

## 11 Hydrogeology Impact Assessment

### 11.1 Introduction

This chapter of the Environmental Impact Statement consists of an assessment of the proposed expansion of the production capacity of the Midleton Distillery site under the heading of hydrogeology. The chapter initially sets out the methodology that was used (Section 11.2), describes the existing hydrogeology environment (Section 11.3), groundwater development drilling and test works (Sections 11.4 to 11.9), water requirements, legislation and abstraction well source protection plan Section 11.10 to 11.14, then details the likely significant hydrogeology impacts associated with both the construction and operational phases of the proposed development (Section 11.15), sets out measures to mitigate the likely significant impacts of the scheme as identified (Section 11.16), and concludes by describing the residual impacts (Section 11.17).

The existing cavern (~2,500 m<sup>3</sup>/day) and river (~1,500 m<sup>3</sup>/day) abstractions for the site cooling and process is expected to double which means an additional groundwater resource requirement of up to 4,000 m<sup>3</sup>/day if the existing supplies are maintained.

The proposed cooling requirement is 6,120 m<sup>3</sup>/day to be obtained from groundwater wells and cavern with process requirement of 3,620 m<sup>3</sup>/day to be obtained from surface water and groundwater wells, with re-use of cooling water as process water to reduce overall water requirements.

### 11.2 Methodology

#### Consultation

Consultation was carried out with the relevant bodies as detailed below.

- National Parks and Wildlife Service (NPWS)
- GSI, Geology of East Cork-Waterford and 1:100,000 Map Sheet 22.
- South County Cork Groundwater Protection Scheme Map 6(E) Resource Protection Zones.
- South County Cork Groundwater Protection Scheme Map (2E) Draft Subsoils Map.
- Teagasc soil and subsoil database.
- Environmental Protection Agency (EPA) online maps database.
- GSI, National Groundwater Database inc vulnerability, aquifer classification, well searches, and geology.

- Fisheries Department
- EPA

#### Previous Studies

A number of groundwater studies have previously been completed at the IDL site. These were;

- KT Cullen & Co, (KTC), January 1998 (Geophysical survey and dye tracing)
- KT Cullen & Co, (KTC), March 2000 (Installation and testing of trial well TW1)
- WYG, July 2007 (Installation and testing of test well PW1)
- WYG, October 2009 (Dungourney River Water Quality Assessment)
- WYG, October 2010 (Installation and testing of test wells PW2-PW4)
- WYG, March 2011 (Re-testing test wells PW2-PW4)
- WYG, August 2011 (Installation and testing of test wells PW5-PW9)

In a hydrogeological study by KT Cullen & Co, (KTC), in January 1998 geophysical resistivity surveys were completed on the IDL site and also groundwater dye tracing tests in the local cave system. A summary of the results of the studies are that:

- The site is underlain by a regionally important limestone karstic aquifer known as the Waulsortian Limestone Formation.
- Underground connectivity was established between a number of the karst features and surface water features across the site.
- The resistivity survey identified variable thicknesses of overburden (subsoil) material across the site area. A general lack of thick overburden makes the bedrock vulnerable to contamination.
- The dye tracing and resistivity surveys confirmed that the trend of main underground channels have a roughly east-west trend along the northern boundary of the IDL site.

In March 2000 KTC supervised and reported on the drilling and testing of a deep trial well at the IDL site with the aim of providing an alternative source of cooling water for the facility. The well was drilled near the existing cooling water supply infrastructure with a view to supplementing the cooling water demand of between 2,000 and 3,000 m<sup>3</sup>/day.

A summary of the results of the drilling and reporting were that;

- difficult drilling conditions, (fractures, dolomitisation), were encountered in the limestone bedrock

- high water flows ~ 1000 m<sup>3</sup>/day were encountered in the upper shallow broken zone.
- a 72 hour pump test was completed on the well, the presence of large amounts of silt and sand in the groundwater caused problems during pumping,
- an estimated sustainable yield of 1,500 m<sup>3</sup>/day was estimated from the pump test, water level was drawn down towards 14.5 metres below ground level (mBGL).
- Analysis of the water quality detected elevated suspended solids, TOC, ammonia, manganese and faecal bacteria levels.

This well (TW1) was never commissioned or used as a groundwater supply for the IDL facility.

In July 2007 WYG supervised and reported on the drilling and testing of a deep trial well at the IDL site with the aim of providing an alternative source of cooling water for the facility. A summary of this groundwater development programme of works is;

- The test well (PW1) was drilled in the south western region of the site to a depth of 90mBGL in the limestone bedrock aquifer.
- The main water strike occurred at a shallow depth at about 25mBGL.
- The pumping test indicated that the well is capable of supplying a sustainable yield of at least 1,260m<sup>3</sup>/day.
- The water quality data indicates elevated levels of bacteriological parameters such as total and faecal coliforms.
- The slightly elevated groundwater hardness may cause scaling on process infrastructure and may require management with softeners.
- Subsequent testing of the water in January 2009 by WYG indicated that the groundwater temperature was elevated, in the region of 16°C, which together with raw water quality issues made this groundwater supply unsuitable as cooling water.

In 2010 WYG were involved in a detailed flood assessment of the Lower Field area of the IDL Midleton site. This work involved drilling and installation of six groundwater monitoring wells in the overburden and/or bedrock and monitoring water table fluctuations using automatic dataloggers. A weir was installed at the natural swallow hole feature on-site known as "Fox's Hollow" and water levels were monitored to assess periods of water backup in this feature in conjunction with water table effects. The report concluded that the groundwater levels in the lower field area are capable of rising close to or above the natural ground level

during periods of cumulative and extreme rainfall events and that Fox's Hollow has a drainage capacity, estimated at about 50 litres/second (l/s).

