ANGLO AMERICAN LISHEEN MINING LTD.

Attachment No. I.2

Investigation of the Impact of an Additional Discharge to the Rossestown River and a Redistribution of Discharge to the Drish River from the Lisheen Mine, Killoran, Co. Tipperary as part of an IPPC Licence Application

November 2007

PROJECT NO. : 1560701

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ATTACHMENT NO. I.2

ASSESSMENT OF IMPACT OF ADDITIONAL DISCHARGE TO THE ROSSESTOWN RIVER AND A REDISTRIBUTION OF DISCHARGE TO THE DRISH RIVER FROM THE LISHEEN MINE, KILLORAN, CO. TIPPERARY AS PART OF AN IPPC LICENCE APPLICATION

1.0 Background

1.1 O'Neill Ground Water Engineering Ltd. (OGE) were engaged by Anglo American Lisheen Mining Ltd. to assess the potential impact of additional discharge to the Rossestown River during heavy rainfall events and to investigate the impact of the redistribution of discharge to the Drish River from the Lisheen Mine.

1.2 The two existing emission points PWE1 and PWE2, into the Drish and Rossestown River respectively, are regulated by the Environmental Protection Agency (EPA) under the Integrated Pollution Prevention Control (IPPC) licence (P0088-02).

1.3 Under the existing licence the Lisheen Mine is permitted to discharge 100ML/day from PWE1. The emission volume limit to the Rossestown River from PWE2 is 20Ml/day. This gives a total of 120Ml/day.

1.4 Although the licenced discharge volume to the Drish River has not been exceeded, engineering works at PWE1 will be required to enable the licenced volume of the water to be discharged from the single existing emission point.

1.5 Anglo American Lisheen Mining Ltd. have been in correspondence with the Environmental Protection Agency (EPA) with regard to the continued necessary use of an emergency weir to the Rossestown River during extended periods of heavy rainfall in order to prevent flooding of the mine and the Tailings Management Facility (TMF).

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2.0 Investigation Objectives

2.1 Anglo American Lisheen Mining Ltd. are seeking to regularise the current off-site discharge issue by submitting an application for a second IPPC licence for two additional emission points to the Drish and Rossestown Rivers.

2.1.1 SW1 – Drish River

2.1.1.1 It is proposed to re-distribute the existing permitted volume of 100Ml/day under IPPC licence number P0088-02 IS such that 80Ml/day is discharged from PWE1 and 20Ml/day is discharge from SW1 via a downstream tributary of the River Drish.

2.1.1.2 The total permitted discharge from the Lisheen Mine to the Drish River would remain at 100Ml/day.

2.1.2 SW2 – Rossestown River

2.1.2.1 In addition to the existing licenced volume of 20Ml/day from PWE2, it is proposed that a second discharge point SW2 is regulated under a revised IPPC licence such that a maximum of 20Ml/day can be discharged in emergency situations via a weir and channel to the Rossestown River downstream of the existing discharge point. Provided that permission for SW2 is granted, the need to use SW2 will be remote.

2.1.2.2 The total permitted discharge from the Lisheen Mine to the Rossestown River would be 40Ml/day, to account for the possibility of discharging via the weir in case of emergency.

2.2 This would give a total permitted off-site discharge of 140Ml/day.

3.0 Approach/Scope of Work

3.1 OGE have carried out numerous hydrological studies on both the Drish and Rossestown Rivers on behalf of the Lisheen Mine. An initial review of all available data on both rivers was conducted.

3.2 A desk study was carried out in order to obtain up-to-date hydrological data concerning the Drish and Rossestown Rivers from the on-going quality and quantity database in Lisheen Mine as well as from third party sources.

3.3 The field work carried out supplemented the desk study by providing more recent field data regarding quality and flow measurements of the Drish and Rossestown. A survey of the Drish tributary (Claugheen River) and the emergency discharge channel to the Rossestown River was conducted to provide information concerning the carrying capacities of these channels.

4.0 Primary Data Sources

- OGE Reports
  - Hydrology and Flood Studies Review of the Drish and Rossestown River, The Lisheen Mine, Co. Tipperary, Project No. 099901/1, December 1999.
  - Hydrological Review of Rossestown River, The Lisheen Mine, Co. Tipperary, Project No. 780101, October 2001
  - Hydrological and Hydrogeological Investigation of Rossestown River, The Lisheen Mine, Project No. 780101/1, March 2002
- Hydrogeology, Hydrology and Mine Dewatering, SRK Ltd. Minorco Lisheen Ltd., 1995, Dublin.
- Office of Public Works (OPW) historical flow data (www.opw.ie).
- Environmental Protection Agency (EPA) publications and website data (www.epa.ie).

- Flood Studies Report, National Environmental Research Council, 1975.

- Flood Estimation following the Flood Studies Report, Cunnane and Lynn, M.A., 1976, IEI, Dublin.

Drish River

5.0 Regional Hydrology and Flow Data

5.1 The Drish River rises in the Slieveardagh Hills approximately 14km south east of Lisheen Mine. It is a tributary of the River Suir and it meanders through low-lying raised bog and agricultural land to its confluence with the River Suir, approximately 1.5km south east of Thurles, Co. Tipperary. At its confluence with the River Suir, the Drish River drains a large catchment area of 210km^2. The Drish River catchment area to the existing licenced discharge point (PWE1) is 54.4km^2. The catchment area to the Drish River at the point of mixing point (referred to as SW1M in this report) between the proposed additional discharge point and the Drish River is 57.9km^2 (*Figure No I.2.1*).

5.2 The flow in the Drish River is gauged by the OPW downstream at Athlummon by an active permanent automatic recorder, approximately 6km south-west of the existing discharge point (*Figure No. I.21*). A summary of the gauging station details are presented in *Table No. I.21* below:

Table No. I.2.1: Historic Flow Data Recorded at Athlummon Gauging Station on the Drish River

Station Number	Location	River	Easting	Northing	Catchment Area (km^2)	Long Term Average Rainfall mm/annum	Start of records	DWF (m^3/s)	95 percentile (m^3/s)
16001	ATHLUMMON	Drish	217654	159410	140	946	JAN 1947	0.08	0.14

5.3 It must be noted that the long term average rainfall used was taken from a Met Eireann Isohyetal Rainfall map for the period 1941-1970. The long term average rainfall generally applied to Lisheen is an average of the rainfall data from Kilkenny and Birr synoptic stations (816mm).

5.4 There is no monitoring data available from the OPW or the EPA regarding the flow regime of the Drish River between the existing discharge point and Athlummon gauging station.

OPW Historical Annual Flow Data

5.5 Information regarding the annual maximum flow data in the River Drish at the gauging station at Athlummon available from the OPW website (www.opw.ie) is presented in *Appendix No. I.21*. The data presents the maximum recorded discharge at the gauging station between 1974 and 2006. The flow statistics are presented in *Table No. I.2.2* below.

Table No. I.2.2: Flow Statistics regarding Historical Maximum Flows at the Athlummon Gauging Station (1974-2004)

Station Number	Location	Average Recorded Flood Flow (m^3/s)	Minimum Recorded Flood Flow (m^3/s)	Maximum Recorded Flood Flow (m^3/s)
16001	ATHLUMMON	15.6	10.0	24.0

Note: flows greater than $17m^3/s$ were derived by extrapolation of the rating curve

5.6 By extrapolation of the above data, the flood flow statistics during the same period for the catchment to the proposed discharge point can be estimated in *Table No. I.2.3* below. This extrapolation is based on relative catchment areas as well as similarity of catchment characteristic such as aquifer and subsoil types.

Table No. I.2.3: Estimates of Flood Flow Statistics at PWE1 andSW1M based on Correlation with Historical Maximum Flows at the Athlummon Gauging Station (1974-2004)

Location	Average Recorded Flood Flow (m^3/s)	Minimum Recorded Flood Flow (m^3/s)	Maximum Recorded Flood Flow (m^3/s)
PWE1	6.1	3.9	9.3
SW1M	6.5	4.1	9.9

5.7 Examination of the annual maximum water level data in *Appendix No. I.2.1* between 1974 and 2006 indicates that the annual maximum water level recorded at Athlummon has been influenced by the commencement of licenced discharge of water into the Drish River at PWE1 in 1998.

Determination of Q_{mean} (Annual Maximum Flood)

5.8 As part of the original IPPC licence application for the discharge from Lisheen Mine to the Drish River, a comprehensive report concerning the hydrology and flood characteristics of the Drish River between the Lisheen discharge point and the OPW flow gauging station at Athlummon was submitted to the EPA (*OGE Report, December 1999*). This report served to provide updated information regarding the impact of the discharge on the River Drish and was based on the original SRK report (1995).

5.9 The flood probabilities for specific sites between the existing discharge point (PWE1) and Athlummon gauging station (*Figure No. I.2.1*) were estimated using the methodology presented in the Flood Studies Report (FSR) and was based on the application of growth factors to the estimated mean annual flood, based on catchment characteristics.

5.10 *The mean annual flood is an average flow*. The annual maximum flood is larger than the mean flow, and statistically it exceeds the one-year flood by approximately 15 percent. This flow is used as a basis for determining larger flows of greater return period.

The equation is:

$$\mathbf{Q\ Mean = 0.00042A^{0.95}F_s^{0.22}G^{1.18}R^{1.05}w^{-0.93}s^{0.19}}$$

Where:

A = catchment area (km^2)

F_s = channel network

G = winter rainfall acceptance potential

R = average annual rainfall (mm)

w = storage index

s = slope of main channel (m/km)

5.11 For the Athlummon station on the River Drish the above formula was reduced to formula below and the mean annual flood for the region could be determined from this equation.

$$\mathbf{Q_{mean} = 0.121A^{0.95}}$$

5.12 The flood peaks for various return periods were calculated using the FSR methodology and were presented in Table 4.1 of the same report (1999). This information is reproduced in *Table No. I.2.4* below and includes the estimated $\mathbf{Q_{mean}}$ and flow volumes for various return periods for the proposed discharge point.

Table No. I.2.4: Flood Peaks for Various Return Periods and Sites on the Drish River

Site	Catchment Area (km^2)	Qmean (m^3/s)	Flood Peak (m^3/s) Return Period (Years)						
			2	5	10	20	50	100	200
Athlummon	140	13.4	12.7	16.1	18.4	21.4	23.7	26.3	28.7
Ballyduff	79	7.8	7.4	9.4	10.7	12.5	13.8	15.3	16.7
Boolabeha	76	7.5	7.2	9.0	10.3	12.0	13.1	14.8	16.1
SW1M	62.5	6.3	6.0	7.5	8.6	10.0	11.1	12.3	13.4
Castletown West	62	6.2	5.9	7.4	8.5	9.9	11.0	12.2	13.3
Castletown East	58	5.8	5.5	7.0	8.0	9.3	10.3	11.4	12.5
PWE1	54.4	5.5	5.2	6.6	7.5	8.8	9.7	10.7	11.7

Bankful Capacity of Channel: Castletown Bridge – Athlummon Gauging Station

5.13 The flood line for various return periods at each of the bridges downstream of the discharge point had been calculated in Appendix E of the original SRK report (1996). These are reproduced in *Appendix No. I.2.2* of this report. The effects of the increased discharge from the mine was calculated by increasing the flood peaks by these amounts and then estimating the increase in depth of water using the Discharge-Water Level curves for each site.

5.14 The predictions of discharging clean mine water on the Drish were summarised in Table 5.1 of the December 1999 report and are reproduced below in *Table No. I.2.5*.

Table No. I.2.5: Summary of Flood Line Predictions for Drish River

Site	**Return Period**	**Mine Discharge (m^3/s)**	**Mine Discharge (Ml/day)**	**Water Level (m OD)**	**Maximum Overflow Height (m OD)**	**Increase due to pumping (m)**
PWE1	1:2	1.5	129.6	119.000	-	0.100
	1:100	1.5	129.6	119.281		0.067
Castletown (East) Bridge	1:2	1.5	129.6	118.784	120.68	0.103
	1:100	1.5	129.6	119.095		0.069
Castletown West Bridge (SW8)	1:2	1.5	129.6	117.547	120.50	0.115
	1:100	1.5	129.6	117.938		0.086
Ballyduff Bridge	1:2	1.5	129.6	98.400	99.828	0.078
	1:100	1.5	129.6	98.733		0.066

5.15 The results indicated that an additional volume of mine water (129.9Ml/day) would have a negligible effect on water levels in the river during large flood events. Water levels at the four sites would increase by 0.066 to 0.086m due to the discharge of 129.6Ml/day to the river during a 1:100 year storm event. An increment of 0.078 to 0.115m would occur during a 1:2 year storm event.

5.16 At present, the Lisheen Mine is licenced to discharge 100Ml/day from the existing discharge point PWE1. It is not proposed to increase the already licenced volume of water but to segregate the discharge between two discharge points.

5.17 The existing discharge has not resulted in exacerbated flooding downstream of the discharge point. Therefore, the segregation of the discharge between PWE1 and SW1 will not impact on the water levels beyond the existing impact.

Lisheen Mine Water Level Monitoring Data on Drish River

5.18 A monitoring station has been set up by the Lisheen Mine at each three bridges downstream of the existing discharge point at which the water height (stage) is recorded twice daily. The hydrographs presenting the average monthly stage level data and monthly rainfall data for 2005 and 2006 are presented graphically in *Figure No. I.2.2*.

5.19 The water level loggers have been set up so that they record the water level relative to an arbitrary datum. Although the water levels cannot be compared to water levels presented in Ordnance Datum, observations regarding the relative change in water level over time can be made.

5.20 These hydrographs illustrate the dampening effect that the increased volume of water in the channel has on the effect of rainfall on the Drish River. The stage at the Castletown East and Castletown West bridges is more marked than at the two gauging stations downstream. However, this may also be a function of the proximity of these bridges to the existing discharge point PWE1, the discharge from which would also increase with increased rainfall.

Instantaneous Measurement of Drish River

5.21 OGE personnel measured the discharge in the Drish River at four sections downstream of the existing discharge point on 24th October 2007. The discharge was calculated using the Mean Section Method. Stage (m) and velocity measurements were recorded at intervals along the river cross section immediately downstream of the bridges. The velocity was recorded using a Global Water FP101 impellor style flow meter. This flow meter calculates the average velocity of the column of water which is being monitored. A summary of the instantaneous discharges recorded is presented in *Table No. I.2.6* below.

Table No. I.2.6: Instantaneous Discharge Measurements Recorded on 24th October 2007

Location	Discharge	
	m^3/s	l/s
Castletown Bridge West	0.96	960
Boolabeha Bridge	1.11	1110
Athlummon	1.39	1390

5.22 The instantaneous discharge measurement on 24th October 2007 at Athlummon was ten times greater than the 95%ile flow shown in *Table No. I.2.1*. As expected, the further downstream the discharge measurement was taken, the greater the discharge that was recorded.

6.0 Main Polluting Substances to Drish River and Associated Mitigation Measures

6.1 The main polluting substances from the mining activities, as defined in the Schedule of S.I. 394 of 2004 and based on the emission limits set out in the existing IPPC licence (P0088-02)

6.1.1 Metals and their compounds

- Aluminium – 0.2mg/l emission limit
- Lead – 0.05mg/l
- Zinc – 0.45mg/l
- Mercury – 0.001mg/l

6.1.2 Materials in suspension

- Suspended Solids – 25mg/l emission limit

6.1.3 Substances which contribute to eutrophication

- Nitrate – 50mg/l

6.1.4 Substances which have an unfavourable influence on the oxygen balance (and can be measured using parameters such as BOD, COD, etc.)

- BOD – 5mg/l
- COD – 40mg/l

6.1.5 Additional substances

- Total P – 0.14mg/l
- Sulphate (as SO_4) – 500mg/l for discharge; 400mg/l downstream (tacit agreement with EPA).
- Ammonium (as NH_4) – 1mg/l

6.2 The following mitigation measures are proposed and/or already being carried out on site:

6.2.1 Sulphate – submissions have been made by Lisheen Mine to the EPA regarding the application of an environmental quality standard for sulphate at the site.

6.2.2 Ammonium – various treatment options have been tested and work is ongoing. Chemical substitution in the concentrator (ammoniacal compound) as well as reduced water make in the Bogzone orebodies, are expected to bring the site into compliance in approximately 18 months. In addition, the promotion of passive nitrification in either the treatment plants or the conditioning ponds will assist with this proposed timeframe and future compliance.

6.3 The existing impacts of these main polluting substances on the Drish River are discussed in Section 7.0 below.

7.0 Drish River Surface Water Chemistry and Quality Data

EPA Data

7.1 Chemical and biological water quality assessments have been conducted on the Drish River by the Environmental Protection Agency as part of the National Water Quality Monitoring Programme. Although the Drish River is not classified as salmonid, the River Suir is salmonid and therefore any potential discharges into the Drish River will need to meet stringent standards.

7.2 The Drish River is monitored by the EPA at two points downstream of the existing discharge point PWE1, at Castletown Bridge and Boolabeha Bridge (*Figure No. I.2.1*). Details of the biological and chemical data for these EPA monitoring stations are presented in *Appendix No. I.2.3*.

7.3 During the monitoring period from 1988 to 1999, the biological water quality at the Castletown Bridge monitoring station deteriorated from an unpolluted status (Q4) in 1988 to seriously polluted (Q2) in 1999. This was only one year after the commencement of discharge from the Lisheen Mine. The biological quality has improved slightly since 1999 and the biological quality of the water in 2005 was described as moderately polluted (Q3).

7.4 Similarly, the water quality at the Boolabeha monitoring station has steadily declined during the monitoring period from an unpolluted status (Q4-5) in 1976 to moderately polluted in (Q3) in 2005.

7.5 The chemical data from the two downstream monitoring stations indicate that from the period of 1998 to 2000 and 2001 to 2003, there were water quality issues at both sites. The EPA has attributed the deterioration in water quality at the Castletown Bridge monitoring station to the mining activities at the Lisheen Mine due to the proximity of the monitoring station to PWE1. The mine is working with the EPA to better understand the cause of the drop in Q rating at Castletown and will implement corrective actions as required for any impact that the Lisheen discharge has on this section.

Lisheen Monitoring Data

7.6 As part of the existing IPPC licence application (P0088-02) for PWE1, the Environmental Laboratory in the Lisheen Mine monitor the discharge to the Drish River as well as the chemistry upstream and downstream of the existing licenced discharge point.

7.7 The quarterly chemistry data from October 2006 to October 2007 from the monitoring points upstream (10m upstream) and at the three bridges downstream of the discharge point are presented in *Appendix No. I.2.4.* The parameters results were compared with the following standards:

- Existing Lisheen Mine IPPC licence (P0088-02) emission limits for off-site discharge
- Freshwater Fish Directive I/PV value (78/659/EC)
- Salmonid Water Regulations I/PV value (1998)

7.8 The quarterly monitoring results will be discussed in more detail in Section 8.0 of this report.

OGE Sampling

7.9 On 18th October 2007, OGE took samples of water from the River Drish upstream of the discharge point, of the discharge water and 336m downstream of the discharge point at Castletown Bridge.

7.10 The samples were sent to Eurofins Analytico and Bord na Mona laboratories on the morning of sampling for analysis. The samples were taken using an extended grab sampler. The samples were analysed for the parameters required as per Table I.2 of the IPPC application form as well as additional parameters.

7.11 The unstable hydrochemical parameters were measured in the field using the YSI 556 multi probe system, the results of which are presented in *Table No. I.2.7* below:

Table No. I.2.7: Unstable Hydrochemical Parameters Recorded at Drish River Sampling Locations on 18th October 2007

Sample ID	Location	Time	pH	Temperature °C	Dissolved Oxygen (%)	Dissolved Oxygen (mg/l)	Conductivity (µS/cm)
ZUSDRIS	Upstream	09:58	6.5	9.9	26.9	3.0	675
DISDRIS	Discharge Point	09:51	6.0	12.9	68.6	7.2	897
QDSDRIS	Downstream	09:38	6.6	12.6	62.6	6.6	873

7.12 The certificates of analysis for the samples are presented in *Appendix No. I.2.5.* A comparison of the sample results with the standards listed in paragraph 6.7 is presented in *Appendix No. I.2.6.*

7.13 When compared with the emission limits in the IPPC licence, the parameters that exceeded these limits for the discharge and downstream samples, were Ammonium, and Lead.

7.14 All samples exceeded the nitrite limit set out in the Freshwater Fish Directive (78/659/EC) of ≤0.03 and the Salmonid Water Regulations (1998) limit of ≤0.03.

8.0 Mixing of Discharge and Drish River Water

8.1 Chemistry

8.1.1 The mixing of waters of differing chemistry has the potential to alter the downstream hydrochemistry and consequently impact on downstream river hydro-ecology.

8.1.2 The results of the samples taken by OGE on 18th October 2007 were entered into proprietary software Aquachem v4.0, which used the data to create a Piper Plot presented as *Figure No. I.2.3.* The Piper plot shows that the major ion chemistry of the upstream and downstream section of the existing discharge point PWE1 is dissimilar. Upstream of PEW1, the water type is calcium magnesium bicarbonate (Ca-Mg-HCO_3). Both the discharge and at the downstream discharge point, the water is calcium magnesium bicarbonate sulphate water (Ca-Mg-HCO_3-SO_4). The influence of the sulphate is a directly result of the mining activities.

8.1.3 OGE utilised the Aquachem 4.0 to determine the potential downstream impact of redistributing the existing licenced discharge in a 1:4 ratio between the proposed

additional downstream discharge point (SW1) and the existing discharge point (PWE1), The model calculates the resulting concentration by mixing the different solutions according to the equation below (Aquachem v.4.0, 2003):

$$C_Z = \frac{\sum_{x,y} Q_x C_x + Q_y C_y}{\sum_{x,y} Q_x + Q_y}$$

Where C_z = Resultant concentration in stream (mg/l)
Q_x = Discharge rate of effluent (l/s)
C_x = Concentration of parameter in effluent (mg/l)
Q_y = Discharge rate of stream (l/s)
C_y = Concentration of parameter in stream (mg/l)

8.1.4 *Appendix No. I.2.7* demonstrates that during annual maximum flooding and in an 1 in 100 year storm event, the addition of an additional 20Ml/day downstream at the proposed SW1 discharge point will be similar in water type and chemistry to the samples taken downstream of the discharge point and of the discharge itself. The redistribution of the licenced discharge will not impact negatively on the existing major ion chemistry of the River Drish.

8.1.5 The quarterly analysis results for samples upstream of the existing discharge point and at three downstream locations are presented in *Appendix No. I.2.4*. The distances downstream of these monitoring points and the SW1M from the existing discharge point is displayed in *Table No. I.2.8*.

Table No. I.2.8: Distances from PWE1 to Downstream Monitoring Points

Downstream Location	**Castletown Bridge East**	**Castletown Bridge West**	**SW1M**	**Boolabeha Bridge**
Distance from PWE1 (m)	336	1698	2240	5056

8.1.6 The IPPC limits for sulphate of 500mg/l and 400mg/l in the discharge and downstream of the discharge point, respectively, were received by tacit agreement with the EPA. There was no evidence of reduction in sulphate concentration downstream of the PWE1. However, all samples were below these IPPC licence limit s.

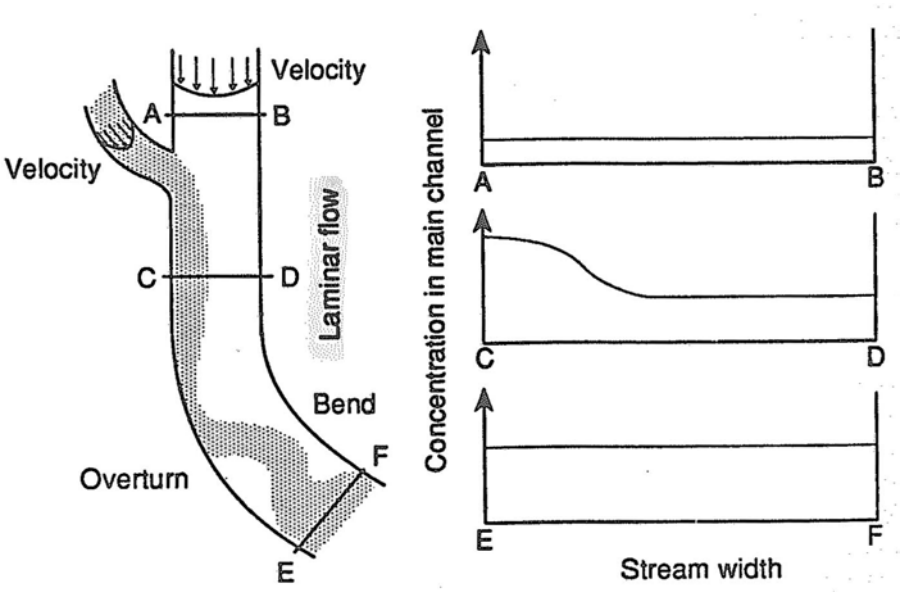
8.1.7 The concentration of lead in the discharge exceeded the emission limit in April 2007. The downstream concentration of lead at 1.6km and 5km downstream was recorded as below emission limit on the same sampling date.

8.1.8 Ammonium concentration shows a marked decrease in concentration the further downstream the sample is taken. The concentration of ammonium in the discharge exceeded the existing IPPC emission limit and the Freshwater Fish Directive (78/659/EC) in April, July and October 2007. However, the upstream sample in April and July 2007 also exceeded these parameters. For all samples, the ammonium concentration at Boolabeha Bridge, at 5056m downstream, was below the standard limits.

Mixing Zone of Discharge and Receiving Water

8.1.9 Water must be sufficiently well mixed a single sample of water to be representative of physico-chemical water quality. Water from tributaries or effluent outfalls will have a different density to the water in the main channel. This combined with poor lateral mixing, especially in straight river sections where the flow is laminar, results in the formation of a long plume of unmixed water usually running along one side of the river (Gray, 1999). This is demonstrated in *Plate No. I.2.1* below.

Plate No. I.2.1: Illustration of Mixing in River Channels (Taken from Chapman, D., 1996)



8.1.10 Complete mixing is normally only achieved when the water turns over at a bend (*Plate No. I.2.1*) or the plume is dispersed as it passes over a weir. Effluent plumes can be eliminated by careful position and design of discharge pipes, or by using weirs or hydraulic jumps immediately below the point of entry (Gray, 1999). *Plate No. I.2.2* presents estimates of the distance downstream that complete mixing would occur.

Plate No. I.2.2: Approximate Distances Downstream of Influent Water entry for Complete Mixing to occur in a River or Stream (taken from Bartram and Ballance (1996)

Average width (m)	Mean depth (m)	Estimated distance for complete mixing (km)
5	1	0.08–0.7
	2	0.05–0.3
	3	0.03–0.2
10	1	0.3–2.7
	2	0.2–1.4
	3	0.1–0.9
	4	0.08–0.7
	5	0.07–0.5
20	1	1.3–11.0
	3	0.4–4.0
	5	0.3–2.0
	7	0.2–1.5
50	1	8.0–70.0
	3	3.0–20.0
	5	2.0–14.0
	10	0.8–7.0
	20	0.4–3.0

8.1.11 Assuming an average width of 5m and a mean water depth of <1m downstream of PWE1, the estimated distance downstream for complete mixing would be 80m to 700m. The first monitoring point downstream of PWE1 is discharge point is at 336m and the second monitoring point is at 1698m downstream.

8.1.12 Based on the guidelines in *Plate No. I.2.2* and considering meandering nature of the Drish River along this section shown in the regional hydrology map in *Figure No. I.2.1*, complete mixing of would occur upstream of the proposed additional discharge point SW1. Complete mixing of the discharge from SW1 would occur upstream of the monitoring point at Boolabeha station.

Reaeration Characteristics of Receiving Water

8.1.13 While the dissolved oxygen concentration is affected by factors such as temperature, BOD and salinity, oxygen depletion is prevented primarily by re-aeration, although other sources of oxygen such as photosynthesis may also be important under certain conditions.

8.1.14 In situations where organic matter from processes such as waste water treatment systems, the amount of organic matter that a receiving water can assimilate is limited by the availability of dissolved oxygen, which is largely determined by the rate oxygen is utilised by microbial oxidation and the rate at which it can be replaced by re-aeration and other processes. How quickly oxygen dissolves in water depends to a large extent on the concentration of oxygen already in solution in relation to the saturation concentration i.e. the oxygen deficit (Gray, 1999).

8.1.15 The oxygen exchange coefficient of the receiving water, f, is expressed units of velocity (mm/h-1)and at 20°C in British rivers, it can be estimated by the following formula (Gray, 1999):

$$F = 7.82 \times 10^{4} U^{0.67} H^{-0.85}$$

where U = water velocity (ms-1)
H = mean depth (mm)

8.1.16 The Lisheen Mine quarterly sampling results and the OGE sampling results presented in Section 7.0 and Section 8.0 of this report indicate that the existing discharge at PWE1 does not have a high organic load. As is evident from the samples results in *Appendix No. I.2.4* and *Appendix No. I.2.6*, the BOD in the discharge is lower than the upstream section. *Table No. I.2.7* shows that the discharge causes the downstream section to become aerated relative to the upstream section. This is primarily a consequence of the siting of a weir at the discharge point. The discharge from PWE1 improves the aeration characteristics of the downstream section of the Drish River.

Tributary of Drish River

9.0 Regional Hydrology and Flow Regime

9.1 The tributary of the Drish River to which it is proposed to discharge 20Ml/day is shown on *Figure No. I.2.4*. It is proposed that the actual discharge point (SW1) will be close to the start of the channel (*Figure No. I.2.4*). The tributary is referred to locally as the Clougheen tributary and in the Lisheen Mine EIS it was referred to as Drish Tributary 2. The EIS stated that tributary had very little flow in the summer months and maintained a flow during the winter.

9.2 The confluence of the tributary with the main body of the Drish River (SW1M) is approximately 2.24km downstream of the existing discharge point (PWE1) to the River Drish.

9.3 The proposed tributary channel is dry for much of the year. OGE visited the tributary on 18th October and again on 23rd October 2007. There was no evidence of flow in the channel on both dates.

10.0 Bankful Capacity of the Drish Tributary

10.1 OGE personnel visited the site on 23rd October 2007 in order to in order to determine its carrying capacity of the channel for the additional water. Cross sections of the stream banks were surveyed using the GPS RTK surveying equipment and the substrate of the banks and streambed were recorded. Where the GPS RTK could not be used due the presence of excess over-hanging vegetation, the location of the survey point was recorded using a handheld GPS and the dimensions of the stream channel were measured in manually.

10.2 The survey points are presented in *Figure No. I.2.4*. The dimensions of the stream cross-sections, as well as information on the stream substrate and slope of the water in the stream were entered into a proprietary software package *Flowmaster V6.1*, the results of which are shown in *Appendix No. I.2.8*.

10.3 *Flowmaster V6.1* uses the following Mannings Equation presented below to determine the maximum flood that could pass along the channel to the height of the lowest bank:

$$Q = (1/n)(A^{1.67}/P^{0.67})(S^{0.5})$$

Where:

n = Manning's Roughness Coefficient

A = cross sectional area (m^2)

P = wetted perimeter (m)

S = slope of channel (m/m)

$$Q_{Manning}\,(stream) = m^3/s$$

10.4 Given that the stream channel is dry for most of the year, much of the channel is overgrown with shrubbery and long grass. In other areas, particularly in the upstream section, the channel banks are bordered by rough earth. In order to be conservative, OGE assigned a roughness coefficient 0.45, which equates to very rough earth with grassy soil. This is the worst case Mannings coefficient that could be entered. The slope of the channel was calculated from the elevation and distance between SP1 and SP22. Generally the slope is calculated from the water levels in the channel. However, given the absence of water, the stream bed slope was adequate.

10.5 *A* summary of the bankful capacity results is presented in *Table No. I.2.9* below.

Table No. I.2.9: Bankful Capacity of Survey Points along the Drish Tributary

Survey Point	Easting	Northing	Bankful Capacity		Additional Capacity
			m^3/s	l/s	%
SP1	221595	166323	0.80	800	246
SP2	221419	166383	2.34	2340	913
SP3	221358	166383	3.28	3.280	1300
SP4	221314	166328	0.29	290	25
SP5	221272	166252	1.15	1.150	397
SP6	221263	166204	0.81	810	250
SP7	221227	166017	2.71	2710	1000
SP8	221201	165902	2.64	2640	1040
SP9	221129	165707	2.71	2710	1730
SP10	221116	165672	1.99	1990	760
SP11	221012	165447	3.84	3840	1560
SP12	220970	165418	6.28	6280	2618
SP13 (Bridge)	220953	165410	1.55	1550	570
SP14	220775	165389	2.16	2160	835
SP15	220704	165376	3.64	3640	1470
SP16	219976	164570	0.46	460	99
SP17 (Bridge)	219980	164535	1.32	1320	470
SP18	219997	164471	1.71	1710	640
SP19	219996	164434	0.553	553	139

Survey Point	Easting	Northing	Bankful Capacity		Additional Capacity
			m³/s	l/s	%
SP20	220129	164059	0.46	460	99
SP21 (Bridge)	220145	164016	1.24	1240	436
SP22	220154	163985	1.59	1590	588

10.6 The cross sections, namely SP13, SP17 and SP21, represent the bridges through which the channel travels under the road. Cross sections SP16 and SP20 represents those estimated from observations from the road side due to access restrictions. In both these sections and upstream, the channel was particularly overgrown, which may cause build-up of debris and over-topping of the banks. OGE would recommend that the channel is cleaned out in sections such as these to mitigate against flooding. As the channel sections in *Appendix No. I.2.8* show, a channel with a 1m x 1m dimension is demonstrated to have almost double the capacity required to discharge the water without impacting on the adjacent land.

10.7 The survey point with the lowest bankful capacity is SP4. This section appeared to be an area previously used by cattle to access the channel. Although there is 25% additional capacity above the proposed 20ML/day discharge, this section may need to be deepened.

10.8 Most of the channel is fenced off along its length. OGE would recommend, for health and safety purposes, that an (approximate) 100m perimeter fence is erected where the tributary borders a dwelling adjacent to SP11-SP13.

10.9 The discharge of 20Ml/day equates to a discharge of 231l/s. It can be seen from *Table No. I.2.9*, that the carrying capacity if the tributary long the surveyed sections, is adequate to accommodate a licenced volume of 231l/s (20Ml/day), with SP4, having the least capacity of all the survey points.

11.0 Summary

11.1 The redistribution of the discharge from the Lisheen Mine will not alter the chemistry and quality of the Drish River downstream of the existing discharge point (PWE1).

11.2 Based on the survey carried out by OGE personnel, the Clougheen tributary has adequate capacity to accept the 20Mlday discharge from the Lisheen Mine.

Rossestown River

12.0 Regional Hydrology and Flow Data

12.1 Rossestown River was described as the only permanent river flowing across the mine area in SRK report (1995) submitted as part of the original Lisheen Mine planning application. The baseline study conducted as part of the original EIS established that it rises as a natural spring in the Derryville Bog. It flows in a south-westerly direction across agricultural land towards its confluence with the River Suir at Rossestown Bridge, approximately 3.5km north of Thurles (*Figure No. I.2.5*).

12.2 At its confluence with the River Suir, the Rossestown River drains a catchment area of approximately 32km^2. The catchment area to the existing licenced discharge point (PWE2) is approximately 10.8km^2. The catchment area to the point of mixing (referred to SW2M in this report) between the emergency discharge point downstream is 15.8km^2.

12.3 The flow in the Rossestown River is gauged by the OPW and Tipperary County Council at Clobanna and Derryville, respectively. The upstream gauging station is in the townland of Derryville at the Templetuohy bridge immediately downstream of PWE2. The second flow gauging station is at Clobanna, sited at the final bridge upstream of the confluence of the Rossestown River with the River Suir (*Figure No. I.2.5*). A summary of the gauging station details are presented in *Table No. I.2.10* below:

Table No. I.2.10: Summary Details of the Rossestown River Gauging Stations

Station Number	Location	River	Easting	Northing	Catchment Area (km^2)	Long Term Average Rainfall mm/annum	Start of records	DWF (m^3/s)	95 percentile (m^3/s)
16039	Derryville	Rossestown	220192	169253	9.7	971	-	-	-
16051	Clobanna	Rossestown	214099	162701	30.2	956	-	0.006	0.014

12.4 The third party data concerning historical flows at both the gauging stations is limited. The station at Clobanna is operated by OPW. According to the OPW, flow measurements at Clobanna have been taken in the range of 0.0049m^3/s to 2.692m^3/s. However, any flow measurements made outside this range were derived from extrapolation and may be unreliable.

Determination of Q_{mean} (Annual Maximum Flood)

12.5 Using the same methodology and reference for calculation of the Q_{mean} as detailed in Section 5.0 of this report, the flood peaks for various return periods for the Rossestown River are reproduced in *Table No. I.2.11* below and includes the estimated **Q_{mean}** and flow volumes for various return periods for the proposed emergency discharge mixing point (SW2M).

Table No. I.2.11: Flood Peaks for Various Return Periods and Sites on the Rossestown River

Site	Catchment Area (km^2)	Qmean (m^3/s)	Flood Peak (m^3/s) Return Period (Years)						
			2	5	10	20	50	100	200
Clobanna	32	2.6	2.5	3.1	3.6	4.2	4.6	5.1	5.6
Kilconagh	22.6	1.9	1.8	2.2	2.5	3.0	3.3	3.6	4.0
Lisaticy	17.1	1.4	1.4	1.7	2.0	2.3	2.5	2.8	3.0
SW2M	15.8	1.3	1.2	1.5	1.8	2.1	2.3	2.5	2.7
Templetuohy	10.8	0.9	0.9	1.1	1.3	1.5	1.6	1.8	2.0

12.6 As described in Section 5.0 above, the effects of increased discharge from the mine was calculated by increasing the flood peaks by these amounts and then estimating the increase in depth of water using the Discharge-Water Level curves for each site. This data is presented in *Appendix No. I.2.10*. A summary of the information is presented in *Table No. I.2.12* below.

Table No. I.2.12: Summary of Flood Line Predictions for Rossestown River

Site	**River Flow**	**Mine Discharge (m^3/s)**	**Mine Discharge (Ml/day)**	**Water Level (m OD)**	**Increase due to pumping (m)**
Kilconagh Bridge	0.535 (mean)	0.5	43.2	97.607	0.121
	6.301 (peak)	0.5	43.2	98.164	0.028
Lisaticy Bridge	0.457 (mean)	0.5	43.2	96.829	0.120
	4.431 (peak)	0.5	43.2	97.293	0.041

12.7 Water levels at the two sites would increase by 0.028m and 0.041m, respectively, at the Kilconagh and Lisaticy Bridges, as a result of discharging of 43.2Ml/day to the river during a peak river flows.

