of the existing pond at Toberbride which is being retrofitted to accept the road runoff from the Proposed Road Development and which will simply provide attenuation to the existing Greenfield Runoff Rate calculated as 8.9l/s.

The designs are generally described in analytical format with the exception of Outfall 01 which is described in descriptive format.

5.2 Outfall 1

Attenuation lagoons were constructed adjacent to the N4 / N17 roundabout at Toberbride townland in 2006.

The purpose of these lagoons was to assist in the attenuation of surface water run-off from the adjacent Toberbride business park.

Between 2006 and present only the infrastructure roads and drainage together with a minor portion of the business park has been constructed. The granted planning permission for the remainder of the business park has now lapsed. In 2006 planning for the business park was granted under 3 separate applications. Two of the three application area for the Toberbride Business Park were granted with no demand for attenuation of the surface flows, therefore the attenuation lagoon is sized to restrict to green field run-off for only a portion of the initial proposed development. The remainder of the development has the benefit of unrestricted flow from the site through the adjacent (SL Developments) business park and ultimately discharging to the Owenmore river. The industrial units that have been constructed on the Toberbride business park are included in the grant of planning that did not require attenuated discharge.

It is the intent of the roads scheme to make use of the attenuation lagoons as retention basins, thereby assisting in the removal of suspended solids from the 'first flush' wash off from the road surface. Often this first flush will also contain an element of hydrocarbons from the road surface. In order to remove these hydrocarbons from this flow an interceptor will be installed in advance of the lagoons.

The design for the storm sewer network and lagoons has been undertaken with use of the MicroDrainage WinDes software package. The default values for the design storm are a M5-60 of 18mm/hr and rainfall return factor (R) value of 0.3. The design has been undertaken by assuming a typical 2 year return period storm. This design original design for these lagoons indicated a top of bank level of 36.6m thus it is possible that the lands adjacent to the lagoon may be flooded to a depth of equivalent to 200mm of the lagoon area. It is considered that this depth/volume of water will not impact on the adjacent road network.

The lagoon during the 100 year 1440 min storm will be catering for a maximum volume of 2087m3 (including the overflow volume). Due to the restrictor on the outflow of 28.2l/sec (green field equivalent) the lagoons will empty the 1440 minute duration storm within 20.5 hrs of the storm event passing.

[1] The Design of the pond at OF 01 has been prepared by the CST Group. The remaining ponds have been design by the National Road Design Department of Sligo County Council.

5.3 Outfall 2

Pond Storage & Treatment Calcs:			Outfall Number 02
Location	**SOIL**	**Soil Type**	**SAAR**
Ardcurley Td.	0.47	4	1182

Catchment Areas				
Element	**Pavement**	**Verge**	**Grass**	**Unit**
Catchment Areas	5.4747	2.1045	3.4539	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	5.200965	1.578375	1.72695	ha

INTERCEPTION STORAGE				
Calculate Runoff from 5mm of Rainfall on the Development Area				
	Pavement	**Verge**	**Grass**	**Unit**
Rainfall	5	5	5	mm
Equivalent Catchment Area	5.200965	1.578375	1.72695	ha
Minimum Interception Storage	260.04825	78.91875	86.3475	**m^3**

TREATMENT STORAGE				
The Treatment Storage (Wet pond volume) needed for 15mm				
	Pavement	**Verge**	**Grass**	**Unit**
Equivalent Catchment Area	5.2010	1.5784	1.7270	ha
Minimum Treatment Storage m^3	780.1448	236.7563	259.0425	**m^3**

Q_{BAR} AND DISCHARGE RATES FOR PONDS/WETLANDS		
QBAR Details		
QBar Per Hectare	8.91	l/sec/ha
Actual Catchment Area	11.024	ha
QBar for Actual Catchment Area	98.2	l/s
QBAR factors for Flood Events		
Flood Event		Q For Catchment l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.		85.47
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.		93.33
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.		161.11
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.		192.55
Difference in Q30 - Q1		75.64
Difference in Q100 - Q30		31.44
Difference in QBar - Q1		12.77

LONG TERM STORAGE (Extra Volume Runoff)		
Based on a 1 in 100 year storm and a 6 hour event.		
Long Term Strorage Volume	1397	m3

STORAGE REQUIRED FOR OPTION 1 AND 2 (as defined in appendix E of the Greater Dublin Strageic Drainage Study)				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	425		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	1276		1276	

2. River Regime Protection				
Criterion 2.1 & 2.2 "Attenuation Storage"				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
For Q 1 year	693		0	
For Q 30 year	2,267		0	
For Q 100 year	3,470		0	
Total m3	**6,430**		**-**	
Less Long term Storage	1,397		-	
Provide Attenuation Storage	5032		0	

3. Level of Service For the Site
N/A: Defined at detailed design phase

4. River Flood Protection				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	1,397		-	
Criterion 4.3 "Attenutaion & Long Term	-		693	This is Q1
			7,400	This is QBAR - Q1
Provide Storage Volume	6,430		8,093	
For Q 1 year	693		693	
Head Discharge Assumption	25%		25%	
	173		173	
Apply Head Discharge Assumption	6,603		8,266	
Design Pond for Volume (m^3)			8,266	
Nb. 1	Option 1 and 2 are as defined in the example calculation given in appendix E of the Greater Dublin Strategic Drainage			

Calculated Residence Time	
Total time to empty (hour's)	23:10

5.4 Outfall 3

Pond Storage & Treatment Calcs:			Outfall Number 03
Location	**SOIL**	**Soil Type**	**SAAR**
Ardcurley Td.	0.47	4	1182

Catchment Areas				
Element	**Pavement**	**Verge**	**Grass**	**Unit**
Catchment Areas	2.4893	0.9799	1.2051	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	2.364835	0.734925	0.60255	ha

INTERCEPTION STORAGE				
Calculate Runoff from 5mm of Rainfall on the Development Area				
	Pavement	**Verge**	**Grass**	**Unit**
Rainfall	5	5	5	mm
Equivalent Catchment Area	2.364835	0.734925	0.60255	ha
Minimum Interception Storage	118.24175	36.74625	30.1275	**m^3**

