TABLE F.1(i)(a): SURFACE/GROUND WATER MONITORING
(Primary Discharge Point – one table per upstream and downstream location)

Discharge Point Code: *aSW1u* **MONITORING POINT CODE:** *Upstream*

Parameter	Results (mg/l unless otherwise stated)				Standard (Note 1)	Sampling method (grab, drift etc.)	Limit of Quantitation	Analysis method / technique
	06/03/07	15/06/07	26/10/07	01/02/08				
pH (pH units)	-	-	-	-	5.5-8.5	-		
Temperature (°C)	-	-	-	-	25	-		
Electrical Conductivity (@25°C) (µS/cm)	-	-	-	-	1,000	-		
Suspended Solids	0.5	0.5	0.5	<1	50	Grab		
Ammonia (as N)	-	-	-	-	0.2	-		
Biochemical Oxygen Demand	1	1	1	0.3	5	Grab		
Chemical Oxygen Demand	32	26	**55**	<1	40 (A3)	Grab		
Dissolved Oxygen (% sat'n O_2)	-	-	-		> 60%	-		
Hardness (mg/l $CaCo_3$)	-	-	-	-	N/A	-		
Total Nitrogen (as N)	-	-	-	-	1	-		
Nitrite (as N)	-	-	-	-	<0.05	-		
Nitrate (as N)	-	-	-	-	50	-		
Total Phosphorus (as P)	-	-	-	-	N/A	-		
Orthophosphate (as P) - unfiltered	-	-	-	-	0.05*	-		
Sulphate (SO_4)	-	-	-	-	200	-		
Phenols (sum) Note 2 (ug/l)	-	-	-	-	0.0005	-		

Note 1: Surface Water Regulations 1989 A1 unless otherwise specified
* Phosphorus Regulations, 1998 (For waters of Q-value 3)
Note 2: USEPA Method 604, AWWA Standard Method 6240, or equivalent.

TABLE F.1(i)(a): SURFACE/GROUND WATER MONITORING
(Primary Discharge Point – one table per upstream and downstream location)

Discharge Point Code: ***aSW1u*** **MONITORING POINT CODE:** ***Upstream (cont.)***

Parameter	Results (mg/l unless otherwise stated)				Standard (Note 1)	Sampling method (grab, drift etc.)	Limit of Quantitation	Analysis method / technique
	14/03/08	15/04/08	04/06/08	23/07/08				
pH (pH units)	-	-	-	7	5.5-8.5	-		
Temperature (°C)	-	-	-	16.9	25	-		
Electrical Conductivity (@25°C) (µS/cm)	-	-	-	386	1,000	-		
Suspended Solids	1.5	<0.5	<0.5	2	50	Grab		
Ammonia (as N)	-	-	-	0.031	0.2	-		
Biochemical Oxygen Demand	0.5	0.46	0.9	<1	5	Grab		
Chemical Oxygen Demand	1	<1	2	<10	40 (A3)	Grab		
Dissolved Oxygen (% sat'n O_2)	-	-	-	69.8	> 60%	-		
Hardness (mg/l $CaCo_3$)	-	-	-	160.4	N/A	-		
Total Nitrogen (as N)	-	-	-	**1.78**	1	-		
Nitrite (as N)	-	-	-	0.035	≤0.05	-		
Nitrate (as N)	-	-	-	0.462	50	-		
Total Phosphorus (as P)	-	-	-	0.13	N/A	-		
Orthophosphate (as P) - unfiltered	-	-	-	**0.111**	0.05*	-		
Sulphate (SO_4)	-	-	-	15.79	200	-		
Phenols (sum) Note 2 (ug/l)	-	-	-	<0.027	0.0005	-		

Note 1: Surface Water Regulations 1989 A1 unless otherwise specified
* Phosphorus Regulations, 1998 (For waters of Q-value 3)
Note 2: USEPA Method 604, AWWA Standard Method 6240, or equivalent.