12.8 At present, the Lisheen Mine is licenced to discharge 20Ml/day from the existing discharge point PWE2. The above information indicates that if the discharge were to be increased to 40Ml/day, this increase would have a negligible impact on the water levels at these locations.

Lisheen Mine Water Level Monitoring Data on Rossestown River

12.9 The stage height in the Rossestown River is recorded twice daily at three bridges downstream of the existing discharge point (PWE2). The hydrographs are presented in *Figure No. I.2.6*.

12.10 The hydrographs from the three monitoring point demonstrate a marked response to the effects of rainfall, the effect being dampened the further downstream the location of the monitoring station.

Instantaneous Measurement in the Rossestown River

12.11 OGE personnel measured the discharge in the Rossestown River at four sections downstream of the existing discharge point on 24th October 2007. The discharge was measured using the Mean Section Method as described in Section 5.0 of this report. A summary of the instantaneous discharges recorded is presented in *Table No. I.2.13* below.

Table No. I.2.13: Instantaneous Discharge Measurements Recorded on 24th October 2007

Location	Discharge	
	m^3/s	l/s
Templetuohy Bridge	0.164	164
Lisaticy Bridge	0.150	150
Kilconagh Bridge	0.172	172
Ballyduag Bridge	0.164	164
Clobanna Bridge	0.171	171

12.12 The variation in discharge recorded at the bridges is reflective of the losing and gaining nature of the Rossestown River along its length (OGE Project No. 099901/1, December 1999).

13.0 Main Polluting Substances to Rossestown River and Associated Mitigation Measures

13.1 The main polluting substances from the mining activities into the Rossestown River , as defined in the Schedule of S.I. 394 of 2004 and based on the emission limits set out in the existing IPPC licence (P0088-02), are the same as described for the Drish River in Section 6.0 above.

13.2 The same mitigation measures described in Section 6.0 apply to the discharge into the Rossestown River.

13.3 The existing impacts of these main polluting substances on the Rossestown River are discussed in Section 14.0 below.

14.0 Rossestown River Surface Water Chemistry and Quality Data

EPA Data Biological Data

14.1 The Rossestown River is monitored both in terms of chemical and biological quality by the EPA at four locations downstream of the existing discharge point (*Figure No. I.2.5).* Details of the data for these EPA monitoring stations are presented in *Appendix No. I.2.11*.

14.2 During the monitoring period from 1988 to 2005, the biological water quality at the Templetuohy Bridge (St. No. 0040) immediately downstream of the discharge point PWE2, deteriorated from a mildly polluted status (Q3-4) in 1988 to a moderately polluted status from 1992 to 2005.

14.3 The biological quality at the next downstream monitoring station at Lisaticy Bridge has indicated an overall trend towards poor water quality. From 1977 to 1988, the water quality was consistently of a mildly polluted status (3-4). During the four year period from 1988 to 1992, the water quality improved to good water quality status. From 1992 to 1996, the quality deteriorated somewhat to a mildly polluted status. The quality improved again when the station was monitored again in 1999 to good water quality status of Q4. From 1999 to 2005, the water quality has dis-improved to a Q index of 3, indicative of moderately polluted waters.

14.4 The water quality status at the station number 0200 at the bridge south of Kilconagh has deteriorated in water quality from a Q value of 4 from 1977 to 2005 to 1999 (apart from a Q value of 3-4 in 1988) to a Q value of 3-4 in 2002 and finally a Q value of 3 in 2005.

14.5 At the monitoring station 0300 upstream of the Suir River confluence, the water quality has improved from a mildly polluted water quality status of Q3-4 from 1981 to 1992 to a good water quality (Q4) status from 1996 to 2005.

Lisheen Monitoring Chemistry Data

14.6 As is the case in the Drish River, the Rossestown River is monitored upstream and downstream of the existing discharge point, PWE2. The quarterly chemistry data from October 2006 to October 2007 from the monitoring points upstream and downstream of the discharge point are presented in *Appendix No. I.2.12*. The parameters were compared with same standards as described in Section 7.0 of this report.

14.7 Apart from the quarterly samples taken in October 2006, the nitrite concentration upstream of the existing discharge point and downstream of PWE2 exceeded both the limit set out in the Freshwater Fish Directive (78/659/EC) and the Salmonid Water Regulations (1998). This reflects the presence of the bog and the Templetuohy waste water treatment plant upstream of PWE2.

14.8 The concentration of ammonium exceeded both the limit set out in the IPPC licence and the Freshwater Fish Directive (78/659/EC) in upstream and downstream samples taken in April and July 2007. The results indicate an overall trend of a decrease in concentration in the samples since April 2007, where only the downstream sample exceeded the limit in October 2007.

14.9 The concentration of COD in the upstream samples exceeded the limit set out in the existing IPPC licence application for all samples. The limit was exceeded in the downstream samples in October 2006 and January 2007 only.

OGE Sampling

14.10 On 28th October 2007, OGE took samples of water from the Rossestown River upstream of the discharge point, of the discharge water and downstream of the discharge point at Lisaticy Bridge.

14.11 The same sampling and analysis procedure was applied as for the samples taken from the Drish River.

14.12 The instantaneous unstable hydrochemical parameters, measured in the field using the YSI 556 multi probe system, at each of the sampling locations, are presented in *Table No. I.2.14* below:

Table No. I.2.14: Unstable Hydrochemical Parameters Recorded at Rossestown River Sampling Locations

Sample ID	Location	Time	pH	Temperature °C	Dissolved Oxygen (%)	Dissolved Oxygen (mg/l)	Conductivity (µS/cm)
EUROSS	Upstream	09:04	6.4	8.0	42.4	5.0	529
DISROSS	Discharge Point	09:00	6.6	13.0	64.8	6.8	897
QDSROSS	Downstream	10:43	6.6	10.7	59.7	6.6	862

14.13 The certificates of analysis for the samples are presented in *Appendix No. I.2.5.* A comparison of the sample results with the standards listed in Section 7.0 is presented in *Appendix No. I.2.13*

14.14 All parameters were within the limits set out in the standards apart from nitrite. The samples taken from all three sampling locations exceeded the limits set out in the Freshwater Fish Directive (78/659/EC) and the Salmonid Regulations (1998). These results are consistent with the Lisheen Mine quarterly samples.

15.0 Mixing of Discharge and Rossestown River Water

15.1 Chemistry

15.1.1 The results of the samples taken by OGE on 28th October 2007, were entered into proprietary software Aquachem v4.0, which used the data to create a Piper Plot presented as *Figure No. I.2.7*.

15.1.2 The Piper plot shows that the major ion chemistry of the upstream and downstream section of the existing discharge point PWE2 is dissimilar. Upstream of PEW2, the water type is calcium bicarbonate (Ca-HCO_3). Both the discharge and at the downstream discharge point, the water is calcium magnesium bicarbonate sulphate water (Ca-Mg-HCO_3-SO_4). The influence of the sulphate and the magnesium are a directly result of the mining activities.

15.1.3 The proposed emergency discharge point will be utilised during extended periods of heavy rainfall. The data shown in *Appendix No. I.2.14* was calculated based on the mixing equation presented in Section 8.0. This demonstrates that during annual maximum flooding and in a 1 in 100 year storm event, the addition of 20Ml/day discharge downstream at the proposed SW2 discharge point will be similar in composition to the samples taken by OGE downstream of the discharge point and of the discharge itself.

15.1.4 A potential doubling of the discharge to the Rossestown River during heavy rainfall events will not alter the existing chemistry in the downstream section of the Rossestown River.

15.1.5 *Appendix No. I.2.12* presents the quarterly analysis results for samples upstream of the existing discharge point and at three downstream locations. The downstream monitoring point is only 10m downstream of PWE2. The proposed emergency discharge point is 2320m downstream of PWE2. Based on historical data it is not possible to determine the trends in parameter concentrations downstream of the discharge point. Based on the approximate distances for complete downstream mixing shown in *Plate No. 2* and the meandering nature of the river, the approximate distance

downstream at which mixing would occur is 80m to 700m downstream. This would occur upstream of the proposed mixing point SW2M, which is 2390m downstream of PWE2.

Reaeration Characteristics

15.1.6 The existing discharge at PWE2 does not have a high organic load. The BOD results in the samples taken by OGE and by Lisheen Mine show that the organic load of the discharge is low. The dissolved oxygen recordings show that the discharge increases aeration downstream of PWE2 relative to the upstream section, which is stagnant. Again, as with PWE1, this is primarily a consequence of the siting of a weir at the discharge point.

Emergency Channel to Rossestown River

16.0 Channel Characteristics

16.1 The proposed emergency emission point SW2 enters the Rossestown River at SW2M, approximately 2390m downstream the existing discharge point (*Figure No. I.2.8*). Water enters this channel via an emergency weir, which is an overflow point on the canal that carries segregated clean water from underground (FAS water).

16.2 The channel comprises a system of drainage ditches which is routed through agricultural land used for grazing and forestry.

16.3 The channel is dry apart from when it is utilised as a discharge route. OGE visited the channel on 23rd October 2007. There was no water in the channel, but there was evidence that it had been used as a discharge route previously.

17.0 Bankful Capacity of the Emergency Channel to the Rossestown River

17.1 Cross sections of the channel were recorded along the length of the discharge route from the emergency weir (SW2) to the point of entry to Rossestown River (SW2M). The GPS RTK equipment could not be used for surveying along the length of this channel due to the presence of overhanging vegetation along most of the route. In this case, the location of the survey point

was recorded using a handheld GPS and the dimensions of the stream channel were measured in manually.

17.2 The proposed emission point (SW2) and emergency discharge route have been utilised previously during periods of heavy rainfall. There was one reported incident by the landowner of the land bordering the channel of the encroachment of water onto the adjoining fields. This was remedied by Anglo American Lisheen Mining Ltd. by the deepening of the channel along the section. There has been no reported incident of flooding along this channel since then.

17.3 The channel itself comprises of rough earth along much of its length. The erosive impact of flowing water is evident in the form of unstable banks and muddy base. OGE would recommend that the base of the channel is covered in gravel and the banks are protected along discrete reaches using gambion structures to prevent bank erosion and deposition of clay and silt particles downstream into the Rossestown River channel.

17.4 The survey points are presented in *Figure No. I.2.8.* As was the case with the tributary of the Drish River, the dimensions of the stream cross-sections, information on the stream substrate and slope of the water in the stream were entered into a proprietary software package *Flowmaster V6.1*, the results of which are shown in *Appendix No. I.2.15*.

17.5 *A* summary of the bankful capacity results is presented in *Table No. I.2.15* below.

Table No. I.2.15: Bankful Capacity of Survey Points along the Emergency Discharge Route

Survey Point	Easting	Northing	Bankful Capacity		Additional Capacity
			m^3/s	l/s	%
ECH1	220268	166989	2.42	2420	947
ECH2	219912	167110	2.25	2250	874
ECH3	219765	167069	1.19	1190	415
ECH4	219734	167095	0.32	320	39
ECH5	219706	167120	1.89	1890	718
ECH6	219698	167224	1.72	1720	645
ECH7	219696	167310	1.94	1940	740
ECH8	219725	167347	0.45	450	95
ECH9	219668	167347	0.74	740	220

17.6 The survey point that represents the lowest bankful capacity is ECH4, a circular pipe which was partially blocked by gravel on the day of surveying. Similarly the downstream section of the bridge, ECH8, could potentially restrict flow where a concrete slab has fallen in front of the downstream section.

17.7 The discharge of 20Ml/day equates to a discharge of 231l/s. It can be seen from the bankful capacity values presented in *Table No. I.2.15* are adequate to accommodated a licenced volume of 231l/s, with ECH4, having the least capacity.

18.0 Summary

18.1 The additional 20Ml/day of discharge from the Lisheen Mine during heavy rainfall events will not alter the chemistry and quality of the Rossestown River downstream of the existing discharge point (PWE2).

18.2 Based on the survey carried out by OGE personnel, the emergency channel has adequate capacity to accept the 20Mlday discharge from the Lisheen Mine.

19.0 References

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Table I.2(i) SURFACE WATER QUALITY

(Sheet 1 of 2) Monitoring Point/ Grid Reference: Upstream of Drish Discharge Point (PWE1) E222032 N163620

Parameter	Results (mg/l)				Sampling method[2] (grab, drift etc.)	Normal Analytical Range[2]	Analysis method / technique
	18/10/07						
pH	6.5				Grab sample for all parameters	0-14 pH Units	Electrometric Probe
Temperature	9.9					-5°C - 45°C	Electrometric Probe
Electrical conductivity EC	0.675					0-200mS	Electrometric Probe
Ammoniacal nitrogen NH_4-N	0.051					>0.05 mg/l NH_4-N	Spectometry
Chemical oxygen demand	38					>10mg/l	G/03: APHA, 2005 Method 5220D
Biochemical oxygen demand	<2					>2mg/l	G/04: APHA, 2005 Method 5210B
Dissolved oxygen DO	3.0					0-50mg/l	Electrometric Probe
Calcium Ca	110					>0.2mg/l	ICP MS
Cadmium Cd	<0.4					>0.4µg/l	ICP MS
Chromium Cr	<1.0					>1µg/l	ICP MS

Parameter	Results (mg/l)				Sampling method[2] (grab, drift etc.)	Normal Analytical Range[2]	Analysis method / technique
Chloride Cl	17					<0.2mg/l	Ion Chromatography
Copper Cu	<5					>5µg/l	ICP MS
Iron Fe	0.12					>0.05mg/l	ICP-MS
Lead Pb	<5					>5µg/l	ICP MS
Magnesium Mg	20					>0.1mg/l	ICP MS
Manganese Mn	0.053					>0.01mg/l	ICP MS
Mercury Hg	<0.05					>0.05µg/l	ICP MS

Surface Water Quality (Sheet 2 of 2)

Parameter	Results (mg/l)				Sampling method (grab, drift etc.)	Normal Analytical Range	Analysis method / technique
	18/10/07	Date	Date	Date			
Nickel Ni	<5					>5µg/l	ICP MS
Potassium K	2.9					>0.1mg/l	ICP MS
Sodium Na	9.4					>0.1mg/l	ICP MS
Sulphate SO_4	21					>0.5mg/l	Ion Chromatography
Zinc Zn	<10					>10µg/l	ICP MS
Total alkalinity (as $CaCO_3$)*	380					>5mg/l HCO_3	Titrimetry
Total organic carbon TOC	13					>5mg/l TOC	TOC Analyser
Total oxidised nitrogen TON**	1.05					>0.2mg/l N	G/67:APHA 2005, 4500-N02B, Colorimetric Method
Nitrite NO_2	0.039					>0.03 mg/l NO_2	Spectrometry
Nitrate NO_3	4.6					>0.44mg/l NO_3	Spectrometry
Faecal coliforms (/100mls)	<1					>1mpn/100ml	MPN, IDEXX defined substrate method
Total coliforms (/100mls)	<1					>1mpn/100ml	MPN, IDEXX defined substrate method

Parameter	Results (mg/l)				Sampling method (grab, drift etc.)	Normal Analytical Range	Analysis method / technique
	18/10/07	Date	Date	Date			
Phosphate PO_4	<0.03					<0.03mg/l PO_4	Spectrometry

*As HCO_3^-
**As N

Table I.2(i) SURFACE WATER QUALITY

(Sheet 1 of 2) Monitoring Point/ Grid Reference: Drish Discharge Point (PWE1) E221999 N163615

Parameter	Results (mg/l)				Sampling method[2] (grab, drift etc.)	Normal Analytical Range[2]	Analysis method / technique
	18/10/07						
pH	6.0				Grab sample for all parameters	0-14 pH Units	Electrometric Probe
Temperature	12.9					-5°C - 45°C	Electrometric Probe
Electrical conductivity EC	0.897					0-200mS	Electrometric Probe
Ammoniacal nitrogen NH_4-N	1.5					>0.05 mg/l NH_4-N	Spectometry
Chemical oxygen demand	<10					>10mg/l	G/03: APHA, 2005 Method 5220D
Biochemical oxygen demand	<2					>2mg/l	G/04: APHA, 2005 Method 5210B
Dissolved oxygen DO	7.2					0-50mg/l	Electrometric Probe
Calcium Ca	110					>0.2mg/l	ICP MS
Cadmium Cd	1.0					>0.4µg/l	ICP MS
Chromium Cr	<1.0					>1µg/l	ICP MS

Parameter	Results (mg/l)				Sampling method[2] (grab, drift etc.)	Normal Analytical Range[2]	Analysis method / technique
Chloride Cl	21					<0.2mg/l	Ion Chromatography
Copper Cu	<5.0					>5µg/l	ICP MS
Iron Fe	0.36					>0.05mg/l	ICP-MS
Lead Pb	19					<5µg/l	ICP MS
Magnesium Mg	42					<0.1mg/l	ICP MS
Manganese Mn	0.08					>0.01mg/l	ICP MS
Mercury Hg	<0.05					>0.05µg/l	ICP MS

Surface Water Quality (Sheet 2 of 2)

Parameter	Results (mg/l)				Sampling method (grab, drift etc.)	Normal Analytical Range	Analysis method / technique
	18/10/07	Date	Date	Date			
Nickel Ni	32					>5µg/l	ICP MS
Potassium K	6.2					>0.1mg/l	ICP MS
Sodium Na	14					>0.1mg/l	ICP MS
Sulphate SO_4	220					>0.5mg/l	Ion Chromatography
Zinc Zn	360					>10µg/l	ICP MS
Total alkalinity (as $CaCO_3$)*	280					>5mg/l HCO_3	Titrimetry
Total organic carbon TOC	<5					>5mg/l TOC	TOC Analyser
Total oxidised nitrogen TON**	1.93					>0.2mg/l N	G/67:APHA 2005, 4500-N02B, Colorimetric Method
Nitrite NO_2	0.27					>0.03 mg/l NO_2	Spectrometry
Nitrate NO_3	7.3					>0.44mg/l NO_3	Spectrometry
Faecal coliforms (/100mls)	<1					>1mpn/100ml	MPN, IDEXX defined substrate method
Total coliforms (/100mls)	<1					>1mpn/100ml	MPN, IDEXX defined substrate method

Parameter	Results (mg/l)				Sampling method (grab, drift etc.)	Normal Analytical Range	Analysis method / technique
	18/10/07	Date	Date	Date			
Phosphate PO_4	<0.03					<0.03mg/l PO_4	Spectrometry

*As HCO_3^-
**As N

Table I.2(i) SURFACE WATER QUALITY

(Sheet 1 of 2) Monitoring Point/ Grid Reference: Downstream of Drish Discharge Point (PWE1) E221746 N163521

Parameter	Results (mg/l)				Sampling method[2] (grab, drift etc.)	Normal Analytical Range[2]	Analysis method / technique
	18/10/07						
pH	6.6				Grab sample for all parameters	0-14 pH Units	Electrometric Probe
Temperature	12.6					-5°C - 45°C	Electrometric Probe
Electrical conductivity EC	0.873					0-200mS	Electrometric Probe
Ammoniacal nitrogen NH_4-N	1.2					>0.05 mg/l NH_4-N	Spectometry
Chemical oxygen demand	<10					>10mg/l	G/03: APHA, 2005 Method 5220D
Biochemical oxygen demand	<2					>2mg/l	G/04: APHA, 2005 Method 5210B
Dissolved oxygen DO	6.6					0-50mg/l	Electrometric Probe
Calcium Ca	110					>0.2mg/l	ICP MS
Cadmium Cd	0.91					>0.4µg/l	ICP MS
Chromium Cr	<1					>1µg/l	ICP MS

Parameter	Results (mg/l)				Sampling method[2] (grab, drift etc.)	Normal Analytical Range[2]	Analysis method / technique
Chloride Cl	21					<0.2mg/l	Ion Chromatography
Copper Cu	<5					>5µg/l	ICP MS
Iron Fe	0.39					>0.05mg/l	ICP-MS
Lead Pb	21					>5µg/l	ICP MS
Magnesium Mg	40					>0.1mg/l	ICP MS
Manganese Mn	0.077					>0.01mg/l	ICP MS
Mercury Hg	<0.05					>0.05µg/l	ICP MS

Surface Water Quality (Sheet 2 of 2)

Parameter	Results (mg/l)				Sampling method (grab, drift etc.)	Normal Analytical Range	Analysis method / technique
	18/10/07	Date	Date	Date			
Nickel Ni	28					>5µg/l	ICP MS
Potassium K	5.8					>0.1mg/l	ICP MS
Sodium Na	13					>0.1mg/l	ICP MS
Sulphate SO_4	200					>0.5mg/l	Ion Chromatography
Zinc Zn	320					>10µg/l	ICP MS
Total alkalinity (as $CaCO_3$)*	280					>5mg/l HCO_3	Titrimetry
Total organic carbon TOC	<5					>5mg/l TOC	TOC Analyser
Total oxidised nitrogen TON**	2.07					>0.2mg/l N	G/67:APHA 2005, 4500-N02B, Colorimetric Method
Nitrite NO_2	0.24					>0.03 mg/l NO_2	Spectrometry
Nitrate NO_3	7.3					>0.44mg/l NO_3	Spectrometry
Faecal coliforms (/100mls)	<1					>1mpn/100ml	MPN, IDEXX defined substrate method
Total coliforms (/100mls)	<1					>1mpn/100ml	MPN, IDEXX defined substrate method

Parameter	Results (mg/l)				Sampling method (grab, drift etc.)	Normal Analytical Range	Analysis method / technique
	18/10/07	Date	Date	Date			
Phosphate PO_4	<0.03					<0.03mg/l PO_4	Spectrometry

*As HCO_3^-
**As N

Table I.2(i) SURFACE WATER QUALITY

(Sheet 1 of 2) Monitoring Point/ Grid Reference: Upstream of Rossestown Discharge Point (PWE2) E220235 N169274

Parameter	Results (mg/l)				Sampling method[2] (grab, drift etc.)	Normal Analytical Range[2]	Analysis method / technique
	18/10/07						
pH	6.4				Grab sample for all parameters	0-14 pH Units	Electrometric Probe
Temperature	8.0					-5°C - 45°C	Electrometric Probe
Electrical conductivity EC	0.529					0-200mS	Electrometric Probe
Ammoniacal nitrogen NH_4-N	0.33					>0.05 mg/l NH_4-N	Spectometry
Chemical oxygen demand	38					>10mg/l	G/03: APHA, 2005 Method 5220D
Biochemical oxygen demand	<2					>2mg/l	G/04: APHA, 2005 Method 5210B
Dissolved oxygen DO	5.0					0-50mg/l	Electrometric Probe
Calcium Ca	87					>0.2mg/l	ICP MS
Cadmium Cd	<0.4					>0.4µg/l	ICP MS
Chromium Cr	<1.0					>1µg/l	ICP MS

Parameter	Results (mg/l)				Sampling method[2] (grab, drift etc.)	Normal Analytical Range[2]	Analysis method / technique
Chloride Cl	15					<0.2mg/l	Ion Chromatography
Copper Cu	<5.0					>5µg/l	ICP MS
Iron Fe	0.8					>0.05mg/l	ICP-MS
Lead Pb	<5.0					>5µg/l	ICP MS
Magnesium Mg	11					>0.1mg/l	ICP MS
Manganese Mn	0.033					>0.01mg/l	ICP MS
Mercury Hg	<0.050					>0.05µg/l	ICP MS

Surface Water Quality (Sheet 2 of 2)

Parameter	Results (mg/l)				Sampling method (grab, drift etc.)	Normal Analytical Range	Analysis method / technique
	18/10/07	Date	Date	Date			
Nickel Ni	<5.0					>5µg/l	ICP MS
Potassium K	1.2					>0.1mg/l	ICP MS
Sodium Na	8.2					>0.1mg/l	ICP MS
Sulphate SO_4	2.5					>0.5mg/l	Ion Chromatography
Zinc Zn	<10					>10µg/l	ICP MS
Total alkalinity (as $CaCO_3$)*	300					>5mg/l HCO_3	Titrimetry
Total organic carbon TOC	14					>5mg/l TOC	TOC Analyser
Total oxidised nitrogen TON**	2.76					>0.2mg/l N	G/67:APHA 2005, 4500-N02B, Colorimetric Method
Nitrite NO_2	0.1					>0.03 mg/l NO_2	Spectrometry
Nitrate NO_3	12					>0.44mg/l NO_3	Spectrometry
Faecal coliforms (/100mls)	<1					>1mpn/100ml	MPN, IDEXX defined substrate method
Total coliforms (/100mls)	<1					>1mpn/100ml	MPN, IDEXX defined substrate method

Parameter	Results (mg/l)				Sampling method (grab, drift etc.)	Normal Analytical Range	Analysis method / technique
	18/10/07	Date	Date	Date			
Phosphate PO_4	0.074					<0.03mg/l PO_4	Spectrometry

*As HCO_3^-
**As N

Table I.2(i) SURFACE WATER QUALITY

(Sheet 1 of 2) Monitoring Point/ Grid Reference: Rossestown Discharge Point (PWE2) E220214 N169270

Parameter	Results (mg/l)				Sampling method[2] (grab, drift etc.)	Normal Analytical Range[2]	Analysis method / technique
	18/10/07						
pH	6.6				Grab sample for all parameters	0-14 pH Units	Electrometric Probe
Temperature	13.0					-5°C - 45°C	Electrometric Probe
Electrical conductivity EC	0.897					0-200mS	Electrometric Probe
Ammoniacal nitrogen NH_4-N	1.5					>0.05 mg/l NH_4-N	Spectometry
Chemical oxygen demand	<10					>10mg/l	G/03: APHA, 2005 Method 5220D
Biochemical oxygen demand	<2					>2mg/l	G/04: APHA, 2005 Method 5210B
Dissolved oxygen DO	6.8					0-50mg/l	Electrometric Probe
Calcium Ca	110					>0.2mg/l	ICP MS
Cadmium Cd	1.0					>0.4µg/l	ICP MS
Chromium Cr	<1.0					>1µg/l	ICP MS

Parameter	Results (mg/l)				Sampling method[2] (grab, drift etc.)	Normal Analytical Range[2]	Analysis method / technique
Chloride Cl	22					<0.2mg/l	Ion Chromatography
Copper Cu	<5.0					>5µg/l	ICP MS
Iron Fe	0.29					>0.05mg/l	ICP-MS
Lead Pb	16					>5µg/l	ICP MS
Magnesium Mg	42					>0.1mg/l	ICP MS
Manganese Mn	0.073					>0.01mg/l	ICP MS
Mercury Hg	<0.050					>0.05µg/l	ICP MS

Surface Water Quality (Sheet 2 of 2)

Parameter	Results (mg/l)				Sampling method (grab, drift etc.)	Normal Analytical Range	Analysis method / technique
	18/10/07	Date	Date	Date			
Nickel Ni	31					>5µg/l	ICP MS
Potassium K	6.2					>0.1mg/l	ICP MS
Sodium Na	13					>0.1mg/l	ICP MS
Sulphate SO_4	220					>0.5mg/l	Ion Chromatography
Zinc Zn	350					>10µg/l	ICP MS
Total alkalinity (as $CaCO_3$)*	280					>5mg/l HCO_3	Titrimetry
Total organic carbon TOC	<5					>5mg/l TOC	TOC Analyser
Total oxidised nitrogen TON**	1.64					>0.2mg/l N	G/67:APHA 2005, 4500-N02B, Colorimetric Method
Nitrite NO_2	0.13					>0.03 mg/l NO_2	Spectrometry
Nitrate NO_3	7.0					>0.44mg/l NO_3	Spectrometry
Faecal coliforms (/100mls)	<1					>1mpn/100ml	MPN, IDEXX defined substrate method
Total coliforms (/100mls)	<1					>1mpn/100ml	MPN, IDEXX defined substrate method

Parameter	Results (mg/l)				Sampling method (grab, drift etc.)	Normal Analytical Range	Analysis method / technique
	18/10/07	Date	Date	Date			
Phosphate PO_4	<0.03					<0.03mg/l PO_4	Spectrometry

*As HCO_3^-
**As N

Table I.2(i) SURFACE WATER QUALITY

(Sheet 1 of 2) Monitoring Point/ Grid Reference: Downstream of Rossestown Discharge Point (PWE2) E218671 N167006

Parameter	Results (mg/l)				Sampling method[2] (grab, drift etc.)	Normal Analytical Range[2]	Analysis method / technique
	18/10/07						
pH	6.6				Grab sample for all parameters	0-14 pH Units	Electrometric Probe
Temperature	10.7					-5°C - 45°C	Electrometric Probe
Electrical conductivity EC	0.862					0-200mS	Electrometric Probe
Ammoniacal nitrogen NH_4-N	0.3					>0.05 mg/l NH_4-N	Spectometry
Chemical oxygen demand	<10					>10mg/l	G/03: APHA, 2005 Method 5220D
Biochemical oxygen demand	<2					>2mg/l	G/04: APHA, 2005 Method 5210B
Dissolved oxygen DO	6.6					0-50mg/l	Electrometric Probe
Calcium Ca	100					>0.2mg/l	ICP MS
Cadmium Cd	<0.4					>0.4µg/l	ICP MS
Chromium Cr	<1.0					>1µg/l	ICP MS

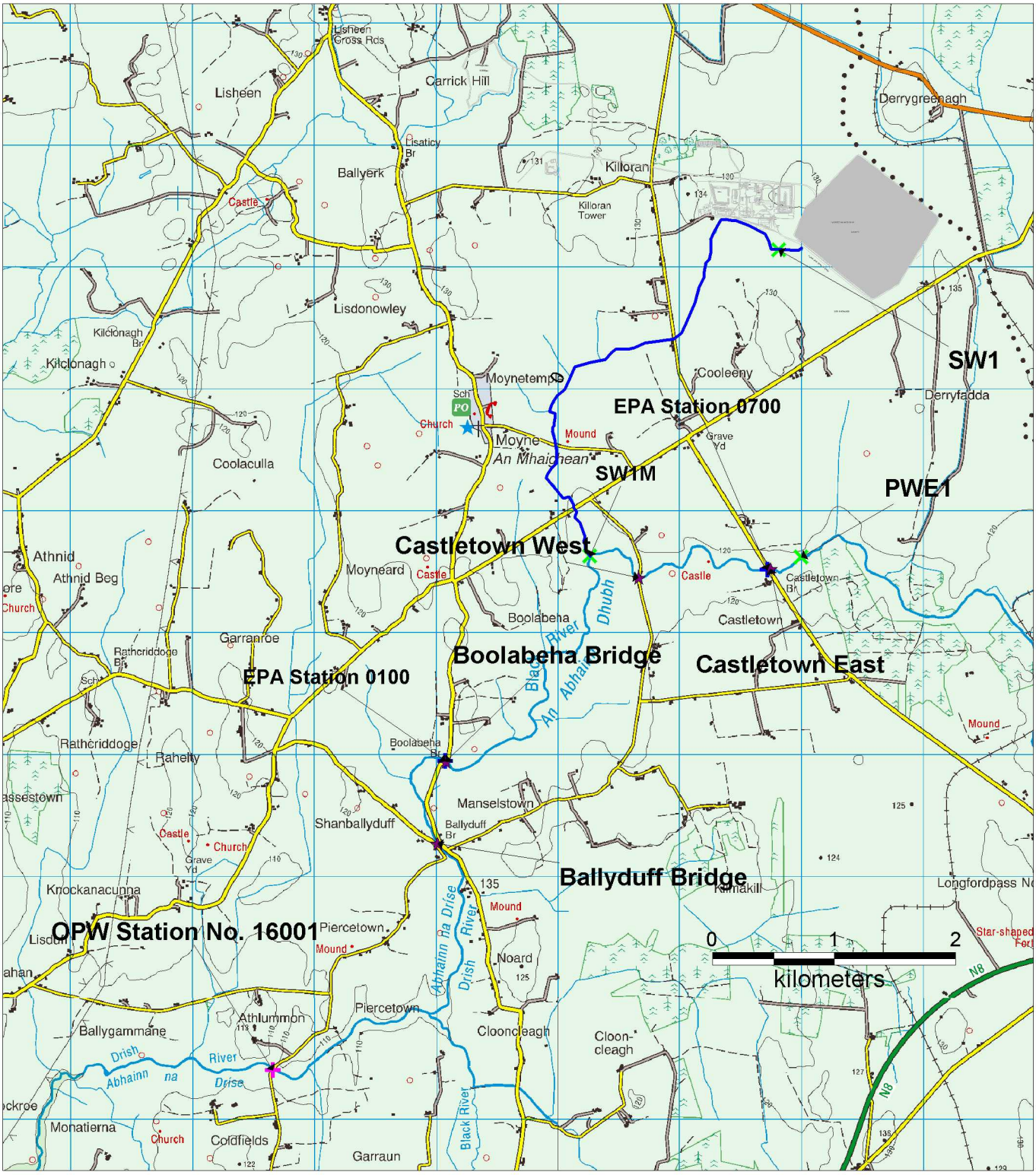
Parameter	Results (mg/l)				Sampling method[2] (grab, drift etc.)	Normal Analytical Range[2]	Analysis method / technique
Chloride Cl	21					<0.2mg/l	Ion Chromatography
Copper Cu	<5.0					>5µg/l	ICP MS
Iron Fe	0.16					>0.05mg/l	ICP-MS
Lead Pb	<5.0					>5µg/l	ICP MS
Magnesium Mg	40					>0.1mg/l	ICP MS
Manganese Mn	0.029					>0.01mg/l	ICP MS
Mercury Hg	<0.05					>0.05µg/l	ICP MS

Surface Water Quality (Sheet 2 of 2)

Parameter	Results (mg/l)				Sampling method (grab, drift etc.)	Normal Analytical Range	Analysis method / technique
	18/10/07	Date	Date	Date			
Nickel Ni	21					>5µg/l	ICP MS
Potassium K	5.8					>0.1mg/l	ICP MS
Sodium Na	13					>0.1mg/l	ICP MS
Sulphate SO_4	200					>0.5mg/l	Ion Chromatography
Zinc Zn	230					>10µg/l	ICP MS
Total alkalinity (as $CaCO_3$)*	270					>5mg/l HCO_3	Titrimetry
Total organic carbon TOC	<5					>5mg/l TOC	TOC Analyser
Total oxidised nitrogen TON**	2.76					>0.2mg/l N	G/67:APHA 2005, 4500-N02B, Colorimetric Method
Nitrite NO_2	0.1					>0.03 mg/l NO_2	Spectrometry
Nitrate NO_3	12					>0.44mg/l NO_3	Spectrometry
Faecal coliforms (/100mls)	<1					>1mpn/100ml	MPN, IDEXX defined substrate method
Total coliforms (/100mls)	<1					>1mpn/100ml	MPN, IDEXX defined substrate method

Parameter	Results (mg/l)				Sampling method (grab, drift etc.)	Normal Analytical Range	Analysis method / technique
	18/10/07	Date	Date	Date			
Phosphate PO_4	<0.03					<0.03mg/l PO_4	Spectrometry

*As HCO_3^-
**As N



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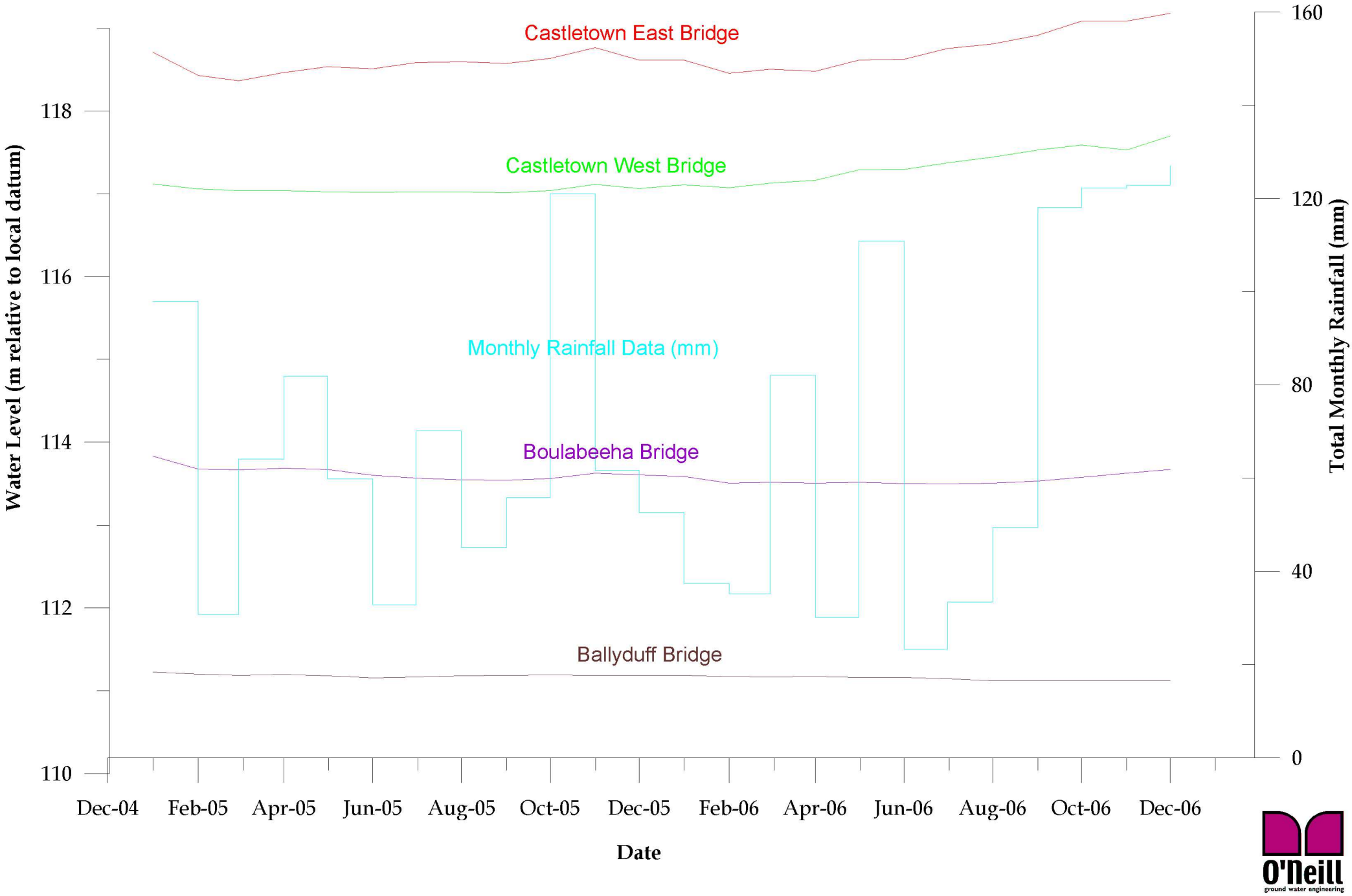
Investigation of the Impact of Additional Discharge to the Rossestown River and a Redistribution of Discharge to the Drish River from the Lisheen Mine, Killoran, Co. Tipperary