TREATMENT STORAGE				
The Treatment Storage (Wet pond volume) needed for 15mm				
	Pavement	**Verge**	**Grass**	**Unit**
Equivalent Catchment Area	2.3648	0.7349	0.6026	ha
Minimum Treatment Storage m^3	354.7253	110.2388	90.3825	**m^3**

Q_{BAR} AND DISCHARGE RATES FOR PONDS/WETLANDS		
QBAR Details		
QBar Per Hectare	8.91	l/sec/ha
Actual Catchment Area	4.674	ha
QBar for Actual Catchment Area	41.7	l/s
QBAR factors for Flood Events		
Flood Event		Q For Catchment l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.		36.24
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.		39.57
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.		68.31
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.		81.64
Difference in Q30 - Q1		32.07
Difference in Q100 - Q30		13.33
Difference in QBar - Q1		5.42

LONG TERM STORAGE (Extra Volume Runoff)		
Based on a 1 in 100 year storm and a 6 hour event.		
Long Term Strorage Volume	630	m3

STORAGE REQUIRED FOR OPTION 1 AND 2 (as defined in appendix E of the Greater Dublin Strageic Drainage Study)				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	185		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	555		555	

2. River Regime Protection				
Criterion 2.1 & 2.2 "Attenuation Storage"				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
For Q 1 year	305		0	
For Q 30 year	1,002		0	
For Q 100 year	1,523		0	
Total m3	**2,829**		**-**	
Less Long term Storage	630		-	
Provide Attenuation Storage	2199		0	

3. Level of Service For the Site
N/A: Defined at detailed design phase

4. River Flood Protection				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	630		-	
Criterion 4.3 "Attenutaion & Long Term	-		305	This is Q1
			3,242	This is QBAR - Q1
Provide Storage Volume	2,829		3,547	
For Q 1 year	305		305	
Head Discharge Assumption	25%		25%	
	76		76	
Apply Head Discharge Assumption	2,905		3,623	
Design Pond for Volume (m^3)			3,623	
Nb. 1	Option 1 and 2 are as defined in the example calculation given in appendix E of the Greater Dublin Strategic Drainage			

Calculated Residence Time	
Total time to empty (hour's)	23:57

5.5 Outfall 4

Pond Storage & Treatment Calcs:			Outfall Number 04
Location	**SOIL**	**Soil Type**	**SAAR**
Doorly Td.	0.47	4	1182

Catchment Areas				
Element	**Pavement**	**Verge**	**Grass**	**Unit**
Catchment Areas	1.5062	0.2187	0.1098	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	1.43089	0.164025	0.0549	ha

INTERCEPTION STORAGE				
Calculate Runoff from 5mm of Rainfall on the Development Area				
	Pavement	**Verge**	**Grass**	**Unit**
Rainfall	5	5	5	mm
Equivalent Catchment Area	1.43089	0.164025	0.0549	ha
Minimum Interception Storage	71.5445	8.20125	2.745	**m^3**

TREATMENT STORAGE				
The Treatment Storage (Wet pond volume) needed for 15mm				
	Pavement	**Verge**	**Grass**	**Unit**
Equivalent Catchment Area	1.4309	0.1640	0.0549	ha
Minimum Treatment Storage m^3	214.6335	24.6038	8.2350	**m^3**

Q_{BAR} AND DISCHARGE RATES FOR PONDS/WETLANDS		
QBAR Details		
QBar Per Hectare	8.91	l/sec/ha
Actual Catchment Area	1.835	ha
QBar for Actual Catchment Area	16.3	l/s
QBAR factors for Flood Events		
Flood Event		Q For Catchment l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.		14.22
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.		15.53
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.		26.81
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.		32.05
Difference in Q30 - Q1		12.59
Difference in Q100 - Q30		5.23
Difference in QBar - Q1		2.13

LONG TERM STORAGE (Extra Volume Runoff)		
Based on a 1 in 100 year storm and a 6 hour event.		
Long Term Strorage Volume	316	m3

STORAGE REQUIRED FOR OPTION 1 AND 2 (as defined in appendix E of the Greater Dublin Strageic Drainage Study)				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	82		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	247		247	

2. River Regime Protection				
Criterion 2.1 & 2.2 "Attenuation Storage"				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
For Q 1 year	149		0	
For Q 30 year	470		0	
For Q 100 year	703		0	
Total m3	**1,322**		**-**	
Less Long term Storage	316		-	
Provide Attenuation Storage	1006		0	

3. Level of Service For the Site
N/A: Defined at detailed design phase

4. River Flood Protection				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	316		-	
Criterion 4.3 "Attenutaion & Long Term	-		149	This is Q1
			1,500	This is QBAR - Q1
Provide Storage Volume	1,322		1,649	
For Q 1 year	149		149	
Head Discharge Assumption	25%		25%	
	37		37	
Apply Head Discharge Assumption	1,359		1,686	
Design Pond for Volume (m^3)			1,686	
Nb. 1	Option 1 and 2 are as defined in the example calculation given in appendix E of the Greater Dublin Strategic Drainage			

Calculated Residence Time	
Total time to empty (hour's)	28:23

5.6 Outfall 5

Pond Storage & Treatment Calcs:			Outfall Number 05
Location	**SOIL**	**Soil Type**	**SAAR**
Knocknagroagh Td.	0.47	4	1182

Catchment Areas				
Element	**Pavement**	**Verge**	**Grass**	**Unit**
Catchment Areas	0.1232	0	0	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	0.11704	0	0	ha

INTERCEPTION STORAGE				
Calculate Runoff from 5mm of Rainfall on the Development Area				
	Pavement	**Verge**	**Grass**	**Unit**
Rainfall	5	5	5	mm
Equivalent Catchment Area	0.11704	0	0	ha
Minimum Interception Storage	5.852	0	0	**m^3**