In June 2010 three test wells were drilled into the limestone bedrock aquifer along the southern boundary of the IDL site. Pumping test work carried out on the abstraction wells indicated the sustainable yield of ~800 m<sup>3</sup>/day from each of the three wells with no noticeable impact on the downgradient cavern abstraction point. Groundwater samples from the three test wells were analysed for a full suite of Drinking Water Standards together with radon analysis and indicated the chemical groundwater quality is good apart from an exceedance of manganese in PW2. Hardness was elevated and would require treatment for on-site process use. The microbiological analysis indicates there is some low level faecal contamination present compared to the surface water source.

In December 2010 further groundwater samples were obtained from the three test wells (PW2-PW4) on the 8th & 9th December, and analysed for a suite of parameters as specified by Veolia Water Ireland Ltd (VWI). VWI are involved in the water treatment design for the proposed groundwater supply.

In March 2011 a 5-day pumping test was repeated on the three test wells (PW2-PW4) on-site. The main purpose of this pumping test was to provide more information on the groundwater quality for VWI to assist in their water treatment design of cooling and process water for the IDL site. The pumping test confirmed the previous test of a conservative groundwater yield of 800 m<sup>3</sup>/day from the three test wells.

### Study Area and Baseline Data Collection

The study area is drained by the Dungourney River that runs along the eastern and southern sides of the site. The Middleton distillery produces a range of distilled spirits and animal feed by-products covers and an area of approximately 45 hectares, as presented in Figure 11.1.

Additional information has been compiled from the following sources:

- *In October 2009 WYG prepared a report on the water quality of the Dungourney River the flows along the southern boundary of the site. A kick sampling assessment methodology was undertaken which is used by the EPA in its River Water Quality Q-value monitoring programme whereby the macro invertebrates obtained are identified indicating the water quality. The EPA Q-rating on the river 1.6km upstream of the IDL site was Q4 (unpolluted) and monitoring location 50m downstream of the site was Q3 (moderately polluted). The kick sampling undertaken by WYG in September 2009 at locations adjacent to, upstream and downstream of the site all had a Q3 rating. Based on the findings of the study it was concluded that the likely causes of the decrease in water quality from the EPA monitoring station 1.6km up stream, is not from activities on the IDL site but by surrounding agricultural land use and the characteristics of the river channel.*

- *A walkover survey of the site to assess the presence of springs and other water features on-site. The survey area was extended beyond this to take account of potentially significant impacts which could arise at a greater distance away (e.g. at source protection areas associated with any groundwater abstractions or at groundwater dependent ecosystems).*
- *A review of existing wells in the vicinity of the site and use of automatic dataloggers in IDL boundary wells to monitor for potential effects during the pumping test. Setup of a gauging station on the Dungourney River and use of an automatic datalogger to monitor for potential effects of groundwater abstraction over the pumping test on the watercourse.*
- *As part of the hydrogeological groundwater development investigation a total of eight test wells were drilled on-site between June 2010 and May 2011 together with the assessment of six monitoring wells in the Lower Field area of the site that were drilled in March 2010. The test wells are installed into bedrock and or gravel aquifer on-site with the monitoring wells installed in the bedrock and/or overburden sediments. These groundwater well installations were logged by WYG and the groundwater development test well geological logs are presented in Appendix A.*

All the information available has been used to describe and evaluate the hydrogeological environment in the vicinity of the proposed production expansion development and the likely impact of future groundwater abstraction. The likely impacts of the proposed production expansion development to the south west and construction of a water treatment plant to the south of the site on this environment have also been identified and a mitigation strategy proposed.

The assessment of the likely impacts of the proposed development expansion on hydrogeology, and the groundwater flow regime takes the following specific topics into consideration:

- *Any high yielding springs and wells used for water supply and their surrounding Source Protection Area (SPA)*
- *Any natural hydrogeological features of importance (including large springs or groundwater fed Special Area of Conservation (SAC), Natural Heritage Area (NHA), Special Protection Areas (SPA) wetland sites. These features are collectively termed as Groundwater Dependant Terrestrial Ecosystems (GWDTE). This also included candidate SACs and proposed NHAs*
- *The water quality status of the Dungourney River was identified as Q3 (moderately polluted) from the WYG September 2009 site assessment.*
- *The dominant hydrogeological characteristics (aquifer classification) of the underlying strata.*

### Impact Assessment Methodology

The potential impact of the proposed production expansion development on the hydrogeological environment has been assessed by classifying the importance of the relevant attributes and quantifying the likely magnitude of any impact on these attributes. The rating criteria for assessing the importance of hydrogeological features within the study area are outlined in Table 11.1 whilst the rating criterion for quantifying the magnitude of impacts is outlined in Table 11.2 below.

The rating of potential environmental impacts on the hydrogeology environment are based on the matrix presented in Table 11.3 below which takes account of both the importance of an attribute and the magnitude of the potential environmental impacts of the proposed site process expansion development on it. These impact ratings are in accordance with impact assessment criteria provided in the EPA publication Draft Guidelines on the Information to be contained in Environmental Impact Statements (EPA, 2002), Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA, 2003) and The Institute of Geologists of Ireland publication on Geology in EIS: A Guide (IGI, 2002). The criteria apply to potential impacts during both the construction and operational phases.

The magnitude of each impact was considered from negligible to large adverse. Negligible impacts are impacts that result in an impact on an attribute but of insufficient magnitude to affect either use or integrity. A large adverse impact results in loss of attribute and/or quality and integrity of an attribute.

The significance of each impact was considered as having either an Imperceptible, Slight, Moderate, Significant, Severe or Profound impact. The duration of each impact was considered to be either temporary, short-term, medium term, long-term or a permanent impact. Temporary impacts are considered to be those which are construction related and last less than one year. Short term impacts were seen as impacts lasting one to seven years. Medium-term impacts are impacts lasting seven to 15 years. Long-term impacts are impacts lasting 15 to 60 years and permanent impacts are impacts lasting over 60 years.