Title:
Regional Hydrology of River Drish

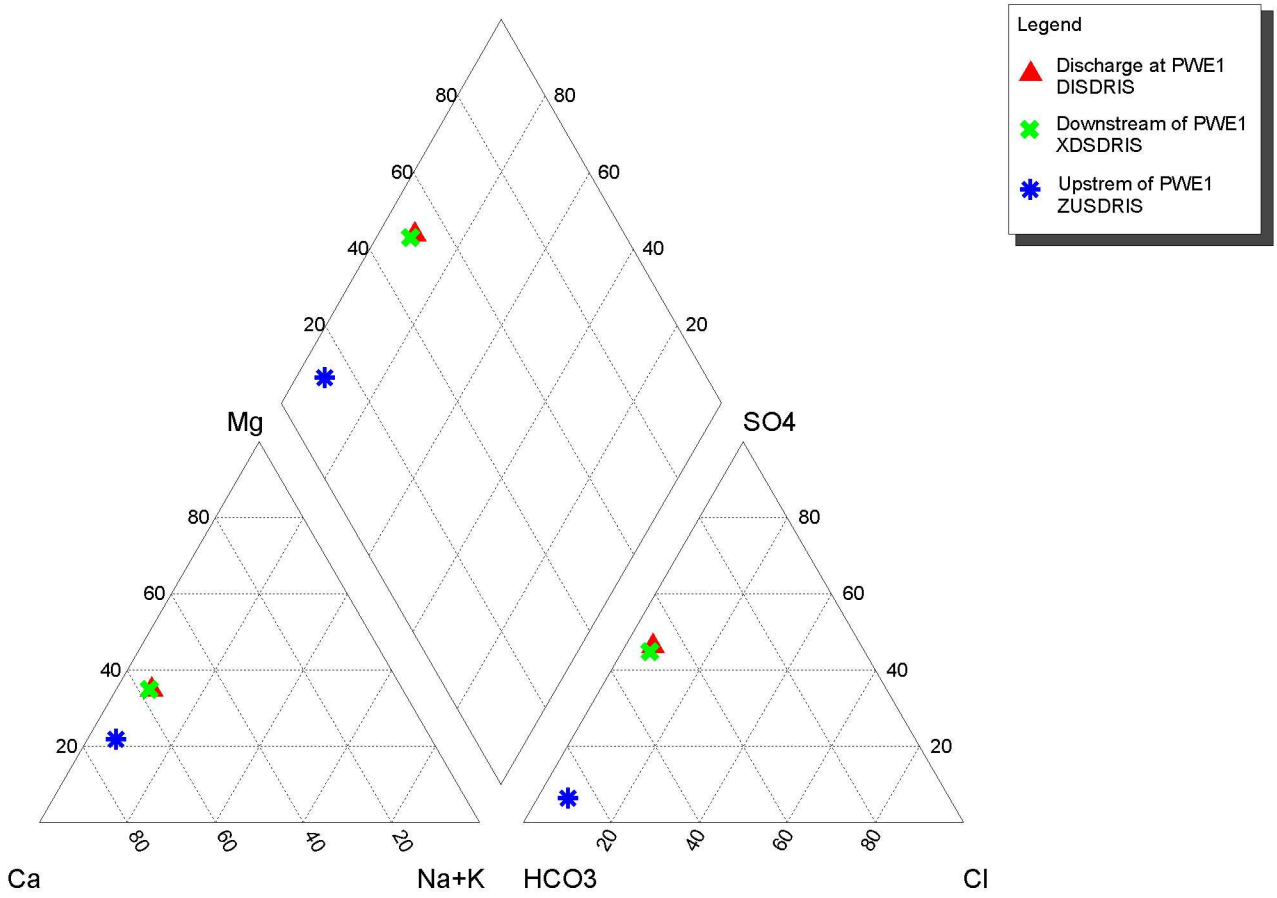
Key:

Scale:	as drawing	**Datum:**	Malin
Date:	November 2007	**Checked:**	SON
Author:	OOC	**Figure no:**	I.2.1
Drawn by:	OOC	**Reference:**	1560701

Figure No. I.2.2: Rainfall and Stage Elevation Hydrographs for Four Monitoring Sites on the Drish River



Piper Plot



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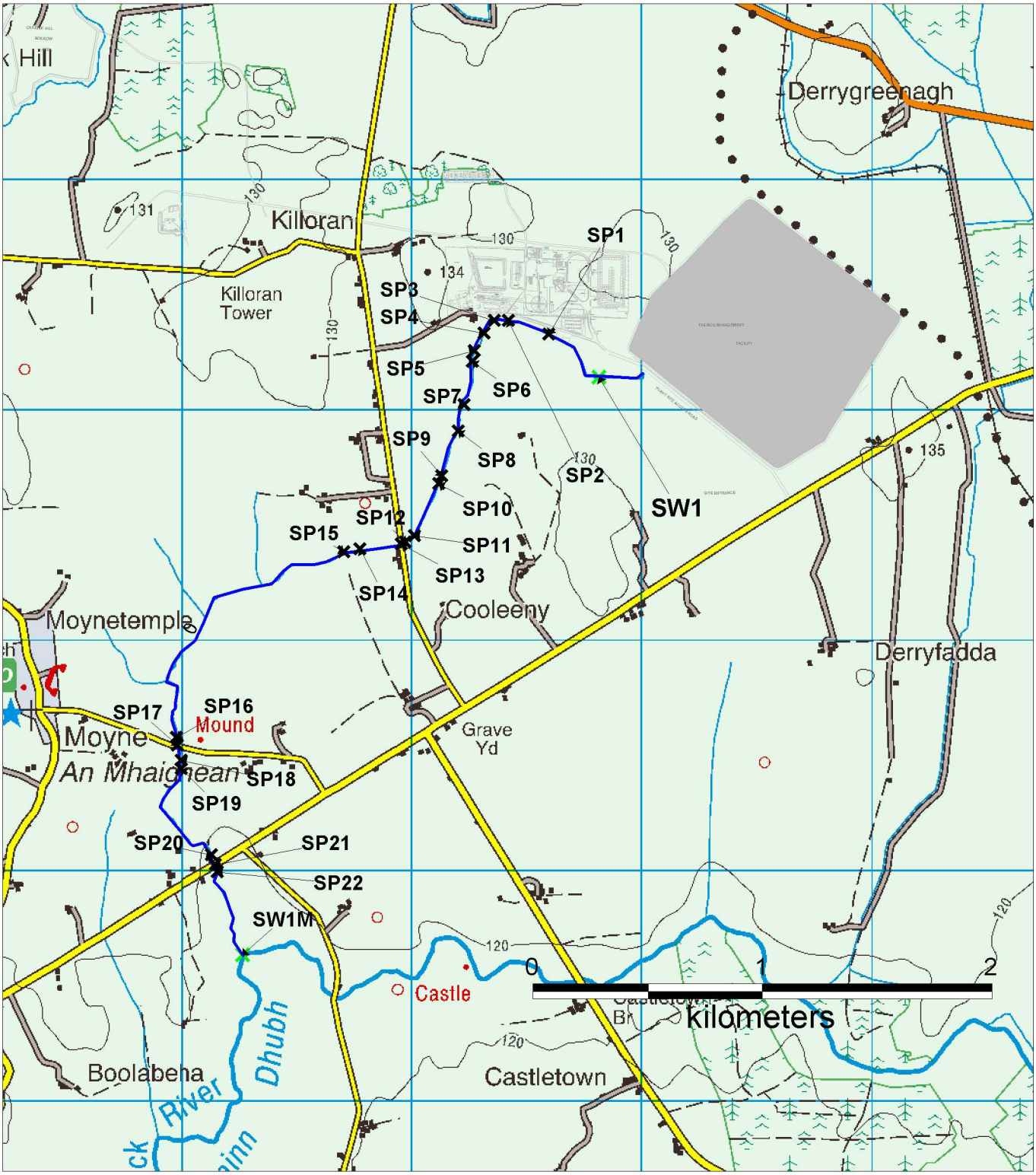
Title :
Piper Plot Drish River Samples

Key :

Scale :		Datum :	
Date :	Dec 2007	Checked :	S. O'Neill
Author :	OOC	Figure No. :	I.2.3
Drawn By :	OOC	Ref :	1560701



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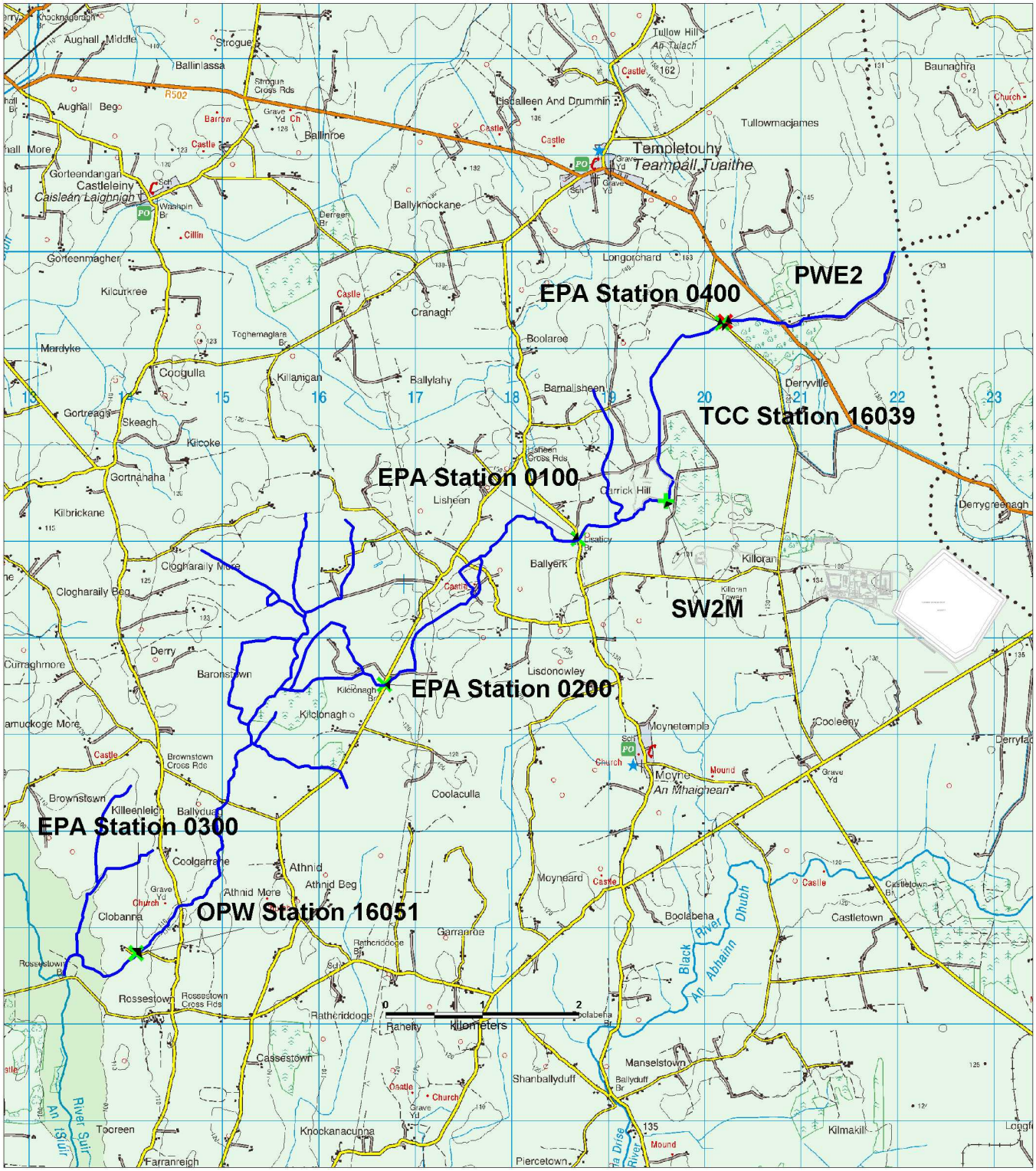
Title: Route and Survey Points along Clougheen Tributary

Key:

Scale:	as drawing	**Datum:**	Malin
Date:	November 2007	**Checked:**	SON
Author:	OOC	**Figure no:**	I.2.4
Drawn by:	OOC	**Reference:**	1560701



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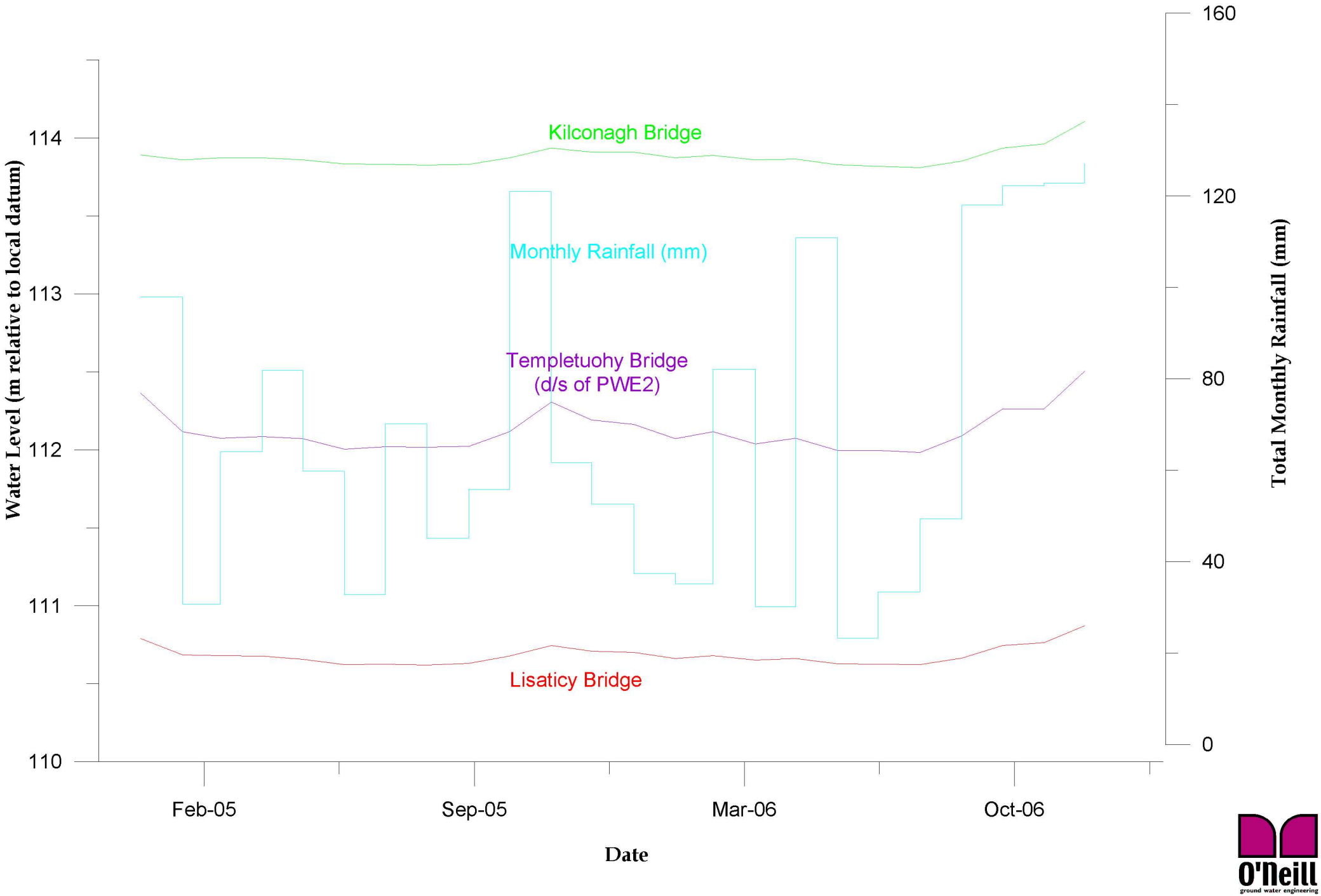
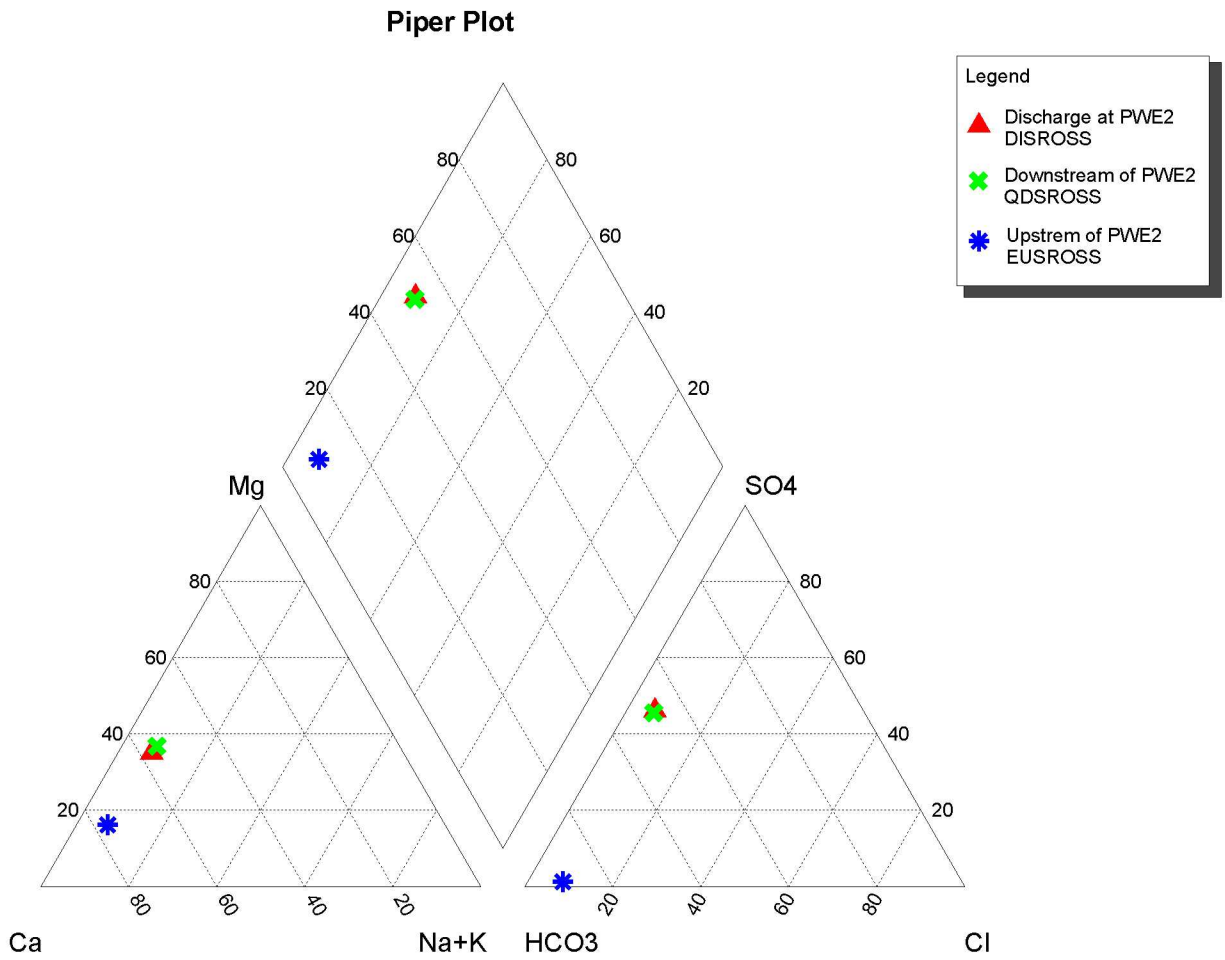
Title:
Regional Hydrology of Rossestown River

Key:

Scale:	as per drawing	**Datum:**	Malin
Date:	November 2007	**Checked:**	SON
Author:	OOC	**Figure no:**	I.2.5
Drawn by:	OOC	**Reference:**	1560701

Figure No. I.2.6: Rainfall and Stage Elevation Hydrographs for Three Monitoring Sites on the Rossestown River





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Title :
Piper Plot of Samples from Rossestown River

Key :

Scale :		Datum :	
Date :	Nov 2007	Checked :	S. O'Neill
Author :	OOC	Figure No. :	I.2.7
Drawn By :	OOC	Ref :	1560701

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Title:
Route of Emergency Channel from SW2 at Emergency Weir to SW2M at Rossestown River

Key:

Scale:	as per drawing	**Datum:**	Malin
Date:	November 2007	**Checked:**	SON
Author:	OOC	**Figure no:**	I.2.8
Drawn by:	OOC	**Reference:**	1560701

APPENDIX NO. I.2.1

FLOW DATA FOR ATHLUMMON GAUGING STATION

Summary Statistics Data

• ***Daily Mean Flow Data*** • ***Daily Mean Level Data*** • ***Annual Maxima Data***

GENERAL STATION DETAILS			
Station Name: Athlummon	Station No: 16001	Watercourse: Drish	NGR: S 176 594
Catchment Area (km^2): 140	Catchment: Suir	Gauge Type: L/AR	Datum: Poolbeg

SUMMARY HYDROMETRIC STATISTICS
Annual Average Rainfall (mm)[1]: 946
Est'd Annual Losses (mm)[1]: 455
Mean Annual Flow (m^3/s): 2.0402 (Data derived for the period 1972 to 2001)

STATION HISTORY
Period of Continuous Hardcopy Records: 1956 to 2005
Period of Digitised Record: 1972 to 2005

Note 1 : Data extracted from the Environmental Protection Agency publication 'Hydrological Data', July 1997

DURATION PERCENTILES							
Flows equalled or exceeded for the given percentage of time (m^3/s) (Data derived for the period 1972 to 2001)							
1%	5%	10%	50%	80%	90%	95%	99%
11.2	6.36	4.61	1.33	0.48	0.27	0.17	0.10
Levels equalled or exceeded for the given percentage of time (mAOD Poolbeg) (Data derived for the period 1972 to 2005)							
1%	5%	10%	50%	80%	90%	95%	99%
108.78	108.66	108.59	108.42	108.33	108.29	108.27	108.20

Annual Maxima Data

• ***Summary Statistics Data*** • ***Daily Mean Flow Data*** • ***Daily Mean Level Data***

GENERAL STATION DETAILS			
Station Name: Athlummon	Station No: 16001	Watercourse: Drish	NGR: S 176 594
Catchment Area (km^2): 140	Catchment: Suir	Gauge Type: L/AR	Datum: Poolbeg

HYDROMETRIC YEAR[1]	WATER LEVEL (mAOD-Poolbeg)	S.G. READING (m)	ESTIMATED FLOWS (m^3/s)	RELIABLE LIMIT[2] (m^3/s)	DATE	COMMENTS / NOTES
1956	108.95	1.07	-	-	**24/09/1957**	Flows > 17m3/s are derived from an extrapolation of the rating and should be treated with caution
1957	108.88	1.00	-	-	**27/08/1958**	
1958	108.85	0.98	-	-	**20/12/1958**	
1959	108.97	1.09	-	-	**14/09/1960**	
1960	109.00	1.12	-	-	**04/12/1960**	
1961	108.86	0.99	-	-	**14/01/1962**	
1962	109.06	1.18	-	-	**06/11/1962**	
1963	109.07	1.19	-	-	**13/11/1963**	
1964	109.04	1.16	-	-	**13/12/1964**	
1965	109.13	1.25	-	-	**17/11/1965**	
1966	109.04	1.16	-	-	**14/10/1966**	
1967	109.03	1.15	-	-	**18/10/1967**	
1968	109.05	1.17	-	-	**21/01/1969**	
1969	108.90	1.02	-	-	**25/01/1970**	
1970	108.93	1.05	-	-	**23/11/1970**	
1971	108.88	1.00	-	-	**07/02/1972**	
1972	108.86	0.94	-	-	**19/01/1973**	
1973	108.92	1.00	-	-	**30/01/1974**	
1974	108.90	0.84	17.0	17	**24/01/1975**	
1975	108.88	0.82	16.0	17	**30/01/1976**	
1976	108.86	0.80	14.0	17	**14/02/1977**	
1977	108.88	0.82	17.0	17	**30/01/1978**	
1978	108.98	0.92	24.0	17	**28/12/1978**	
1979	108.92	0.86	20.0	17	**26/12/1979**	
1980	108.86	0.80	16.0	17	**27/05/1981**	
1981	108.83	0.77	14.0	17	**28/12/1981**	
1982	108.86	0.80	15.0	17	**08/11/1982**	
1983	108.92	0.86	19.0	17	**27/01/1984**	

1984	108.76	0.70	10.0	17	**08/02/1985**	
1985	108.88	0.82	17.0	17	**26/08/1986**	
1986	108.83	0.77	14.0	17	**09/12/1986**	
1987	108.89	0.83	17.0	17	**19/01/1988**	
1988	108.83	0.77	12.0	17	**26/10/1988**	
1989	108.92	0.86	17.0	17	**04/01/1990**	
1990	108.78	0.72	11.0	17	**28/12/1990**	
1991	108.74	0.68	10.0	17	**25/11/1991**	
1992	108.79	0.73	12.0	17	**26/05/1993**	
1993	108.85	0.79	15.0	17	**04/02/1994**	
1994	108.90	0.84	18.0	17	**10/03/1995**	
1995	108.91	0.85	19.0	17	**07/01/1996**	
1996	108.82	0.76	13.0	17	**07/08/1997**	
1997	108.82	0.76	13.0	17	**05/01/1998**	
1998	108.79	0.73	12.0	17	**05/01/1999**	
1999	108.90	0.84	18.0	17	**16/12/1999**	
2000	108.91	0.85	19.0	17	**06/11/2000**	
2001	108.86	0.80	15.7	-	**02/03/2002**	
2002	108.89	0.83	17.5	17.32	**27/11/2002**	
2003	108.76	0.70	10.4	17.32	**15/01/2004**	
2004	108.95	0.89	21.3	-	**29/10/2004**	

Note 1 : These are the highest recorded water levels or estimated flows in each available hydrometric year of record. A hydrometric year runs from 1st October in the given year to the 30th September the following year, i.e., the hydrometric year 2000 runs from 1st October 2000 to 30th September 2001.

Note 2 : Limit of Reliable Rating: Estimated flows greater than the values given have been derived from an extrapolation of the rating and should be treated with caution

OFFICE OF PUBLIC WORKS
HYDROMETRIC SECTION

STATION NAME **Athlummon**
STATION No. **16001**
RIVER **Drish**
CATCHMENT **Suir**

Annual Maximum Series of Recorded Water Levels and Estimated Flows (1)

HYDROMETRIC YEAR	WATER LEVEL (mAOD - Poolbeg)	S.G. READING (m)	ESTIMATED FLOW (m3/s)	DATE
2005	108.81	0.75	12.8	03/11/2005
2006	108.91	0.85	18.8	03/12/2006 (2)

(1) Flows > 17m3/s are derived from an extrapolation of the rating and should be treated with caution
(2) Highest water level recorded during hydrometric year 2006 to 09/08/2007

Hydrometric years run from the 1st October to 30th September, e.g., hydrometric year 1980 begins on 1st October 1980.
Current Staff Gauge Zero = 108.06 mAOD (Poolbeg)

OFFICE OF PUBLIC WORKS
HYDROMETRIC SECTION

STATION NAME **Athlummon**
STATION No. **16001**
RIVER **Drish**
CATCHMENT **Suir**

Annual Maximum Series of Recorded Water Levels and Estimated Flows (1)

HYDROMETRIC YEAR	WATER LEVEL (mAOD - Poolbeg)	S.G. READING (m)	ESTIMATED FLOW (m3/s)	DATE
2005	108.81	0.75	12.8	03/11/2005
2006	108.91	0.85	18.8	03/12/2006 (2)

(1) Flows > 17m3/s are derived from an extrapolation of the rating and should be treated with caution
(2) Highest water level recorded during hydrometric year 2006 to 09/08/2007

Hydrometric years run from the 1st October to 30th September, e.g., hydrometric year 1980 begins on 1st October 1980.
Current Staff Gauge Zero = 108.06 mAOD (Poolbeg)

APPENDIX NO. I.2.2

DATA FOR DRISH FLOOD LINE PREDICTIONS

Discharge Site (Natural Section)

Looking Downstream

Water level elevation	(m)	Unknown
Initial offset	(m)	-27.250
Section distance	(m)	4.54

Arch	Offset	Floor	Opening	Overflow
None	-27.250	Unknown	None	None
	-22.708	-0.310	None	None
	-18.167	-0.420	None	None
	-13.625	-0.530	None	None
	-9.083	-0.550	None	None
	-4.542	-0.520	None	None
	0.000	-0.580	None	None
	4.542	-0.490	None	None
	9.083	-0.470	None	None
	13.625	-0.370	None	None
	18.167	-0.340	None	None
	22.708	-0.280	None	None
	27.250	-0.220	None	None

Looking Upstream

Water level elevation	(m)	Unknown
Initial offset	(m)	-27.250
Section distance	(m)	4.54

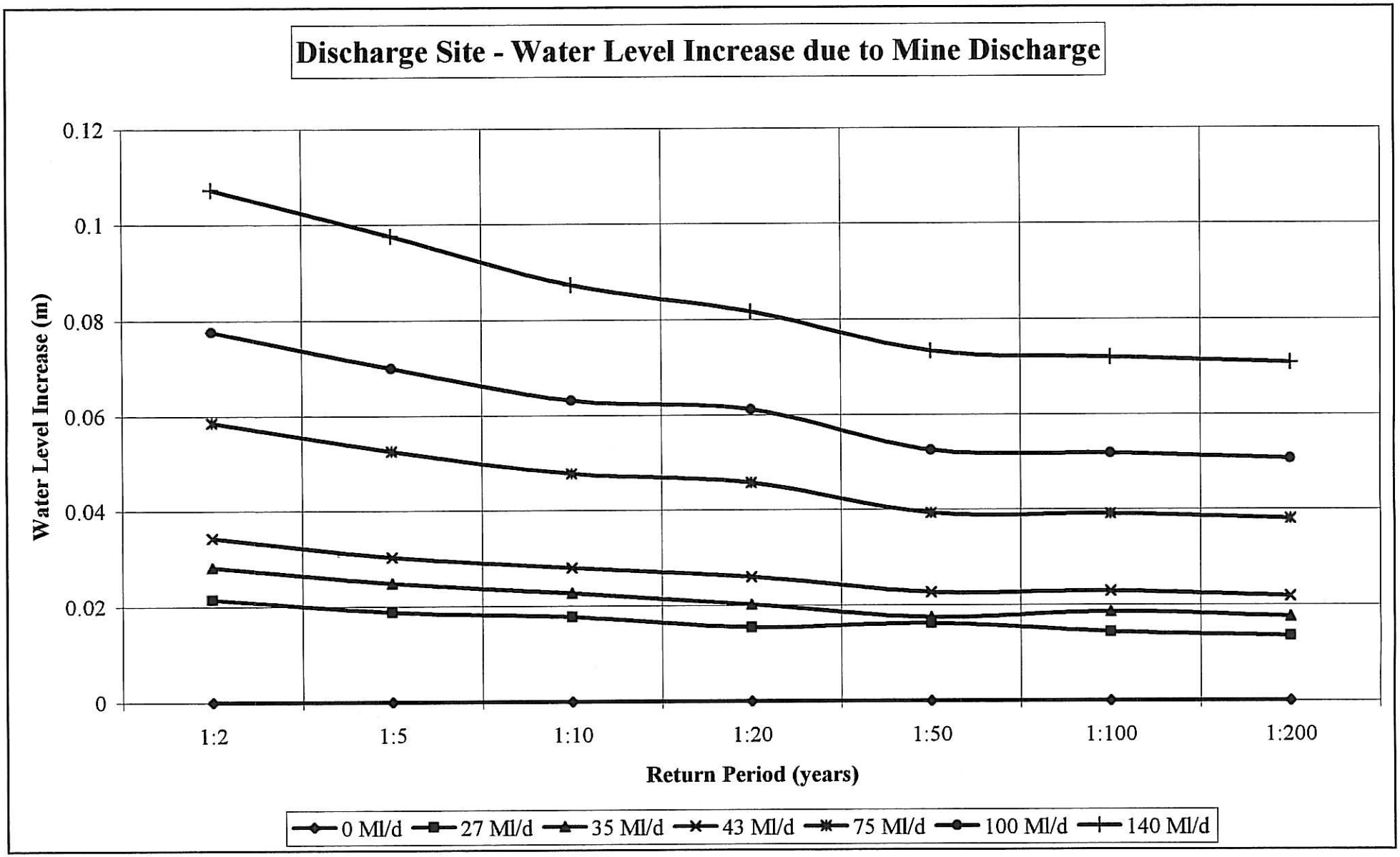
Arch	Offset	Floor	Opening	Overflow
None	-27.250	-0.220	None	None
	-22.708	-0.280	None	None
	-18.167	-0.340	None	None
	-13.625	-0.370	None	None
	-9.083	-0.470	None	None
	-4.542	-0.490	None	None
	0.000	-0.580	None	None
	4.542	-0.520	None	None
	9.083	-0.550	None	None
	13.625	-0.530	None	None
	18.167	-0.420	None	None
	22.708	-0.310	None	None
	27.250	Unknown	None	None

Stage - Discharge Table for the Mine Discharge Site

Stage (m)	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.000	0.005	0.013	0.024	0.036	0.050	0.065	0.082	0.099	0.117
0.1	0.137	0.157	0.178	0.199	0.222	0.245	0.269	0.293	0.319	0.344
0.2	0.371	0.398	0.425	0.454	0.482	0.511	0.541	0.571	0.602	0.633
0.3	0.665	0.697	0.730	0.763	0.797	0.831	0.865	0.900	0.935	0.971
0.4	1.007	1.043	1.080	1.118	1.155	1.193	1.232	1.271	1.310	1.349
0.5	1.389	1.429	1.470	1.511	1.552	1.594	1.636	1.678	1.720	1.763
0.6	1.807	1.850	1.894	1.938	1.983	2.028	2.073	2.118	2.164	2.210
0.7	2.256	2.303	2.350	2.397	2.444	2.492	2.540	2.588	2.637	2.686
0.8	2.735	2.784	2.834	2.884	2.934	2.985	3.036	3.087	3.138	3.189
0.9	3.241	3.293	3.346	3.398	3.451	3.504	3.557	3.611	3.665	3.719
1.0	3.773	5.089	5.227	5.366	5.508	5.653	5.799	5.948	6.100	6.254
1.1	6.410	6.568	6.730	6.893	7.059	7.228	7.399	7.573	7.749	7.928
1.2	8.109	8.293	8.479	8.668	8.860	9.055	9.252	9.452	9.654	9.859
1.3	10.067	10.278	10.491	10.707	10.926	11.148	11.373	11.600	11.830	12.063

OGE

Discharge Site							
Return Period (years)	Natural Flood Peaks (m^3/s)	Mine Discharge (Ml/d)	Mine Discharge (m^3/s)	Flow Rate (m^3/s)	Water Level (m)	Depth increase due to pumping (m)	Flood Width (m)
1:2	5.200	0	0.000	5.200	118.907	0.000	36.896
	5.200	27	0.310	5.510	118.929	0.021	38.086
	5.200	35	0.400	5.600	118.935	0.028	38.458
	5.200	43	0.500	5.700	118.942	0.034	38.799
	5.200	75	0.870	6.070	118.966	0.059	40.145
	5.200	100	1.160	6.360	118.985	0.078	41.199
	5.200	140	1.620	6.820	119.015	0.107	42.847
1:5	6.600	0	0.000	6.600	119.001	0.000	42.081
	6.600	27	0.310	6.910	119.020	0.019	43.124
	6.600	35	0.400	7.000	119.026	0.025	43.457
	6.600	43	0.500	7.100	119.031	0.030	43.762
	6.600	75	0.870	7.470	119.053	0.053	44.679
	6.600	100	1.160	7.760	119.071	0.070	45.535
	6.600	140	1.620	8.220	119.098	0.098	46.894
1:10	7.500	0	0.000	7.500	119.055	0.000	44.758
	7.500	27	0.310	7.810	119.073	0.018	45.629
	7.500	35	0.400	7.900	119.078	0.023	45.875
	7.500	43	0.500	8.000	119.083	0.028	46.136
	7.500	75	0.870	8.370	119.103	0.048	47.105
	7.500	100	1.160	8.660	119.118	0.063	47.863
	7.500	140	1.620	9.120	119.142	0.087	49.049
1:20	8.800	0	0.000	8.800	119.126	0.000	48.262
	8.800	27	0.310	9.110	119.141	0.015	49.020
	8.800	35	0.400	9.200	119.146	0.020	49.256
	8.800	43	0.500	9.300	119.152	0.026	49.541
	8.800	75	0.870	9.670	119.172	0.046	50.511
	8.800	100	1.160	9.960	119.187	0.061	51.269
	8.800	140	1.620	10.420	119.208	0.082	52.278
1:50	9.700	0	0.000	9.700	119.173	0.000	50.585
	9.700	27	0.310	10.010	119.189	0.016	51.382
	9.700	35	0.400	10.100	119.191	0.017	51.441
	9.700	43	0.500	10.200	119.196	0.023	51.702
	9.700	75	0.870	10.570	119.213	0.039	52.519
	9.700	100	1.160	10.860	119.226	0.053	53.169
	9.700	140	1.620	11.320	119.247	0.073	54.192
1:100	10.700	0	0.000	10.700	119.218	0.000	52.804
	10.700	27	0.310	11.010	119.233	0.014	53.513
	10.700	35	0.400	11.100	119.237	0.019	53.720
	10.700	43	0.500	11.200	119.241	0.023	53.931
	10.700	75	0.870	11.570	119.257	0.039	54.729
	10.700	100	1.160	11.860	119.270	0.052	55.354
	10.700	140	1.620	12.320	119.290	0.072	56.343
1:200	11.700	0	0.000	11.700	119.263	0.000	55.009
	11.700	27	0.310	12.010	119.277	0.014	55.674
	11.700	35	0.400	12.100	119.281	0.018	55.871
	11.700	43	0.500	12.200	119.285	0.022	56.086
	11.700	75	0.870	12.570	119.301	0.038	56.879
	11.700	100	1.160	12.860	119.314	0.051	57.505
	11.700	140	1.620	13.320	119.334	0.071	58.494