TREATMENT STORAGE				
The Treatment Storage (Wet pond volume) needed for 15mm				
	Pavement	**Verge**	**Grass**	**Unit**
Equivalent Catchment Area	0.1170	0.0000	0.0000	ha
Minimum Treatment Storage m^3	17.5560	0.0000	0.0000	**m^3**

Q_{BAR} AND DISCHARGE RATES FOR PONDS/WETLANDS		
QBAR Details		
QBar Per Hectare	8.91	l/sec/ha
Actual Catchment Area	0.123	ha
QBar for Actual Catchment Area	1.1	l/s
QBAR factors for Flood Events		
Flood Event		Q For Catchment l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.		0.96
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.		1.04
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.		1.80
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.		2.15
Difference in Q30 - Q1		0.85
Difference in Q100 - Q30		0.35
Difference in QBar - Q1		0.14

LONG TERM STORAGE (Extra Volume Runoff)		
Based on a 1 in 100 year storm and a 6 hour event.		
Long Term Strorage Volume	22	m3

STORAGE REQUIRED FOR OPTION 1 AND 2 (as defined in appendix E of the Greater Dublin Strageic Drainage Study)				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	6		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	18		18	

2. River Regime Protection				
Criterion 2.1 & 2.2 "Attenuation Storage"				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
For Q 1 year	11		0	
For Q 30 year	34		0	
For Q 100 year	51		0	
Total m3	**95**		**-**	
Less Long term Storage	22		-	
Provide Attenuation Storage	74		0	

3. Level of Service For the Site
N/A: Defined at detailed design phase

4. River Flood Protection				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	22		-	
Criterion 4.3 "Attenutaion & Long Term	-		11	This is Q1
			108	This is QBAR - Q1
Provide Storage Volume	95		119	
For Q 1 year	11		11	
Head Discharge Assumption	25%		25%	
	3		3	
Apply Head Discharge Assumption	98		122	
Design Pond for Volume (m^3)			122	
Nb. 1	Option 1 and 2 are as defined in the example calculation given in appendix E of the Greater Dublin Strategic Drainage			

Calculated Residence Time	
Total time to empty (hour's)	30:31

5.7 Outfall 6

Pond Storage & Treatment Calcs:			Outfall Number 06
Location	**SOIL**	**Soil Type**	**SAAR**
Knocknagroagh Td.	0.47	4	1182

Catchment Areas				
Element	**Pavement**	**Verge**	**Grass**	**Unit**
Catchment Areas	1.3109	0.3174	0.3664	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	1.245355	0.23805	0.1832	ha

INTERCEPTION STORAGE				
Calculate Runoff from 5mm of Rainfall on the Development Area				
	Pavement	**Verge**	**Grass**	**Unit**
Rainfall	5	5	5	mm
Equivalent Catchment Area	1.245355	0.23805	0.1832	ha
Minimum Interception Storage	62.26775	11.9025	9.16	**m^3**

TREATMENT STORAGE				
The Treatment Storage (Wet pond volume) needed for 15mm				
	Pavement	**Verge**	**Grass**	**Unit**
Equivalent Catchment Area	1.2454	0.2381	0.1832	ha
Minimum Treatment Storage m^3	186.8033	35.7075	27.4800	**m^3**

Q_{BAR} AND DISCHARGE RATES FOR PONDS/WETLANDS		
QBAR Details		
QBar Per Hectare	8.91	l/sec/ha
Actual Catchment Area	1.995	ha
QBar for Actual Catchment Area	17.8	l/s
QBAR factors for Flood Events		
Flood Event		Q For Catchment l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.		15.46
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.		16.89
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.		29.15
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.		34.84
Difference in Q30 - Q1		13.69
Difference in Q100 - Q30		5.69
Difference in QBar - Q1		2.31

LONG TERM STORAGE (Extra Volume Runoff)		
Based on a 1 in 100 year storm and a 6 hour event.		
Long Term Strorage Volume	298	m3

STORAGE REQUIRED FOR OPTION 1 AND 2 (as defined in appendix E of the Greater Dublin Strageic Drainage Study)				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	83		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	250		250	

2. River Regime Protection				
Criterion 2.1 & 2.2 "Attenuation Storage"				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
For Q 1 year	143		0	
For Q 30 year	462		0	
For Q 100 year	696		0	
Total m3	**1,300**		**-**	
Less Long term Storage	298		-	
Provide Attenuation Storage	1002		0	

3. Level of Service For the Site
N/A: Defined at detailed design phase

4. River Flood Protection				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	298		-	
Criterion 4.3 "Attenutaion & Long Term	-		143	This is Q1
			1,480	This is QBAR - Q1
Provide Storage Volume	1,300		1,623	
For Q 1 year	143		143	
Head Discharge Assumption	25%		25%	
	36		36	
Apply Head Discharge Assumption	1,336		1,659	
Design Pond for Volume (m^3)			1,659	
Nb. 1	Option 1 and 2 are as defined in the example calculation given in appendix E of the Greater Dublin Strategic Drainage			

Calculated Residence Time	
Total time to empty (hour's)	25:41

5.8 Outfall 7

Pond Storage & Treatment Calcs:			Outfall Number 07
Location	**SOIL**	**Soil Type**	**SAAR**
Drumfin Td.	0.47	4	1182

Catchment Areas				
Element	**Pavement**	**Verge**	**Grass**	**Unit**
Catchment Areas	3.483	0.9302	2.1701	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	3.30885	0.69765	1.08505	ha

INTERCEPTION STORAGE				
Calculate Runoff from 5mm of Rainfall on the Development Area				
	Pavement	**Verge**	**Grass**	**Unit**
Rainfall	5	5	5	mm
Equivalent Catchment Area	3.30885	0.69765	1.08505	ha
Minimum Interception Storage	165.4425	34.8825	54.2525	**m^3**

TREATMENT STORAGE				
The Treatment Storage (Wet pond volume) needed for 15mm				
	Pavement	**Verge**	**Grass**	**Unit**
Equivalent Catchment Area	3.3089	0.6977	1.0851	ha
Minimum Treatment Storage m^3	496.3275	104.6475	162.7575	**m^3**