Table 11.1 - Criteria for Rating Site Importance

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. SAC or SPA status
Very High	Attribute has a high quality or value on a regional or national scale	Regionally important aquifer with multiple well fields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – NHA status Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source
High	Attribute has a high quality or value on a local scale	Regionally Important Aquifer Groundwater provides large proportion of baseflow to local rivers Locally important potable water source supplying >1000 homes Outer source protection area for regionally important water source Inner source protection area for locally important water source
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer Potable water source supplying >50 homes Outer source protection area for locally important water source
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer Potable water source supplying <50 homes

Table 11.2 - Criteria for rating impact significance at EIA stage

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	Removal of large proportion of aquifer Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems Potential high risk of pollution to groundwater from routine run-off <sup>2</sup> Calculated risk of serious pollution incident >2% annually <sup>3</sup>
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Removal of moderate proportion of aquifer Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems Potential medium risk of pollution to groundwater from routine run-off <sup>2</sup> Calculated risk of serious pollution incident >1% annually <sup>3</sup>
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Removal of small proportion of aquifer Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems Potential low risk of pollution to groundwater from routine run-off <sup>2</sup> Calculated risk of serious pollution incident >0.5% annually <sup>3</sup>
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Calculated risk of serious pollution incident <0.5% annually <sup>3</sup>

Following the assessment of impacts, specific mitigation measures have been developed in the course of the preliminary design phase to avoid, reduce and, if possible, remedy any negative impacts on the local groundwater resource. These are described in Section 11.16 below. Residual impacts which are the final or designed impacts which result after mitigation measures have been fully established are described in Section 11.17 below.

### 11.3 Existing Environment

#### Introduction

The following sections provide an overview of the regional hydrogeological environment. Further detail is provided within the proposed development area. Aquifer classification, vulnerability and hydrogeological features of importance such as any public groundwater abstractions, and GWTDE are documented.

#### Development Site

The proposed development expansion of the existing process plant on site is largely to the south western corner of the IDL site together with a new water treatment plant in the south region of the site. The expansion works to the plant consist of new fermenters, distillation columns, still house and tankfarms together with a proposed fire water retention pond. This area of the site has the capacity to accommodate the proposed works apart from the proposed firewater retention pond. The construction of this pond in the south western corner of the site below the WWTP will require the demolition of the existing Warehouse A3.

The existing water supply for cooling and process demand on the site is provided by a combination of surface water from the Dungourney River and a shallow groundwater source associated with a subterranean stream flowing out of a cave/cavern feature in the limestone bedrock on the south western corner of the site. The surface water is primarily used in the process system and requires approximately a supply of 1,500 m<sup>3</sup>/day while the cavern groundwater is used in the cooling system and requires a supply between 2,000 to 3,000 m<sup>3</sup>/day. Both these water sources are vulnerable to contamination and also reduced supplies can occur during drought periods in the river.

#### Dungourney River

The IDL site is within the catchment to the Dungourney River which flows from north east to south west along the facilities southern boundary. Water is abstracted by IDL from the Dungourney River in this area. The Dungourney River flows into tidal estuary of the Owennacurra River to the south of Midleton town and from there into the middle section called the Great Island Channel of Cork Harbour.

Table 11.3 - Rating of Significant Environmental Impacts at EIA Stage

		Magnitude of Impact			
		Negligible	Small	Moderate	Large
Importance of Attribute	Extremely High	Imperceptible	Significant	Profound	Profound
	Very High	Imperceptible	Significant/ Moderate	Profound/ Significant	Profound
	High	Imperceptible	Moderate/ Slight	Significant/ Moderate	Profound/ Significant
	Medium	Imperceptible	Slight	Moderate	Significant
	Low	Imperceptible	Imperceptible	Slight	Slight/Moderate

Groundwater level monitoring is completed by the EPA throughout Ireland which includes the Dower Spring and Cloyne water supply schemes. There are no EPA monitoring points located in the vicinity of the IDL site. As discussed in Section 11.2. the kick sampling to assess the river water quality was undertaken by WYG in September 2009 at locations, adjacent to, upstream and downstream of the site and all had a Q3 rating (moderately polluted). Based on the findings of the study it was concluded that the likely causes of the decrease in water quality from the EPA monitoring station 1.6km up stream is not from activities on the IDL site but by surrounding agricultural land use and the characteristics of the river channel.

In the catchment area around the warehouses in the northern portion of the IDL site surface water runoff is controlled by an existing drainage system that discharges to a low lying area adjacent to the eastern end of warehouse 30. This low lying area drains into an active karst swallow hole known as Fox's Hollow. In times of prolonged and/or high rainfall events this karst drainage system can back up causing flooding along the drainage system. Rainwater runoff from the on site warehouses is contained by a purpose built fire water retention pond which releases surface water, in a controlled manner, to the Fox's Hollow karst drainage system.

The mill race located to the southern boundary of the site is currently not in use and has some surface water present on occasion which drains to the Dungourney River.

### Legacy Landfills and Contaminated Sites

In 1996 the Environmental Protection Agency (EPA) began licensing certain activities in the waste sector. These include landfills, transfer stations, hazardous waste disposal and other significant waste disposal and recovery activities. It has been determined from the EPA website that there are no waste licensed facilities within the study area.

### Integrated Pollution Prevention Control (IPPC) Licensed Facilities

The EPA has been licensing certain large-scale industrial and agriculture activities since 1994. The Act was amended in 2003 by the Protection of the Environment Act, 2003 which gave effect to the Integrated Pollution Prevention Control (IPPC) Directive. Detailed procedures concerning the IPPC licensing process are set out in the EPA Acts 1992 to 2007 and the associated licensing regulations. Apart from the existing Midleton Distillery IPPC licenced (Reg No. P0442-01) the only other facility in the Midleton area is Dawn Meats Ltd located in Knockgriffin Midleton Co. Cork (Reg No. P0176-01). However, the Dawn Meats facility ceased production in December 2009.