Discharge Site - Water Level Increase due to Mine Discharge
Water Level Increase (m)
0.12
0.1
0.08
0.06
0.04
0.02
0
1:2
1:5
1:10
1:20
1:50
1:100
1:200
Return Period (years)
0 Ml/d
27 Ml/d
35 Ml/d
43 Ml/d
75 Ml/d
100 Ml/d
140 Ml/d

OGE

Castletown Bridge (Elliptical Arches)

Looking Downstream

Water level elevation	(m)	117.929
Initial offset	(m)	-4.332
Arch angle division	(rad)	0.262
Max. overflow height	(m)	120.680
Left overflow slope		0.030
Right overflow slope		0.028

Arch	Offset	Floor	Opening	Overflow
First	-4.332	117.704	117.704	120.550
	-4.331	117.704	119.354	120.550
	-4.300	117.704	119.516	120.551
	-4.207	117.704	119.667	120.554
	-4.058	117.704	119.796	120.559
	-3.865	117.704	119.895	120.564
	-3.639	117.679	119.958	120.571
	-3.397	117.679	119.974	120.578
	-3.155	117.679	119.958	120.586
	-2.930	117.679	119.895	120.592
	-2.736	117.679	119.796	120.598
	-2.587	117.704	119.667	120.603
	-2.494	117.704	119.516	120.605
	-2.462	117.704	119.354	120.606
	-2.461	117.704	117.704	120.606
Second	-1.261	117.704	117.704	120.642
	-1.260	117.704	119.484	120.642
	-1.217	117.704	119.670	120.644
	-1.091	117.704	119.844	120.647
	-0.891	117.704	119.993	120.653
	-0.630	117.704	120.108	120.661
	-0.326	117.629	120.179	120.670
	0.000	117.629	120.204	120.680
	0.326	117.629	120.179	120.671
	0.630	117.629	120.108	120.662
	0.891	117.629	119.993	120.655
	1.091	117.709	119.844	120.649
	1.217	117.709	119.670	120.645
	1.260	117.709	119.484	120.644
	1.261	117.709	117.709	120.644
Third	2.478	117.709	117.709	120.610
	2.479	117.709	119.509	120.610
	2.511	117.709	119.646	120.609
	2.605	117.709	119.774	120.606
	2.754	117.709	119.884	120.602
	2.949	117.709	119.968	120.596
	3.176	117.669	120.021	120.590
	3.419	117.669	120.034	120.583
	3.662	117.669	120.021	120.576
	3.889	117.669	119.968	120.570
	4.084	117.669	119.884	120.564
	4.233	117.709	119.774	120.560
	4.327	117.709	119.646	120.557
	4.358	117.709	119.509	120.556
	4.359	117.709	117.709	120.556

Looking Upstream

Water level elevation	(m)	117.926
Initial offset	(m)	-4.500
Arch angle division	(rad)	0.262
Max. overflow height	(m)	120.680
Left overflow slope		0.028
Right overflow slope		0.030

Arch	Offset	Floor	Opening	Overflow
Third	-4.500	117.716	117.716	120.552
	-4.499	117.716	119.416	120.552
	-4.465	117.716	119.575	120.553
	-4.364	117.716	119.724	120.556
	-4.203	117.716	119.851	120.561
	-3.993	117.716	119.949	120.567
	-3.748	117.696	120.010	120.574
	-3.485	117.696	120.046	120.581
	-3.222	117.696	120.010	120.589
	-2.978	117.696	119.949	120.595
	-2.767	117.696	119.851	120.601
	-2.606	117.701	119.724	120.606
	-2.505	117.701	119.575	120.609
	-2.470	117.701	119.416	120.610
	-2.469	117.701	117.701	120.610
Second	-1.291	117.701	117.701	120.643
	-1.290	117.701	119.286	120.643
	-1.246	117.701	119.503	120.645
	-1.117	117.701	119.706	120.648
	-0.912	117.701	119.880	120.654
	-0.645	117.701	120.013	120.662
	-0.334	117.646	120.097	120.671
	0.000	117.646	120.126	120.680
	0.334	117.646	120.097	120.670
	0.645	117.646	120.013	120.661
	0.912	117.646	119.880	120.653
	1.117	117.696	119.706	120.647
	1.246	117.696	119.503	120.643
	1.290	117.696	119.286	120.641
	1.291	117.696	117.696	120.641
First	2.439	117.696	117.696	120.607
	2.440	117.696	119.376	120.607
	2.472	117.696	119.533	120.606
	2.565	117.696	119.679	120.603
	2.714	117.696	119.804	120.599
	2.908	117.696	119.900	120.593
	3.133	117.666	119.960	120.586
	3.375	117.666	119.996	120.579
	3.617	117.666	119.960	120.572
	3.843	117.666	119.900	120.565
	4.036	117.666	119.804	120.559
	4.185	117.671	119.679	120.555
	4.278	117.671	119.533	120.552
	4.309	117.671	119.376	120.551
	4.310	117.671	117.671	120.551

OGE

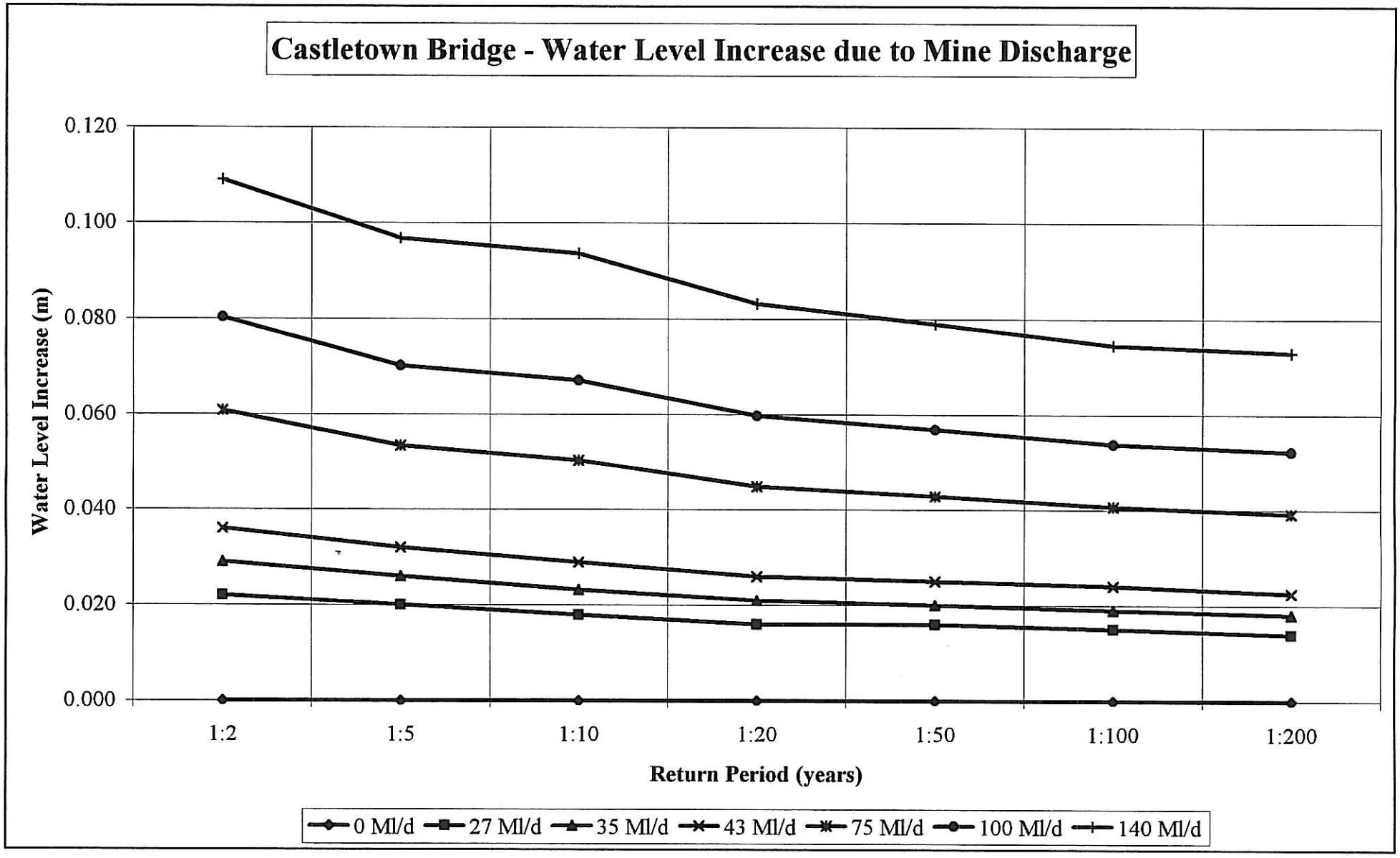
Stage - Discharge Table for the Castletown Bridge (SW008)

Stage (m)	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.000	0.015	0.034	0.055	0.078	0.101	0.125	0.149	0.175	0.200
0.1	0.227	0.253	0.281	0.308	0.336	0.364	0.393	0.422	0.451	0.480
0.2	0.510	0.540	0.570	0.601	0.632	0.662	0.694	0.725	0.756	0.788
0.3	0.820	0.852	0.884	0.917	0.950	0.982	1.015	1.048	1.082	1.115
0.4	1.148	1.182	1.216	1.250	1.284	1.318	1.353	1.387	1.422	1.456
0.5	1.491	1.526	1.561	1.597	1.632	1.667	1.703	1.739	1.774	1.810
0.6	1.846	1.882	1.918	1.955	1.991	2.027	2.064	2.101	2.137	2.174
0.7	2.211	2.248	2.285	2.323	2.360	2.397	2.435	2.472	2.510	2.547
0.8	2.585	2.623	2.661	2.699	2.737	2.775	2.814	2.852	2.890	2.929
0.9	2.967	3.006	3.045	3.084	3.122	3.161	3.200	3.239	3.279	3.318
1.0	3.357	3.396	3.436	3.475	3.515	3.554	3.594	3.634	3.673	6.030
1.1	6.173	6.318	6.465	6.614	6.765	6.918	7.074	7.231	7.391	7.552
1.2	7.716	7.882	8.050	8.221	8.393	8.568	8.745	8.924	9.105	9.289
1.3	9.475	9.663	9.853	10.045	10.240	10.437	10.637	10.839	11.043	11.249
1.4	11.458	11.669	11.882	12.098	12.316	12.537	12.760	12.985	13.213	13.443
1.5	13.676	13.911	14.148	14.388	14.631	14.876	15.123	15.373	15.625	15.880
1.6	16.138	16.398	16.660	16.925	17.193	17.463	17.736	18.011	18.289	18.569
1.7	18.853	19.138	19.427	19.718	20.011	20.308	20.607	20.908	21.213	21.520
1.8	21.829	22.142	22.457	22.775	23.095	23.418	23.744	24.073	24.405	24.739
1.9	25.076	25.416	25.759	26.104	26.453	26.804	27.158	27.515	27.874	28.237
2.0	28.602	28.970	29.341	29.715	30.092	30.472	30.855	31.240	31.629	32.020
2.1	32.415	32.812	33.213	33.616	34.022	34.431	34.844	35.259	35.677	36.098
2.2	36.523	36.950	37.380	37.814	38.250	38.690	39.132	39.578	40.026	40.478
2.3	40.933	41.391	41.852	42.317	42.784	43.254	43.728	44.205	44.685	45.168
2.4	45.654	46.144	46.636	47.132	47.631	48.134	48.639	49.148	49.660	50.175
2.5	50.693	51.215	51.740	52.268	52.800	53.335	53.873	54.414	54.959	55.507

OGE

Castletown Bridge

Return Period years	Natural Flood Peaks (m^3/s)	Mine Discharge (Ml/d)	Mine Discharge (m^3/s)	Flow Rate (m^3/s)	Water Level (m)	Depth increase due to pumping (m)	Flood Width (m)
1:2	5.500	0	0.000	5.500	118.681	0.000	8.810
	5.500	27	0.310	5.810	118.703	0.022	8.810
	5.500	35	0.400	5.900	118.710	0.029	8.810
	5.500	43	0.500	6.000	118.717	0.036	8.810
	5.500	75	0.870	6.370	118.742	0.061	8.810
	5.500	100	1.160	6.660	118.761	0.080	8.810
	5.500	140	1.620	7.120	118.790	0.109	8.810
1:5	7.000	0	0.000	7.000	118.784	0.000	8.810
	7.000	27	0.310	7.310	118.804	0.020	8.810
	7.000	35	0.400	7.400	118.810	0.026	8.810
	7.000	43	0.500	7.500	118.816	0.032	8.810
	7.000	75	0.870	7.870	118.837	0.053	8.810
	7.000	100	1.160	8.160	118.854	0.070	8.810
	7.000	140	1.620	8.620	118.881	0.097	8.810
1:10	8.000	0	0.000	8.000	118.845	0.000	8.810
	8.000	27	0.310	8.310	118.863	0.018	8.810
	8.000	35	0.400	8.400	118.868	0.023	8.810
	8.000	43	0.500	8.500	118.874	0.029	8.810
	8.000	75	0.870	8.870	118.895	0.050	8.810
	8.000	100	1.160	9.160	118.912	0.067	8.810
	8.000	140	1.620	9.620	118.938	0.094	8.810
1:20	9.300	0	0.000	9.300	118.920	0.000	8.810
	9.300	27	0.310	9.610	118.936	0.016	8.810
	9.300	35	0.400	9.700	118.941	0.021	8.810
	9.300	43	0.500	9.800	118.946	0.026	8.810
	9.300	75	0.870	10.170	118.965	0.045	8.810
	9.300	100	1.160	10.460	118.980	0.060	8.810
	9.300	140	1.620	10.920	119.003	0.083	8.810
1:50	10.300	0	0.000	10.300	118.972	0.000	8.810
	10.300	27	0.310	10.610	118.988	0.016	8.810
	10.300	35	0.400	10.700	118.992	0.020	8.810
	10.300	43	0.500	10.800	118.997	0.025	8.810
	10.300	75	0.870	11.170	119.015	0.043	8.810
	10.300	100	1.160	11.460	119.029	0.057	8.810
	10.300	140	1.620	11.920	119.051	0.079	8.810
1:100	11.400	0	0.000	11.400	119.026	0.000	8.810
	11.400	27	0.310	11.710	119.041	0.015	8.810
	11.400	35	0.400	11.800	119.045	0.019	8.810
	11.400	43	0.500	11.900	119.050	0.024	8.810
	11.400	75	0.870	12.270	119.067	0.041	8.810
	11.400	100	1.160	12.560	119.080	0.054	8.810
	11.400	140	1.620	13.020	119.100	0.074	8.810
1:200	12.500	0	0.000	12.500	119.077	0.000	8.810
	12.500	27	0.310	12.810	119.091	0.014	8.810
	12.500	35	0.400	12.900	119.095	0.018	8.810
	12.500	43	0.500	13.000	119.100	0.023	8.810
	12.500	75	0.870	13.370	119.116	0.039	8.810
	12.500	100	1.160	13.660	119.129	0.052	8.810
	12.500	140	1.620	14.120	119.150	0.073	8.810


Castletown Bridge - Water Level Increase due to Mine Discharge
0.120
0.100
0.080
0.060
0.040
0.020
0.000
Water Level Increase (m)
1:2
1:5
1:10
1:20
1:50
1:100
1:200
Return Period (years)
0 Ml/d
27 Ml/d
35 Ml/d
43 Ml/d
75 Ml/d
100 Ml/d
140 Ml/d

OGE

SW8 Bridge (SW8) (Elliptical Arches)

Looking Downstream

Water level elevation	(m)	116.801
Initial offset	(m)	-3.520
Arch angle division	(rad)	0.262
Max. overflow height	(m)	120.500
Left overflow slope		0.083
Right overflow slope		0.034

Arch	Offset	Floor	Opening	Overflow
First	-3.520	117.146	117.146	120.207
	-3.519	117.146	117.666	120.208
	-3.471	117.146	117.942	120.212
	-3.370	117.146	118.139	120.220
	-3.369	116.666	118.141	120.220
	-3.326	116.666	118.200	120.224
	-3.095	116.666	118.421	120.243
	-2.795	116.601	118.591	120.268
	-2.445	116.601	118.698	120.297
	-2.070	116.601	118.729	120.328
	-1.695	116.601	118.698	120.359
	-1.345	116.601	118.591	120.388
	-1.045	116.651	118.421	120.413
	-0.814	116.651	118.200	120.432
	-0.771	116.651	118.141	120.436
	-0.770	117.171	118.139	120.436
	-0.669	117.171	117.942	120.444
	-0.620	117.171	117.666	120.448
	-0.619	117.171	117.171	120.449
Second	0.619	117.171	117.171	120.479
	0.620	117.171	117.821	120.479
	0.667	117.171	118.038	120.478
	0.770	117.171	118.203	120.474
	0.771	116.671	118.204	120.474
	0.804	116.671	118.241	120.473
	1.023	116.671	118.415	120.466
	1.308	116.616	118.548	120.456
	1.639	116.616	118.632	120.445
	1.995	116.616	118.666	120.433
	2.351	116.616	118.632	120.421
	2.683	116.616	118.548	120.410
	2.967	116.651	118.415	120.400
	3.186	116.651	118.241	120.393
	3.269	116.651	118.137	120.390
	3.270	117.141	118.135	120.390
	3.323	117.141	118.038	120.388
	3.369	117.141	117.821	120.387
	3.370	117.141	117.141	120.387

Looking Upstream

Water level elevation	(m)	116.649
Initial offset	(m)	-3.470
Arch angle division	(rad)	0.262
Max. overflow height	(m)	120.500
Left overflow slope		0.034
Right overflow slope		0.083

Arch	Offset	Floor	Opening	Overflow
Second	-3.470	116.939	116.939	120.383
	-3.469	116.939	117.379	120.383
	-3.421	116.939	117.661	120.385
	-3.279	116.939	117.924	120.390
	-3.180	116.449	118.038	120.393
	-3.179	116.449	118.039	120.393
	-3.053	116.449	118.150	120.397
	-2.758	116.539	118.323	120.407
	-2.414	116.539	118.432	120.419
	-2.045	116.539	118.479	120.431
	-1.676	116.539	118.432	120.444
	-1.333	116.539	118.323	120.455
	-1.037	116.529	118.150	120.465
	-0.811	116.529	117.924	120.473
	-0.771	116.529	117.867	120.474
	-0.770	116.999	117.866	120.474
	-0.669	116.999	117.661	120.478
	-0.620	116.999	117.379	120.479
	-0.619	116.999	116.999	120.479
First	0.619	116.999	116.999	120.449
	0.620	116.999	117.649	120.448
	0.668	116.999	117.929	120.445
	0.770	116.999	118.135	120.436
	0.771	116.529	118.137	120.436
	0.808	116.529	118.189	120.433
	1.030	116.529	118.413	120.414
	1.320	116.499	118.584	120.390
	1.658	116.499	118.692	120.362
	2.020	116.499	118.709	120.332
	2.382	116.499	118.692	120.302
	2.720	116.499	118.584	120.274
	3.010	116.529	118.413	120.250
	3.232	116.529	118.189	120.231
	3.259	116.529	118.152	120.229
	3.260	116.999	118.150	120.229
	3.372	116.999	117.929	120.220
	3.419	116.999	117.649	120.216
	3.420	116.999	116.999	120.216

OGE

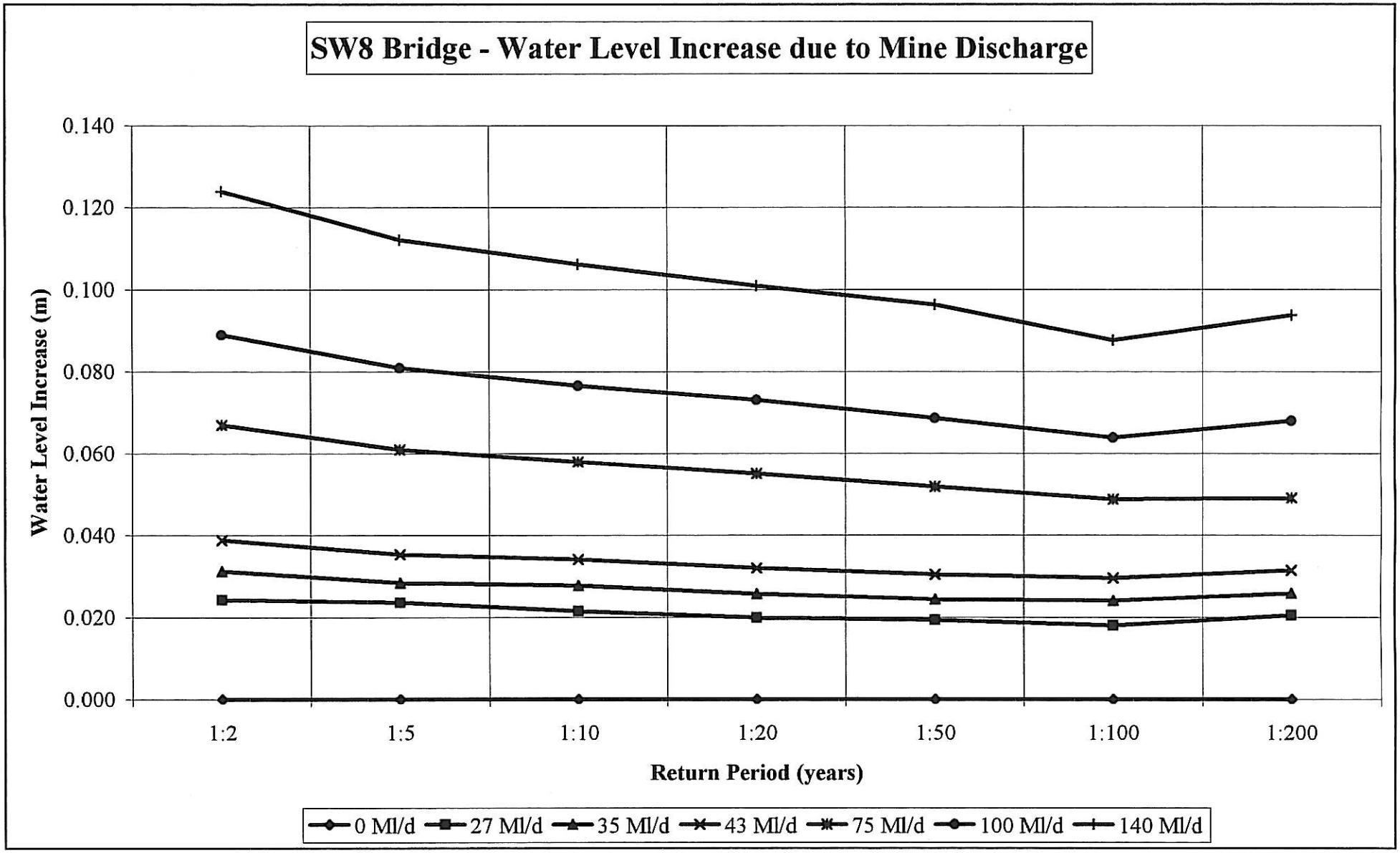
Stage - Discharge Table for the SW8 Bridge (SW8)

Stage (m)	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.000	0.019	0.044	0.073	0.105	0.138	0.173	0.210	0.247	0.286
0.1	0.326	0.367	0.409	0.452	0.495	0.539	0.584	0.630	0.676	0.722
0.2	0.770	0.818	0.866	0.915	0.965	1.015	1.065	1.116	1.168	1.220
0.3	1.272	1.325	1.378	1.432	1.485	1.540	1.594	1.649	1.705	1.761
0.4	1.817	1.873	1.930	1.987	2.044	2.102	2.160	2.218	2.277	2.336
0.5	2.395	2.454	2.525	2.612	2.700	2.789	2.880	2.972	3.065	3.160
0.6	3.255	3.352	3.450	3.550	3.650	3.752	3.855	3.959	4.065	4.172
0.7	4.279	4.389	4.499	4.610	4.723	4.837	4.952	5.068	5.186	5.304
0.8	5.424	5.545	5.667	5.790	5.914	6.040	6.167	6.295	6.423	6.554
0.9	6.685	6.817	6.951	7.085	7.221	7.358	7.496	7.635	7.775	7.917
1.0	8.059	8.203	8.348	8.493	8.640	8.788	8.937	9.088	9.239	9.391
1.1	9.545	9.699	9.855	10.011	10.169	10.328	10.488	10.649	10.811	10.974
1.2	11.138	11.304	11.470	11.637	11.806	11.975	12.146	12.317	12.490	12.664
1.3	12.838	13.014	13.191	13.369	13.548	13.728	13.909	14.091	14.274	14.458
1.4	14.643	14.829	15.016	15.205	15.394	15.584	15.775	15.967	16.161	16.355
1.5	16.550	16.747	16.944	17.142	17.342	17.542	17.743	17.946	18.149	18.353
1.6	18.559	18.765	18.972	19.181	19.390	19.600	19.812	20.024	20.237	20.452
1.7	20.667	20.883	21.100	21.319	21.538	21.758	21.979	22.201	22.424	22.648
1.8	22.873	23.099	23.326	23.554	23.783	24.013	24.244	24.476	24.708	24.942
1.9	25.177	25.412	25.649	25.887	26.125	26.365	26.605	26.846	27.089	27.332
2.0	27.576	27.821	28.068	28.315	28.563	28.812	29.061	29.312	29.564	29.817
2.1	30.070	30.325	30.581	30.837	31.094	31.353	31.612	31.872	32.133	32.395

OGE

SW8 Bridge

Return Period years	Natural Flood Peaks (m^3/s)	Mine Discharge (Ml/d)	Mine Discharge (m^3/s)	Flow Rate (m^3/s)	Water Level (m)	Depth increase due to pumping (m)	Flood Width (m)
1:2	5.900	0	0.000	5.900	117.440	0.000	7.164
	5.900	27	0.310	6.210	117.464	0.024	7.164
	5.900	35	0.400	6.300	117.471	0.031	7.164
	5.900	43	0.500	6.400	117.479	0.039	7.164
	5.900	75	0.870	6.770	117.507	0.067	7.164
	5.900	100	1.160	7.060	117.529	0.089	7.165
	5.900	140	1.620	7.520	117.564	0.124	7.165
1:5	7.400	0	0.000	7.400	117.555	0.000	7.165
	7.400	27	0.310	7.710	117.578	0.024	7.165
	7.400	35	0.400	7.800	117.583	0.028	7.165
	7.400	43	0.500	7.900	117.590	0.035	7.165
	7.400	75	0.870	8.270	117.615	0.061	7.166
	7.400	100	1.160	8.560	117.636	0.081	7.166
	7.400	140	1.620	9.020	117.667	0.112	7.166
1:10	8.500	0	0.000	8.500	117.631	0.000	7.166
	8.500	27	0.310	8.810	117.653	0.021	7.166
	8.500	35	0.400	8.900	117.659	0.028	7.166
	8.500	43	0.500	9.000	117.665	0.034	7.166
	8.500	75	0.870	9.370	117.689	0.058	7.166
	8.500	100	1.160	9.660	117.708	0.077	7.166
	8.500	140	1.620	10.120	117.737	0.106	7.166
1:20	9.900	0	0.000	9.900	117.723	0.000	7.166
	9.900	27	0.310	10.210	117.743	0.020	7.166
	9.900	35	0.400	10.300	117.749	0.026	7.166
	9.900	43	0.500	10.400	117.755	0.032	7.166
	9.900	75	0.870	10.770	117.778	0.055	7.166
	9.900	100	1.160	11.060	117.796	0.073	7.166
	9.900	140	1.620	11.520	117.824	0.101	7.166
1:50	11.000	0	0.000	11.000	117.793	0.000	7.166
	11.000	27	0.310	11.310	117.812	0.019	7.166
	11.000	35	0.400	11.400	117.817	0.024	7.166
	11.000	43	0.500	11.500	117.823	0.030	7.166
	11.000	75	0.870	11.870	117.844	0.052	7.166
	11.000	100	1.160	12.160	117.861	0.069	7.166
	11.000	140	1.620	12.620	117.889	0.096	7.166
1:100	12.200	0	0.000	12.200	117.864	0.000	7.166
	12.200	27	0.310	12.510	117.882	0.018	7.166
	12.200	35	0.400	12.600	117.888	0.024	7.166
	12.200	43	0.500	12.700	117.893	0.029	7.166
	12.200	75	0.870	13.070	117.912	0.049	7.166
	12.200	100	1.160	13.360	117.927	0.064	7.166
	12.200	140	1.620	13.820	117.951	0.088	7.166
1:200	13.300	0	0.000	13.300	117.924	0.000	7.166
	13.300	27	0.310	13.610	117.945	0.020	7.166
	13.300	35	0.400	13.700	117.950	0.026	7.166
	13.300	43	0.500	13.800	117.956	0.031	7.166
	13.300	75	0.870	14.170	117.973	0.049	7.166
	13.300	100	1.160	14.460	117.992	0.068	7.166
	13.300	140	1.620	14.920	118.018	0.094	7.166


SW8 Bridge - Water Level Increase due to Mine Discharge
Water Level Increase (m)
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
1:2
1:5
1:10
1:20
1:50
1:100
1:200
Return Period (years)
0 Ml/d
27 Ml/d
35 Ml/d
43 Ml/d
75 Ml/d
100 Ml/d
140 Ml/d

Ballyduff Bridge (Elliptical Arches)

Looking Downstream

Water level elevation	(m)	97.803
Initial offset	(m)	-4.205
Arch angle division	(rad)	0.262
Max. overflow height	(m)	99.828
Left overflow slope		0.054
Right overflow slope		0.033

Arch	Offset	Floor	Opening	Overflow
First	-4.205	97.803	97.803	99.601
	-4.175	97.470	98.136	99.603
	-4.166	97.428	98.178	99.603
	-4.086	97.428	98.446	99.608
	-3.946	97.428	98.712	99.615
	-3.763	97.428	98.916	99.625
	-3.549	97.428	99.044	99.637
	-3.320	97.428	99.088	99.649
	-3.091	97.428	99.044	99.661
	-2.878	97.428	98.916	99.673
	-2.694	97.428	98.712	99.683
	-2.554	97.428	98.446	99.690
	-2.474	97.428	98.178	99.695
	-2.465	97.470	98.136	99.695
	-2.435	97.803	97.803	99.697
Second	-1.220	97.803	97.803	99.762
	-1.185	97.423	98.183	99.764
	-1.178	97.423	98.217	99.764
	-1.057	97.423	98.603	99.771
	-0.863	97.423	98.934	99.782
	-0.610	97.423	99.189	99.795
	-0.316	97.423	99.348	99.811
	0.000	97.423	99.403	99.828
	0.316	97.423	99.348	99.845
	0.610	97.423	99.189	99.861
	0.863	97.423	98.934	99.874
	1.057	97.423	98.603	99.885
	1.178	97.423	98.217	99.892
	1.185	97.423	98.183	99.892
	1.220	97.803	97.803	99.894
Third	5.750	97.803	97.803	99.638
	5.781	97.482	98.124	99.637
	5.815	97.343	98.263	99.635
	5.872	97.343	98.423	99.634
	6.017	97.343	98.680	99.629
	6.205	97.343	98.877	99.623
	6.424	97.343	99.001	99.615
	6.660	97.343	99.043	99.607
	6.896	97.343	99.001	99.600
	7.115	97.343	98.877	99.592
	7.303	97.343	98.680	99.586
	7.448	97.343	98.423	99.581
	7.505	97.343	98.263	99.579
	7.539	97.482	98.124	99.578
	7.570	97.803	97.803	99.577
Mill	12.970	97.803	97.803	99.398
	13.009	97.803	98.095	99.397
	13.124	97.803	98.368	99.393
	13.307	97.803	98.602	99.387
	13.545	97.803	98.782	99.379
	13.822	97.803	98.894	99.370
	14.120	97.803	98.933	99.360
	14.418	97.803	98.894	99.351
	14.695	97.803	98.782	99.341
	14.933	97.803	98.602	99.333
	15.116	97.803	98.368	99.327
	15.231	97.803	98.095	99.324
	15.270	97.803	97.803	99.322

Looking Upstream

Water level elevation	(m)	97.723
Initial offset	(m)	-15.330
Arch angle division	(rad)	0.262
Max. overflow height	(m)	99.828
Left overflow slope		0.033
Right overflow slope		0.054

Arch	Offset	Floor	Opening	Overflow
Mill	-15.330	97.723	97.723	99.002
	-15.291	97.723	98.015	99.004
	-15.176	97.723	98.288	99.010
	-14.993	97.723	98.522	99.020
	-14.755	97.723	98.702	99.033
	-14.478	97.723	98.814	99.048
	-14.180	97.723	98.853	99.064
	-13.882	97.723	98.814	99.080
	-13.605	97.723	98.702	99.095
	-13.367	97.723	98.522	99.108
	-13.184	97.723	98.288	99.118
	-13.069	97.723	98.015	99.124
	-13.030	97.723	97.723	99.126
Third	-7.630	97.723	97.723	99.417
	-7.598	97.407	98.039	99.419
	-7.584	97.343	98.103	99.419
	-7.506	97.343	98.333	99.424
	-7.359	97.343	98.586	99.431
	-7.168	97.343	98.780	99.442
	-6.944	97.343	98.901	99.454
	-6.705	97.343	98.943	99.467
	-6.466	97.343	98.901	99.480
	-6.243	97.343	98.780	99.492
	-6.051	97.343	98.586	99.502
	-5.904	97.343	98.333	99.510
	-5.826	97.343	98.103	99.514
	-5.812	97.407	98.039	99.515
	-5.780	97.723	97.723	99.517
Second	-1.250	97.723	97.723	99.869
	-1.211	97.343	98.103	99.868
	-1.207	97.343	98.122	99.868
	-1.083	97.343	98.493	99.864
	-0.884	97.343	98.812	99.857
	-0.625	97.343	99.057	99.849
	-0.324	97.343	99.211	99.839
	0.000	97.343	99.263	99.828
	0.324	97.343	99.211	99.817
	0.625	97.343	99.057	99.807
	0.884	97.343	98.812	99.799
	1.083	97.343	98.493	99.792
	1.207	97.343	98.122	99.788
	1.211	97.343	98.103	99.788
	1.250	97.723	97.723	99.787
First	2.465	97.723	97.723	99.746
	2.495	97.393	98.053	99.745
	2.504	97.348	98.098	99.745
	2.584	97.348	98.361	99.742
	2.726	97.348	98.625	99.738
	2.910	97.348	98.827	99.732
	3.125	97.348	98.955	99.725
	3.355	97.348	98.998	99.717
	3.585	97.348	98.955	99.709
	3.800	97.348	98.827	99.702
	3.984	97.348	98.625	99.696
	4.126	97.348	98.361	99.691
	4.206	97.348	98.098	99.689
	4.215	97.393	98.053	99.688
	4.245	97.723	97.723	99.687

OGE

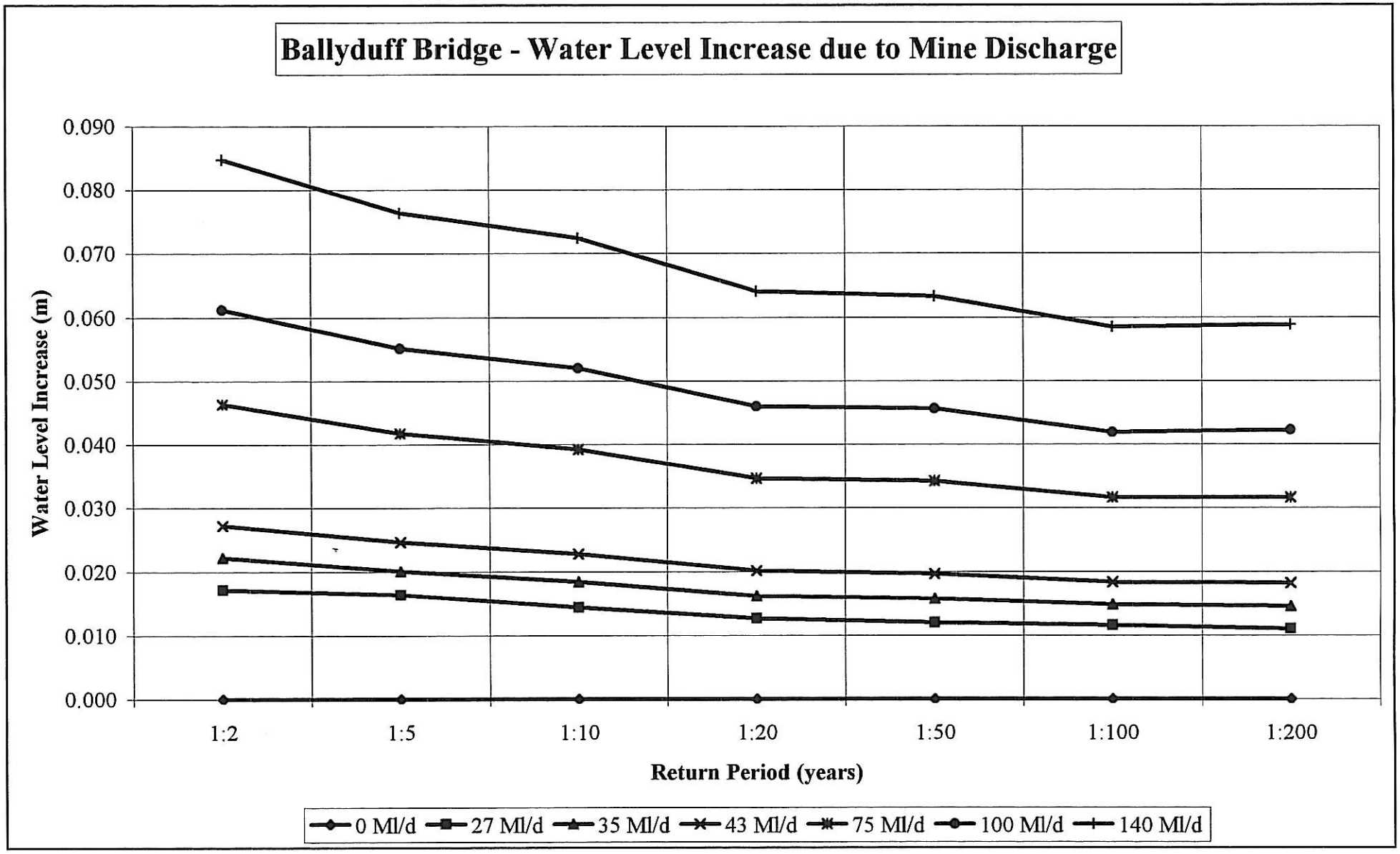
Stage - Discharge Table for the Ballyduff Bridge