TABLE F.1(i)(b): SURFACE/GROUND WATER MONITORING (Dangerous Substances)
(Primary Discharge Point - one table per upstream and downstream location)

Discharge Point Code: *aSW1u* **MONITORING POINT CODE:** ***Upstream (cont.)***

Parameter	Results (µg/l)				Standard[Note 1] (µg/l) Hardness of Water measured in mg/l Ca CO_3 ≤100	>100	Sampling method (grab, drift etc.)	Limit of Quantitation	Analysis method / technique
	23/07/08								
Atrazine	<0.003				1.0	**1.0**	Grab		
Dichloromethane	<1				10.0	**10.0**	Grab		
Simazine	<0.007				1.0	**1.0**	Grab		
Toluene	<1				10.0	**10.0**	Grab		
Tributyltin[Note 2]	<0.02				0.001	**0.001**	Grab		
Xylenes	<1				10.0	**10.0**	Grab		
Arsenic	<0.5				25	**25**	Grab		
Chromium	<0.5				5	**30**	Grab		
Copper	<1				5	**30**	Grab		
Cyanide	1.2				10	**10**	Grab		
Fluoride (mg/l	30				500	**500**	Grab		
Lead	<0.5				5	**10**	Grab		
Nickel	<0.5				8	**50**	Grab		
Zinc	<5				**(Note 3)**	**100**	Grab		
Boron	**12**				2.0*		Grab		
Cadmium	<0.5				0.005*		Grab		
Mercury	<0.05				0.001*		Grab		
Selenium	<0.5				0.01*		Grab		
Barium	**18**				0.10*		Grab		

NT – Not Taken
Note 1 – Water Quality (Dangerous Substances) Regulations, 2001; * Surface Water Regulations [1989]
Note 2 – The standard for Tributyltin shall apply in relation to tidal waters only and shall be deemed to be met if the results of monitoring for biological effects indicate no reproductive impairment in gastropods.
Note 3 – In the case of Zinc, the standard shall be – 8 µg/l for water hardness less than or equal to 10 mg/l $CaCO_3$
50 µg/l for water hardness greater than 10 mg/l $CaCO_3$ and less than or equal to 100 mg/l $CaCO_3$

TABLE F.1(i)(b): SURFACE/GROUND WATER MONITORING

(Primary Discharge Point – one table per upstream and downstream location)

Discharge Point Code: *aSW1d* **MONITORING POINT CODE:** ***Downstream***

Parameter	Results (mg/l unless otherwise stated)				Standard (Note 1)	Sampling method (grab, drift etc.)	Limit of Quantitation	Analysis method / technique
	06/03/07	15/06/07	26/10/07	01/02/08				
pH (pH units)	-	-	-	-	5.5-8.5	-		
Temperature (°C)	-	-	-	-	25	-		
Electrical Conductivity (@25°C) (µS/cm)	-	-	-	-	1,000	-		
Suspended Solids	0.5	0.5	0.5	<1	50	Grab		
Ammonia (as N)	-	-	-	-	0.2	-		
Biochemical Oxygen Demand	1	2	1	0.6	5	Grab		
Chemical Oxygen Demand	28	**47**	20	2	40 (A3)	Grab		
Dissolved Oxygen (% sat'n O_2)	-	-	-	-	≥ 60%	-		
Hardness (mg/l $CaCo_3$)	-	-	-	-	N/A	-		
Total Nitrogen (as N)	-	-	-	-	1	-		
Nitrite (as N)	-	-	-	-	≤0.05	-		
Nitrate (as N)	-	-	-	-	50	-		
Total Phosphorus (as P)	-	-	-	-	N/A	-		
Orthophosphate (as P) - unfiltered	-	-	-	-	0.05*	-		
Sulphate (SO_4)	-	-	-	-	200	-		
Phenols (sum) Note 2 (µg/l)	-	-	-	-	0.0005	-		

Note 1: Surface Water Regulations 1989 A1 unless otherwise specified
* Phosphorus Regulations, 1998 (For waters of Q-value 3)
Note 2: USEPA Method 604, AWWA Standard Method 6240, or equivalent.