### Groundwater Dependent Ecosystems & Areas of Scientific Interest

The Dungourney River discharges into the tidal estuary of the Owennacurra River to the south of Midleton town and from there into the middle section of Cork Harbour. National Parks and Wildlife Service data indicates the tidally influenced shoreline of the Great Island Channel that reaches Midleton town is a Special Area of Conservation (SAC) and proposed National Heritage Area (pNHA). Cork Harbour located to the south of Midleton town is classified as a Special Protection Area (SPA). There are no protected areas in the immediate vicinity of the IDL site or any Groundwater Dependant Terrestrial Ecosystem (GWDTE).

The most common groundwater dependant ecosystems in the Irish environment include turloughs, fens, bogs and calcareous springs, none of which are present in the study area.

### Regional Overview of Hydrogeology

An aquifer is any stratum or combination of strata that stores or transmits groundwater (Local Government (Water Pollution) Act, 1990) i.e. a permeable geological stratum or formation that can both store and transmit water in significant quantities.

The GSI (Geological Survey of Ireland) has devised a system for classifying the aquifers of Ireland. The aquifer classification depends on a number of parameters including, the aerial extent ( $k\ m^2$ ), well yield ( $m^3/d$ ), specific capacity ( $m^3/d/m$ ), aquifer transmissivity ( $m^2/d$ ) and groundwater flow. The three main aquifer classifications are listed as follows:

#### Regionally Important (R) Aquifers

- (i) Karstified aquifers (**Rk**)
- (ii) Fissured bedrock aquifers (**Rf**)
- (iii) Extensive sand/gravel aquifers (**Rg**)

#### Locally Important (L) Aquifers

- (i) Sand/gravel (**Lg**)
- (ii) Bedrock which is Generally Moderately Productive (**Lm**)
- (iii) Bedrock which is Moderately Productive only in Local Zones (**LI**)
- (iv) Locally important karstified bedrock (**Lk**)

#### Poor (P) Aquifers

- (i) Bedrock which is Generally Unproductive except for Local Zones (**PI**)
- (ii) Bedrock which is Generally Unproductive (**Pu**)

The GSI classifies the limestone bedrock formation present beneath the IDL site as a regionally important karstified diffuse aquifer (Rkd).

Typically this aquifer classification is classified as capable of having excellent well yields in excess of  $400m^3/day$ , although largely dependant on the intersection of bedrock fractures.

These limestone rocks are devoid of inter-granular permeability as the groundwater flows through a diffuse network of solutionally enlarged fissures, small conduits, fractures and along faults, (secondary permeability). There is evidence of extensive karstification in the form of caves, swallow holes, subterranean streams/rivers etc identified on site. The interconnections that have been established between the various karst features would suggest that for the most part the major karst channels are shallow.

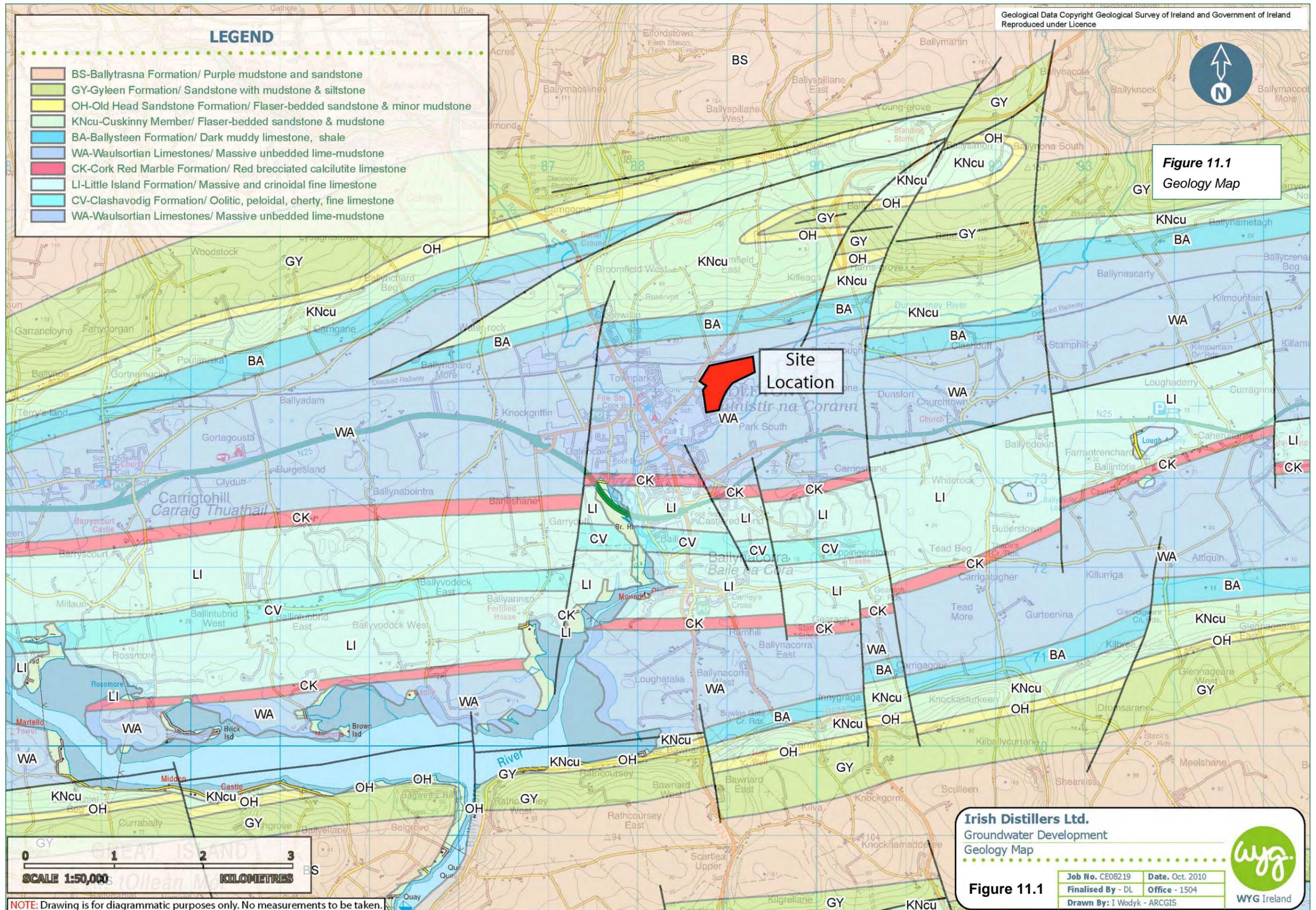
The bedrock formation to the north of the Waulsortian Limestone is identified as the Ballysteen Limestone Formation which is classified as a locally important aquifer (LI). To the south the bedrock units are identified as the Cork Red Marble and Little Island Limestone Formations which are classified as regionally important aquifers (Rkd), as presented in Figure 11.1.