Stage (m)	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.000	0.000	0.000	0.000	0.001	0.002	0.003	0.004	0.006	0.009
0.1	0.012	0.015	0.020	0.025	0.031	0.038	0.045	0.054	0.064	0.075
0.2	0.087	0.100	0.114	0.130	0.147	0.166	0.185	0.207	0.230	0.255
0.3	0.281	0.309	0.339	0.370	0.404	0.439	0.476	0.516	0.557	0.601
0.4	0.647	0.695	0.745	0.798	0.853	0.910	0.970	1.032	1.097	1.165
0.5	1.235	1.308	1.384	1.462	1.544	1.628	1.715	1.806	1.899	1.996
0.6	2.095	2.198	2.304	2.414	2.527	2.643	2.762	2.885	3.012	3.142
0.7	3.276	3.414	3.555	3.651	3.770	3.891	4.015	4.140	4.268	4.398
0.8	4.531	4.665	4.802	4.942	5.083	5.227	5.373	5.522	5.672	5.826
0.9	5.981	6.139	6.299	6.462	6.627	6.795	6.964	7.137	7.311	7.489
1.0	7.668	7.850	8.035	8.222	8.411	8.603	8.798	8.995	9.194	9.396
1.1	9.601	9.808	10.017	10.229	10.444	10.662	10.881	11.104	11.329	11.557
1.2	11.787	12.020	12.256	12.494	12.735	12.978	13.224	13.473	13.725	13.979
1.3	14.236	14.495	14.758	15.023	15.290	15.561	15.834	16.110	16.388	16.670
1.4	16.954	17.241	17.531	17.823	18.119	18.417	18.718	19.021	19.328	19.637
1.5	19.949	20.264	20.582	20.903	21.227	21.553	21.882	22.215	22.550	22.888
1.6	23.229	23.572	23.919	24.269	24.621	24.977	25.335	25.697	26.061	26.428
1.7	26.798	27.172	27.548	27.927	28.309	28.694	29.082	29.474	29.868	30.265
1.8	30.665	31.068	31.475	31.884	32.296	32.712	33.130	33.552	33.977	34.404
1.9	34.835	35.269	35.706	36.146	36.589	37.036	37.485	37.937	38.393	38.852

OGE

Ballyduff Bridge

Return Period years	Natural Flood Peaks (m^3/s)	Mine Discharge (Ml/d)	Mine Discharge (m^3/s)	Flow Rate (m^3/s)	Water Level (m)	Depth increase due to pumping (m)	Flood Width (m)
1:2	7.400	0	0.000	7.400	98.328	0.000	11.920
	7.400	27	0.310	7.710	98.345	0.017	11.920
	7.400	35	0.400	7.800	98.350	0.022	11.920
	7.400	43	0.500	7.900	98.355	0.027	11.920
	7.400	75	0.870	8.270	98.374	0.046	11.920
	7.400	100	1.160	8.560	98.389	0.061	11.920
	7.400	140	1.620	9.020	98.413	0.085	11.920
1:5	9.400	0	0.000	9.400	98.432	0.000	11.920
	9.400	27	0.310	9.710	98.448	0.016	11.920
	9.400	35	0.400	9.800	98.452	0.020	11.920
	9.400	43	0.500	9.900	98.457	0.025	11.920
	9.400	75	0.870	10.270	98.474	0.042	11.920
	9.400	100	1.160	10.560	98.487	0.055	11.920
	9.400	140	1.620	11.020	98.508	0.076	11.920
1:10	10.700	0	0.000	10.700	98.494	0.000	11.920
	10.700	27	0.310	11.010	98.508	0.014	11.920
	10.700	35	0.400	11.100	98.512	0.018	11.920
	10.700	43	0.500	11.200	98.516	0.023	11.920
	10.700	75	0.870	11.570	98.533	0.039	11.920
	10.700	100	1.160	11.860	98.546	0.052	11.920
	10.700	140	1.620	12.320	98.566	0.072	11.920
1:20	12.500	0	0.000	12.500	98.574	0.000	11.920
	12.500	27	0.310	12.810	98.586	0.013	11.920
	12.500	35	0.400	12.900	98.590	0.016	11.920
	12.500	43	0.500	13.000	98.594	0.020	11.920
	12.500	75	0.870	13.370	98.608	0.035	11.920
	12.500	100	1.160	13.660	98.620	0.046	11.920
	12.500	140	1.620	14.120	98.638	0.064	11.920
1:50	13.800	0	0.000	13.800	98.625	0.000	11.920
	13.800	27	0.310	14.110	98.637	0.012	11.920
	13.800	35	0.400	14.200	98.641	0.016	11.920
	13.800	43	0.500	14.300	98.645	0.020	11.920
	13.800	75	0.870	14.670	98.659	0.034	11.920
	13.800	100	1.160	14.960	98.671	0.046	11.920
	13.800	140	1.620	15.420	98.688	0.063	11.920
1:100	15.300	0	0.000	15.300	98.684	0.000	11.920
	15.300	27	0.310	15.610	98.695	0.012	11.920
	15.300	35	0.400	15.700	98.698	0.015	11.920
	15.300	43	0.500	15.800	98.702	0.018	11.920
	15.300	75	0.870	16.170	98.715	0.032	11.920
	15.300	100	1.160	16.460	98.725	0.042	11.920
	15.300	140	1.620	16.920	98.742	0.059	11.920
1:200	16.700	0	0.000	16.700	98.734	0.000	11.920
	16.700	27	0.310	17.010	98.745	0.011	11.920
	16.700	35	0.400	17.100	98.749	0.015	11.920
	16.700	43	0.500	17.200	98.752	0.018	11.920
	16.700	75	0.870	17.570	98.766	0.032	11.920
	16.700	100	1.160	17.860	98.776	0.042	11.920
	16.700	140	1.620	18.320	98.793	0.059	11.920


Ballyduff Bridge - Water Level Increase due to Mine Discharge
Water Level Increase (m)
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
1:2
1:5
1:10
1:20
1:50
1:100
1:200
Return Period (years)
0 Ml/d
27 Ml/d
35 Ml/d
43 Ml/d
75 Ml/d
100 Ml/d
140 Ml/d

APPENDIX NO. I.2.3

EPA WATER QUALITY DATA FOR DRISH RIVER

Station No: 0070

River Code: 16D02
Situated On: DRISH
Location: Bridge N.E. of Castletown
Hydrometric Area: Suir
Chemical Data Available For:

2001 to 2003
1998 to 2000

Biological Data:

YEAR	QUALITY
2005	3/0
2002	2-3/0
1999	2/0
1996	3-4
1992	4-5
1988	4

Station No: 0070 **Location:** Bridge N.E. of Castletown **Date From:** 2001 **To:** 2003
A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg O21-1	**<1.0**	**1.8**	**3.1**	14	Kilkenny	EPA
Chloride	mg Cl 1-1	**14**	**19**	**30**	14	Kilkenny	EPA
Colour	Hazen	**5**	**40**	**200**	14	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**0.01**	**0.02**	**0.03**	8	Kilkenny	EPA
Oxidised Nitrogen	mg N 1-1	**0.9**	**1.5**	**2.9**	14	Kilkenny	EPA
pH		**7.7**	**7.9**	**8.2**	14	Kilkenny	EPA
Temperature	oC	**6.2**	**12.9**	**14.8**	14	Kilkenny	EPA
Total Ammonia	mg N 1-1	**<0.03**	**0.51**	**1.10**	14	Kilkenny	EPA

Station No: 0070 **Location:** Bridge N.E. of Castletown **Date From:** 1998 **To:** 2000
A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg O21-1	**0.8**	**0.9**	**1.9**	7	Kilkenny	EPA
Chloride	mg Cl 1-1	**16**	**18**	**20**	6	Kilkenny	EPA
Colour	Hazen	**10**	**50**	**85**	7	Kilkenny	EPA
Conductivity	µS cm-1	563	592	653	7	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**<0.02**	**0.00**	**0.03**	5	Kilkenny	EPA
Oxidised Nitrogen	mg N 1-1	**1.1**	**1.5**	**2.8**	7	Kilkenny	EPA
pH		**7.9**	**8.0**	**8.1**	7	Kilkenny	EPA
Temperature	oC	**8.1**	**13.1**	**15.5**	7	Kilkenny	EPA
Total Ammonia	mg N 1-1	**0.30**	**0.41**	**0.50**	5	Kilkenny	EPA

Station No: 0100

River Code: 16D02
Situated On: DRISH
Location: Boolabeha Bridge
Hydrometric Area: Suir
Chemical Data Available For:

2001 to 2003
1998 to 2000
1995 to 1997

Biological Data:

YEAR	QUALITY
2005	3
2002	3
1999	3-4
1996	4
1992	4
1988	4-5
1983	4
1980	4
1976	4-5

Station No: 0100 **Location:** Boolabeha Bridge **Date From:** 2001 **To:** 2003
A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg O21-1	**0.3**	**1.4**	**3.0**	13	Kilkenny	EPA
Chloride	mg Cl 1-1	**14**	**18**	**28**	13	Kilkenny	EPA
Colour	Hazen	**5**	**30**	**175**	13	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**0.01**	**0.02**	**0.03**	7	Kilkenny	EPA
Oxidised Nitrogen	mg N 1-1	**1.3**	**2.1**	**3.2**	13	Kilkenny	EPA
pH		**7.7**	**7.9**	**8.5**	13	Kilkenny	EPA
Temperature	oC	**5.9**	**13.1**	**15.6**	13	Kilkenny	EPA
Total Ammonia	mg N 1-1	**0.01**	**0.17**	**0.32**	12	Kilkenny	EPA

Station No: 0100 **Location:** Boolabeha Bridge **Date From:** 1998 **To:** 2000
A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg O21-1	**0.2**	**1.0**	**4.7**	13	Kilkenny	EPA
Chloride	mg Cl 1-1	**16**	**18**	**22**	10	Kilkenny	EPA
Colour	Hazen	**5**	**40**	**150**	12	Kilkenny	EPA
Conductivity	µS cm-1	470	600	688	13	Kilkenny	EPA
Conductivity	µS cm-1	374	574	679	25	Three Rivers Project	LA
Ortho-Phosphate	mg P 1-1	**<0.02**	**<0.02**	**0.03**	11	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**0.00**	**0.01**	**0.09**	25	Three Rivers Project	LA
Oxidised Nitrogen	mg N 1-1	**1.0**	**1.6**	**4.3**	12	Kilkenny	EPA
pH		**7.3**	**8.1**	**8.4**	13	Kilkenny	EPA
pH		**7.8**	**8.1**	**8.5**	25	Three Rivers Project	LA
Temperature	oC	**3.6**	**11.8**	**17.3**	13	Kilkenny	EPA
Temperature	oC	**5.8**	**10.8**	**18.7**	25	Three Rivers Project	LA
Total Ammonia	mg N 1-1	**<0.01**	**0.12**	**0.56**	11	Kilkenny	EPA
Total Ammonia	mg N 1-1	**0.00**	**0.08**	**0.41**	22	Three Rivers Project	LA

Station No: 0100 **Location:** Boolabeha Bridge **Date From:** 1995 **To:** 1997
A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg O21-1	**1.1**	**1.7**	**2.3**	13	Kilkenny	EPA
Chloride	mg Cl 1-1	**17**	**20**	**36**	14	Kilkenny	EPA
Colour	Hazen	**40**	**60**	**125**	11	Kilkenny	EPA
Conductivity	µS cm-1	451	640	697	14	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**0.02**	**0.02**	**0.07**	13	Kilkenny	EPA
Oxidised Nitrogen	mg N 1-1	**1.2**	**2.9**	**6.1**	28	Kilkenny	EPA
pH		**7.6**	**8.2**	**8.5**	14	Kilkenny	EPA
Temperature	oC	**3.9**	**12.4**	**16.9**	14	Kilkenny	EPA
Total Ammonia	mg N 1-1	**0.01**	**0.01**	**0.23**	14	Kilkenny	EPA

APPENDIX NO. I.2.4

QUARTERLY SAMPLING DATA FOR DRISH RIVER

	Month:	October	October	October	October	Lisheen	Freshwater	Salmonid
	Date Sampled:	26-Oct-06	26-Oct-06	26-Oct-06	26-Oct-06	Discharge	Fish	Water
	Sample No.:	2006014607	2006014608	2006014609	2006014610	IPPC	Directive	Regulations
		Upstream	Downstream	Castletown West	Boolabeha	Licence	(78/659/EC)	1998
Parameter	**Units**							
Fluoride	mg/L F	0.063	0.101	0.1	0.084			
Chloride	mg/L Cl	13.395	16.127	15.87	16.804			
Nitrite	mg/L N	0.092	0.135	0.096	0.046		≤0.03	≤0.05
Nitrate	mg/L N	3.58	2.791	3.28	3.26	11.3		
Phosphate	mg/L P	<0.001	<0.001	<0.001	<0.001			
Sulphate	mg/L SO4	37.317	102.667	103.231	110.447	500[1]/400[2]		
Lithium	mg/L Li	<0.001	<0.001	<0.001	<0.001			
Sodium	mg/L Na	7.18	9.351	9.36	9.24			
Ammonium	mg/L NH4	<0.001	0.71	0.23	<0.001	1	<0.78/≤0.78	
Calcium	mg/L Ca	72.815	75.022	73.264	75.359			
Magnesium	mg/L Mg	11.244	20.43	20.167	20.067			
Potassium	mg/L K	1.42	5.08	5.09	6.62			
pH	pH units	7.53	7.53	7.50	7.55		≤6.0≥9.0	≤6.0≥9.0
Conductivity	uS/cm	463	560	558	576			
Dissolved Oxygen	mg/L O2	5.78	5.90	5.70	5.56			
Temperature	Deg.C	10.5	11.4	11.3	11.37			
BOD	mg/L	2.07	3.33	2.565	1.615	5	≤6	≤5
COD	mg/L	71	51	49	48	40		
Suspended Solids	mg/L	5.05	4.35	4.5	5.85			
Aluminium	mg/L Al	0.0227	0.0182	0.0177	0.0203	0.2		
Arsenic	mg/L As	0.0044	0.0081	0.0117	0.0142			
Barium	mg/L Ba	0.0764	0.1306	0.1300	0.1267			
Cadmium	mg/L Cd	<0.001	<0.001	<0.001	<0.001	0.0050		
Cobalt	mg/L Co	0.0002	0.0011	0.0007	0.0002			
Chromium	mg/L Cr	0.0004	0.0021	0.0002	0.0001			
Copper	mg/L Cu	<0.001	<0.001	<0.001	<0.001			
Iron	mg/L Fe	0.1931	0.1909	0.1528	0.1087			
Manganese	mg/L Mn	0.0358	0.0321	0.0233	0.0144			
Nickel	mg/L Ni	0.0014	0.0062	0.0062	0.0067			
Lead	mg/L Pb	<0.001	<0.001	<0.001	<0.001	0.0500		
Zinc	mg/L Zn	<0.001	0.0643	0.0692	0.0671	0.4500		
Mercury	mg/L Hg	<0.0004	<0.0004	<0.0004	<0.0004	0.001		
Hardness		228	271	265	270			

Note [1] Limit for discharge received by tacit agreement with the EPA

Note [2] Limit for downstream samples received by tacit agreement with the EPA

	Month:	January	January	January	January	Lisheen	Freshwater	Salmonid
	Date Sampled:	18-Jan-07	18-Jan-07	18-Jan-07	18-Jan-07	Discharge	Fish	Water
	Sample No.:	2007000924	2007000925	2007000926	2007000927	IPPC	Directive	Regulations
		Upstream	Downstream	Castletown West	Boolabeha	Licence	(78/659/EC)	1998
Parameter	**Units**							
Fluoride	mg/L F	0.17	0.142	0.11	0.10			
Chloride	mg/L Cl	20.43	24.46	24.09	23.28			
Nitrite	mg/L N	0.13	0.387	0.17	0.05		≤0.03	≤0.05
Nitrate	mg/L N	1.01	4.853	4.83	4.33	11.3		
Phosphate	mg/L P	<0.001	0.046	<0.001	<0.001			
Sulphate	mg/L SO4	41.30	122.70	116.46	99.85	400/500		
Lithium	mg/L Li	-	-	-	-			
Sodium	mg/L Na	-	-	-	-			
Ammonium	mg/L NH4	-	-	-	-	1	<0.78/≤0.78	
Calcium	mg/L Ca	-	-	-	-			
Magnesium	mg/L Mg	-	-	-	-			
Potassium	mg/L K	-	-	-	-			
pH	pH units	7.75	7.91	7.92	7.93		≤6.0≥9.0	≤6.0≥9.0
Conductivity	uS/cm	590	670	670	640			
Dissolved Oxygen	mg/L O2	8.25	7.80	7.45	7.18			
Temperature	Deg.C	7.70	8.2	8.00	7.90			
BOD	mg/L	2.58	2.03	1.97	1.74	5	≤6	≤5
COD	mg/L	59	52	47	43	40		
Suspended Solids	mg/L	15.80	8.75	8.40	8.25			
Aluminium	mg/L Al	0.0265	0.0224	0.0259	0.0324	0.2		
Arsenic	mg/L As	0.0036	0.0020	0.0132	0.0102			
Barium	mg/L Ba	0.0688	0.0847	0.0952	0.0977			
Cadmium	mg/L Cd	<0.001	<0.001	<0.001	<0.001	0.0050		
Cobalt	mg/L Co	0.0003	0.0018	0.0014	0.0024			
Chromium	mg/L Cr	<0.001	0.0004	0.0002	<0.001			
Copper	mg/L Cu	<0.001	<0.001	<0.001	<0.001			
Iron	mg/L Fe	0.1923	0.1541	0.1765	0.1866			
Manganese	mg/L Mn	0.0538	0.0516	0.0600	0.0768			
Nickel	mg/L Ni	<0.001	0.0031	0.0028	0.0031			
Lead	mg/L Pb	0.0021	0.0021	0.0033	0.0040	0.0500		
Zinc	mg/L Zn	<0.001	0.0644	0.0515	0.0698	0.4500		
Mercury	mg/L Hg	0.0005	<0.0004	<0.0004	<0.0004	0.001		
Hardness								

Note [1] Limit for discharge rec

Note [2] Limit for downstream s

	Month:	April	April	April	April	Lisheen	Freshwater	Salmonid
	Date Sampled:	19-Apr-07	19-Apr-07	19-Apr-07	19-Apr-07	Discharge	Fish	Water
	Sample No.:	2007005397	2007005398	2007005407	2007005408	IPPC	Directive	Regulations
		Upstream	Downstream	Castletown West	Boolabeha	Licence	(78/659/EC)	1998
Parameter	**Units**							
Fluoride	mg/L F	0.13	0.167	0.11	0.19			
Chloride	mg/L Cl	19.34	24.30	23.90	23.99			
Nitrite	mg/L N	0.03	0.09	0.09	0.06		≤0.03	≤0.05
Nitrate	mg/L N	4.01	2.622	2.90	3.54	11.3		
Phosphate	mg/L P	<0.001	<0.001	<0.001	<0.001			
Sulphate	mg/L SO4	21.1	291.76	292.8	285.6	400/500		
Lithium	mg/L Li	0.01	0.0161	0.02	0.02			
Sodium	mg/L Na	9.5	16.5	16.1	16.8			
Ammonium	mg/L NH4	1.40	1.40	1.05	0.50	1	<0.78/≤0.78	
Calcium	mg/L Ca	110.7	123.2	119.0	124.5			
Magnesium	mg/L Mg	20.94	39.20	38.57	40.17			
Potassium	mg/L K	2.13	7.437	7.21	7.46			
pH	pH units	7.88	7.68	7.63	7.42		≤6.0≥9.0	≤6.0≥9.0
Conductivity	uS/cm	600	810	860	870			
Dissolved Oxygen	mg/L O2	8.84	7.30	8.37	6.90			
Temperature	Deg.C	13.6	13.2	12.70	12.30			
BOD	mg/L	1.73	2.11	2.11	2.04	5	≤6	≤5
COD	mg/L	21	10	5	6	40		
Suspended Solids	mg/L	3.5	5.3	2.90	5.50			
Aluminium	mg/L Al	0.0354	0.0627	0.0663	0.0345	0.2		
Arsenic	mg/L As	0.0088	0.0266	0.0169	0.0168			
Barium	mg/L Ba	0.1183	0.1955	0.1915	0.2013			
Cadmium	mg/L Cd	0.0008	0.0012	0.0010	0.0010	0.0050		
Cobalt	mg/L Co	0.0013	0.0070	0.0050	0.0028			
Chromium	mg/L Cr	0.0002	0.0006	0.0006	0.0004			
Copper	mg/L Cu	0.0017	0.0017	0.0013	0.0004			
Iron	mg/L Fe	0.2780	0.3330	0.1819	0.1112			
Manganese	mg/L Mn	0.0400	0.0627	0.0523	0.0575			
Nickel	mg/L Ni	0.0042	0.0280	0.0283	0.0280			
Lead	mg/L Pb	0.0174	0.0659	0.0243	0.0125	0.0500		
Zinc	mg/L Zn	0.0127	0.3715	0.3464	0.3614	0.4500		
Mercury	mg/L Hg	<0.0004	<0.0004	<0.0004	<0.0004	0.001		
Hardness		*362*	*468*	*455*	*475*			

Note [1] Limit for discharge rec

Note [2] Limit for downstream s

	Month:	July	July	July	July	Lisheen	Freshwater	Salmonid
	Date Sampled:	19-Jul-07	19-Jul-07	19-Jul-07	19-Jul-07	Discharge	Fish	Water
	Sample No.:	2007009725	2007009726	2007009727	2007009728	IPPC	Directive	Regulations
		Upstream	Downstream	Castletown West	Boolabeha	Licence	(78/659/EC)	1998
Parameter	**Units**							
Fluoride	mg/L F	0.059	0.125	0.105	0.167			
Chloride	mg/L Cl	12354.0	23.69	23.7	23.7			
Nitrite	mg/L N	0.369	0.466	0.605	0.009		≤0.03	≤0.05
Nitrate	mg/L N	1.685	1.684	2.591	3.072	11.3		
Phosphate	mg/L P	<0.001	<0.001	<0.001	<0.001			
Sulphate	mg/L SO4	16.65	302.23	307.233	303.328	400/500		
Lithium	mg/L Li	<0.001	0.02	0.016338	0.0162			
Sodium	mg/L Na	7.6	13.88	14.0	14.1			
Ammonium	mg/L NH4	1.77	1.61	0.57	0.16	1	<0.78/≤0.78	
Calcium	mg/L Ca	48.11	123.35	125.34	129.42			
Magnesium	mg/L Mg	6.83	35.90	36.29	36.12			
Potassium	mg/L K	1.88	8.41	8.48	8.44			
pH	pH units	7.41	7.14	7.29	7.23		≤6.0≥9.0	≤6.0≥9.0
Conductivity	uS/cm	292	911	932	929			
Dissolved Oxygen	mg/L O2	3.50	5.30	3.50	4.40			
Temperature	Deg.C	16.9	15.80	16.2	15.5			
BOD	mg/L	3.23	0.99	1.007	1.14	5	≤6	≤5
COD	mg/L	79	20	18	15	40		
Suspended Solids	mg/L	6.1	2.65	10.4	4.7			
Aluminium	mg/L Al	0.1803	0.0546	0.0254	0.0129	0.2		
Arsenic	mg/L As	0.0030	0.0248	0.0131	0.0109			
Barium	mg/L Ba	0.0598	0.2010	0.1998	0.2008			
Cadmium	mg/L Cd	0.0013	0.0016	0.0016	0.0017	0.0050		
Cobalt	mg/L Co	0.0007	0.0056	0.0021	0.0015			
Chromium	mg/L Cr	0.0012	0.0012	0.0012	0.0011			
Copper	mg/L Cu	<0.001	<0.001	<0.001	0.0002			
Iron	mg/L Fe	0.2808	0.1875	0.1014	0.0511			
Manganese	mg/L Mn	0.0329	0.0567	0.0238	0.0147			
Nickel	mg/L Ni	0.0032	0.0284	0.0265	0.0265			
Lead	mg/L Pb	<0.001	0.0048	0.0024	0.0014	0.0500		
Zinc	mg/L Zn	<0.001	0.2037	0.1807	0.0199	0.4500		
Mercury	mg/L Hg	<0.0004	0.0004	<0.0004	<0.0004	0.001		
Hardness		*148*	*455*	*462*	*471*			

Note [1] Limit for discharge rec

Note [2] Limit for downstream s

	Month:	October	October	October	October	Lisheen	Freshwater	Salmonid
	Date Sampled:	11-Oct-07	11-Oct-07	11-Oct-07	11-Oct-07	Discharge	Fish	Water
	Sample No.:	2007014279	2007014280	2007014281	2007014282	IPPC	Directive	Regulations
		Upstream	Downstream	Castletown West	Boolabeha	Licence	(78/659/EC)	1998
Parameter	**Units**							
Fluoride	mg/L F	0.096	0.119	0.114	0.107			
Chloride	mg/L Cl	15.215	19.947	19.992	20.45			
Nitrite	mg/L N	0.024	0.062	0.073	0.051		≤0.03	≤0.05
Nitrate	mg/L N	1.18	1.507	1.65	2.72	11.3		
Phosphate	mg/L P	<0.001	<0.001	0.001	<0.001			
Sulphate	mg/L SO4	18.484	193.949	198.69	200.846	400/500		
Lithium	mg/L Li	0.000	0.014	0.014	0.0146			
Sodium	mg/L Na	9.51	13.511	13.54	13.84			
Ammonium	mg/L NH4	0.3300	1.1800	1.0000	0.1000	1	<0.78/≤0.78	
Calcium	mg/L Ca	113.088	123.834	124.135	131.173			
Magnesium	mg/L Mg	18.9097	40.97	40.9628	39.452			
Potassium	mg/L K	4.40	7.00	7.04	7.29			
pH	pH units	7.56	7.52	7.46	7.50		≤6.0≥9.0	≤6.0≥9.0
Conductivity	uS/cm	618	856	864	872			
Dissolved Oxygen	mg/L O2	3.85	6.99	7.11	5.79			
Temperature	Deg.C	13.5	14.1	14.0	13.8			
BOD	mg/L	1.14	2.64	3.572	2.413	5	≤6	≤5
COD	mg/L	43	8	9	11	40		
Suspended Solids	mg/L	0.35	4.80	6.15	9.15			
Aluminium	mg/L Al	0.0181	0.0585	0.0503	0.04949	0.2		
Arsenic	mg/L As	<0.001	0.0111	0.0426	0.0288			
Barium	mg/L Ba	0.0883	0.2383	0.2327	0.2267			
Cadmium	mg/L Cd	<0.001	0.0009	0.0004	0.0001	0.0050		
Cobalt	mg/L Co	0.0003	0.0067	0.0068	0.0022			
Chromium	mg/L Cr	0.0003	0.0005	0.0005	0.0005			
Copper	mg/L Cu	0.0014	0.0011	0.0005	0.0001			
Iron	mg/L Fe	0.1327	0.3704	0.3146	0.1728			
Manganese	mg/L Mn	0.0632	0.0791	0.0915	0.0751			
Nickel	mg/L Ni	0.0013	0.0294	0.0294	0.0236			
Lead	mg/L Pb	<0.001	0.0153	0.0119	0.0018	0.0500		
Zinc	mg/L Zn	<0.001	0.3798	0.3530	0.2583	0.4500		
Mercury	mg/L Hg					0.001		
Hardness		*359*	*477*	*478*	*489*			

Note [1] Limit for discharge rec

Note [2] Limit for downstream s

APPENDIX NO. I.2.5

CERTIFICATES OF ANALYSIS FOR OGE SAMPLES

BORD NA MÓNA

BORD NA MÓNA ENVIRONMENTAL LIMITED

Analysis Report

Project Code : 07-12695 **Report Unique ID:** 14665

Report Date : 31-Oct-2007 **Commen. Date:** 18/10/2007

Customer: **Ms. Aishling Whelan**
O'Neill Groundwater
UNIT D7 M7 BUSINESS PARK NEWHALL NAAS CO. KILDARE

Contact Details:
AWHELAN@GROUNDWATERENG.IE
COREILLY@GROUNDWATERENG.IE
bsebastian@groundwatereng.ie
avantzelfde@GROUNDWATERENG.IE

Approved by : **Shona Fox**
Laboratory Manager

Sample Number : 122474 Client ID: EUSROSS 18/10/07
Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
BOD	*BOD	-	<2	mg/l
COD	*COD	-	38	mg/l

Sample Number : 122475 Client ID: DISSROSS 18/10/07
Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
BOD	*BOD	-	<2	mg/l
COD	*COD	-	<10	mg/l
Organic Carbon	Total Organic Carbon	-	<5	mg/l
TON as N	*TON as N	-	1.64	mg/l

Project Code : 07-12695 **Report Unique ID: 14665**

Sample Number : 122476 Client ID: QDSROSS 18/10/07
Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
BOD	*BOD	-	<2	mg/l
COD	*COD	-	<10	mg/l
Organic Carbon	Total Organic Carbon	-	<5	mg/l
TON as N	*TON as N	-	2.76	mg/l

Sample Number : 122477 Client ID: ZUSDRIS 18/10/07
Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
BOD	*BOD	-	<2	mg/l
COD	*COD	-	38	mg/l
Organic Carbon	Total Organic Carbon	-	13	mg/l
TON as N	*TON as N	-	1.05	mg/l

Sample Number : 122478 Client ID: DISDRIS 18/10/07
Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
BOD	*BOD	-	<2	mg/l
COD	*COD	-	<10	mg/l
Organic Carbon	Total Organic Carbon	-	<5	mg/l
TON as N	*TON as N	-	1.93	mg/l

BORD NA MÓNA

BORD NA MÓNA ENVIRONMENTAL LIMITED

Analysis Report

Project Code : 07-12695 **Report Unique ID: 14665**

Sample Number : 122479 Client ID: XDSDRIS 18/10/07

Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
BOD	*BOD	-	<2	mg/l
COD	*COD	-	<10	mg/l
Organic Carbon	Total Organic Carbon	-	<5	mg/l
TON as N	*TON as N	-	2.07	mg/l

Sample Number : 122480 Client ID: DRISTRIBUS 18/10/07

Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
BOD	*BOD	-	<2	mg/l
COD	*COD	-	34	mg/l
Organic Carbon	Total Organic Carbon	-	12	mg/l
TON as N	*TON as N	-	2.68	mg/l

Sample Number : 122481 Client ID: EUROSS 18/10/07

Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
e.Coli	e.Coli ***	-	<1	MPN/100 mls
Total Coliforms	Total Coliforms ***	-	<1	MPN/100 mls

Project Code : 07-12695 **Report Unique ID: 14665**

Sample Number : 122482 Client ID: EUSROSS 18/10/07
Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
Organic Carbon	Total Organic Carbon	-	14	mg/l
TON as N	*TON as N	-	2.76	mg/l

Sample Number : 122483 Client ID: DISSROSS 18/10/07
Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
e.Coli	e.Coli ***	-	<1	MPN/100 mls
Total Coliforms	Total Coliforms ***	-	<1	MPN/100 mls

Sample Number : 122484 Client ID: QDSROSS 18/10/07
Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
e.Coli	e.Coli ***	-	<1	MPN/100 mls
Total Coliforms	Total Coliforms ***	-	<1	MPN/100 mls

Sample Number : 122485 Client ID: ZUSDRIS 18/10/07
Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
e.Coli	e.Coli ***	-	<1	MPN/100 mls
Total Coliforms	Total Coliforms ***	-	<1	MPN/100 mls

BORD NA MÓNA

BORD NA MÓNA ENVIRONMENTAL LIMITED

Analysis Report

Project Code : 07-12695 **Report Unique ID: 14665**

Sample Number : 122486 Client ID: DISDRIS 18/10/07

Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
e.Coli	e.Coli ***	-	<1	MPN/100 mls
Total Coliforms	Total Coliforms ***	-	<1	MPN/100 mls

Sample Number : 122487 Client ID: XDSDRIS 18/10/07

Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
e.Coli	e.Coli ***	-	<1	MPN/100 mls
Total Coliforms	Total Coliforms ***	-	<1	MPN/100 mls

Sample Number : 122488 Client ID: DRISTRIBUS 18/10/07

Sample Type:Groundwater Received: 18/10/2007 Condition: Good

Analysis	*Component*	*Specification*	*Result*	*Units*
e.Coli	e.Coli ***	-	<1	MPN/100 mls
Total Coliforms	Total Coliforms ***	-	<1	MPN/100 mls

BORD NA MÓNA

BORD NA MÓNA ENVIRONMENTAL LIMITED

Analysis Report

Project Code : 07-12695 **Report Unique ID: 14665**

Methods of Analysis

Analysis Name:	Method:
BOD	G/04: Based on APHA, 2005, 21st Edition, Method 5210B. TCMP Nitrification inhibition.
COD	G/03: Based on APHA, 2005, 21st Edition, Method 5220D
Organic Carbon	TOC Analyser
TON as N	G/67 Based on APHA,2005,21st Edition,4500-N02B.Colorimetric method
Total Coliforms	MPN based on IDEXX defined substrate method
e.Coli	G/72 MPN based on IDEXX defined substrate method

Notes

* = INAB accredited test ** = subcontracted test *** = outside accredited range

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2. Results contained in this report relate only to the items tested.
3. All Comments concerning this report or its contents should be forwarded to the Laboratory Manager

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OGE - O'Neill Groundwater Engi
Attention Örla O'Connell
Unit D5, M7 Business Park, Newhall

IRELAND

Certificate of analysis

Date: 11-01-2007

Please find enclosed the analytical results of the following analysis.

Certificate number	2007146468
Your project number	1560701
Your project name	Lisheen
Your order number	
Samples received on	10-22-2007

This Certificate of Analysis may only be used in its entirety.
Additional information concerning this Certificate of Analysis can be found in the Analytico document 'Specifications of Methods of Analysis'. Copies are available from our Customer Service department.

Soil samples will be stored under controlled conditions for a period of 6 weeks and water samples for a period of 2 weeks after receipt of the samples at our laboratory. Without any additional request, samples will be disposed when the above periods have expired. If you require Analytico to store the samples for a longer period, please complete this page and return it to Analytico at least one week before the period is due to expire. The costs of prolonged storage periods may be found in our fees overview.

Storage period:
Date: Name: Signature:

We trust that we have performed the order in accordance with your expectations. If you have any remaining questions concerning this Certificate of Analysis, please don't hesitate to contact our Customer Service.

Yours sincerely,

Analytico Milieu B.V.

Ing. A. Veldhuizen
Laboratory Manager

Analytico Milieu B.V.