TABLE F.1(i)(b): SURFACE/GROUND WATER MONITORING
(Primary Discharge Point – one table per upstream and downstream location)

Discharge Point Code: *aSW1d* **MONITORING POINT CODE:** *Downstream (cont.)*

Parameter	Results (mg/l unless otherwise stated)				Standard (Note 1)	Sampling method (grab, drift etc.)	Limit of Quantitation	Analysis method / technique
	14/03/08	15/04/08	04/06/08	23/07/08				
pH (pH units)	-	-	-	6.7	5.5-8.5	Grab		
Temperature (°C)	-	-	-	16.6	25	Grab		
Electrical Conductivity (@25°C) (µS/cm)	-	-	-	651	1,000	Grab		
Suspended Solids	<0.5	<0.5	<0.5	5	50	Grab		
Ammonia (as N)	-	-	-	**0.608**	0.2	Grab		
Biochemical Oxygen Demand	0.78	0.16	1.3	<1	5	Grab		
Chemical Oxygen Demand	2	<1	1	<10	40 (A3)	Grab		
Dissolved Oxygen (% sat'n O_2)	-	-	-	85	> 60%	Grab		
Hardness (mg/l $CaCo_3$)	-	-	-	187.7	N/A	Grab		
Total Nitrogen (as N)	-	-	-	**2.45**	1	Grab		
Nitrite (as N)	-	-	-	<0.005	≤0.05	Grab		
Nitrate (as N)	-	-	-	0.386	50	Grab		
Total Phosphorus (as P)	-	-	-	1.467	N/A	Grab		
Orthophosphate (as P) - unfiltered	-	-	-	**1.501**	0.05*	Grab		
Sulphate (SO_4)	-	-	-	94.16	200	Grab		
Phenols (sum) Note 2 (µg/l)	-	-	-	<0.027	0.0005	Grab		

Note 1: Surface Water Regulations 1989 A1 unless otherwise specified
* Phosphorus Regulations, 1998 (For waters of Q-value 3)
Note 2: USEPA Method 604, AWWA Standard Method 6240, or equivalent.

TABLE F.1(i)(b): SURFACE/GROUND WATER MONITORING (Dangerous Substances)
(Primary Discharge Point - one table per upstream and downstream location)

Discharge Point Code: ***aSW1d*** **MONITORING POINT CODE:** ***Downstream (cont)***

Parameter	Results (µg/l)				Standard[Note 1] (µg/l) Hardness of Water measured in mg/l Ca CO_3		Sampling method (grab, drift etc.)	Limit of Quantitation	Analysis method / technique
	23/07/08				≤100	>100			
Atrazine	<0.003				1.0	**1.0**	Grab		
Dichloromethane	<1				10.0	**10.0**	Grab		
Simazine	0.009				1.0	**1.0**	Grab		
Toluene	<1				10.0	**10.0**	Grab		
Tributyltin[Note 2]	<0.02				0.001	**0.001**	Grab		
Xylenes	<1				10.0	**10.0**	Grab		
Arsenic	<0.5				25	**25**	Grab		
Chromium	<0.5				5	**30**	Grab		
Copper	<1				5	**30**	Grab		
Cyanide	1.2				10	**10**	Grab		
Fluoride	500				500	**500**	Grab		
Lead	<0.5				5	**10**	Grab		
Nickel	<0.5				8	**50**	Grab		
Zinc	<5				**(Note 3)**	**100**	Grab		
Boron	**14**				2.0*		Grab		
Cadmium	<0.5				0.005*		Grab		
Mercury	<0.05				0.001*		Grab		
Selenium	<0.5				0.01*		Grab		
Barium	**19**				0.10*		Grab		

NT – Not Taken
Note 1 – Water Quality (Dangerous Substances) Regulations [2001], unless otherwise stated; * Surface Water Regulations [1989]
Note 2 – The standard for Tributyltin shall apply in relation to tidal waters only and shall be deemed to be met if the results of monitoring for biological effects indicate no reproductive impairment in gastropods.
Note 3 – In the case of Zinc, the standard shall be –

8 µg/l for water hardness less than or equal to 10 mg/l $CaCO_3$

50 µg/l for water hardness greater than 10 mg/l $CaCO_3$ and less than or equal to 100 mg/l $CaCO_3$

Introduction

The Moycullen Waste Water Treatment Plant (WWTP) is located to the north-east of Moycullen town towards Ballyquirke West. Treated effluent is discharged into the Ballyquirke Canal.

Receiving Water – The Ballyquirke Canal

The final effluent from the WWTP discharges to the Ballyquirke Canal via a constructed wetland area. The canal flows into the Ballyquirke Lough which is connected through a series of streams and tributaries to Lough Corrib. Ballyquirke Lake is an important amenity in the locality – it is contains good stocks of pike, and a stand has been built to accommodate disabled anglers.