### Hydrogeological Features

Water Supplies refer to any large springs, holy wells and groundwater abstractions for Local Authorities, commercial/industrial or Group Water Schemes. Source Protection Plans are created to define the groundwater catchment for large public water supplies and state appropriate land use practices within that catchment. These Source Protection Areas (SPA) have an Inner and Outer Protection zone associated with them which are defined by the travel time of potential contaminants to the abstraction well. Local groundwater abstractions do not have SPAs associated with them, due to their smaller size and the lesser significance of their supply. There is a Source Protection Plan of the Dower Spring water supply scheme located approximately 9km to the east of the site and the Cloyne SPP water supply scheme approximately 7km to the south, with no existing SPA in the immediate vicinity of the Midleton site.

Midleton town is supplied by a mains water supply and potable water for the Midleton distillery site is supplied by mains water.

The results of a GSI well search for the area of the site indicates that there are several large groundwater abstraction wells located in Midleton town between approximately 0.5km and 0.8km to the south west (downgradient) of the IDL site. These water supplies are reported as having well yields in the region of  $327\ m^3/day$  to  $764\ m^3/day$  for industrial use. There are no reported groundwater abstraction wells in the immediate vicinity of the site.



**Hydraulic Conditions**

Both unconfined and semi-confined aquifers are present in the study area. An aquifer is unconfined when it does not have an impermeable layer above it and the water table can vary with surface water contributions. In bedrock aquifers of this type the water table is generally a subdued reflection of the topography. This is the case for the regionally important karstified limestone bedrock aquifer beneath the IDL site together with the gravel aquifer deposit identified along the eastern site boundary. A confined/semi-confined aquifer is one whose natural water level would lie above the top of the aquifer except where there is a low permeability material above it which prevents/restricts it from moving upwards. In this case the groundwater is contained within the aquifer except for in areas where the overlying low permeability material is removed. Where aquifers are semi-confined this will primarily be by thick low permeability glacial deposits such as encountered in the Lower Field northern region of the IDL site.

A programme of groundwater level monitoring began following the completion of groundwater test well installations together with monitoring of the cavern groundwater abstraction well and surface watercourses. The data available shows the water table varies from 2.5mBGL (Cavern) in the western region of the site (downgradient) to 4mBGL (PW8) in the eastern region of the site (upgradient). The semi-confined monitoring well (MW5) installed in the overburden sediment adjacent to PW8 was approximately 0.3m higher at 4.3mBGL when measured on the 16th May 2011.

Groundwater levels will vary naturally seasonally during the year and the level of variability will be largely dependent on the specific yield (i.e. storage) of the aquifer and the recharge. The recharge varies greatly throughout the area due to variations in the effective rainfall and the thickness and permeability of subsoils over the aquifers.

Although the groundwater and surface water analysis show differences in quality there is likely to be some baseflow hydraulic connection between the bedrock aquifer and the river. Given the karst environment the hydraulic connection between the groundwater and surface water is likely to be quite complex with the river gaining baseflow from the aquifer during high water table and losing it to the bedrock during drier periods.

**Groundwater Vulnerability**

The vulnerability of a groundwater body is the term used to describe the ease with which the groundwater in the area can be contaminated by human activities. The vulnerability is determined by many factors including the travel time, the quantity of contaminants and the capacity of the deposits overlying the bedrock to attenuate contaminants. These factors in turn are based on the thickness and permeability of the overburden, e.g. groundwater in bedrock which has a thick cover of low permeability clay is less vulnerable than the groundwater in bedrock

**Table 11.4 - GSI Groundwater Vulnerability Mapping Guidelines (DoELG 1999)**

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) & Thickness			Unsaturated Zone	Karst Features
	High Permeability (sand/gravel)	Moderate permeability (e.g. sandy subsoil)	Low permeability (e.g. clayey subsoil, clay, peat)	(sand/gravel aquifers only)	(<30m radius)
Extreme (E)	0 – 3.0m	0 – 3.0m	0 – 3.0m	0 – 3.0m	-
High (H)	>3.0m	3.0 – 10.0m	3.0 – 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0 – 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

*Notes: (1) N/A = not applicable  
 (2) Precise permeability values cannot be given at present  
 (3) Release point of contaminants is assumed to be 1-2m below ground surface*

which is exposed at the surface. The criteria for determining groundwater vulnerability, as developed by the GSI, are shown in Table 11.4 below.