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KvK No. 09088623

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Certificate of analysis

Your project number	1560701	Certificate number	2007146468
Your project name	Lisheen	Start date	10-22-2007
Your order number		Report date	11-01-2007/12:58
Date sampling	10-18-2007	Enclosure	A,B,C
Sampled by	ÖOC	Page	1/4

	Analysis	Unit	1	2	3	4	5
	Elements						
Q	Cadmium (Cd)	µg/L	<0.40	1.0	<0.40	<0.40	1.0
Q	Chromium (Cr)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Q	Copper (Cu)	µg/L	<5.0	<5.0	<5.0	<5.0	<5.0
Q	Mercury (Hg)	µg/L	<0.050	<0.050	<0.050	<0.050	<0.050
Q	Nickel (Ni)	µg/L	<5.0	31	21	<5.0	32
Q	Lead (Pb)	µg/L	<5.0	16	<5.0	<5.0	19
Q	Zinc (Zn)	µg/L	<10	350	230	<10	360
Q	Calcium (Ca)	mg/L	87	110	100	110	110
Q	Iron (Fe)	mg/L	0.80	0.29	0.16	0.12	0.36
Q	Potassium (K)	mg/L	1.2	6.2	5.8	2.9	6.2
Q	Magnesium (Mg)	mg/L	11	42	40	20	42
Q	Manganese (Mn)	mg/L	0.033	0.073	0.029	0.053	0.080
Q	Sodium (Na)	mg/L	8.2	13	13	9.4	14
	Inorganic Compounds						
	Composite alkalinity (P-value)	mmol/L	<0.10	<0.10	<0.10	<0.10	<0.10
	Total alkalinity (M-value)	mmol/L	4.9	4.5	4.4	6.2	4.6
Q	Ammonia as NH4-N	mg N/L	0.33	1.5	0.30	0.051	1.5
Q	Ammonia (NH4)	mg/L	0.42	1.9	0.38	0.066	1.9
Q	Carbonate	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0
Q	Bicarbonate (HCO3)	mg/L	300	280	270	380	280
Q	Ortho-phosphate (PO4-P)	mg P/L	0.024	<0.010	<0.010	<0.010	<0.010
Q	Ortho-phosphate (PO4)	mg PO4/L	0.074	<0.030	<0.030	<0.030	<0.030
Q	Bromide	mg/L	<0.050	0.075	<0.050	<0.050	<0.050
Q	Chloride	mg/L	15	22	21	17	21
Q	Sulphate	mg/L	2.5	220	200	21	220
Q	Nitrate equivalent NO3-N	mg N/L	2.7	1.6	2.7	1.0	1.6
Q	Nitrate (NO3)	mg/L	12	7.0	12	4.6	7.3
Q	Nitrite as NO2-N	mg N/L	0.031	0.041	0.031	0.012	0.081
Q	Nitrite (NO2)	mg/L	0.10	0.13	0.10	0.039	0.27
	Hardness temporary	mmol/L	2.5	2.8	2.2	3.1	2.3

No.	Sample description	Analytico-#
1	EUSROSS	3497588
2	DISROSS	3497589
3	QDSROSS	3497590
4	ZUSDRIS	3497591
5	DISDRIS	3497592

Q: Dutch Accreditation Council (RvA) accredited operation
A: AP04 accredited operation
S: AS3000 accredited operation

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Certificate of analysis

Your project number	1560701	Certificate number	2007146468
Your project name	Lisheen	Start date	10-22-2007
Your order number		Report date	11-01-2007/12:58
Date sampling	10-18-2007	Enclosure	A,B,C
Sampled by	ÖOC	Page	2/4

Analysis	Unit	1	2	3	4	5
Hardness temporary	°D	14	13	12	17	13
Hardness temporary	°F	25	23	22	31	23

No.	Sample description	Analytico-#
1	EUSROSS	3497588
2	DISROSS	3497589
3	QDSROSS	3497590
4	ZUSDRIS	3497591
5	DISDRIS	3497592

Q: Dutch Accreditation Council (RvA) accredited operation
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NL 8043.14.883.B01
KvK No. 09088623

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Certificate of analysis

Your project number	1560701	Certificate number	2007146468
Your project name	Lisheen	Start date	10-22-2007
Your order number		Report date	11-01-2007/12:58
Date sampling	10-18-2007	Enclosure	A,B,C
Sampled by	ÖOC	Page	3/4

	Analysis	Unit	6	7
	Elements			
Q	Cadmium (Cd)	µg/L	0.91	<0.40
Q	Chromium (Cr)	µg/L	<1.0	<1.0
Q	Copper (Cu)	µg/L	<5.0	<5.0
Q	Mercury (Hg)	µg/L	<0.050	<0.050
Q	Nickel (Ni)	µg/L	28	<5.0
Q	Lead (Pb)	µg/L	21	<5.0
Q	Zinc (Zn)	µg/L	320	<10
Q	Calcium (Ca)	mg/L	110	110
Q	Iron (Fe)	mg/L	0.39	0.17
Q	Potassium (K)	mg/L	5.8	4.1
Q	Magnesium (Mg)	mg/L	40	22
Q	Manganese (Mn)	mg/L	0.077	<0.010
Q	Sodium (Na)	mg/L	13	8.4
	Inorganic Compounds			
	Composite alkalinity (P-value)	mmol/L	<0.10	<0.10
	Total alkalinity (M-value)	mmol/L	4.6	6.4
Q	Ammonia as NH4-N	mg N/L	1.2	<0.050
Q	Ammonia (NH4)	mg/L	1.6	<0.065
Q	Carbonate	mg/L	<5.0	<5.0
Q	Bicarbonate (HCO3)	mg/L	280	390
Q	Ortho-phosphate (PO4-P)	mg P/L	<0.010	<0.010
Q	Ortho-phosphate (PO4)	mg PO4/L	<0.030	<0.030
Q	Bromide	mg/L	<0.050	<0.050
Q	Chloride	mg/L	21	19
Q	Sulphate	mg/L	200	24
Q	Nitrate equivalent NO3-N	mg N/L	1.6	2.6
Q	Nitrate (NO3)	mg/L	7.3	12
Q	Nitrite as NO2-N	mg N/L	0.074	<0.010
Q	Nitrite (NO2)	mg/L	0.24	<0.030
	Hardness temporary	mmol/L	2.3	3.2

No.	Sample description	Analytico-#
6	ZDSDRIS	3497593
7	DRISTRIBUS	3497594

Q: Dutch Accreditation Council (RvA) accredited operation
A: AP04 accredited operation
S: AS3000 accredited operation

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VAT/BTW No.
NL 8043.14.883.B01
KvK No. 09088623

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Certificate of analysis

Your project number	1560701	Certificate number	2007146468
Your project name	Lisheen	Start date	10-22-2007
Your order number		Report date	11-01-2007/12:58
Date sampling	10-18-2007	Enclosure	A,B,C
Sampled by	ÖOC	Page	4/4

Analysis	Unit	6	7
Hardness temporary	°D	13	18
Hardness temporary	°F	23	32

No.	Sample description	Analytico-#
6	ZDSDRIS	3497593
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Q: Dutch Accreditation Council (RvA) accredited operation
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Initials
Pr.coord.
JM

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Enclosure (A) concerning subsample information referring to certificate of analysis 2007146468

Analytico-#	Drill-#	Description	Description	From	To	Barcode	Sample description
3497588						0730015397	EUSROSS
3497588						0730015454	
3497588						0720077814	
3497588						0840202342	
3497588						0580385086	
3497589						0730015473	DISROSS
3497589						0730015418	
3497589						0720059567	
3497589						0840202257	
3497589						0580385034	
3497590						0730015345	QDSROSS
3497590						0730015234	
3497590						0720077938	
3497590						0840202505	
3497590						0580385091	
3497591						0730015462	ZUSDRIS
3497591						0730015246	
3497591						0720077807	
3497591						0840202516	
3497591						0580385099	
3497592						0730015119	DISDRIS
3497592						0730015274	
3497592						0720077809	
3497592						0840202273	
3497592						0580385062	
3497593						0730015099	ZDSDRIS
3497593						0730015157	
3497593						0720077820	
3497593						0840202124	
3497593						0580385088	
3497594						0730015193	DRISTRIBUS
3497594						0730015272	
3497594						0720077810	
3497594						0840202266	
3497594						0580385081	

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Enclosure (B) concerning remarks referring to certificate of analysis 2007146468

General remark referring to certificate of analysis
Revised version dated 1st of November 2007

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Enclosure (C) concerning method references referring to certificate of analysis 2007146468

Analysis	Method	Technique	Method reference
Sulphate ionchromatography	W0304	Ion Chromatography	In accordance with NEN-EN-ISO 10304-1/
ICP-MS Sodium (Na)	W0420	ICP-MS	In acc. with NEN-EN-ISO 17294-2: 2004/ i
Nitrite (discrete analyser)	W0566	Spectrometry	In accordance with O-NEN 6604:2006
Chloride ionchromatography	W0304	Ion Chromatography	In accordance with NEN-EN-ISO 10304-1/
ICP-MS Cadmium	W0420	ICP-MS	In acc. with NEN-EN-ISO 17294-2: 2004/ i
ICP-MS Iron (Fe)	W0420	ICP-MS	In acc. with NEN-EN-ISO 17294-2: 2004/ i
ICP-MS Lead	W0420	ICP-MS	In acc. with NEN-EN-ISO 17294-2: 2004/ i
ICP-MS Zinc	W0420	ICP-MS	In acc. with NEN-EN-ISO 17294-2: 2004/ i
ICP-MS Magnesium (Mg)	W0420	ICP-MS	In acc. with NEN-EN-ISO 17294-2: 2004/ i
ICP-MS Copper	W0420	ICP-MS	In acc. with NEN-EN-ISO 17294-2: 2004/ i
Hardness temporary	W0545	Titrimetry	In house method
Ammonium (discrete analyser)	W0566	Spectrometry	In accordance with O-NEN 6604:2006
ICP-MS Chromium	W0420	ICP-MS	In acc. with NEN-EN-ISO 17294-2: 2004/ i
Manganese (Mn)	W0420	ICP-MS	In acc. with NEN-EN-ISO 17294-2: 2004/ i
Composite alkalinity (P-value)	W0545	Titrimetry	In accordance with NEN-EN-ISO 9963-1
ICP-MS Mercury	W0420	ICP-MS	Cf. NEN-EN-ISO 17294-2: 2004 / Gelijk.w.
Nitrate (discrete analyser)	W0566	Spectrometry	In accordance with O-NEN 6604:2006
ICP-MS Potassium (K)	W0420	ICP-MS	In acc. with NEN-EN-ISO 17294-2: 2004/ i
ICP-MS Nickel	W0420	ICP-MS	In acc. with NEN-EN-ISO 17294-2: 2004/ i
Ortho-phosphate (discrete analyser)	W0566	Spectrometry	In accordance with O-NEN 6604:2006
Bromide ionchromatography	W0304	Ion Chromatography	In accordance with NEN-EN-ISO 10304-1/
ICP-MS Calcium (Ca)	W0420	ICP-MS	In acc. with NEN-EN-ISO 17294-2: 2004/ i
Carbonate /Bicarbonate	W0545	Titrimetry	In house method

Further information about the applied methods as well as the classification of the accuracy, are listed in our supplement: "Specification of methods of analyses", version January 2004.

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APPENDIX NO. I.2.6

OGE SAMPLING DATA FOR DRISH RIVER

Parameter	ZUSDRIS	DISDRIS	XDSDRIS	Lisheen Discharge IPPC Licence	Freshwater Fish Directive	Salmonid Water Regulations
	18/10/07 @ 09:58	18/10/07 @ 09:51	18/10/07 @ 09:38		(78/659/EC)	1998
					I/PV	I/PV
pH	6.5	6	6.6		≤6.0≥9.0	≤6.0≥9.0
Temperature (°C)	10	12.9	12.6			
Electrical Conductivity EC	675	897	873		-	-
Dissolved Oxygen (%)	26.9	68.6	62.6		50%≥9/50%≥7	≥6≤9
Dissolved Oxygen (mg/l)	3.03	7.21	6.6			
Ammoniacal nitrogen NH4-N	0.051	1.5	1.2	1	<0.78/≤0.78	-
Biological Oxygen Demand (mg/l O_2)	<2	<2	<2	5	≤6	≤5
Chemical Oxygen Demand (mg/l O_2)	38	<10	<10	40	-	-
Calcium (mg/l)	110	110	110		-	-
Cadmium (mg/l)	<0.0004	0.001	0.00091	0.005	-	-
Chloride (mg/l)	17	21	21		-	-
Chromium (mg/l)	<0.001	<0.001	<0.001		-	-
Copper (mg/l)	<0.005	<0.005	<0.005			
Iron (mg/l)	0.12	0.36	0.39		-	-
Lead (mg/l)	<0.005	19	21	0.05	-	-
Magnesium (mg/l)	20	42	40		-	-
Manganese (mgl)	0.053	0.08	0.077		-	-
Mercury (mg/l)	<0.00005	<0.00005	<0.00005	0.001	-	-
Nickel (mg/l)	<5.0	0.032	0.028		-	-
Potassium (mg/l)	2.9	6.2	5.8		-	-
Sodium (mg/l)	9.4	14	13		-	-
Sulphate	21	220	200	$500^1/400^2$	-	-
Zinc (mg/l)	<0.01	0.36	0.32	0.45		
Total Alkalinity (mg/l)						
Total Organic Carbon (mg/l)	13	<5	<5		-	-
Total Oxidised Nitrogen (mg/l)	1.05	1.93	2.07			
Nitrate as NO_3 (mg/l)	4.6	7.3	7.3	50	-	-
Nitrite as NO_2 (mg/l)	0.039	0.27	0.24		≤0.03	≤0.05
Faecal Coliforms (cfu/100mls	<1	<1	<1		-	-
Total Coliforms (cfu/100mls)	<1	<1	<1			
Phosphate (as PO_4)	<0.03	<0.03	<0.03		-	-

Note [1] Limit for discharge received by tacit agreement with the EPA

Note [2] Limit for downstream samples received by tacit agreement with the EPA

APPENDIX NO. I.2.7

MIXING CALCULATIONS FOR DRISH RIVER

Discharge (l/s)	Upstream of SW1	Mine Water from PWE1	Total Upstream	SW2 Discharge			
Q mean	6300	926	7226.00	231.00			
Q100	12300	926	13226.00	231.00			
Parameter	**Receiving Water Upstream of SW1**	**SW1 Discharge**	**Downstream of SW1**		**Lisheen Discharge IPPC Licence**	**Freshwater Fish Directive**	**Salmonid Water Regulations**
			Qmean	**Q100**		**(78/659/EC)**	**1998**
						I/PV	**I/PV**
pH	6.6	6	6.60	6.01		≤6.0≥9.0	≤6.0≥9.0
Temperature (°C)	12.6	12.9	12.60	12.89			
Electrical Conductivity EC	873	897	874.00	896.61		-	-
Dissolved Oxygen (%)	62.6	68.6	62.80	68.50		50%≥9/50%≥7	≥6≤9
Dissolved Oxygen (mg/l)	6.6	7.21	6.60	7.20			
Ammoniacal nitrogen NH4-N	1.2	1.5	1.20	1.49	1	<0.78/≤0.78	-
Biological Oxygen Demand (mg/l O_2)	<2	<2	<2	<2	5	≤6	≤5
Chemical Oxygen Demand (mg/l O_2)	<10	<10	<10	<10	40	-	-
Calcium (mg/l)	110	110	110	110.00		-	-
Cadmium (mg/l)	0.00091	0.001	0.0009	0.00	0.005	-	-
Chloride (mg/l)	21	21	21	21.00		-	-
Chromium (mg/l)	<0.001	<0.001	<0.001	<0.001		-	-
Copper (mg/l)	<0.005	<0.001	<0.005	<0.005			
Iron (mg/l)	0.39	0.36	0.39	0.36		-	-
Lead (mg/l)	21	19	21.00	19.03	0.05	-	-
Magnesium (mg/l)	40	42	40.00	41.97		-	-
Manganese (mgl)	0.077	0.08	0.08	0.08		-	-
Mercury (mg/l)	<0.00005	<0.00005	<0.00005	<0.00005	0.001	-	-
Nickel (mg/l)	0.028	0.032	0.03	0.03		-	-
Potassium (mg/l)	5.8	6.2	5.80	6.19		-	-
Sodium (mg/l)	13	14	13.00	13.98		-	-
Sulphate	200	220	201.00	219.67	$500^1/400^2$	-	-
Zinc (mg/l)	0.32	0.36	0.32	0.36	0.45		
Bicarbonate (mg/l)	270	280	270	280			
Total Organic Carbon (mg/l)	<5	<5	<5	<5		-	-
Total Oxidised Nitrogen (mg/l)	2.07	1.93	2.07	1.93			
Nitrate as NO_3 (mg/l)	7.3	7.3	7.3	7.3	50	-	-
Nitrite as NO_2 (mg/l)	0.24	0.27	0.24	0.27		≤0.03	≤0.05
Faecal Coliforms (cfu/100mls	<1	<1	<1	<1		-	-
Total Coliforms (cfu/100mls)	<1	<1	<1	<1			
Phosphate (as PO_4)	<0.03	<0.03	<0.03	<0.03		-	-

Note [1] Limit for discharge received by tacit agreement with the EPA

Note [2] Limit for downstream samples received by tacit agreement with the EPA

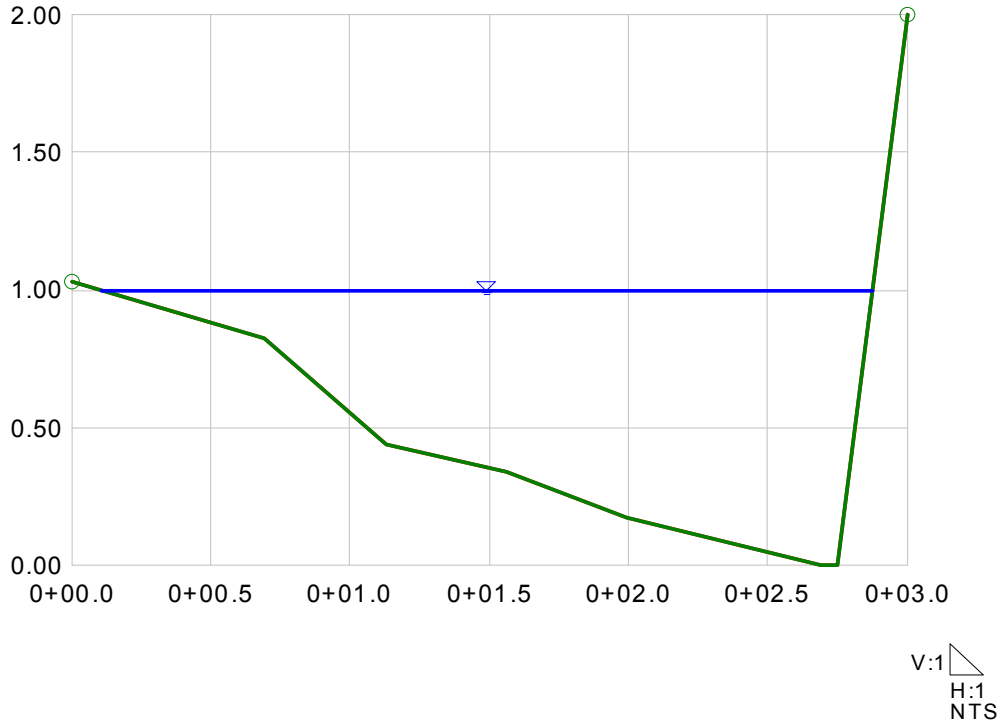
APPENDIX NO. I.2.8

BANKFUL CAPACITY CALCULATIONS FOR DRISH TRIBUTARY

Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

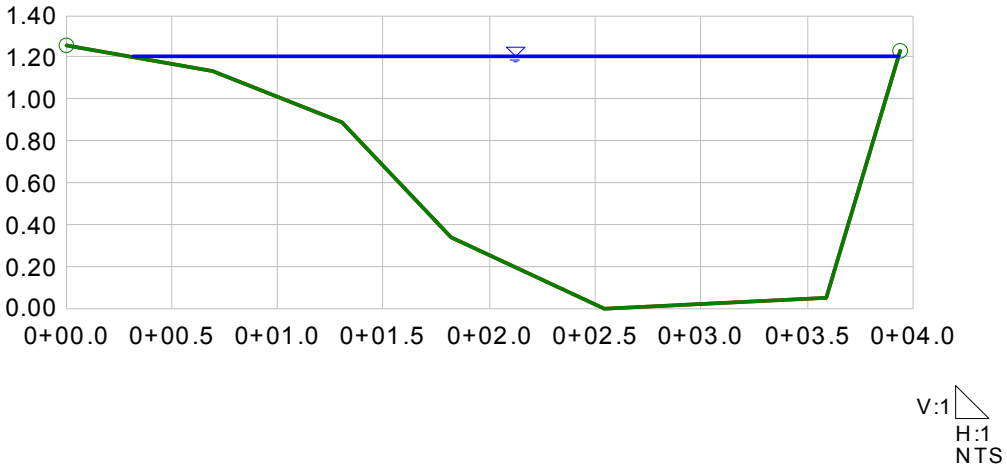
Section Data		
Mannings Coefficient	0.050	
Slope	0.002270	m/m
Water Surface Elevation	1.00	m
Elevation Range	0.00 to 2.00	
Discharge	0.8015	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

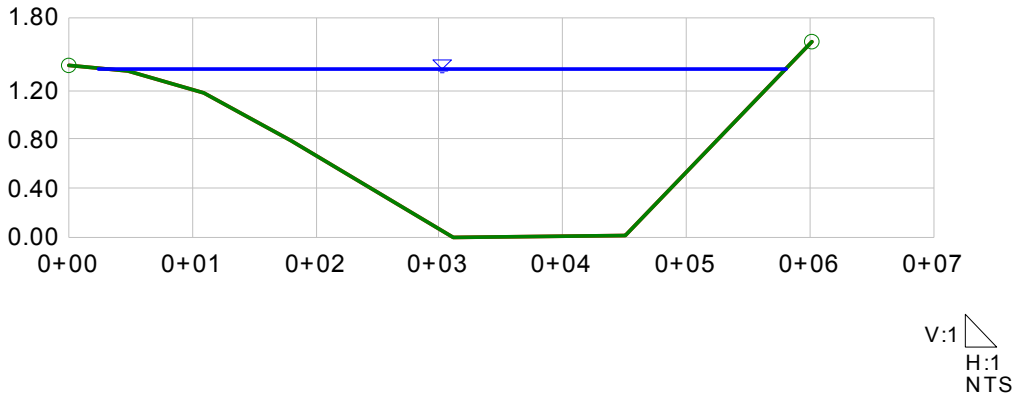
Section Data		
Mannings Coefficient	0.035	
Slope	0.002270	m/m
Water Surface Elevation	1.20	m
Elevation Range	0.00 to 1.26	
Discharge	2.3413	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP3
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

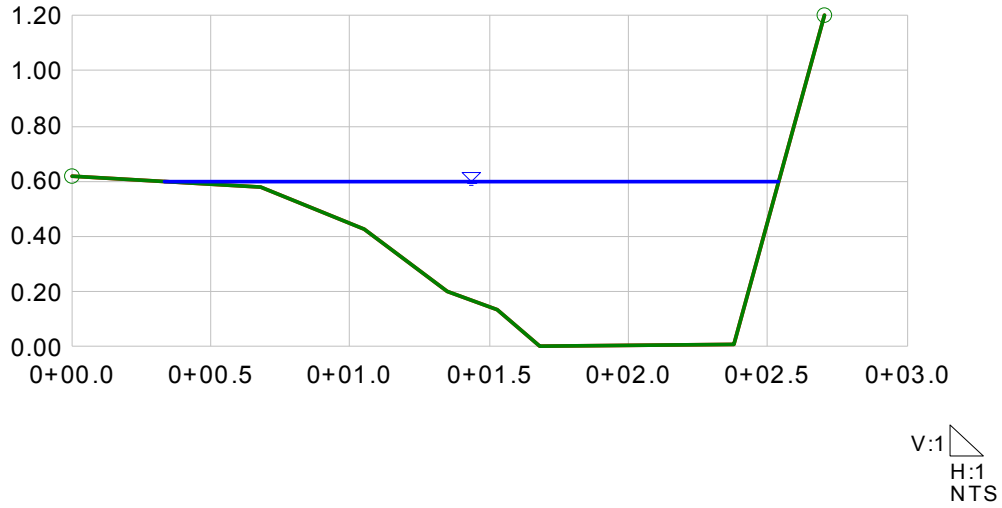
Section Data		
Mannings Coefficient	0.050	
Slope	0.002270	m/m
Water Surface Elevation	1.38	m
Elevation Range	0.00 to 1.60	
Discharge	3.2808	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP4
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

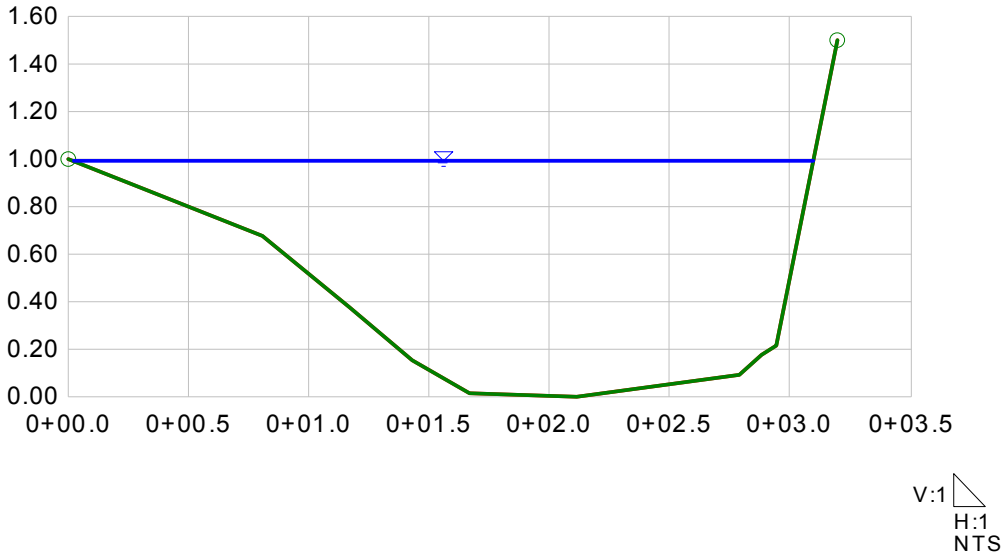
Section Data		
Mannings Coefficient	0.050	
Slope	0.002270	m/m
Water Surface Elevation	0.60	m
Elevation Range	0.00 to 1.20	
Discharge	0.2944	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP5
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

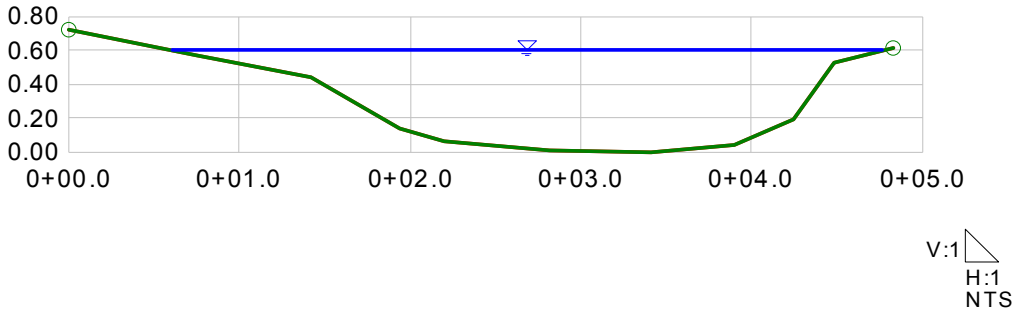
Section Data		
Mannings Coefficient	0.050	
Slope	0.002270	m/m
Water Surface Elevation	0.99	m
Elevation Range	0.00 to 1.50	
Discharge	1.1469	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP6
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

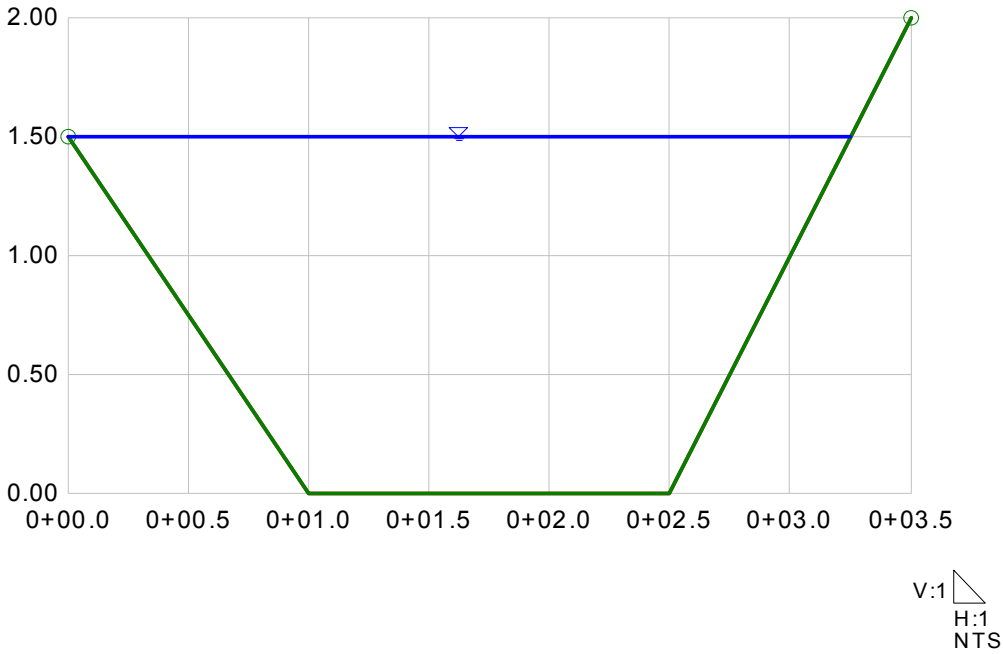
Section Data		
Mannings Coefficient	0.050	
Slope	0.002700	m/m
Water Surface Elevation	0.60	m
Elevation Range	0.00 to 0.72	
Discharge	0.8151	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP7
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

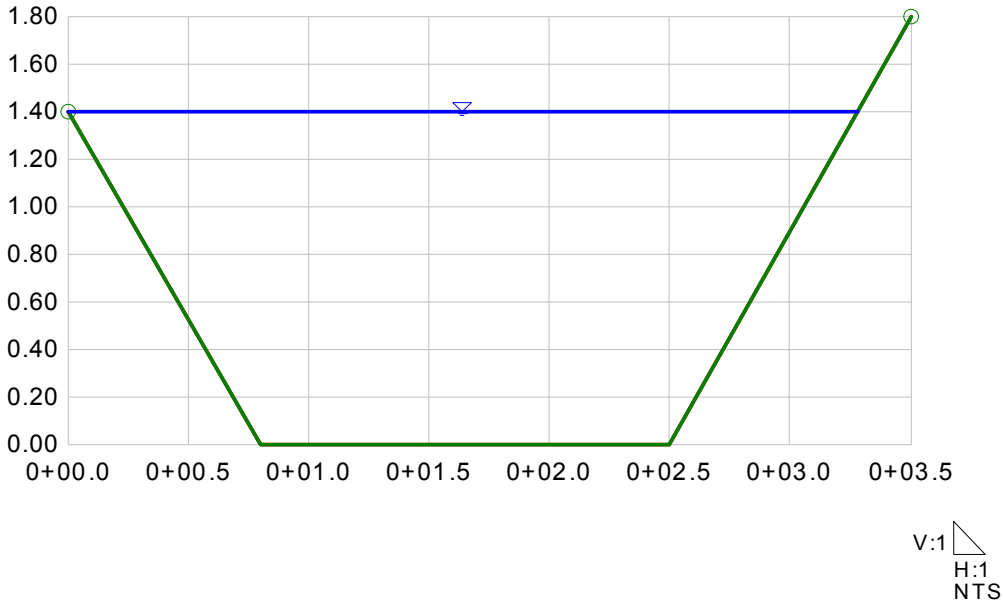
Section Data		
Mannings Coefficient	0.050	
Slope	0.002270	m/m
Water Surface Elevation	1.50	m
Elevation Range	0.00 to 2.00	
Discharge	2.7153	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP8
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

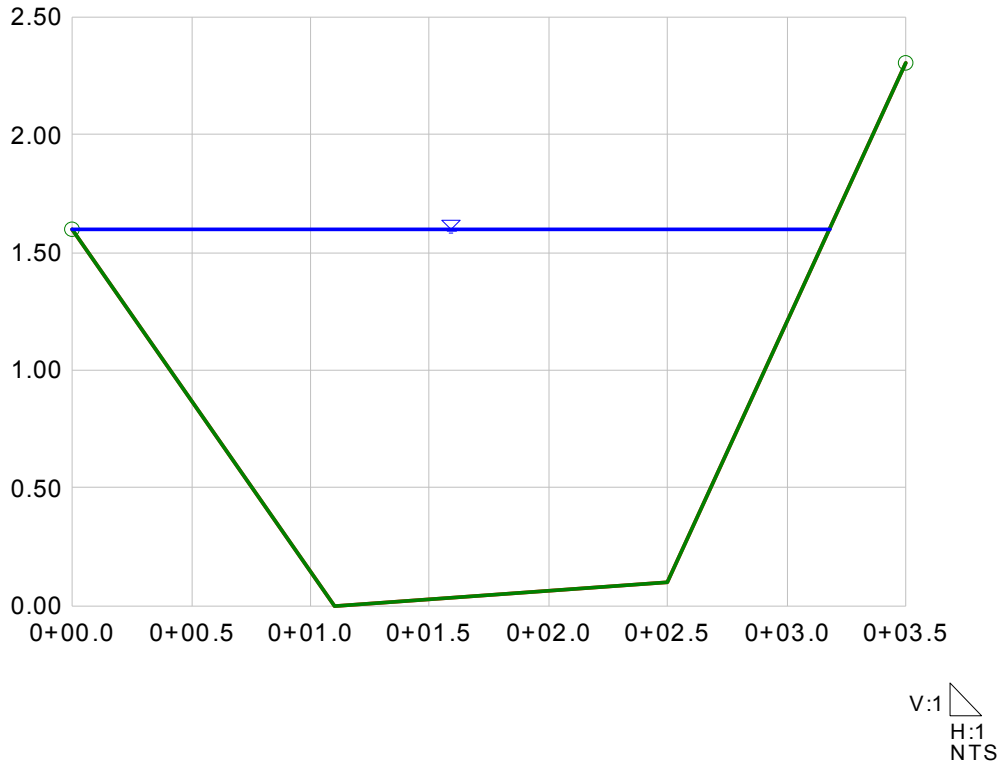
Section Data		
Mannings Coefficient	0.050	
Slope	0.002270	m/m
Water Surface Elevation	1.40	m
Elevation Range	0.00 to 1.80	
Discharge	2.6402	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP9
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

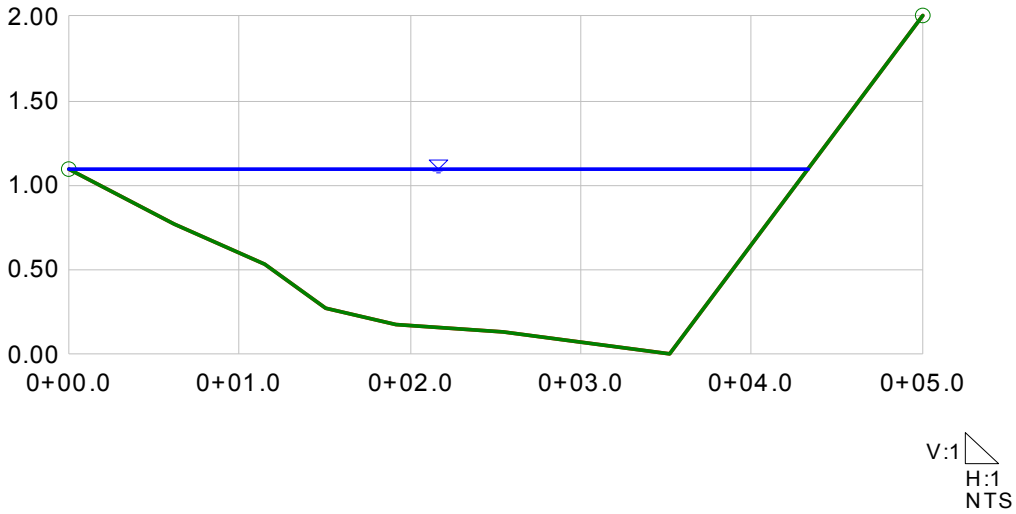
Section Data		
Mannings Coefficient	0.050	
Slope	0.002270	m/m
Water Surface Elevation	1.60	m
Elevation Range	0.00 to 2.30	
Discharge	2.7092	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP10
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

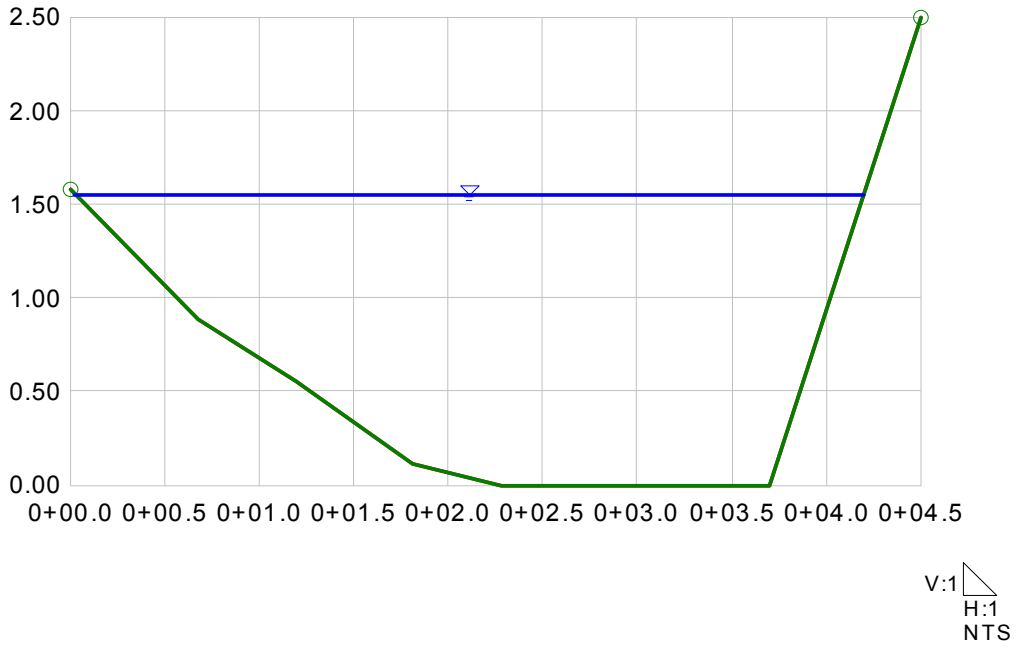
Section Data		
Mannings Coefficient	0.050	
Slope	0.002270	m/m
Water Surface Elevation	1.10	m
Elevation Range	0.00 to 2.00	
Discharge	1.9987	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP11
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

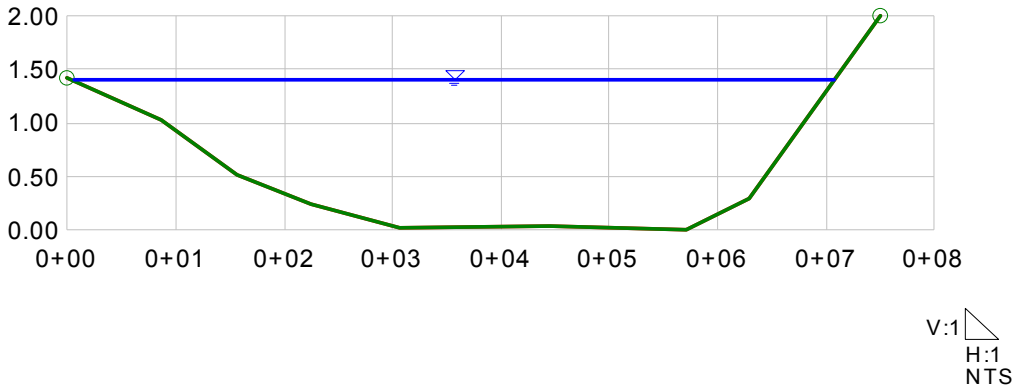
Section Data		
Mannings Coefficient	0.050	
Slope	0.002270	m/m
Water Surface Elevation	1.55	m
Elevation Range	0.00 to 2.50	
Discharge	3.8458	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP12
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

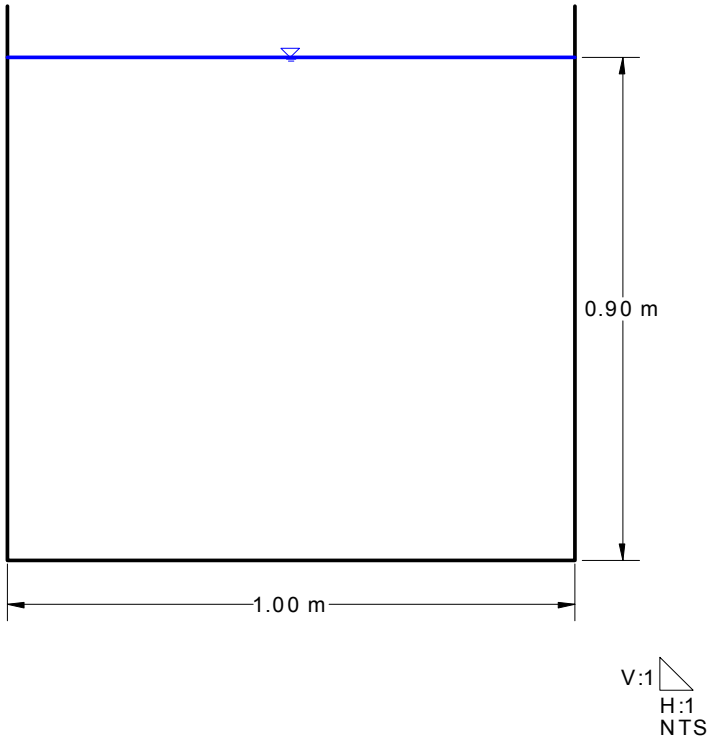
Section Data		
Mannings Coefficient	0.050	
Slope	0.002270	m/m
Water Surface Elevation	1.40	m
Elevation Range	0.00 to 2.00	
Discharge	6.2822	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP13
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Discharge