There are several sites of conservation importance in the area (see **Figure F.1**). Ballyquirke Lough, located 500m south of the discharge point, is a proposed Natural Heritage Area (pNHA) (Site Code NHA 000228) and is also part of the Lough Corrib Special Area of Conservation (SAC) (Site Code 000297). Ballyquirke Lough is of interest due to the presence of certain species of freshwater algae and invertebrates.

Lough Corrib SAC/NHA/SPA, also located 500m to the south of the discharge point, is the second largest lake in Ireland and is of major conservation concern due to the presence of 12 habitats listed on Annex I of the EU Habitats Directive – 6 of which are priority habitats (limestone pavement, active raised bog, bog woodland, orchid-rich calcareous grassland, *Cladium* fen and petrifying springs). The other Annex I habitats present on the site are lowland oligotrophic lakes, alkaline fens, floating river vegetation, hard water lakes, Oak woodlands and *Molinia* meadows. Atlantic Salmon (*Salmo salmar*) spawn in the lake, and there is a population of Sea Lamprey (*Petromyzon marinus*) – both listed on Annex II of the Habitats Directive. Another endangered fish species present in the lake is the Arctic Char (*Salvelinus alpinus*), a Red Data-listed species. Another Annex II species that has been recorded in the lake is the White-clawed Crayfish, and the site also contains a summer roost of Lesser Horseshoe Bat (*Rhinolophus hipposideros*), also an Annex II species. The site has also been designated a Special Protection Area as it is home to many nationally- and internationally-important populations of waterfowl such as Pochard, Tufted Duck and Coot. Overall, this site is of major conservation concern due to the presence of many