Q_{BAR} AND DISCHARGE RATES FOR PONDS/WETLANDS		
QBAR Details		
QBar Per Hectare	8.91	l/sec/ha
Actual Catchment Area	6.583	ha
QBar for Actual Catchment Area	58.7	l/s
QBAR factors for Flood Events		
Flood Event		Q For Catchment l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.		51.04
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.		55.73
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.		96.21
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.		114.99
Difference in Q30 - Q1		45.17
Difference in Q100 - Q30		18.77
Difference in QBar - Q1		7.63

LONG TERM STORAGE (Extra Volume Runoff)		
Based on a 1 in 100 year storm and a 6 hour event.		
Long Term Strorage Volume	829	m3

STORAGE REQUIRED FOR OPTION 1 AND 2 (as defined in appendix E of the Greater Dublin Strageic Drainage Study)				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	255		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	764		764	

2. River Regime Protection				
Criterion 2.1 & 2.2 "Attenuation Storage"				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
For Q 1 year	415		0	
For Q 30 year	1,359		0	
For Q 100 year	2,079		0	
Total m3	**3,852**		**-**	
Less Long term Storage	829		-	
Provide Attenuation Storage	3024		0	

3. Level of Service For the Site
N/A: Defined at detailed design phase

4. River Flood Protection				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	829		-	
Criterion 4.3 "Attenutaion & Long Term	-		415	This is Q1
			4,432	This is QBAR - Q1
Provide Storage Volume	3,852		4,847	
For Q 1 year	415		415	
Head Discharge Assumption	25%		25%	
	104		104	
Apply Head Discharge Assumption	3,956		4,951	
Design Pond for Volume (m^3)			4,951	
Nb. 1	Option 1 and 2 are as defined in the example calculation given in appendix E of the Greater Dublin Strategic Drainage			

Calculated Residence Time	
Total time to empty (hour's)	23:14

5.9 Outfall 8

Pond Storage & Treatment Calcs:			Outfall Number 08
Location	**SOIL**	**Soil Type**	**SAAR**
Drumfin Td.	0.47	4	1182

Catchment Areas				
Element	**Pavement**	**Verge**	**Grass**	**Unit**
Catchment Areas	2.5991	0.4788	1.0789	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	2.469145	0.3591	0.53945	ha

INTERCEPTION STORAGE				
Calculate Runoff from 5mm of Rainfall on the Development Area				
	Pavement	**Verge**	**Grass**	**Unit**
Rainfall	5	5	5	mm
Equivalent Catchment Area	2.469145	0.3591	0.53945	ha
Minimum Interception Storage	123.45725	17.955	26.9725	**m^3**

TREATMENT STORAGE				
The Treatment Storage (Wet pond volume) needed for 15mm				
	Pavement	**Verge**	**Grass**	**Unit**
Equivalent Catchment Area	2.4691	0.3591	0.5395	ha
Minimum Treatment Storage m^3	370.3718	53.8650	80.9175	**m^3**

Q_{BAR} AND DISCHARGE RATES FOR PONDS/WETLANDS		
QBAR Details		
QBar Per Hectare	8.91	l/sec/ha
Actual Catchment Area	4.157	ha
QBar for Actual Catchment Area	37.0	l/s
QBAR factors for Flood Events		
Flood Event		Q For Catchment l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.		32.23
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.		35.19
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.		60.75
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.		72.61
Difference in Q30 - Q1		28.52
Difference in Q100 - Q30		11.85
Difference in QBar - Q1		4.82

LONG TERM STORAGE (Extra Volume Runoff)		
Based on a 1 in 100 year storm and a 6 hour event.		
Long Term Strorage Volume	576	m3

STORAGE REQUIRED FOR OPTION 1 AND 2 (as defined in appendix E of the Greater Dublin Strageic Drainage Study)				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	168		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	505		505	

2. River Regime Protection				
Criterion 2.1 & 2.2 "Attenuation Storage"				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
For Q 1 year	281		0	
For Q 30 year	921		0	
For Q 100 year	1,394		0	
Total m3	**2,597**		**-**	
Less Long term Storage	576		-	
Provide Attenuation Storage	2020		0	

3. Level of Service For the Site
N/A: Defined at detailed design phase

4. River Flood Protection				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	576		-	
Criterion 4.3 "Attenutaion & Long Term	-		281	This is Q1
			2,964	This is QBAR - Q1
Provide Storage Volume	2,597		3,245	
For Q 1 year	281		281	
Head Discharge Assumption	25%		25%	
	70		70	
Apply Head Discharge Assumption	2,667		3,316	
Design Pond for Volume (m^3)			3,316	
Nb. 1	Option 1 and 2 are as defined in the example calculation given in appendix E of the Greater Dublin Strategic Drainage			

Calculated Residence Time	
Total time to empty (hour's)	24:39

5.10 Outfall 9

Pond Storage & Treatment Calcs:			Outfall Number 09
Location	**SOIL**	**Soil Type**	**SAAR**
Carrownagark Td.	0.47	4	1182

Catchment Areas				
Element	**Pavement**	**Verge**	**Grass**	**Unit**
Catchment Areas	1.2915	0.3712	0.0712	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	1.226925	0.2784	0.0356	ha

INTERCEPTION STORAGE				
Calculate Runoff from 5mm of Rainfall on the Development Area				
	Pavement	**Verge**	**Grass**	**Unit**
Rainfall	5	5	5	mm
Equivalent Catchment Area	1.226925	0.2784	0.0356	ha
Minimum Interception Storage	61.34625	13.92	1.78	**m^3**

TREATMENT STORAGE				
The Treatment Storage (Wet pond volume) needed for 15mm				
	Pavement	**Verge**	**Grass**	**Unit**
Equivalent Catchment Area	1.2269	0.2784	0.0356	ha
Minimum Treatment Storage m^3	184.0388	41.7600	5.3400	**m^3**