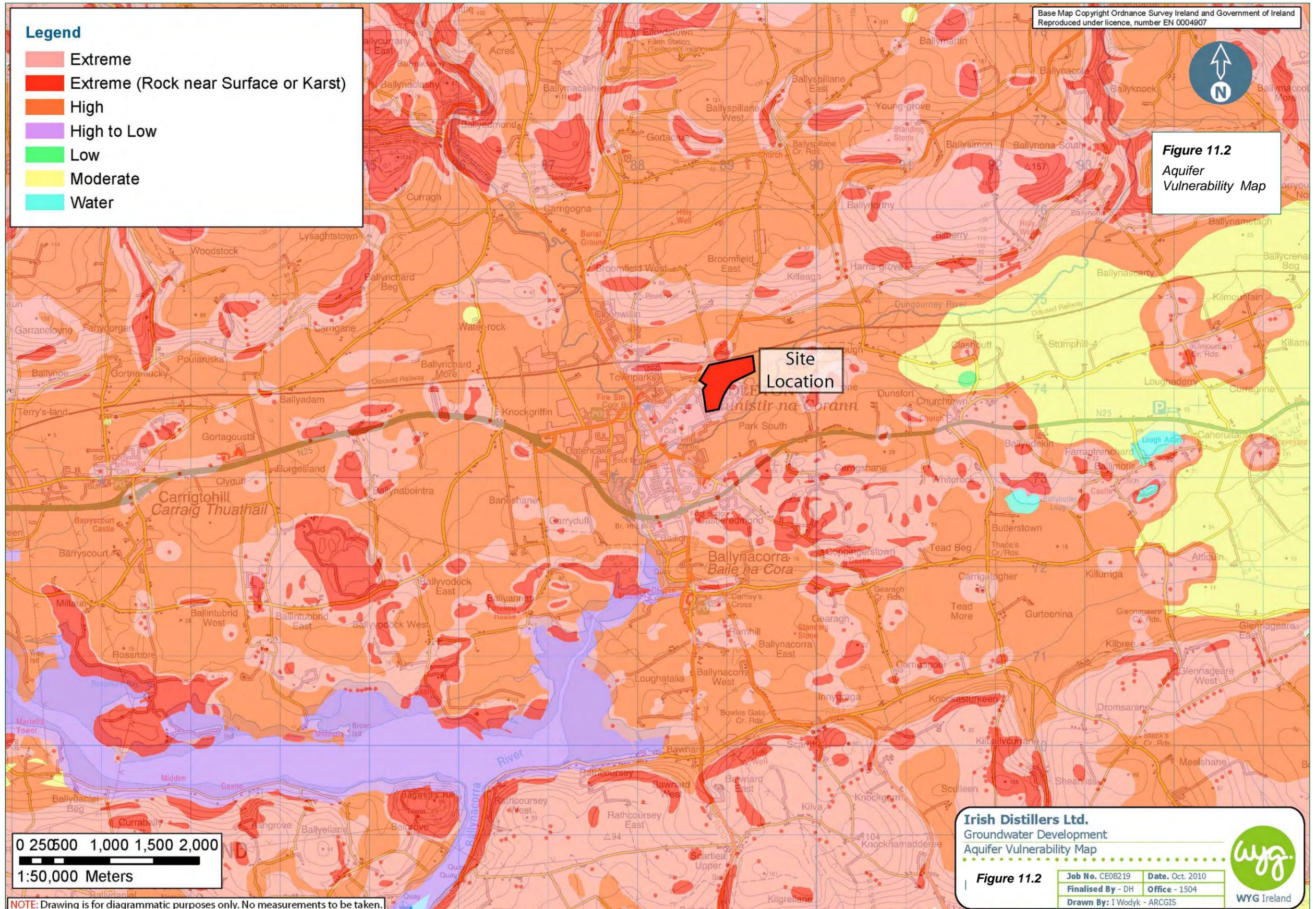
Groundwater vulnerability maps have been produced for the country by the GSI and these have six classifications. ‘Extreme’ and ‘Extreme rock near surface or karst’ are those areas most at risk from contamination and mitigation measures should be put in place for their protection. Areas classified as having ‘High’ vulnerability are less vulnerable to contamination; however they still need a certain measure of protection. ‘Low’ vulnerability areas have natural protection in place and mitigation measures do not need to be put in place here. In areas which have been classified as ‘High-Low’ only an interim study has taken place.

The South County Cork Groundwater Protection Scheme Map(2E) Draft Subsoils Map indicates the site area consists of made ground surrounded by glacial tills. Vulnerability information from the South County Cork Groundwater Protection Scheme Map(6E) Resource Protection Zones Map shows that the area in the vicinity of the site is classified as extreme to high. The GSI classifies the vulnerability of the bedrock aquifer on site as high (H) over the north eastern area of the site indicating an overburden thickness of 3m to 10m, as presented in Figure 11.2. The borehole drilling information from the lower field area encountered >10m of moderate permeability subsoils indicating a moderate (M) vulnerability.

The majority of the site has an extreme (E) to high (H) vulnerability rating indicating bedrock or karst features are within 10m of ground level with limestone bedrock outcrop visible in the area of Fox’s Hollow swallow hole towards the centre of the site and at the cavern abstraction point in the south western corner. The high (H) rating is located along the southern and eastern boundaries of the site and adjacent Dungourney river valley at the eastern site boundary, indicating an overburden cover of 3 to 10m.

Historical water quality data from the previous site works indicates that the aquifer is susceptible to contamination. Once impacted there is little attenuation of contaminants within karstic limestone and the connectivity of the karstic fissures usually results in rapid movement of contamination in the aquifer.

Overburden thickness across the proposed development site varies from approximately 5m to 9mBGL, based on information from the test wells PW1 and TW1 in the area of the still house and new distillation columns and tankfarms. The geotechnical borehole logs from the site investigation assessment in the area around Warehouse A3 where the proposed new fire water retention pond is to be located indicate the overburden thickness of between 5.4mBGL in the north to 15mBGL in the south, indicating the vulnerability rating is generally high (H) to moderate (M). These borehole logs are presented in the Soils/Geology Chapter 9.0.