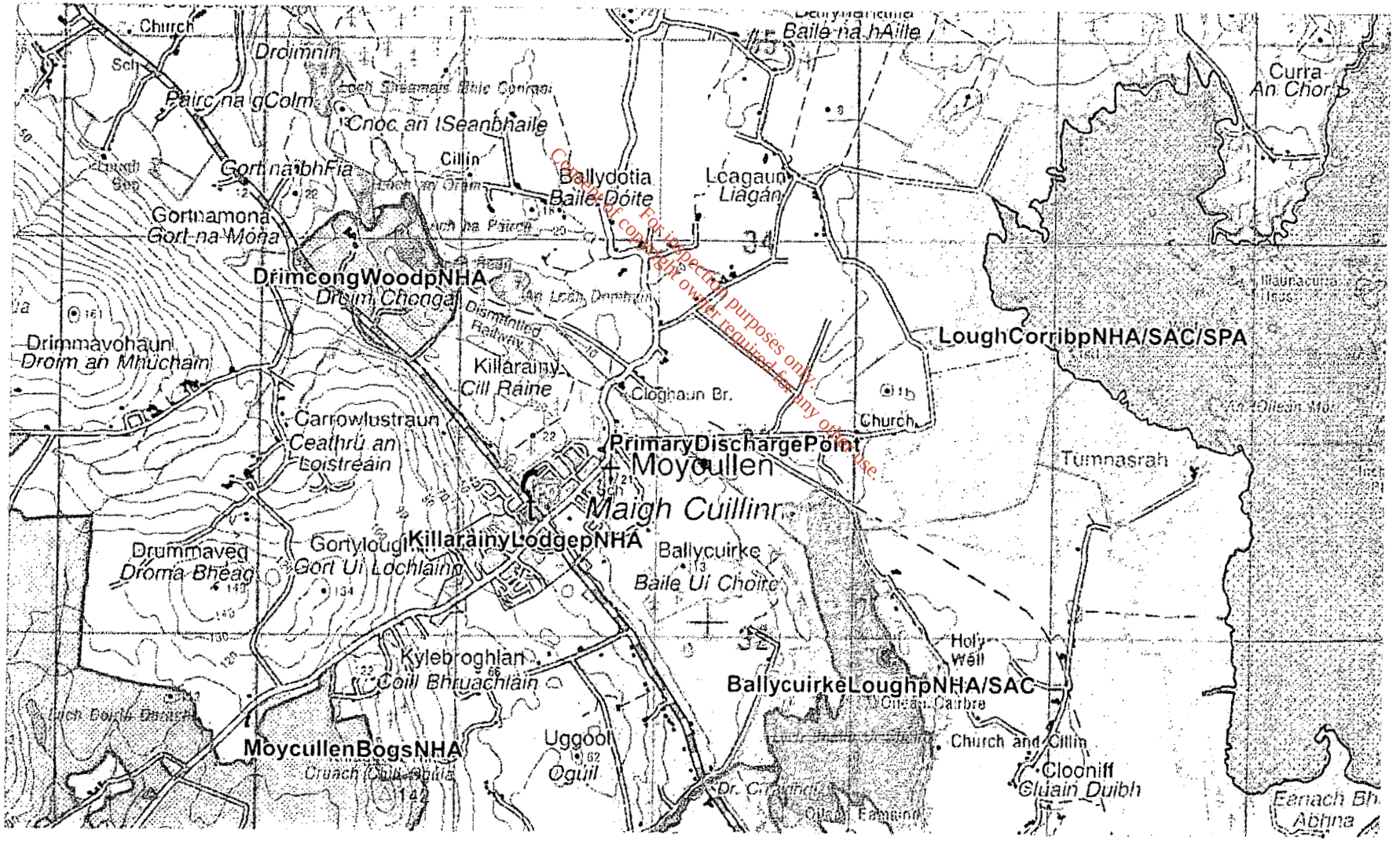

Figure F.1: Designation Map

rare and protected species and habitats, and is highly sensitive to water pollution from the intensification of agriculture and the uncontrolled discharge of sewage.

There is another proposed Natural Heritage Area (pNHA) located 800m from the discharge point, in the town of Moycullen itself – Killarainy Lodge (Site Code pNHA 002083) is known to be a nursery roost of the Natterer's bat (*Myotis nattereri*). There is an estimated population of 70 bats using the roof of a stone building within the grounds of Killarainy Lodge, Moycullen. This species is of national importance and is also considered vulnerable in Europe.

Moycullen Bogs Natural Heritage Area (NHA – Site Code 002364) lies approximately 2km south of the discharge point. It is a large area of lowland blanket bog, and contains a wide diversity of other habitats including dry heath, wet heath, regenerating cutaway and alkaline fen. Blanket bog is a resource which is globally scarce and has been heavily exploited and is therefore of extreme conservation importance.

Another proposed Natural Heritage Area (pNHA), Drimcong Wood (Site Code 001260), lies approximately 1.5km to the north west of the discharge point. It is a mixture of deciduous and coniferous woodland. The main habitat on the site is deciduous woodland with Common Birch (*Betula pubescens*) and Ash (*Fraxinus excelsior*) common species. Woodland is not a common habitat in the west of Ireland, and this is the main reason for its proposal as a Natural Heritage Area.

The Ballyquirke Canal is part of the Western International River Basin District (IRBD). A Monitoring Programme for the Western IRBD is being developed and a Draft Management Plan is expected to be published in December 2008.

- The Ballyquirke Canal is not listed under Protected Areas – Drinking Waters in the Western IRBD.
- The Ballyquirke Canal is not designated for the protection of economically significant aquatic species such as fish or shellfish.
- The Ballyquirke Canal is not a designated Recreational Waters Protected Area.
- The Ballyquirke Canal is not designated as a Nutrient Sensitive Area under the Urban Wastewater Treatment Regulations, 2001.

Potential Impacts

Potential impacts from the discharge of effluent from the Wastewater Treatment Plant include:

- Eutrophication due to discharge of Phosphorus and Nitrogen. The primary effect of eutrophication is to stimulate algal growth. Excess algal growth can

create problems by de-oxygenating the water and killing fish and invertebrates. Nitrogen is mainly limiting only in marine environments but it can have some effect in freshwater.

- Contamination of the entire aquatic food chain with a variety of pollutants in particular heavy metals. Heavy metals can bioaccumulate in plants and invertebrates and can be toxic to fish.

These potential impacts could lead to a general impoverishment of aquatic flora and fauna and the depletion or elimination of salmonid fish from some or all of Lough Corrib downstream of the WWTP.

There is also the possibility that drinking water quality may be affected by the discharge. High levels of certain substances such as heavy metals could have an adverse effect on human health.