Q_{BAR} AND DISCHARGE RATES FOR PONDS/WETLANDS		
QBAR Details		
QBar Per Hectare	8.91	l/sec/ha
Actual Catchment Area	1.734	ha
QBar for Actual Catchment Area	15.5	l/s
QBAR factors for Flood Events		
Flood Event		Q For Catchment l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.		13.44
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.		14.68
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.		25.34
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.		30.29
Difference in Q30 - Q1		11.90
Difference in Q100 - Q30		4.94
Difference in QBar - Q1		2.01

LONG TERM STORAGE (Extra Volume Runoff)		
Based on a 1 in 100 year storm and a 6 hour event.		
Long Term Strorage Volume	296	m3

STORAGE REQUIRED FOR OPTION 1 AND 2 (as defined in appendix E of the Greater Dublin Strageic Drainage Study)				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	77		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	231		231	

2. River Regime Protection				
Criterion 2.1 & 2.2 "Attenuation Storage"				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
For Q 1 year	138		0	
For Q 30 year	437		0	
For Q 100 year	654		0	
Total m3	**1,230**		**-**	
Less Long term Storage	296		-	
Provide Attenuation Storage	934		0	

3. Level of Service For the Site
N/A: Defined at detailed design phase

4. River Flood Protection				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	296		-	
Criterion 4.3 "Attenutaion & Long Term	-		138	This is Q1
			1,396	This is QBAR - Q1
Provide Storage Volume	1,230		1,534	
For Q 1 year	138		138	
Head Discharge Assumption	25%		25%	
	35		35	
Apply Head Discharge Assumption	1,264		1,568	
Design Pond for Volume (m^3)			1,568	
Nb. 1	Option 1 and 2 are as defined in the example calculation given in appendix E of the Greater Dublin Strategic Drainage			

Calculated Residence Time	
Total time to empty (hour's)	27:56

5.11Outfall 10

Pond Storage & Treatment Calcs:			Outfall Number 10
Location	**SOIL**	**Soil Type**	**SAAR**
Carrownagark/Kingsbrook Td.	0.47	4	1182

Catchment Areas				
Element	**Pavement**	**Verge**	**Grass**	**Unit**
Catchment Areas	2.0334	0.5533	1.2127	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	1.93173	0.414975	0.60635	ha

INTERCEPTION STORAGE				
Calculate Runoff from 5mm of Rainfall on the Development Area				
	Pavement	**Verge**	**Grass**	**Unit**
Rainfall	5	5	5	mm
Equivalent Catchment Area	1.93173	0.414975	0.60635	ha
Minimum Interception Storage	96.5865	20.74875	30.3175	**m^3**

TREATMENT STORAGE				
The Treatment Storage (Wet pond volume) needed for 15mm				
	Pavement	**Verge**	**Grass**	**Unit**
Equivalent Catchment Area	1.9317	0.4150	0.6064	ha
Minimum Treatment Storage m^3	289.7595	62.2463	90.9525	**m^3**

Q_{BAR} AND DISCHARGE RATES FOR PONDS/WETLANDS		
QBAR Details		
QBar Per Hectare	8.91	l/sec/ha
Actual Catchment Area	3.799	ha
QBar for Actual Catchment Area	33.9	l/s
QBAR factors for Flood Events		
Flood Event		Q For Catchment l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.		29.46
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.		32.17
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.		55.53
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.		66.36
Difference in Q30 - Q1		26.07
Difference in Q100 - Q30		10.83
Difference in QBar - Q1		4.40

LONG TERM STORAGE (Extra Volume Runoff)		
Based on a 1 in 100 year storm and a 6 hour event.		
Long Term Strorage Volume	549	m3

STORAGE REQUIRED FOR OPTION 1 AND 2 (as defined in appendix E of the Greater Dublin Strageic Drainage Study)				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	148		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	443		443	

2. River Regime Protection				
Criterion 2.1 & 2.2 "Attenuation Storage"				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
For Q 1 year	241		0	
For Q 30 year	790		0	
For Q 100 year	1,207		0	
Total m3	**2,239**		**-**	
Less Long term Storage	549		-	
Provide Attenuation Storage	1690		0	

3. Level of Service For the Site
N/A: Defined at detailed design phase

4. River Flood Protection				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	549		-	
Criterion 4.3 "Attenutaion & Long Term	-		241	This is Q1
			2,574	This is QBAR - Q1
Provide Storage Volume	2,239		2,815	
For Q 1 year	241		241	
Head Discharge Assumption	25%		25%	
	60		60	
Apply Head Discharge Assumption	2,299		2,875	
Design Pond for Volume (m^3)			2,875	
Nb. 1	Option 1 and 2 are as defined in the example calculation given in appendix E of the Greater Dublin Strategic Drainage			

Calculated Residence Time	
Total time to empty (hour's)	23:23

5.12 Outfall 11

Pond Storage & Treatment Calcs:			Outfall Number 11
Location	**SOIL**	**Soil Type**	**SAAR**
Kingsbrook Td.	0.47	4	1182

Catchment Areas				
Element	**Pavement**	**Verge**	**Grass**	**Unit**
Catchment Areas	1.5546	0.3105	0	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	1.47687	0.232875	0	ha

INTERCEPTION STORAGE				
Calculate Runoff from 5mm of Rainfall on the Development Area				
	Pavement	**Verge**	**Grass**	**Unit**
Rainfall	5	5	5	mm
Equivalent Catchment Area	1.47687	0.232875	0	ha
Minimum Interception Storage	73.8435	11.64375	0	**m^3**

TREATMENT STORAGE				
The Treatment Storage (Wet pond volume) needed for 15mm				
	Pavement	**Verge**	**Grass**	**Unit**
Equivalent Catchment Area	1.4769	0.2329	0.0000	ha
Minimum Treatment Storage m^3	221.5305	34.9313	0.0000	**m^3**