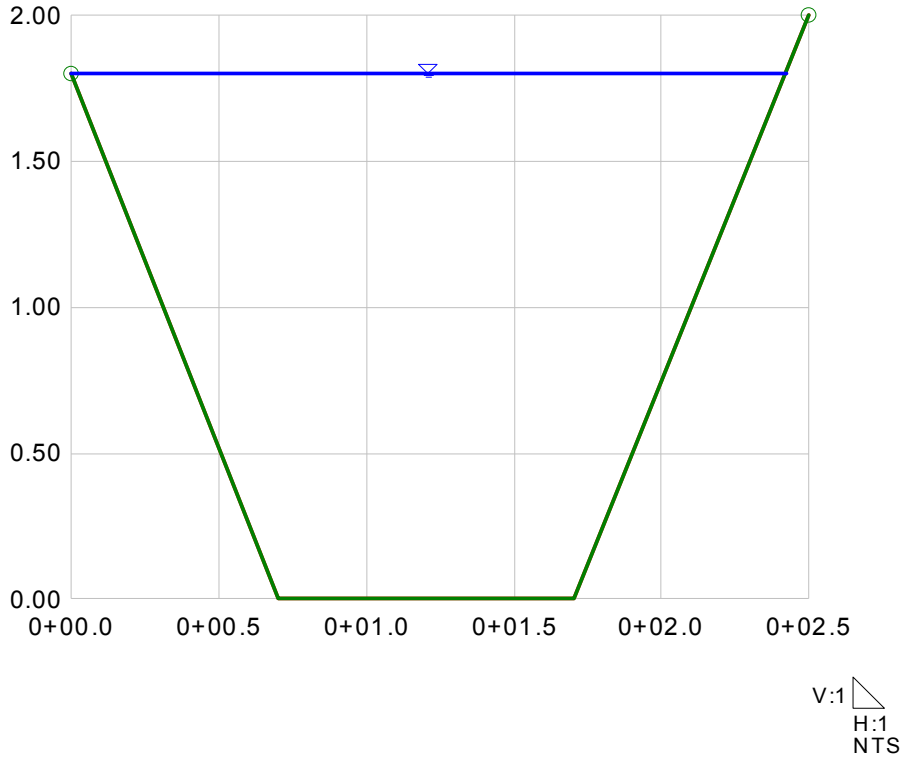
Section Data		
Mannings Coefficient	0.013	
Slope	0.002 270	m/ m
Depth	0.90	m
Bottom Width	1.00	m
Discharge	1.547 8	m³/ s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP14
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

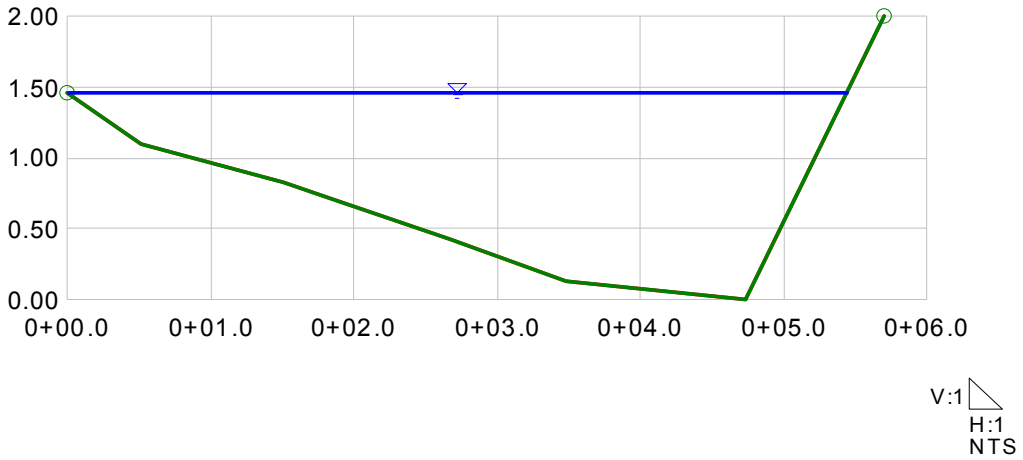
Section Data		
Mannings Coefficient	0.050	
Slope	0.002270	m/m
Water Surface Elevation	1.80	m
Elevation Range	0.00 to 2.00	
Discharge	2.1601	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP15
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

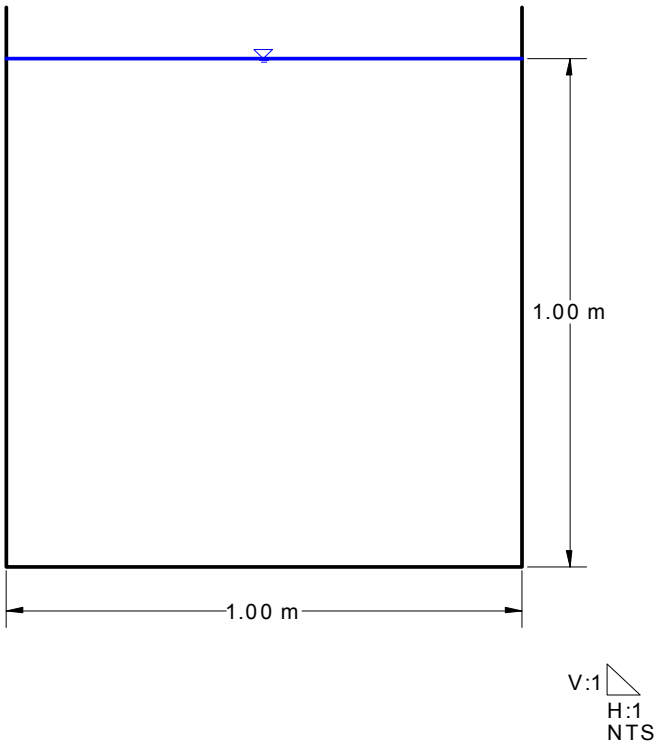
Section Data		
Mannings Coefficient	0.050	
Slope	0.002270	m/m
Water Surface Elevation	1.46	m
Elevation Range	0.00 to 2.00	
Discharge	3.6439	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP16
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Discharge

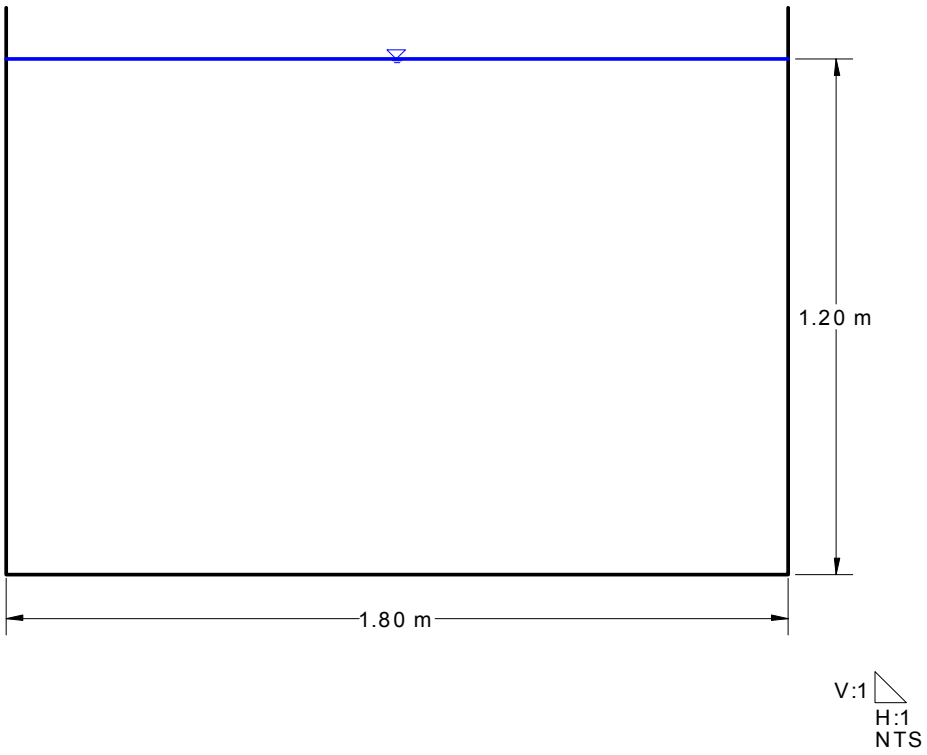
Section Data		
Mannings Coefficient	0.050	
Slope	0.002 270	m/ m
Depth	1.00	m
Bottom Width	1.00	m
Discharge	0.458 1	m³/ s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP17
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Discharge

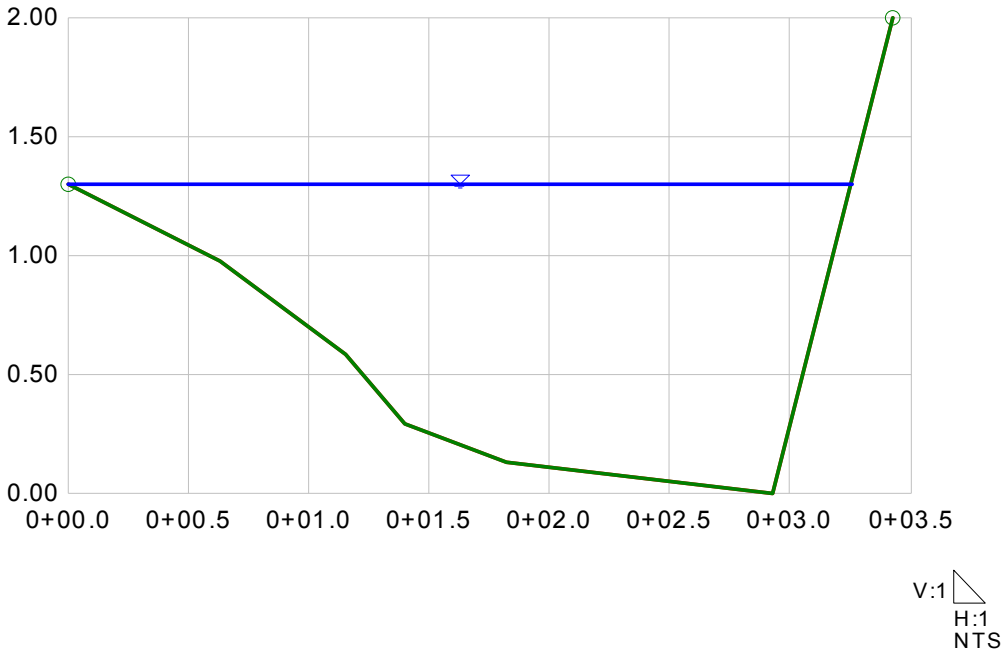
Section Data		
Mannings Coefficient	0.050	
Slope	0.002 270	m/ m
Depth	1.20	m
Bottom Width	1.80	m
Discharge	1.321 2	m³/ s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP18
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

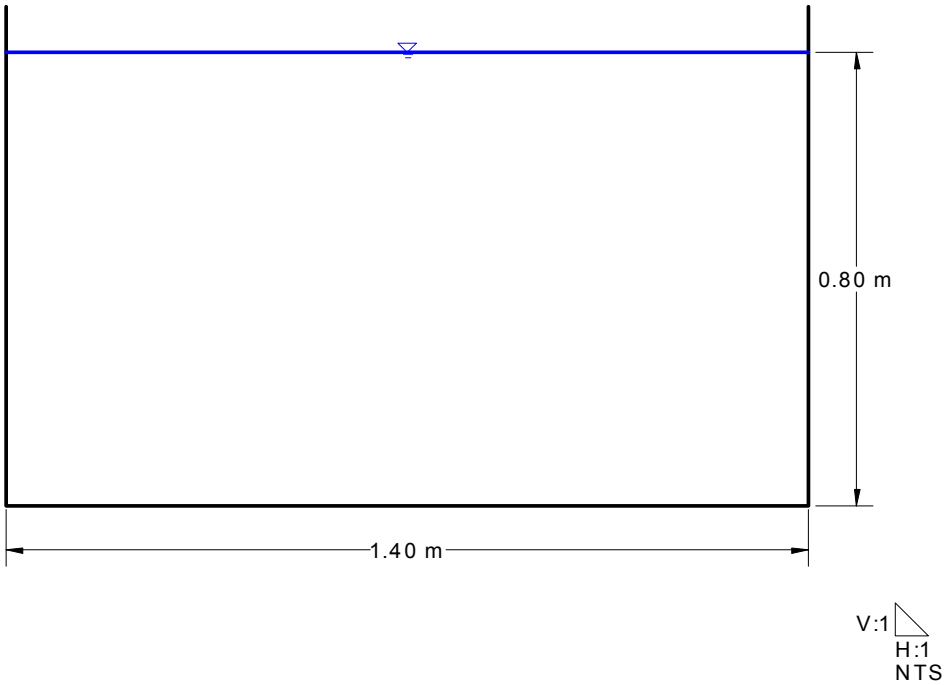
Section Data		
Mannings Coefficient	0.050	
Slope	0.002270	m/m
Water Surface Elevation	1.30	m
Elevation Range	0.00 to 2.00	
Discharge	1.7112	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP19
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Discharge

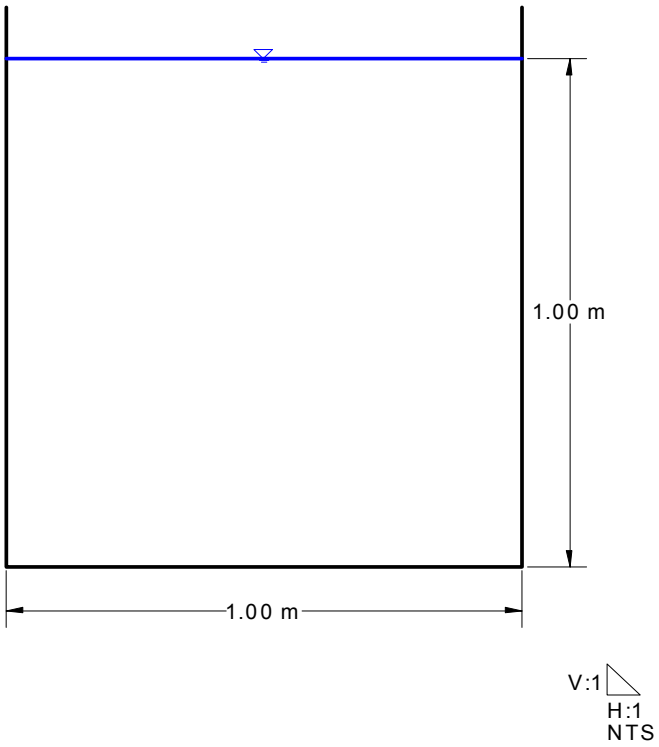
Section Data		
Mannings Coefficient	0.050	
Slope	0.002 270	m/ m
Depth	0.80	m
Bottom Width	1.40	m
Discharge	0.553 3	m³/ s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP20
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Discharge

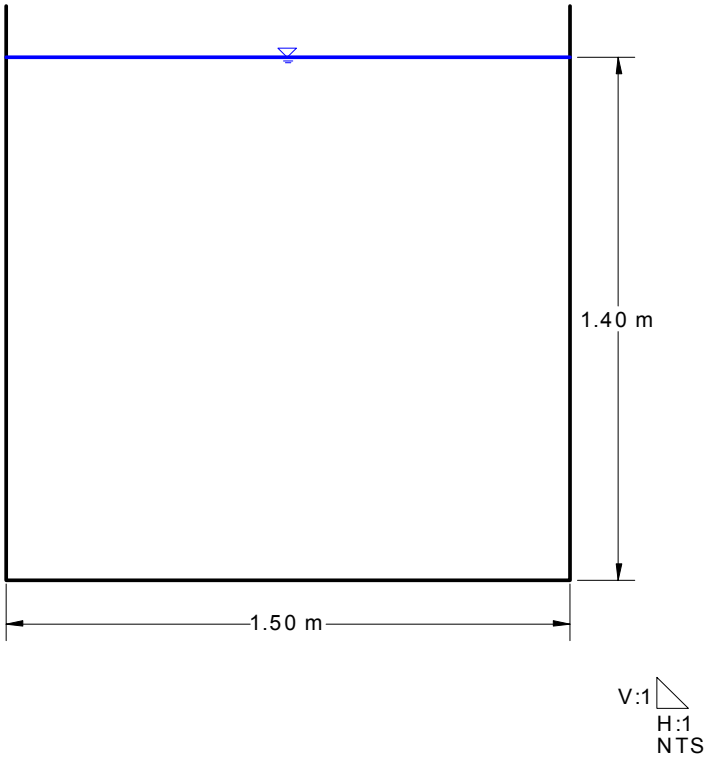
Section Data		
Mannings Coefficient	0.050	
Slope	0.002 270	m/ m
Depth	1.00	m
Bottom Width	1.00	m
Discharge	0.458 1	m³/ s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP21
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Discharge

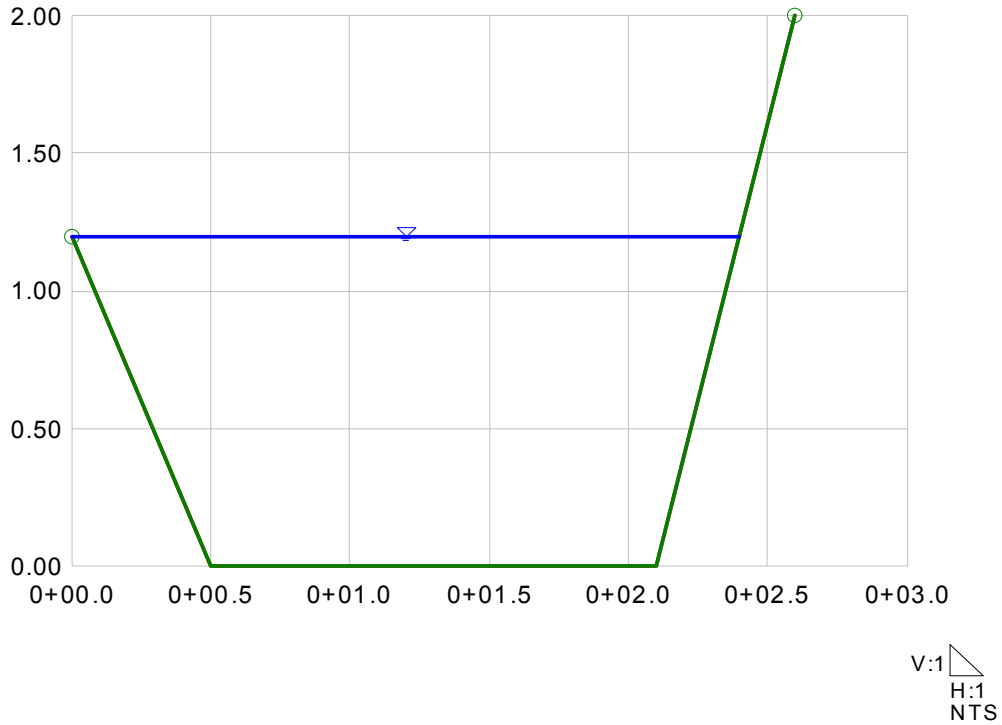
Section Data		
Mannings Coefficient	0.050	
Slope	0.002 270	m/ m
Depth	1.40	m
Bottom Width	1.50	m
Discharge	1.241 0	m³/ s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	SP22
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.050	
Slope	0.002270	m/m
Water Surface Elevation	1.20	m
Elevation Range	0.00 to 2.00	
Discharge	1.5908	m³/s



APPENDIX NO. I.2.9

FLOW DATA FOR CLOBANNA GAUGING STATION

OFFICE OF PUBLIC WORKS

HYDROLOGY AND HYDROMETRIC SECTION

STATION NAME **CLOBANNA**
STATION No. **16051**
RIVER **ROSSESTOWN**
CATCHMENT **SUIR**

Annual Maximum Series of Recorded Water Levels

HYDROMETRIC YEAR	WATER LEVEL (mAOD - Poolbeg)	S.G. READING (m)	DATE
1991	104.61	0.45	12/09/1992
1992	104.64	0.48	13/01/1993
1993	104.77	0.61	15/01/1994
1994	104.89	0.73	27/01/1995
1995	104.83	0.67	06/01/1996
1996	104.72	0.56	06/08/1997
1997	104.75	0.59	17/11/1997
1998	104.69	0.53	29/12/1998
1999	104.69	0.53	25/12/1999 (1.)
2000	104.68	0.52	07/11/2000
2001	104.68	0.52	26/02/2002
2002	104.75	0.59	27/11/2002
2003	104.63	0.46	15/01/2004
2004	104.75	0.59	29/10/2004
2005	104.67	0.51	03/11/2005
2006	104.64	0.48	15/12/2006 (2)

(1) Highest water level recorded during the 1999 hydrometric year up to *(Date of last chart)*
(2) Highest water level recorded during the 2006 hydrometric year up to 27/08/2007

Hydrometric years run from the 1st October to 30th September, e.g., hydrometric year 1980 begins on 1st October 1980.

Current Staff Gauge Zero = 104.164 mAOD (Poolbeg)

APPENDIX NO. I.2.10

DATA FOR ROSSESTOWN FLOOD LINE PREDICTIONS

Lisaticy Bridge (SW2) (Rectangular Arches)

Looking Downstream		
Water level elevation	(m)	96.690
Initial offset	(m)	-1.768
Max. overflow height	(m)	99.187
Left overflow slope		-0.006
Right overflow slope		0.003

Arch	Offset	Floor	Opening	Overflow
First	-1.768	97.145	97.145	99.198
	-1.767	97.145	98.335	99.198
	-1.086	96.265	98.335	99.194
	1.085	96.265	98.335	99.183
	1.766	97.145	98.335	99.181
	1.767	97.145	97.145	99.181

Looking Upstream		
Water level elevation	(m)	96.660
Initial offset	(m)	-1.780
Max. overflow height	(m)	99.187
Left overflow slope		0.003
Right overflow slope		-0.006

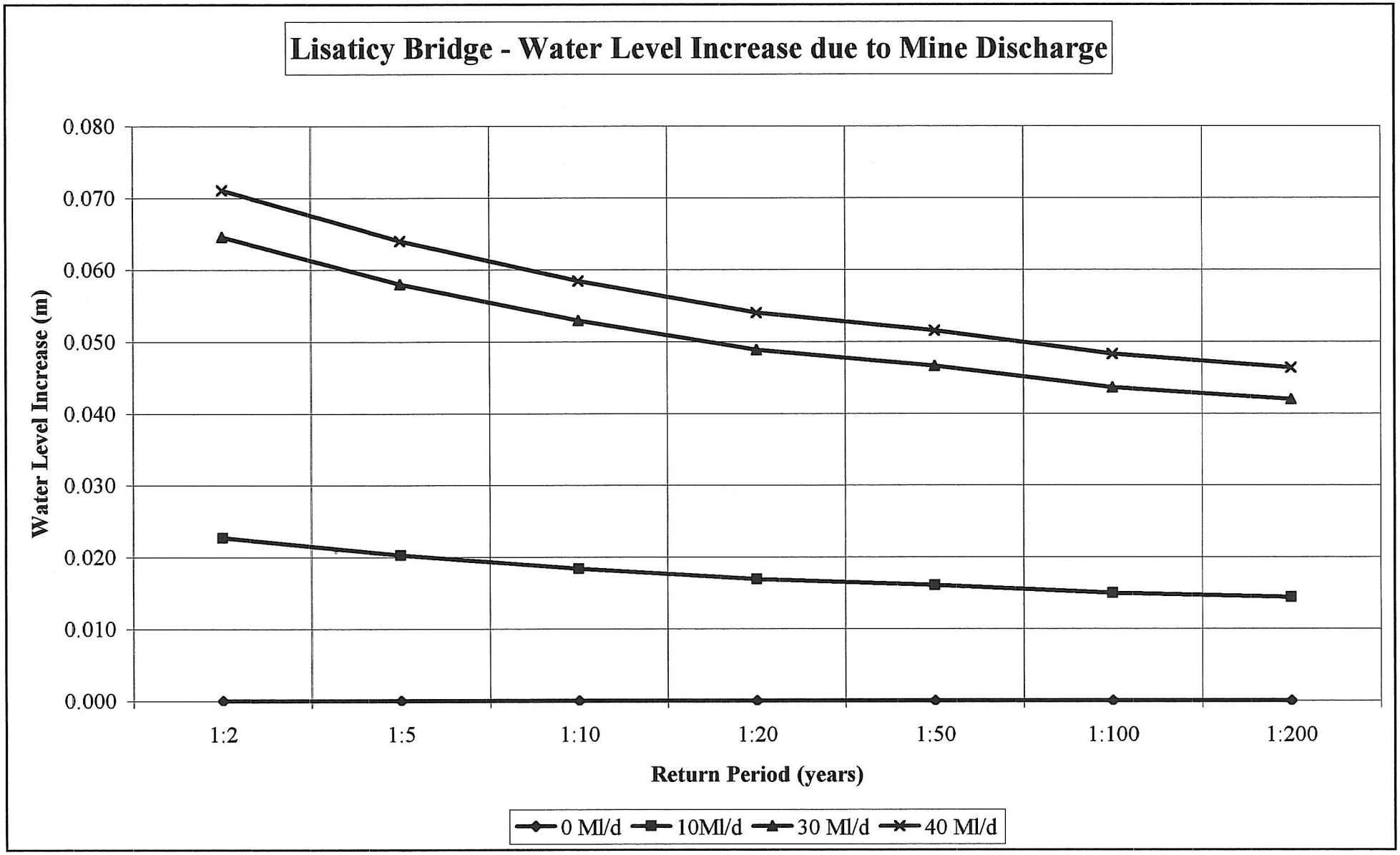
Arch	Offset	Floor	Opening	Overflow
First	-1.780	97.160	97.160	99.181
	-1.779	97.160	98.320	99.181
	-1.085	96.260	98.320	99.183
	1.085	96.260	98.320	99.194
	1.779	97.160	98.320	99.198
	1.780	97.160	97.160	99.198

Stage - Discharge Table for the Lisaticy Bridge (SW2)

Stage (m)	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.000	0.000	0.000	0.000	0.001	0.002	0.003	0.004	0.006	0.008
0.1	0.011	0.014	0.018	0.022	0.027	0.033	0.039	0.045	0.053	0.061
0.2	0.070	0.079	0.090	0.101	0.113	0.126	0.140	0.154	0.170	0.186
0.3	0.204	0.222	0.241	0.262	0.283	0.306	0.330	0.354	0.380	0.407
0.4	0.435	0.465	0.495	0.527	0.560	0.594	0.630	0.667	0.705	0.744
0.5	0.785	0.827	0.871	0.916	0.962	1.010	1.059	1.110	1.162	1.215
0.6	1.271	1.327	1.386	1.445	1.507	1.570	1.634	1.701	1.769	1.838
0.7	1.909	1.982	2.057	2.133	2.211	2.291	2.372	2.456	2.541	2.628
0.8	2.717	2.807	2.900	2.994	3.090	3.189	3.289	3.391	3.495	3.600
0.9	3.708	3.818	3.930	4.044	4.160	4.278	4.398	4.520	4.644	4.770
1.0	4.898	5.029	5.161	5.296	5.433	5.572	5.713	5.857	6.002	6.150
1.1	6.301	6.453	6.608	6.765	6.924	7.085	7.249	7.416	7.584	7.755
1.2	7.929	8.104	8.282	8.463	8.646	8.831	9.019	9.209	9.402	9.598
1.3	9.795	9.996	10.198	10.404	10.612	10.822	11.035	11.251	11.469	11.690
1.4	11.913	12.139	12.368	12.600	12.834	13.070	13.310	13.552	13.797	14.045
1.5	14.295	14.548	14.804	15.063	15.324	15.588	15.855	16.125	16.398	16.674
1.6	16.952	17.233	17.517	17.805	18.094	18.387	18.683	18.982	19.284	19.588
1.7	19.896	20.207	20.520	20.837	21.157	21.479	21.805	22.134	22.466	22.801
1.8	23.139	23.480	23.824	24.171	24.522	24.875	25.232	25.592	25.955	26.321
1.9	26.691	27.064	27.440	27.819	28.201	28.587	28.975	29.368	29.763	30.162
2.0	30.564	30.969	31.378	31.790	32.205	32.624	33.046	33.471	33.900	34.332

OGE

Lisaticy Bridge							
Return Period (years)	**Natural Flood Peaks (m^3/s)**	**Mine Discharge (Ml/d)**	**Mine Discharge (m^3/s)**	**Flow Rate (m^3/s)**	**Water Level (m)**	**Depth increase due to pumping (m)**	**Flood Width (m)**
1:2	1.400	0	0.000	1.400	96.887	0.000	3.535
	1.400	10	0.139	1.539	96.910	0.023	3.535
	1.400	30	0.417	1.817	96.952	0.065	3.535
	1.400	40	0.463	1.863	96.959	0.071	3.535
1:5	1.700	0	0.000	1.700	96.935	0.000	3.535
	1.700	10	0.139	1.839	96.955	0.020	3.535
	1.700	30	0.417	2.117	96.993	0.058	3.535
	1.700	40	0.463	2.163	96.999	0.064	3.535
1:10	2.000	0	0.000	2.000	96.977	0.000	3.535
	2.000	10	0.139	2.139	96.996	0.018	3.535
	2.000	30	0.417	2.417	97.030	0.053	3.535
	2.000	40	0.463	2.463	97.036	0.058	3.535
1:20	2.300	0	0.000	2.300	97.016	0.000	3.535
	2.300	10	0.139	2.439	97.033	0.017	3.535
	2.300	30	0.417	2.717	97.065	0.049	3.535
	2.300	40	0.463	2.763	97.070	0.054	3.535
1:50	2.500	0	0.000	2.500	97.040	0.000	3.535
	2.500	10	0.139	2.639	97.056	0.016	3.535
	2.500	30	0.417	2.917	97.087	0.047	3.535
	2.500	40	0.463	2.963	97.092	0.051	3.535
1:100	2.800	0	0.000	2.800	97.074	0.000	3.535
	2.800	10	0.139	2.939	97.089	0.015	3.535
	2.800	30	0.417	3.217	97.118	0.044	3.535
	2.800	40	0.463	3.263	97.122	0.048	3.535
1:200	3.000	0	0.000	3.000	97.096	0.000	3.535
	3.000	10	0.139	3.139	97.110	0.014	3.535
	3.000	30	0.417	3.417	97.138	0.042	3.535
	3.000	40	0.463	3.463	97.142	0.046	3.535


Lisaticy Bridge - Water Level Increase due to Mine Discharge
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
Water Level Increase (m)
1:2
1:5
1:10
1:20
1:50
1:100
1:200
Return Period (years)
0 Ml/d
10Ml/d
30 Ml/d
40 Ml/d

Kilclonagh Bridge (SW3) (Trapezoidal Arches)

Looking Downstream		
Water level elevation	(m)	97.510
Initial offset	(m)	-1.495
Max. overflow height	(m)	99.210
Left overflow slope		0.033
Right overflow slope		0.018

Arch	Offset	Floor	Opening	Overflow
First	-1.495	97.510	97.510	99.160
	-1.494	97.190	98.490	99.160
	0.000	97.190	98.460	99.210
	1.494	97.190	98.460	99.183
	1.495	97.510	97.510	99.183

Looking Upstream		
Water level elevation	(m)	97.387
Initial offset	(m)	-1.500
Max. overflow height	(m)	99.210
Left overflow slope		0.018
Right overflow slope		0.033

Arch	Offset	Floor	Opening	Overflow
First	-1.500	97.387	97.387	99.183
	-1.499	97.107	98.367	99.183
	0.000	97.077	98.337	99.210
	1.499	97.027	98.327	99.160
	1.500	97.387	97.387	99.160

OGE

Stage - Discharge Table for the Kilclonagh Bridge (SW3)

Stage (m)	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.000	0.000	0.000	0.001	0.001	0.002	0.004	0.006	0.008	0.011
0.1	0.014	0.018	0.023	0.028	0.034	0.041	0.048	0.057	0.066	0.075
0.2	0.086	0.098	0.110	0.124	0.138	0.153	0.170	0.187	0.205	0.225
0.3	0.245	0.267	0.290	0.314	0.339	0.365	0.393	0.422	0.452	0.483
0.4	0.516	0.550	0.585	0.622	0.660	0.699	0.740	0.782	0.826	0.871
0.5	0.918	0.966	1.016	1.067	1.119	1.174	1.230	1.287	1.346	1.407
0.6	1.470	1.534	1.599	1.667	1.736	1.807	1.880	1.954	2.030	2.108
0.7	2.188	2.270	2.353	2.438	2.526	2.615	2.706	2.798	2.893	2.990
0.8	3.089	3.189	3.292	3.397	3.503	3.612	3.723	3.836	3.951	4.067
0.9	4.187	4.308	4.431	4.556	4.684	4.814	4.946	5.080	5.216	5.355
1.0	5.496	5.639	5.784	5.931	6.081	6.233	6.388	6.545	6.704	6.865
1.1	7.029	7.195	7.364	7.535	7.708	7.884	8.062	8.243	8.426	8.611
1.2	8.800	8.990	9.183	9.379	9.577	9.778	9.981	10.187	10.395	10.606
1.3	10.820	11.036	11.255	11.476	11.701	11.927	12.157	12.389	12.624	12.861

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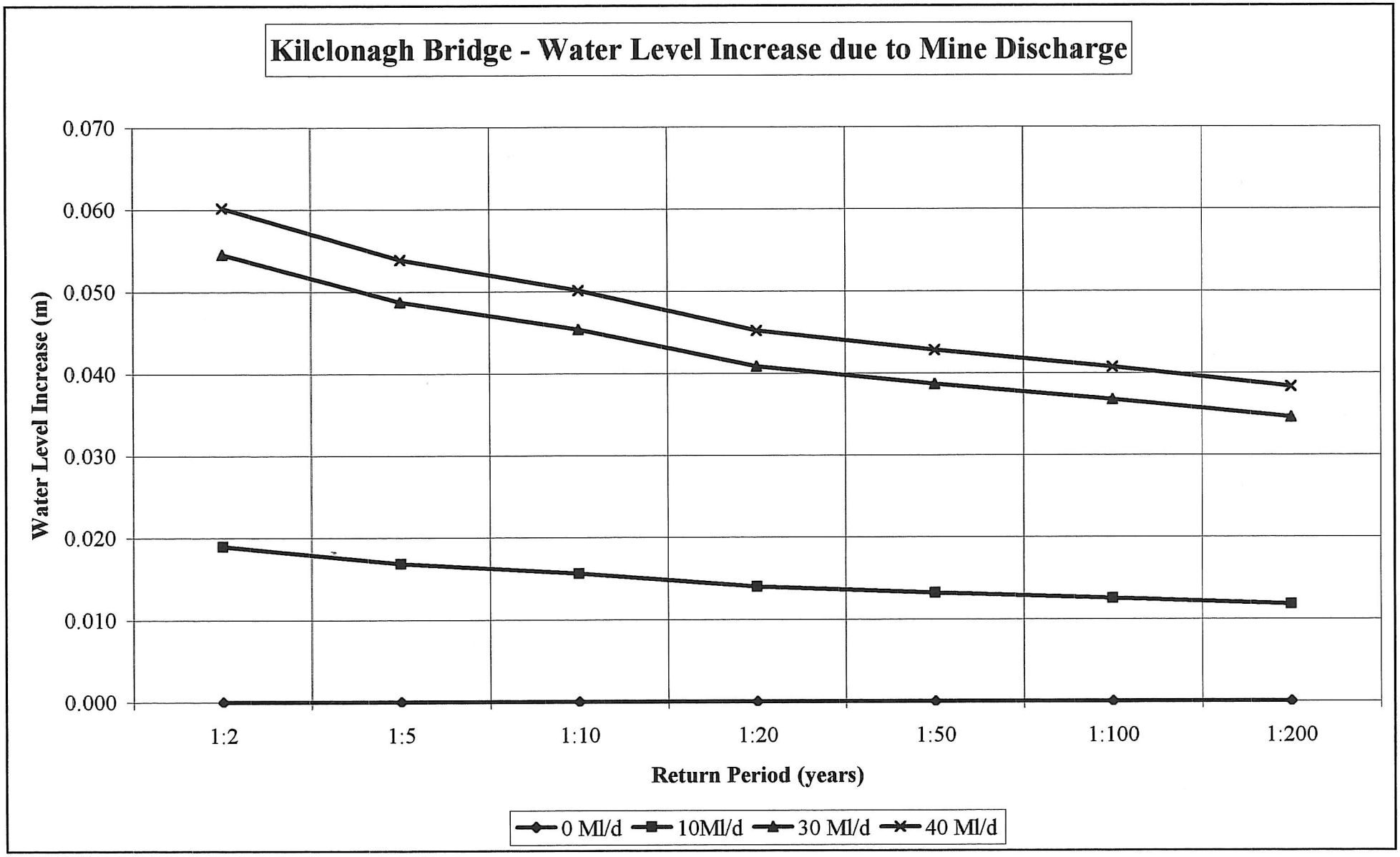
Kilclonagh Bridge							
Return Period (years)	Natural Flood Peaks (m^3/s)	Mine Discharge (Ml/d)	Mine Discharge (m^3/s)	Flow Rate (m^3/s)	Water Level (m)	Depth increase due to pumping (m)	Flood Width (m)
1:2	1.800	0	0.000	1.800	97.839	0.000	2.990
	1.800	10	0.139	1.939	97.858	0.019	2.990
	1.800	30	0.417	2.217	97.894	0.055	2.990
	1.800	40	0.463	2.263	97.899	0.060	2.990
1:5	2.200	0	0.000	2.200	97.891	0.000	2.990
	2.200	10	0.139	2.339	97.908	0.017	2.990
	2.200	30	0.417	2.617	97.940	0.049	2.990
	2.200	40	0.463	2.663	97.945	0.054	2.990
1:10	2.500	0	0.000	2.500	97.927	0.000	2.990
	2.500	10	0.139	2.639	97.943	0.016	2.990
	2.500	30	0.417	2.917	97.972	0.045	2.990
	2.500	40	0.463	2.963	97.977	0.050	2.990
1:20	3.000	0	0.000	3.000	97.981	0.000	2.990
	3.000	10	0.139	3.139	97.995	0.014	2.990
	3.000	30	0.417	3.417	98.022	0.041	2.990
	3.000	40	0.463	3.463	98.026	0.045	2.990
1:50	3.300	0	0.000	3.300	98.011	0.000	2.990
	3.300	10	0.139	3.439	98.024	0.013	2.990
	3.300	30	0.417	3.717	98.049	0.039	2.990
	3.300	40	0.463	3.763	98.054	0.043	2.990
1:100	3.600	0	0.000	3.600	98.039	0.000	2.990
	3.600	10	0.139	3.739	98.051	0.013	2.990
	3.600	30	0.417	4.017	98.076	0.037	2.990
	3.600	40	0.463	4.063	98.080	0.041	2.990
1:200	4.000	0	0.000	4.000	98.074	0.000	2.990
	4.000	10	0.139	4.139	98.086	0.012	2.990
	4.000	30	0.417	4.417	98.109	0.035	2.990
	4.000	40	0.463	4.463	98.113	0.038	2.990