Primary Discharge – Quality

The final effluent standards recommended are shown in **Table F.2**:

Table F.2: Standards for Final Effluent/Primary Discharge

Parameter	Unit	Standard	Reference
BOD	mg/l	25	UWWT Regulations, 2001
Total Suspended Solids TSS	mg/l	35	UWWT Regulations, 2001
Total Nitrogen	mg/l	15	UWWT Regulations, 2001
Total Phosphorus	mg/l	2	UWWT Regulations, 2001
COD	mg/l	125	UWWT Regulations, 2001

Tables D.1 (i) (b) and **(c)** outlines the monitoring results for the primary discharge. In comparison with the standards in **Table F.2**, exceedences were recorded for Biochemical Oxygen Demand (BOD) on the 15/06/07 with a level of 32mg/l, and Total Phosphorus on the 15/04/08 and 04/06/08 with levels of 2.6mg/l and 9.5mg/l respectively.

Water Quality Monitoring – The Ballyquirke Canal

The Environmental Protection Agency conducts an ongoing monitoring programme by which river water quality is assessed with respect to biological and physico-chemical criteria. All of the major rivers and their more important tributaries are included in the programme.

In addition ambient monitoring upstream and downstream of the primary discharge is also carried out by Galway County Council (100m upstream and 100m downstream). These results are detailed in **Tables F.1**.

No EPA Monitoring Stations are located on the Ballyquirke Canal. However, one is located on the Knockaunranny Stream which flows in to Ross Lake approximately 5km upstream of the discharge point, and another is located downstream of the discharge point on the Lough Kip River approximately 1.5km south of the discharge point to the east of Ballyquirke Lough (see **Figure F.2**).

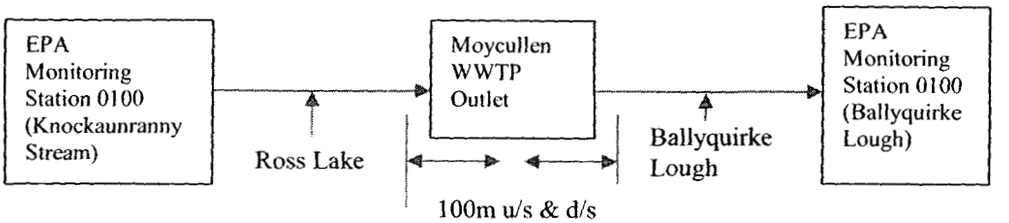

Figure F.2: Schematic Location Plan of Sampling Points and Relevant Water Bodies.

Based on biological monitoring carried out by the EPA in 2003, the biological water quality index just downstream of Ballyquirke Lough at Station 0100 was Q 3, which indicates moderate pollution. The latest data available for Monitoring Station 0100 on the Knockaunranny Stream, upstream of the discharge point, is from 1997. The biological water quality index recorded on this sampling occasion was Q4, which indicates that the water is unpolluted upstream of the discharge. It is likely though that this situation has changed since the last sampling occasion. No chemical data is available for these EPA monitoring stations.

Tables F.1 show the results from water quality monitoring carried out by Galway County Council and a comparison with relevant legislative standards. The receiving water is not a designated Salmonid River, and so standards are instead taken from the Surface Water Regulations, 1989 and Phosphorus Regulations, 1998. These results are from samples taken 100 meters upstream and 100 meters downstream of the primary discharge point from the Wastewater Treatment Plant.

Non-compliances were recorded in relation to Ammonia, Ortho-phosphate, Total Nitrogen, Chemical Oxygen Demand, Boron and Barium. A level of 0.608mg/l Ammonia was recorded downstream of the discharge point on the 23/07/08, the only occasion that this parameter was sampled for. On the same sampling occasion, the level of Orthophosphate was above the required limit both upstream and downstream of the discharge, with levels of 0.111mg/l and 1.501mg/l respectively. Also on the 23/07/08, exceedences were recorded for Total Nitrogen both upstream and downstream of the discharge point, with levels of 1.78mg/l and 2.45mg/l respectively.