QBAR AND DISCHARGE RATES FOR PONDS/WETLANDS		
QBAR Details		
QBar Per Hectare	8.91	l/sec/ha
Actual Catchment Area	1.865	ha
QBar for Actual Catchment Area	16.6	l/s
QBAR factors for Flood Events		
Flood Event		Q For Catchment l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.		14.46
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.		15.79
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.		27.26
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.		32.58
Difference in Q30 - Q1		12.80
Difference in Q100 - Q30		5.32
Difference in QBar - Q1		2.16

LONG TERM STORAGE (Extra Volume Runoff)		
Based on a 1 in 100 year storm and a 6 hour event.		
Long Term Strorage Volume	336	m3

STORAGE REQUIRED FOR OPTION 1 AND 2 (as defined in appendix E of the Greater Dublin Strageic Drainage Study)				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	85		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	256		256	

2. River Regime Protection				
Criterion 2.1 & 2.2 "Attenuation Storage"				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
For Q 1 year	156		0	
For Q 30 year	490		0	
For Q 100 year	732		0	
Total m3	**1,379**		**-**	
Less Long term Storage	336		-	
Provide Attenuation Storage	1043		0	

3. Level of Service For the Site
N/A: Defined at detailed design phase

4. River Flood Protection				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	336		-	
Criterion 4.3 "Attenutaion & Long Term	-		156	This is Q1
			1,563	This is QBAR - Q1
Provide Storage Volume	1,379		1,719	
For Q 1 year	156		156	
Head Discharge Assumption	25%		25%	
	39		39	
Apply Head Discharge Assumption	1,418		1,758	
Design Pond for Volume (m^3)			1,758	
Nb. 1	Option 1 and 2 are as defined in the example calculation given in appendix E of the Greater Dublin Strategic Drainage			

Calculated Residence Time	
Total time to empty (hour's)	29:7

5.13 Outfall 12

Pond Storage & Treatment Calcs:			Outfall Number 12
Location	**SOIL**	**Soil Type**	**SAAR**
Aghaleneane and Ardloy Td.	0.47	4	1182

Catchment Areas				
Element	**Pavement**	**Verge**	**Grass**	**Unit**
Catchment Areas	0.8186	0.1249	0.0623	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	0.77767	0.093675	0.03115	ha

INTERCEPTION STORAGE				
Calculate Runoff from 5mm of Rainfall on the Development Area				
	Pavement	**Verge**	**Grass**	**Unit**
Rainfall	5	5	5	mm
Equivalent Catchment Area	0.77767	0.093675	0.03115	ha
Minimum Interception Storage	38.8835	4.68375	1.5575	**m^3**

TREATMENT STORAGE				
The Treatment Storage (Wet pond volume) needed for 15mm				
	Pavement	**Verge**	**Grass**	**Unit**
Equivalent Catchment Area	0.7777	0.0937	0.0312	ha
Minimum Treatment Storage m^3	116.6505	14.0513	4.6725	**m^3**

Q_{BAR} AND DISCHARGE RATES FOR PONDS/WETLANDS		
QBAR Details		
QBar Per Hectare	8.91	l/sec/ha
Actual Catchment Area	1.006	ha
QBar for Actual Catchment Area	9.0	l/s
QBAR factors for Flood Events		
Flood Event		Q For Catchment l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.		7.80
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.		8.52
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.		14.70
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.		17.57
Difference in Q30 - Q1		6.90
Difference in Q100 - Q30		2.87
Difference in QBar - Q1		1.17

LONG TERM STORAGE (Extra Volume Runoff)		
Based on a 1 in 100 year storm and a 6 hour event.		
Long Term Strorage Volume	173	m3

STORAGE REQUIRED FOR OPTION 1 AND 2 (as defined in appendix E of the Greater Dublin Strageic Drainage Study)				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	45		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	135		135	

2. River Regime Protection				
Criterion 2.1 & 2.2 "Attenuation Storage"				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
For Q 1 year	81		0	
For Q 30 year	257		0	
For Q 100 year	384		0	
Total m3	**723**		**-**	
Less Long term Storage	173		-	
Provide Attenuation Storage	550		0	

3. Level of Service For the Site
N/A: Defined at detailed design phase

4. River Flood Protection				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	173		-	
Criterion 4.3 "Attenutaion & Long Term	-		81	This is Q1
			820	This is QBAR - Q1
Provide Storage Volume	723		901	
For Q 1 year	81		81	
Head Discharge Assumption	25%		25%	
	20		20	
Apply Head Discharge Assumption	743		922	
Design Pond for Volume (m^3)			922	
Nb. 1	Option 1 and 2 are as defined in the example calculation given in appendix E of the Greater Dublin Strategic Drainage			

Calculated Residence Time	
Total time to empty (hour's)	28:18

5.14 Outfall 13

Pond Storage & Treatment Calcs:			Outfall Number 13
Location	**SOIL**	**Soil Type**	**SAAR**
Springfield Td.	0.47	4	1182

Catchment Areas				
Element	**Pavement**	**Verge**	**Grass**	**Unit**
Catchment Areas	0.6261	0.1626	0	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	0.594795	0.12195	0	ha

INTERCEPTION STORAGE				
Calculate Runoff from 5mm of Rainfall on the Development Area				
	Pavement	**Verge**	**Grass**	**Unit**
Rainfall	5	5	5	mm
Equivalent Catchment Area	0.594795	0.12195	0	ha
Minimum Interception Storage	29.73975	6.0975	0	**m^3**

TREATMENT STORAGE				
The Treatment Storage (Wet pond volume) needed for 15mm				
	Pavement	**Verge**	**Grass**	**Unit**
Equivalent Catchment Area	0.5948	0.1220	0.0000	ha
Minimum Treatment Storage m^3	89.2193	18.2925	0.0000	**m^3**

Q_{BAR} AND DISCHARGE RATES FOR PONDS/WETLANDS		
QBAR Details		
QBar Per Hectare	8.91	l/sec/ha
Actual Catchment Area	0.789	ha
QBar for Actual Catchment Area	7.0	l/s
QBAR factors for Flood Events		
Flood Event		Q For Catchment l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.		6.11
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.		6.68
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.		11.53
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.		13.78
Difference in Q30 - Q1		5.41
Difference in Q100 - Q30		2.25
Difference in QBar - Q1		0.91