### 11.4 Well Drilling Results

In June 2010 test wells (PW2-PW4) were drilled along the southern site boundary in the limestone bedrock aquifer. All three wells were drilled at a diameter of 300mm to install 12m of steel casing into competent limestone bedrock. Weathered limestone bedrock was encountered at 5mBGL, 4.5mBGL and 4mBGL respectively in PW-2, PW-3 and PW-4 with competent limestone bedrock encountered at 8mBGL, 10mBGL, and 7mBGL. A bentonite/cement grout slurry was pumped between the 300mm and 200mm steel casing into the bedrock as presented in the borehole logs in Appendix A. The purpose of this grout seal is to minimise the potential for contaminated surface or perched groundwater from entering the wells, as per best practice.

Once the grout had set the borehole was advanced at 200mm diameter. In well PW-2 a significant groundwater strike was encountered in a limestone cavity at 20 to 21.5mBGL which was infilled with bluish green clay. Due to the significant groundwater strike in this limestone cavity and drilling difficulties with proceeding further without sealing off this supply the well was completed at 21.5mBGL.

Similarly, well PW-3 encountered a productive groundwater strike in a clay infilled limestone cavity at 21.0mBGL and completed at 24mBGL. In well PW-4 a productive groundwater strike was encountered at 15mBGL with a limestone cavity encountered at 27.2mBGL. This well was drilled to 28mBGL but collapsed back to 27.2mBGL, so the drilling was finished at this depth. All three test wells (PW-2 to PW-4) were air lifted following drilling with the drilling rig to develop the well by removing the suspended sediment/estuarine clay from the water column. This involved flushing the groundwater from the completed borehole until the groundwater returns were as clear as possible.

Once the initial three test wells (PW2-PW4) were developed each well was installed with 150mm diameter machine slotted PVC screen in the limestone bedrock aquifer as shown in the borehole logs. A gravel pack was not installed as the groundwater became clear with development of the wells. The limited interaction and excellent groundwater yields indicated that there was a potential to extend the groundwater well field along the eastern site boundary towards the Lower Field area in the north east of the site.

In March 2011 a further four test wells (PW5 to PW8) were proposed along the eastern site boundary. A further test well (PW9) was located near PW6 where a significant gravel aquifer resource was encountered during the drilling works. This gravel aquifer well (PW9) was installed to examine this gravel aquifer resource. The test well locations are presented in Figure 11.3.

All five boreholes were drilled by Southern Pumps Ltd using a combination of a dual air rotary drilling rig and second air rotary rig to provide an additional required compressor in order to drill wide diameter

(up to 400mm) test wells. A biodegradable drilling foam additive was used in the drilling process in order to remove the gravel and rock chippings from the well.

PW5 encountered weathered bedrock at 8mBGL and a bentonite cement grout placed between 400mm and 300mm steel casing to 12mBGL, into the bedrock as per best practice to minimise the potential for contaminated surface or perched groundwater from entering the well. A limestone cavity was encountered at 34mBGL and 42mBGL with significant groundwater strikes at 14mBGL and 34mBGL. The borehole was completed at 43.5mBGL.

PW6 encountered significant groundwater bearing gravels at 13mBGL. These rounded to subrounded sandstone and limestone gravels are likely to be associated with a buried valley fluvio-glacial deposit deposited on the bedrock in this area of the site. A significant groundwater strike was encountered at 16mBGL. The well was drilled and installed with 400mm steel casing to 32mBGL which is two metres into the weathered limestone bedrock. The borehole was advanced at 400mm diameter into the bedrock where a large groundwater strike was encountered at 74mBGL. The borehole was completed at 41.5mBGL and installed with a 225mm PVC liner.

PW7 encountered significant groundwater bearing gravels at 15mBGL. These rounded to subrounded sandstone and limestone gravels are likely to extend to the gravel deposit encountered in PW6. The well was drilled and installed with 300mm steel casing to 41mBGL which is 16 metres into the limestone bedrock. The borehole was advanced at 300mm diameter into the bedrock to 105m where no large groundwater strikes were encountered. In order to target the main groundwater strike encountered in the gravel deposits the steel casing was pulled back to 25mBGL.

PW8 encountered 18m of low permeability silt and fine sand with the groundwater bearing gravel encountered from 18mBGL to 25mBGL. The borehole was drilled and installed with 400mm diameter steel casing to 25.5mBGL which is 0.5 metres into the limestone bedrock. The borehole was advanced at 400mm diameter into the bedrock to 30m where large groundwater strikes were encountered between 26mBGL to 30mBGL. Due to the significant groundwater encountered and fractured nature of the bedrock the borehole was completed at 30mBGL which collapsed to 26.5mBGL. Although the borehole is installed in the limestone bedrock there is direct hydraulic connection with the significant groundwater present in the overlying gravel deposits.

PW9 was located near PW6 to target the extensive groundwater bearing gravels encountered in this area. These gravel deposits were seen to be present across the north eastern region of the site from PW6 to PW8 and therefore a potential good yielding groundwater resource. PW9 was drilled at 400mm diameter with steel casing installed to 24mBGL. The

groundwater bearing gravels were encountered from 22mBGL to 30mBGL with weathered bedrock at 30mBGL. The borehole was completed at 33mBGL and installed with a 225mm PVC liner.

All five groundwater wells (PW-5 to PW-9) were air lifted following drilling with the drilling rig to develop the well by removing the suspended sediment/estuarine clay from the water column. This involved flushing the groundwater from the completed borehole until the groundwater returns were as clear as possible. PW8 had limited development due to the significant groundwater returns undermining the drilling rig jack supports. A gravel pack was not installed as the groundwater became clear with the development of the wells.