Both Boron and Barium were also above the required limit upstream and downstream of the discharge point on this occasion. A level of 12µg/l was recorded for Boron upstream of the discharge and 14µg/l was recorded downstream, while for Barium a level of 18µg/l was recorded upstream and 19µg/l was recorded downstream. Again, this was the only sampling occasion for these parameters so further monitoring of these substances is required. Levels of Chemical Oxygen Demand were monitored throughout the sampling period and were mostly within the required limit, except for elevated levels of 55mg/l upstream of the discharge point on the 26/10/07 and 47mg/l downstream of the discharge point on the 15/06/07.

Table F.4 shows the average results of several of these parameters during the monitoring period 06.03.07 – 23.07.08 (8 no. sampling occasions).

Table F.4 Water Quality – Receiving Waters (Galway County Council. 2007-2008)

	BOD_5 (mg/l)	Total Ammonia* (mg N/l)	Ortho-P* (mg/l)	Suspended Solids (mg/l)
100 meters u/s	0.74	0.031	**0.111**	1
100 meters d/s	0.98	**0.608**	**1.501**	1.625
Standard	**5****	**0.2****	**0.050*****	**50****

*** Only sampled on one occasion – 23.07.08**
**** Surface Water Regulations, 1989**
***** Phosphorus Regulations, 1998 (For waters of Q-value 3)**

Under the terms of the Water Pollution Act (Water Quality for Phosphorus) Regulations 1998, specific water quality objectives (WQO) are to be assigned to specific surface water bodies depending on its biological condition in terms of Biotic Index (Q- rating) or median molybdate-reactive phosphorus (MRP) concentration (equivalent to Ortho-phosphate) as assessed by the EPA over the monitoring period 1995 to 1997.

Results from the 1995-1997 monitoring period give a biological water quality index of 3 at Station 0100 on the Ballyquirke Lough Stream downstream of the WWTP. Therefore the target Q-rating is 4 and the annual median orthophosphate concentration to be achieved is 0.05mg/l P.

Table F.4 shows that on the one occasion where sampling was carried out, the Orthophosphate concentration in waters both upstream and downstream of the Wastewater Treatment Plant exceeded this limit, but more monitoring is required as results have only been obtained for one sampling occasion.

The Dangerous Substances Regulations, 2001 prescribe standards for water quality for listed substances which include solvents (dichloromethane, toluene, xylene), metals

(arsenic, chromium, copper, lead, nickel, zinc), pesticides (atrazine, simazine, tributyltin) and certain other compounds (cyanide and fluoride).

A survey of heavy metals, pesticides and other organic substances in surface waters carried out by the EPA in 2008 indicated that there was no evidence of pollution from any of the surveyed dangerous substances in the four monitoring stations in County Galway.

Monitoring of Dangerous Substances carried out by Galway County Council on the 23/07/08 on receiving waters both upstream and downstream of the WWTP show no exceedences in the standard limits.

Conclusion

The primary discharge from Moycullen WWTP is largely compliant with the relevant legislation, except for elevated levels of Biochemical Oxygen Demand (BOD) on one sampling occasion and Total Phosphorus on two sampling occasions.

The water quality in the Ballyquirke Canal immediately downstream of the Moycullen WWTP complies with Surface Water and Dangerous Substances Regulations for most parameters. Non-compliances were recorded in relation to Ammonia, Orthophosphate, Total Nitrogen, Chemical Oxygen Demand, Boron and Barium downstream of the Wastewater Treatment Plant. Non-compliances were also recorded upstream of the WWTP in all of these parameters except for Ammonia. The Ballyquirke Stream, downstream of the Discharge Point, was given a Q-value of 3 following Biological Monitoring carried out by the EPA in the monitoring period 1995-1997. Receiving waters upstream and downstream of the Wastewater Treatment Plant do not comply with the recommended limit of 0.05mg/l P as set out in the Phosphorus Regulations, 1998 for waters with a Q-value of 3.

The water abstraction point for Galway City is located at Terryland at the southern end of Lough Corrib, downstream of the Wastewater Treatment Plant. The receiving water is of relatively poor quality and could be impacting on this public water supply and several European sites of Conservation Importance (the Ballyquirke Lough proposed Natural Heritage Area (pNHA) and Special Area of Conservation (SAC) and the Lough Corrib proposed Natural Heritage Area (pNHA), Special Area of Conservation (SAC) and Special Protection Area (SPA)).