LONG TERM STORAGE (Extra Volume Runoff)		
Based on a 1 in 100 year storm and a 6 hour event.		
Long Term Strorage Volume	140	m3

STORAGE REQUIRED FOR OPTION 1 AND 2 (as defined in appendix E of the Greater Dublin Strageic Drainage Study)				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	36		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	108		108	

2. River Regime Protection				
Criterion 2.1 & 2.2 "Attenuation Storage"				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
For Q 1 year	65		0	
For Q 30 year	205		0	
For Q 100 year	306		0	
Total m3	**576**		**-**	
Less Long term Storage	140		-	
Provide Attenuation Storage	436		0	

3. Level of Service For the Site
N/A: Defined at detailed design phase

4. River Flood Protection				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	140		-	
Criterion 4.3 "Attenutaion & Long Term	-		65	This is Q1
			654	This is QBAR - Q1
Provide Storage Volume	576		719	
For Q 1 year	65		65	
Head Discharge Assumption	25%		25%	
	16		16	
Apply Head Discharge Assumption	593		735	
Design Pond for Volume (m^3)			735	
Nb. 1	Option 1 and 2 are as defined in the example calculation given in appendix E of the Greater Dublin Strategic Drainage			

Calculated Residence Time	
Total time to empty (hour's)	28:47

5.15 Outfall 14

Pond Storage & Treatment Calcs:			Outfall Number 14
Location	**SOIL**	**Soil Type**	**SAAR**
Sheerevagh Td.	0.47	4	1182

Catchment Areas				
Element	**Pavement**	**Verge**	**Grass**	**Unit**
Catchment Areas	4.0036	1.0323	2.7866	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	3.80342	0.774225	1.3933	ha

INTERCEPTION STORAGE				
Calculate Runoff from 5mm of Rainfall on the Development Area				
	Pavement	**Verge**	**Grass**	**Unit**
Rainfall	5	5	5	mm
Equivalent Catchment Area	3.80342	0.774225	1.3933	ha
Minimum Interception Storage	190.171	38.71125	69.665	**m^3**

TREATMENT STORAGE				
The Treatment Storage (Wet pond volume) needed for 15mm				
	Pavement	**Verge**	**Grass**	**Unit**
Equivalent Catchment Area	3.8034	0.7742	1.3933	ha
Minimum Treatment Storage m^3	570.5130	116.1338	208.9950	**m^3**

Q_{BAR} AND DISCHARGE RATES FOR PONDS/WETLANDS		
QBAR Details		
QBar Per Hectare	8.91	l/sec/ha
Actual Catchment Area	7.823	ha
QBar for Actual Catchment Area	69.7	l/s
QBAR factors for Flood Events		
Flood Event		Q For Catchment l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.		60.65
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.		66.22
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.		114.33
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.		136.63
Difference in Q30 - Q1		53.68
Difference in Q100 - Q30		22.31
Difference in QBar - Q1		9.06

LONG TERM STORAGE (Extra Volume Runoff)		
Based on a 1 in 100 year storm and a 6 hour event.		
Long Term Strorage Volume	953	m3

STORAGE REQUIRED FOR OPTION 1 AND 2 (as defined in appendix E of the Greater Dublin Strageic Drainage Study)				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	299		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	896		896	

2. River Regime Protection				
Criterion 2.1 & 2.2 "Attenuation Storage"				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
For Q 1 year	484		0	
For Q 30 year	1,581		0	
For Q 100 year	2,428		0	
Total m3	**4,493**		**-**	
Less Long term Storage	953		-	
Provide Attenuation Storage	3540		0	

3. Level of Service For the Site
N/A: Defined at detailed design phase

4. River Flood Protection				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	953		-	
Criterion 4.3 "Attenutaion & Long Term	-		484	This is Q1
			5,180	This is QBAR - Q1
Provide Storage Volume	4,493		5,664	
For Q 1 year	484		484	
Head Discharge Assumption	25%		25%	
	121		121	
Apply Head Discharge Assumption	4,614		5,785	
Design Pond for Volume (m^3)			5,785	
Nb. 1	Option 1 and 2 are as defined in the example calculation given in appendix E of the Greater Dublin Strategic Drainage			

Calculated Residence Time	
Total time to empty (hour's)	22:51

5.16 Outfall 15

Pond Storage & Treatment Calcs:			Outfall Number 15
Location	**SOIL**	**Soil Type**	**SAAR**
Cloghogue Upper Td.	0.47	4	1182

Catchment Areas				
Element	**Pavement**	**Verge**	**Grass**	**Unit**
Catchment Areas	2.7213	0.3594	1.7766	ha
Runoff coefficient	95	75	50	%
Equivalent Catchment Area	2.585235	0.26955	0.8883	ha

INTERCEPTION STORAGE				
Calculate Runoff from 5mm of Rainfall on the Development Area				
	Pavement	**Verge**	**Grass**	**Unit**
Rainfall	5	5	5	mm
Equivalent Catchment Area	2.585235	0.26955	0.8883	ha
Minimum Interception Storage	129.26175	13.4775	44.415	**m^3**

TREATMENT STORAGE				
The Treatment Storage (Wet pond volume) needed for 15mm				
	Pavement	**Verge**	**Grass**	**Unit**
Equivalent Catchment Area	2.5852	0.2696	0.8883	ha
Minimum Treatment Storage m^3	387.7853	40.4325	133.2450	**m^3**

QBAR AND DISCHARGE RATES FOR PONDS/WETLANDS		
QBAR Details		
QBar Per Hectare	8.91	l/sec/ha
Actual Catchment Area	4.857	ha
QBar for Actual Catchment Area	43.3	l/s
QBAR factors for Flood Events		
Flood Event		Q For Catchment l/s
Q 1 year (1 year throttle); FSR Growth curve factor is 0.87.		37.66
Q 2 year (2 year throttle); FSR Growth curve factor is 0.95.		41.12
Q 30 year (30 year throttle); FSR Growth curve factor is 1.64.		70.99
Q 100 year (100 year throttle); FSR Growth curve factor is 1.96.		84.84
Difference in Q30 - Q1		33.33
Difference in Q100 - Q30		13.85
Difference in QBar - Q1		5.63