Kilclonagh Bridge - Water Level Increase due to Mine Discharge
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
Water Level Increase (m)
1:2
1:5
1:10
1:20
1:50
1:100
1:200
Return Period (years)
0 Ml/d
10Ml/d
30 Ml/d
40 Ml/d

APPENDIX NO. I.2.11

EPA WATER QUALITY DATA FOR ROSSESTOWN RIVER

Station No: 0040

River Code: 16R01
Situated On: ROSSESTOWN
Location: Bridge N.E. of Barnalisheen
Hydrometric Area: Suir
Chemical Data Available For:

2001 to 2003
1998 to 2000
1995 to 1997

Biological Data:

YEAR	QUALITY
2005	3*
2002	3*
1999	3*
1996	3*
1992	3
1988	3-4

Station No: 0040 **Location:** Bridge N.E. of Barnalisheen **Date From:** 1995 **To:** 1997
A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg O21-1	**1.7**	**2.7**	**5.5**	12	Kilkenny	EPA
Chloride	mg Cl 1-1	**15**	**18**	**25**	13	Kilkenny	EPA
Colour	Hazen	**60**	**100**	**200**	10	Kilkenny	EPA
Conductivity	µS cm-1	398	542	633	13	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**0.02**	**0.07**	**0.41**	12	Kilkenny	EPA
Oxidised Nitrogen	mg N 1-1	**1.0**	**2.2**	**5.0**	26	Kilkenny	EPA
pH		**7.5**	**7.9**	**8.2**	13	Kilkenny	EPA
Temperature	oC	**4.3**	**12.0**	**14.5**	13	Kilkenny	EPA
Total Ammonia	mg N 1-1	**0.12**	**0.62**	**3.80**	12	Kilkenny	EPA

Station No: 0040 **Location:** Bridge N.E. of Barnalisheen **Date From:** 1998 **To:** 2000

A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg O21-1	**0.7**	**3.0**	**4.9**	12	Kilkenny	EPA
Chloride	mg Cl 1-1	**14**	**16**	**34**	10	Kilkenny	EPA
Colour	Hazen	**30**	**110**	**225**	10	Kilkenny	EPA
Conductivity	µS cm-1	346	522	666	12	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**<0.02**	**0.01**	**0.03**	11	Kilkenny	EPA
Oxidised Nitrogen	mg N 1-1	**0.7**	**1.4**	**2.8**	12	Kilkenny	EPA
pH		**7.6**	**7.9**	**8.1**	12	Kilkenny	EPA
Temperature	oC	**3.1**	**11.0**	**15.8**	12	Kilkenny	EPA
Total Ammonia	mg N 1-1	**0.25**	**0.68**	**1.04**	11	Kilkenny	EPA

Station No: 0040 **Location:** Bridge N.E. of Barnalisheen **Date From:** 2001 **To:** 2003

A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg O21-1	**0.3**	**2.1**	**4.2**	13	Kilkenny	EPA
Chloride	mg Cl 1-1	**14**	**18**	**24**	12	Kilkenny	EPA
Colour	Hazen	**5**	**70**	**250**	13	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**0.01**	**0.01**	**0.02**	8	Kilkenny	EPA
Oxidised Nitrogen	mg N 1-1	**1.0**	**1.2**	**2.9**	12	Kilkenny	EPA
pH		**7.4**	**7.8**	**8.1**	13	Kilkenny	EPA
Temperature	oC	**5.5**	**10.6**	**16.8**	13	Kilkenny	EPA
Total Ammonia	mg N 1-1	**0.07**	**0.79**	**2.10**	12	Kilkenny	EPA

Station No: 0100

River Code: 16R01
Situated On: ROSSESTOWN
Location: Lisaticy Bridge
Hydrometric Area: Suir
Chemical Data Available For:

1998 to 2000
1995 to 1997

Biological Data:

YEAR	QUALITY
2005	3
2002	3
1999	4
1996	3-4
1992	4
1988	3-4
1985	3-4
1981	3-4
1977	3-4

Station No: 0100 **Location:** Lisaticy Bridge **Date From:** 1998 **To:** 2000
A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg O21-1	**0.5**	**2.6**	**4.0**	9	Kilkenny	EPA
Chloride	mg Cl 1-1	**15**	**17**	**23**	6	Kilkenny	EPA
Colour	Hazen	**20**	**85**	**225**	6	Kilkenny	EPA
Conductivity	µS cm-1	316	538	598	9	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**<0.02**	**<0.02**	**0.04**	7	Kilkenny	EPA
Oxidised Nitrogen	mg N 1-1	**0.6**	**1.4**	**2.5**	9	Kilkenny	EPA
pH		**7.7**	**7.9**	**8.3**	9	Kilkenny	EPA
Temperature	oC	**5.2**	**10.5**	**15.7**	9	Kilkenny	EPA

Total Ammonia	mg N 1-1	**0.01**	**0.41**	**1.30**	7	Kilkenny	EPA

Station No: 0100 **Location:** Lisaticy Bridge **Date From:** 1995 **To:** 1997
A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	**Parameter Units**	**Minimum**	**Median**	**Maximum**	**No of Samples**	**Source**	**Source Type**
B.O.D	mg O21-1	**1.2**	**2.0**	**3.3**	13	Kilkenny	EPA
Chloride	mg Cl 1-1	**16**	**19**	**25**	14	Kilkenny	EPA
Colour	Hazen	**60**	**85**	**175**	11	Kilkenny	EPA
Conductivity	µS cm-1	425	589	662	14	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**0.02**	**0.03**	**0.12**	13	Kilkenny	EPA
Oxidised Nitrogen	mg N 1-1	**1.9**	**2.4**	**5.1**	28	Kilkenny	EPA
pH		**7.7**	**8.0**	**8.7**	14	Kilkenny	EPA
Temperature	oC	**4.6**	**11.0**	**14.0**	14	Kilkenny	EPA
Total Ammonia	mg N 1-1	**0.01**	**0.11**	**0.86**	14	Kilkenny	EPA

Station No: 0200

River Code: 16R01
Situated On: ROSSESTOWN
Location: Bridge S. of Kilclonagh
Hydrometric Area: Suir
Chemical Data Available For:

1998 to 2000
1995 to 1997

Biological Data:

YEAR	QUALITY
2005	3
2002	3-4
1999	4
1996	4
1992	4
1988	3-4
1985	4
1981	4
1977	4

Station No: 0200 **Location:** Bridge S. of Kilclonagh **Date From:** 1995 **To:** 1997
A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg O21-1	**1.0**	**1.7**	**2.7**	13	Kilkenny	EPA
Chloride	mg Cl 1-1	**17**	**20**	**24**	14	Kilkenny	EPA
Colour	Hazen	**30**	**70**	**150**	11	Kilkenny	EPA
Conductivity	µS cm-1	447	641	694	14	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**0.02**	**0.03**	**0.15**	13	Kilkenny	EPA
Oxidised Nitrogen	mg N 1-1	**2.3**	**3.6**	**6.4**	28	Kilkenny	EPA
pH		**7.7**	**8.2**	**8.4**	14	Kilkenny	EPA
Temperature	oC	**4.9**	**12.2**	**15.1**	14	Kilkenny	EPA

Total Ammonia	mg N 1-1	**0.01**	**0.02**	**0.60**	14	Kilkenny	EPA

Station No: 0200 **Location:** Bridge S. of Kilclonagh **Date From:** 1998 **To:** 2000
A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	**Parameter Units**	**Minimum**	**Median**	**Maximum**	**No of Samples**	**Source**	**Source Type**
B.O.D	mg O21-1	**0.3**	**2.2**	**5.4**	11	Kilkenny	EPA
Chloride	mg Cl 1-1	**15**	**18**	**21**	8	Kilkenny	EPA
Colour	Hazen	**15**	**55**	**225**	8	Kilkenny	EPA
Conductivity	µS cm-1	355	560	616	11	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**<0.02**	**<0.02**	**0.04**	9	Kilkenny	EPA
Oxidised Nitrogen	mg N 1-1	**1.0**	**2.1**	**3.5**	11	Kilkenny	EPA
pH		**7.8**	**8.2**	**8.4**	11	Kilkenny	EPA
Temperature	oC	**4.9**	**10.9**	**16.1**	11	Kilkenny	EPA
Total Ammonia	mg N 1-1	**<0.01**	**0.21**	**0.79**	9	Kilkenny	EPA

Station No: 0300

River Code: 16R01
Situated On: ROSSESTOWN
Location: Bridge u/s Suir River confl
Hydrometric Area: Suir
Chemical Data Available For:

2001 to 2003
1998 to 2000
1995 to 1997

Biological Data:

YEAR	QUALITY
2005	4
2002	4
1999	4
1996	4
1992	3-4
1988	3-4
1985	3-4
1981	3-4
1977	4

Station No:	Location:	Date From:	To:
0300	Bridge u/s Suir River confl	2001	2003

A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg O21-1	**0.3**	**1.5**	**3.2**	13	Kilkenny	EPA
Chloride	mg Cl 1-1	**15**	**18**	**23**	13	Kilkenny	EPA
Colour	Hazen	**20**	**50**	**225**	13	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**0.01**	**0.02**	**0.06**	12	Kilkenny	EPA
Oxidised Nitrogen	mg N 1-1	**1.8**	**2.3**	**2.9**	13	Kilkenny	EPA
pH		**7.7**	**8.0**	**8.2**	13	Kilkenny	EPA
Temperature	oC	**5.0**	**10.9**	**15.5**	13	Kilkenny	EPA
Total	mg N 1-1	**0.04**	**0.13**	**0.47**	12	Kilkenny	EPA

Ammonia							

Station No: 0300 **Location:** Bridge u/s Suir River confl **Date From:** 1998 **To:** 2000
A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg O21-1	**0.6**	**1.2**	**3.7**	13	Kilkenny	EPA
Chloride	mg Cl 1-1	**11**	**18**	**21**	9	Kilkenny	EPA
Colour	Hazen	**15**	**45**	**225**	10	Kilkenny	EPA
Conductivity	µS cm-1	503	616	752	13	Kilkenny	EPA
Conductivity	µS cm-1	486	612	669	42	Three Rivers Project	LA
Ortho-Phosphate	mg P 1-1	**<0.02**	**0.02**	**0.08**	11	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**0.09**	**0.09**	**0.09**	1	Three Rivers Project	LA
Ortho-Phosphate	mg P 1-1	**0.01**	**0.02**	**0.13**	43	Three Rivers Project	LA
Oxidised Nitrogen	mg N 1-1	**1.3**	**2.1**	**3.7**	13	Kilkenny	EPA
pH		**7.8**	**8.1**	**8.3**	13	Kilkenny	EPA
pH		**7.6**	**8.1**	**8.4**	42	Three Rivers Project	LA
Temperature	oC	**4.4**	**11.2**	**15.7**	13	Kilkenny	EPA
Temperature	oC	**5.6**	**11.0**	**15.6**	42	Three Rivers Project	LA
Total Ammonia	mg N 1-1	**0.01**	**0.09**	**0.50**	11	Kilkenny	EPA
Total Ammonia	mg N 1-1	**0.01**	**0.09**	**0.37**	43	Three Rivers Project	LA
Total Ammonia	mg N 1-1	**0.10**	**0.10**	**0.10**	1	Three Rivers Project	LA

Station No: 0300 **Location:** Bridge u/s Suir River confl **Date From:** 1995 **To:** 1997
A value displayed in **BOLD** indicates the value falls outside either an upper or lower threshold and highlights stations where there may be water quality problems.

Parameter	Parameter Units	Minimum	Median	Maximum	No of Samples	Source	Source Type
B.O.D	mg O21-1	**0.9**	**1.8**	**2.7**	13	Kilkenny	EPA
Chloride	mg Cl 1-1	**19**	**21**	**34**	14	Kilkenny	EPA
Colour	Hazen	**40**	**70**	**150**	12	Kilkenny	EPA
Conductivity	µS cm-1	444	705	752	14	Kilkenny	EPA
Ortho-Phosphate	mg P 1-1	**0.02**	**0.03**	**0.09**	13	Kilkenny	EPA
Oxidised Nitrogen	mg N 1-1	**2.2**	**3.5**	**6.4**	28	Kilkenny	EPA
pH		**7.8**	**8.2**	**8.6**	14	Kilkenny	EPA
Temperature	oC	**4.7**	**12.1**	**16.8**	14	Kilkenny	EPA
Total Ammonia	mg N 1-1	**0.01**	**0.03**	**0.40**	14	Kilkenny	EPA

APPENDIX NO. I.2.12

QUARTERLY SAMPLING DATA FOR ROSSESTOWN RIVER

	Month:	October	October	January	January	April	April	July	July	October	October	Lisheen	Freshwater	Salmonid
	Date Sampled:	26-Oct-06	26-Oct-06	18-Jan-07	18-Jan-07	19-Apr-07	19-Apr-07	19-Jul-07	19-Jul-07	11-Oct-07	11-Oct-07	Discharge	Fish	Water
	Sample No.:	2006014611	2006014612	2007000928	2007000929	2007005409	2007005410	2007009729	2007009730	2007014283	2007014284	IPPC	Directive	Regulations
		Upstream	Downstream	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream	Licence	(78/659/EC)	1998
Parameter	**Units**													
Fluoride	mg/L F	0.015	0.026	0.0056	0.0450	0.11	0.17	0.037	0.112	0.068	0.115			
Chloride	mg/L Cl	5.541	8.181	14.9481	16.2400	14.89	21.42	13.205	20.88	13.281	19.545			
Nitrite	mg/L N	0.015	0.016	0.1259	0.0850	0.05	0.06	0.218	0.268	0.044	0.047		≤0.03	≤0.05
Nitrate	mg/L N	1.309	1.635	1.7639	1.6360	0.88	1.81	0.726	1.283	2.34	1.562	11.3		
Phosphate	mg/L P	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001			
Sulphate	mg/L SO_4	5.71	39.454	13.3981	20.35	5.3	235.7	4.408	221.47	1.82	189.442	$500^1/400^2$		
Lithium	mg/L Li	<0.001	<0.001	-	-	0.0011932		<0.001	0.01	<0.001	0.01			
Sodium	mg/L Na	4.338	5.87	-	-	10.1		7.66	12.49	8.44973	13.42			
Ammonium	mg/L NH_4	0.082	0.26	-	-	1.76	1.69	1.60	1.62	0.5500	1.2800	1	<0.78/≤0.78	
Calcium	mg/L Ca	15.7	27.632	-	-	97.2		50.49	106.46	88.1	120.589			
Magnesium	mg/L Mg	2.498	8.587	-	-	12.18		6.36	29.79	10.3853	39.9915			
Potassium	mg/L K	1.259	4.05	-	-	0.94		0.79	6.53	1.67908	6.67			
pH	pH units	6.46	7.14	7.45	7.55	7.64	7.52	7.51	7.60	7.35	7.60		≤6.0≥9.0	≤6.0≥9.0
Conductivity	uS/cm	108	238	150	310	490	750	286	768	479	839			
Dissolved Oxygen	mg/L O_2	7.80	6.75	7.32	7.37	6.20	7.03	4.80	5.10	5.32	7.63			
Temperature	Deg.C	10.8	11.0	7.1	8.0	11.9	12.7	14.8	15.2	13.1	14.1			
BOD	mg/L	2.30	2.51	2.04	2.67	3.54	2.44	3.65	3.11	2.30	2.72	5	≤6	≤5
COD	mg/L	113	91	77	65	46	18	83	35	41	10	40		
Suspended Solids	mg/L	12.25	10.40	11.95	9.35	4.55	6.85	4.7	4.8	0.5	4.45			
Aluminium	mg/L Al	0.0390	0.0419	0.0268	0.0257	0.0524	0.0521	0.0349	0.0354	<0.001	0.0304	0.2		
Arsenic	mg/L As	0.0140	0.0126	0.0053	0.0156	0.0385	0.0228	0.0228	0.0200	0.0318	0.0300			
Barium	mg/L Ba	0.1046	0.1261	0.0864	0.2022	0.6476	0.3357	0.3004	0.2465	0.6376	0.2775			
Cadmium	mg/L Cd	<0.001	<0.001	0.0001	0.0002	0.0009	0.0011	0.0015	0.0016	<0.001	0.0007	0.0050		
Cobalt	mg/L Co	<0.001	0.0004	<0.001	0.0008	0.0007	0.0060	0.0005	0.0042	<0.001	0.0058			
Chromium	mg/L Cr	<0.001	<0.001	<0.001	0.0003	0.0001	0.0004	0.0009	0.0009	0.0005	0.0005			
Copper	mg/L Cu	<0.001	<0.001	<0.001	<0.001	0.0011	0.0012	<0.001	0.0003	0.0005	0.0011			
Iron	mg/L Fe	0.4092	0.4314	0.1896	0.3680	1.1608	0.7130	0.8527	0.4657	0.7804	0.4498			
Manganese	mg/L Mn	0.0477	0.0506	0.0323	0.0586	0.1061	0.0761	0.0855	0.0691	0.0355	0.0704			
Nickel	mg/L Ni	0.0005	0.0028	0.0010	0.0045	0.0062	0.0248	0.0043	0.0222	0.0013	0.0298			
Lead	mg/L Pb	<0.001	<0.001	0.0001	0.0033	0.0063	0.0449	<0.001	0.0054	<0.001	0.0162	0.0500		
Zinc	mg/L Zn	<0.001	0.0364	0.0077	0.1303	<0.001	0.2954	<0.001	0.1506	<0.001	0.3985	0.4500		
Mercury	mg/L Hg	<0.0004	<0.0004	<0.0004	<0.0004	0.0020	0.0011	<0.0004	<0.0004	<0.001		0.001		
Hardness		49	104			34	0	19	388	33	465			

Note [1] Limit for discharge received by tacit agreement with the EPA

Note [2] Limit for downstream samples received by tacit agreement with the EPA

APPENDIX NO. I.2.13

OGE SAMPLING DATA FOR ROSSESTOWN RIVER

Parameter	EUSROSS	DISROSS	QDSROSS	Lisheen Discharge IPPC Licence	Freshwater Fish Directive	Salmonid Water Regulations
	18/10/07 @ 09:04	18/10/07 @ 09:00	18/10/07 @ 10:43		(78/659/EC)	1998
					I/PV	I/PV
pH	6.4	6.6	6.6		≤6.0≥9.0	≤6.0≥9.0
Temperature (°C)	8	13	10.7			
Electrical Conductivity EC	529	897	862		-	-
Dissolved Oxygen (%)	42.4	64.8	59.7		50%≥9/50%≥7	≥6≤9
Dissolved Oxygen (mg/l)	5	6.8	6.6			
Ammoniacal nitrogen NH4-N	0.33	1.5	0.3	1	<0.78/≤0.78	-
Biological Oxygen Demand (mg/l O_2)	<2	<2	<2	5	≤6	≤5
Chemical Oxygen Demand (mg/l O_2)	38	10	<10	40	-	-
Calcium (mg/l)	87	110	100		-	-
Cadmium (mg/l)	<0.0004	0.001	<0.0004	0.005	-	-
Chloride (mg/l)	15	22	21		-	-
Chromium (mg/l)	<0.001	<0.001	<0.001		-	-
Copper (mg/l)	<0.005	<0.005	<0.005			
Iron (mg/l)	0.8	0.29	0.16		-	-
Lead (mg/l)	<0.005	0.016	<0.005	0.05	-	-
Magnesium (mg/l)	11	42	40		-	-
Manganese (mgl)	0.033	0.073	0.029		-	-
Mercury (mg/l)	<0.00005	<0.00005	<0.00005	0.001	-	-
Nickel (mg/l)	<0.005	0.031	0.021		-	-
Potassium (mg/l)	1.2	6.2	5.8		-	-
Sodium (mg/l)	8.2	13	13		-	-
Sulphate	2.5	220	200	$500^1/400^2$	-	-
Zinc (mg/l)	<0.01	0.35	0.23	0.45		
Total Alkalinity (mg/l)						
Total Organic Carbon (mg/l)	14	<5	<5		-	-
Total Oxidised Nitrogen (mg/l)	2.76	1.64	2..76			
Nitrate as NO_3 (mg/l)	12	7	12	50	-	-
Nitrite as NO_2 (mg/l)	0.1	0.13	0.1		≤0.03	≤0.05
Faecal Coliforms (cfu/100mls	<1	<1	<1		-	-
Total Coliforms (cfu/100mls)	<1	<1	<1			
Phosphate (as PO_4)	0.074	<0.03	<0.03		-	-

Note [1] Limit for discharge received by tacit agreement with the EPA

Note [2] Limit for downstream samples received by tacit agreement with the EPA

APPENDIX NO. I.2.14

MIXING CALCULATIONS FOR ROSSESTOWN RIVER

Discharge (l/s)	Upstream of SW2	Mine Water from PWE2	Total Upstream	SW2 Discharge
Q mean	1300	231	1531.00	231.00
Q100	2500	231	2731.00	231.00

Parameter	Receiving Water Upstream of SW2	SW2 Discharge	Downstream of SW2		Lisheen Discharge IPPC Licence	Freshwater Fish Directive	Salmonid Water Regulations
			Qmean	Q100		(78/659/EC)	1998
						I/PV	I/PV
pH	6.6	6.6	6.60	6.60		≤6.0≥9.0	≤6.0≥9.0
Temperature (°C)	10.7	13	11.00	12.84			
Electrical Conductivity EC	862	897	866.59	894.63		-	-
Dissolved Oxygen (%)	59.7	64.8	60.37	64.45		50%≥9/50%≥7	≥6≤9
Dissolved Oxygen (mg/l)	6.6	6.8	6.63	6.79			
Ammoniacal nitrogen NH4-N	0.3	1.5	0.46	1.42	1	<0.78/≤0.78	-
Biological Oxygen Demand (mg/l O_2)	<2	<2	#VALUE!	#VALUE!	5	≤6	≤5
Chemical Oxygen Demand (mg/l O_2)	<10	10	#VALUE!	#VALUE!	40	-	-
Calcium (mg/l)	100	110	101.31	109.32		-	-
Cadmium (mg/l)	<0.0004	0.001	#VALUE!	#VALUE!	0.005	-	-
Chloride (mg/l)	21	22	21.13	21.93		-	-
Chromium (mg/l)	<0.001	<0.001	#VALUE!	#VALUE!		-	-
Copper (mg/l)	<0.005	<0.005	#VALUE!	#VALUE!			
Iron (mg/l)	0.16	0.29	0.18	0.28		-	-
Lead (mg/l)	<0.005	0.016	#VALUE!	#VALUE!	0.05	-	-
Magnesium (mg/l)	40	42	40.26	41.86		-	-
Manganese (mgl)	0.029	0.073	0.03	0.07		-	-
Mercury (mg/l)	<0.00005	<0.00005	#VALUE!	#VALUE!	0.001	-	-
Nickel (mg/l)	0.021	0.031	0.02	0.03		-	-
Potassium (mg/l)	5.8	6.2	5.85	6.17		-	-
Sodium (mg/l)	13	13	13.00	13.00		-	-
Sulphate	200	220	202.62	218.64	$500^1/400^2$	-	-
Zinc (mg/l)	0.23	0.35	0.25	0.34	0.45		
Bicarbonate (HCO3-) (mg/l)	270	280	271.31	279.32			
Total Organic Carbon (mg/l)	<5	<5	#VALUE!	#VALUE!		-	-
Total Oxidised Nitrogen (mg/l)	2..76	1.64	#VALUE!	#VALUE!			
Nitrate as NO_3 (mg/l)	12	7	11.34	7.34	50	-	-
Nitrite as NO_2 (mg/l)	0.1	0.13	0.10	0.13		≤0.03	≤0.05
Faecal Coliforms (cfu/100mls	<1	<1	#VALUE!	#VALUE!		-	-
Total Coliforms (cfu/100mls)	<1	<1	#VALUE!	#VALUE!			
Phosphate (as PO_4)	<0.03	<0.03	#VALUE!	#VALUE!		-	-

Note [1] Limit for discharge received by tacit agreement with the EPA

Note [2] Limit for downstream samples received by tacit agreement with the EPA

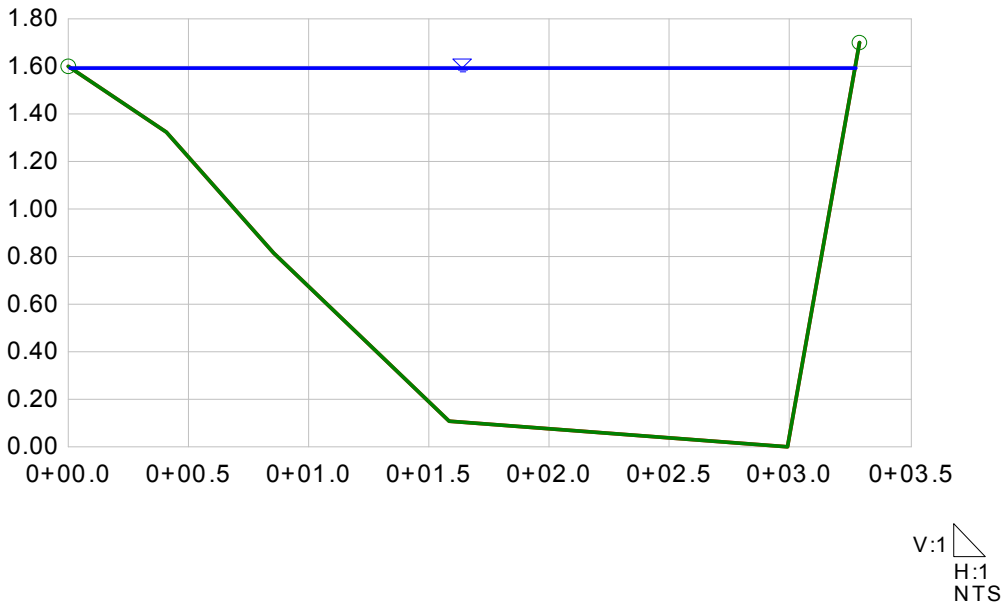
APPENDIX NO. I.2.15

BANKFUL CAPACITY CALCULATIONS FOR ROSSESTOWN EMERGENCY DISCHARGE ROUTE

Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	ECH1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

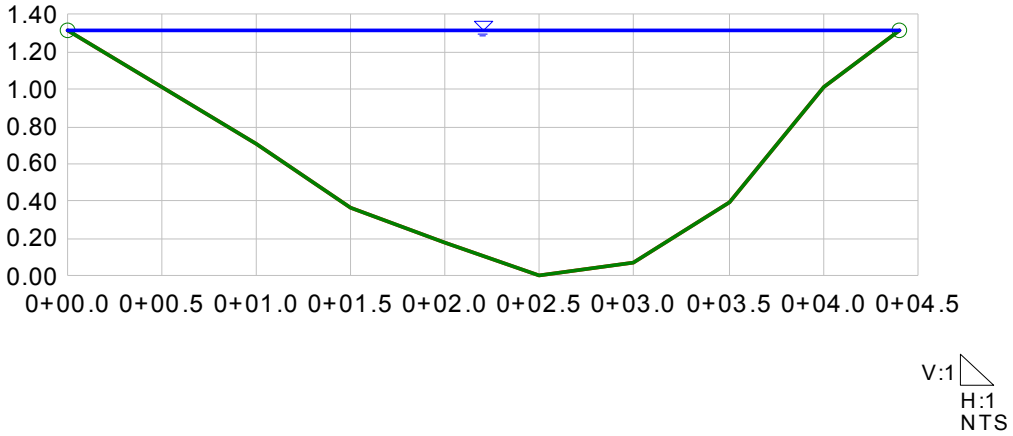
Section Data		
Mannings Coefficient	0.035	
Slope	0.001000	m/m
Water Surface Elevation	1.59	m
Elevation Range	0.00 to 1.70	
Discharge	2.4275	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	ECH2
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

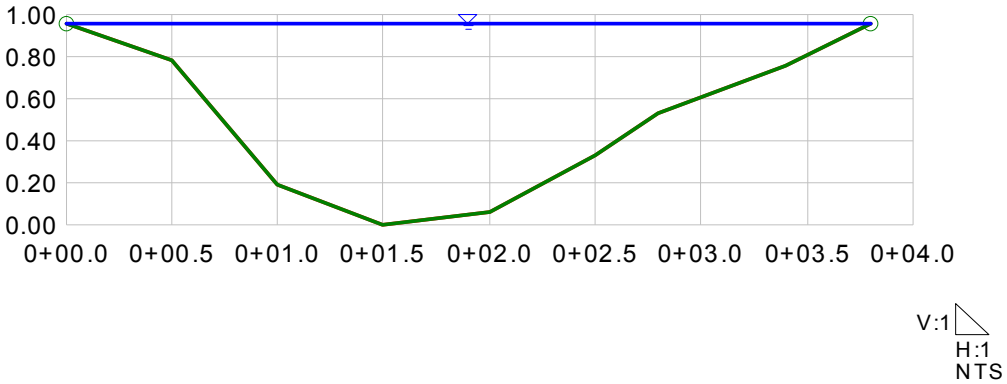
Section Data		
Mannings Coefficient	0.035	
Slope	0.001000	m/m
Water Surface Elevation	1.31	m
Elevation Range	0.00 to 1.31	
Discharge	2.2541	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	ECH3
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

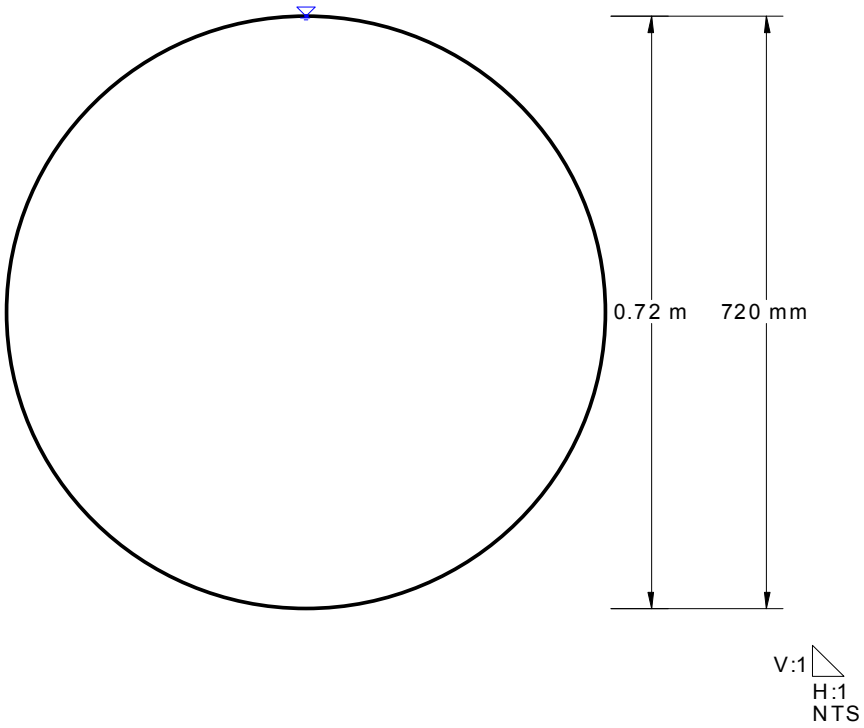
Section Data		
Mannings Coefficient	0.030	
Slope	0.001000	m/m
Water Surface Elevation	0.96	m
Elevation Range	0.00 to 0.96	
Discharge	1.1964	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	ECH4
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

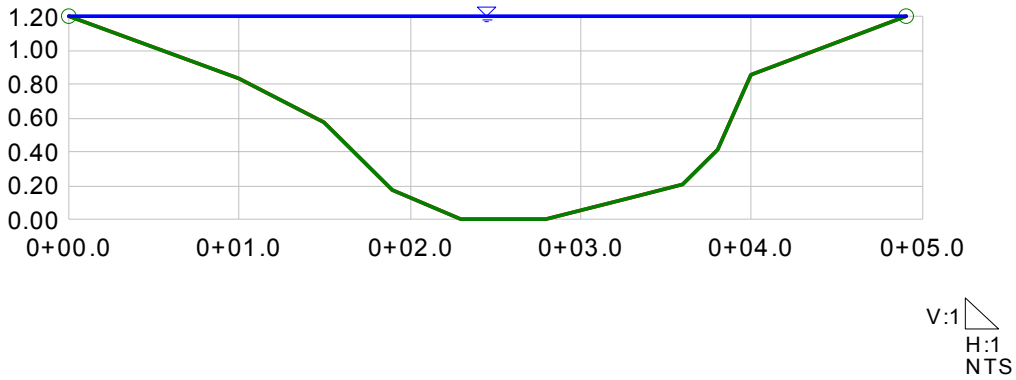
Section Data		
Mannings Coefficient	0.013	
Slope	0.001 000	m/m
Depth	0.72	m
Diameter	720	mm
Discharge	0.315 7	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	ECH5
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

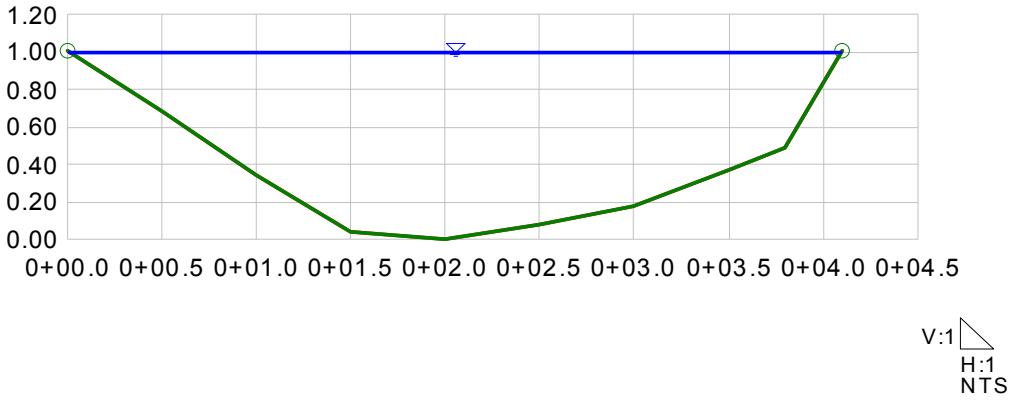
Section Data		
Mannings Coefficient	0.035	
Slope	0.001000	m/m
Water Surface Elevation	1.20	m
Elevation Range	0.00 to 1.20	
Discharge	1.8946	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	ECH6
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

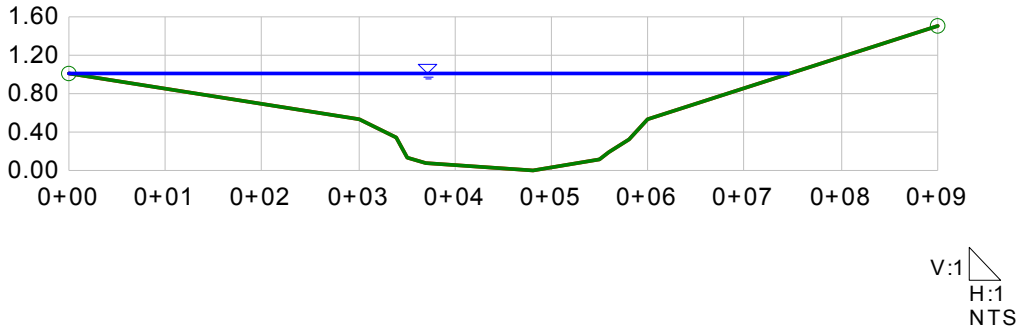
Section Data		
Mannings Coefficient	0.035	
Slope	0.001000	m/m
Water Surface Elevation	1.00	m
Elevation Range	0.00 to 1.01	
Discharge	1.7155	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	ECH7
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

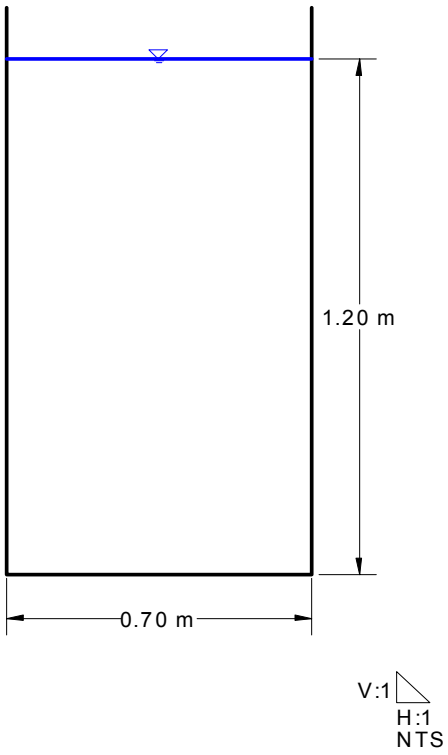
Section Data		
Mannings Coefficient	0.035	
Slope	0.001000	m/m
Water Surface Elevation	1.00	m
Elevation Range	0.00 to 1.50	
Discharge	1.9356	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	ECH8
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.035	
Slope	0.002 000	m/m
Depth	1.20	m
Bottom Width	0.70	m
Discharge	0.449 4	m³/s



Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	ECH9
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.040	
Slope	0.001000	m/m
Water Surface Elevation	0.80	m
Elevation Range	0.00 to 0.80	
Discharge	0.7351	m³/s