LONG TERM STORAGE (Extra Volume Runoff)		
Based on a 1 in 100 year storm and a 6 hour event.		
Long Term Strorage Volume	595	m3

STORAGE REQUIRED FOR OPTION 1 AND 2 (as defined in appendix E of the Greater Dublin Strageic Drainage Study)				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
1. River Water Quality Protection				
	m3	Notes	m3	Notes
Criterion 1.1 "Interception Storage"	187		0	
Criterion 1.2 "Treatment Storage" - Permanent Wet Pond	561		561	

2. River Regime Protection				
Criterion 2.1 & 2.2 "Attenuation Storage"				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
For Q 1 year	305		0	
For Q 30 year	997		0	
For Q 100 year	1,526		0	
Total m3	**2,828**		**-**	
Less Long term Storage	595		-	
Provide Attenuation Storage	2233		0	

3. Level of Service For the Site
N/A: Defined at detailed design phase

4. River Flood Protection				
Criterion	**Option 1 (See Nb. 1)**		**Option 2 (See Nb. 1)**	
	m3	Notes	m3	Notes
Criterion 4.1 "Long Term Storage"	595		-	
Criterion 4.3 "Attenutaion & Long Term	-		305	This is Q1
			3,255	This is QBAR - Q1
Provide Storage Volume	2,828		3,560	
For Q 1 year	305		305	
Head Discharge Assumption	25%		25%	
	76		76	
Apply Head Discharge Assumption	2,904		3,636	
Design Pond for Volume (m^3)			3,636	
Nb. 1	Option 1 and 2 are as defined in the example calculation given in appendix E of the Greater Dublin Strategic Drainage			

Calculated Residence Time	
Total time to empty (hour's)	23:8

6 Culvert Sizes: Main Watercourses

6.1 Culvert Sizes

The Following is an overview of the main watercourse crossings on the *Proposed Road Development* and their associated sizes with the exception of the river crossings which are described in Chapter 4 of Volume 2. The following design principles apply to each crossing point:

- Bridge's or culverts are capable of passing a fluvial flood flow with a 1 % Annual Exceedance Probability or 1 in 100 year flow without significantly changing the hydraulic characteristics of the watercourse;
- Structures are capable of operating under the above design conditions while maintaining a freeboard of at least 300 mm;
- Where the land potentially affected does not include dwellings and infrastructure, culverts are capable of operating under the above design conditions while causing a hydraulic loss of no more than 300 mm (excluding the culvert gradient);
- Where the land potentially affected includes dwellings and infrastructure, it is demonstrated that those dwellings and/or infrastructure are not adversely affected by constructing the bridge or culvert;
- Culvert diameters, or height and width are not less than 900mm to facilitate maintenance access and reduce the likelihood of debris blockage.

Table 6-1: Main Watercourse Crossings

Location (approx.)	ID	Structure Type	Maximum Design Characteristics		Comments
			Width	Height	
Ch. 500m	Open Drain	Circular Culvert	1.05m dia.		N/A
Ch. 900m	Open Drain	Circular Culvert	1.8m dia.		N/A
Ch. 1,100m	Markree Demesne Stream	Box Culvert (2no. broken sections)	3m	2.0m	The culvert will be broken between the interface of the proposed N4 and the proposed Eastern Parallel Link. This will be in the form of a plan opening of 4.5m long x 3.5m wide. The invert will be depressed by 0.5m for fish passage.
Ch. 3,550m	Open Drain to Turnalaydan Stream	Box Culvert	1.22m	1.830m	N/A
Ch. 3,700m	Open Drain to Turnalaydan Stream	Box Culvert	1.22m	1.520m	N/A
Ch. 5,300m	Open Drain to Lough Corran	Box Culvert	2.13m	2.13m	N/A
Ch. 5,620m	Open Drain to Turnalaydan Stream (u/s of Lough Corran	Box Culvert	1.52m	1.83m	N/A

Location (approx.)	ID	Structure Type	Maximum Design Characteristics		Comments
			Width	Height	
Ch. 6,590m	Open Drain to Turnalaydan Stream (u/s of Lough Corran	Circular Culvert	1.35m dia.		N/A
Ch. 8,620m	Open Drain to Aghalenane Lough Outflow	Circular Culvert	0.9m dia.		N/A
Ch. 8,640m	Open Drain to Aghalenane Lough Outflow	Circular	1.2m dia.		N/A
Ch. 9,400m	Open Drain to Aghalenane Lough Outflow	Box Culvert	1.52m	1.52m	N/A
Ch. 9,650m	Open Drain to Aghalenane Lough	Box Culvert	1.05m dia.		N/A
Ch. 10,180m	Open Drain to Ardloy Lough	Box Culvert	1.52m	1.83m	N/A
Ch. 10,710m	Springfield Stream	Box Culvert	2.44m	2.13m	The invert will be depressed by 0.5m for fish passage.
	Springfield Stream	Box Culvert	2.74m	2.13m	The invert will be depressed by 0.5m for fish passage.
Ch. 10,850m	Open Drain to Springfield Stream	Circular Culvert	1.52m	1.52m	N/A
Ch. 11,320m	Open Drain to Springfield Stream	Circular Culvert	1.5m dia.		N/A
Ch. 12,250m	Lissycoyne Stream	Box Culvert	2.44m	1.830m	The invert will be depressed by 0.5m for fish passage.
Ch. 13,910m	Open Drain to Drumderry Stream	Box Culvert	1.83m	1.52m	The invert will be depressed by 0.5m for fish passage.
Ch. 14,230m	Tributary of Drumderry Stream	Bottomless Arch.	2.13m	2.13m	The invert will be depressed by 0.5m for fish passage.