As outlined in the soils and geology chapter, the overburden consists of low permeability silts and clay to highly permeable gravel deposits ranging in thickness from bedrock near surface at 0.20mBGL in the area along the southern boundary of Warehouse 30 to thick overburden deposits in the eastern site of the site at approximately 30m, as detailed in the Soil & Geology Chapter 9. The completed borehole drilling logs and installation details are presented in Appendix A.

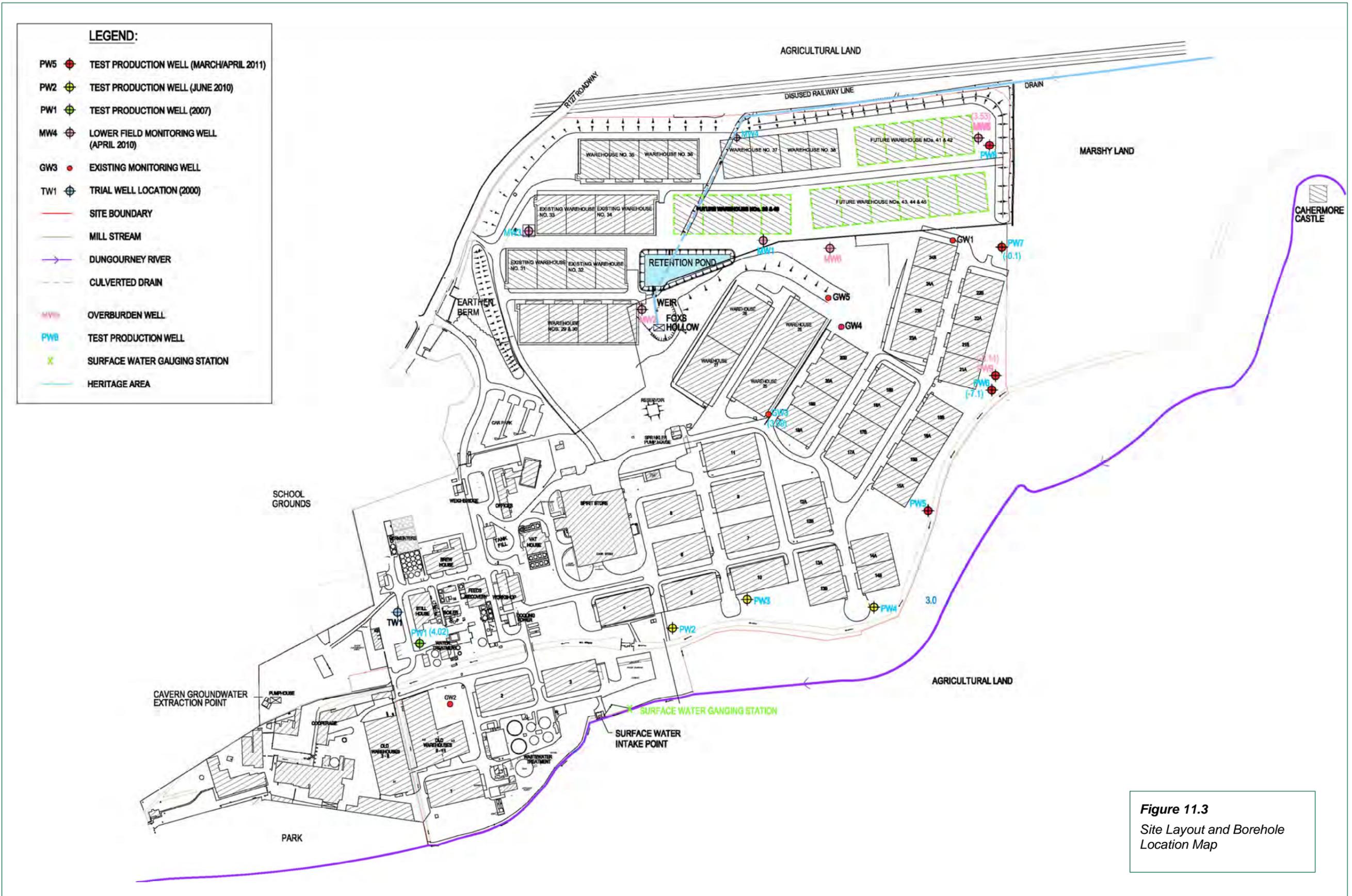
The static water level in the eight test wells (PW2-PW9) were recorded between 3.36 and 4.38metres above ordnance datum (mAOD) on 16th May 2011 before the start of the five day pumping test, with the Dungourney River surface water level of 3.2mAOD.

Information from the geotechnical site investigation in the proposed firewater retention pond area in June 2011 indicate the overburden consists of sandy gravelly clay, silty sand and sandy gravel with the Clay and Sand generally present between 5.7 to 8mBGL underlain by glacial gravel to the top of bedrock.

### 11.5 Pumping Tests

This pumping test methodology carried out on-site follows best practice whereby a step test is carried out initially to assess the optimum yield suited to operation of the five day constant rate discharge test followed by recovery monitoring at the end of the test. The discharge water from the pumping wells was piped to the on-site storm drains which discharged to a disused mill race to the south west of the site down gradient of the pumping wells. The mill stream was dammed at this groundwater discharge location to prevent groundwater moving along the mill stream towards the pumping wells preventing recirculation of groundwater during the pumping test.

From the mill stream discharge location the groundwater was culverted to the Dungourney River. In a section of the mill stream that carried the groundwater from the pumping test an automatic datalogger placed in an adjacent groundwater well PW1 showed an increase in the water table, indicating some leakage during the pumping test. Calculations from flow measurements on the discharged water on the culvert near the river



indicated that approximately half the groundwater being discharged during the pumping test was being lost to ground through the Mill stream. However this leakage to the aquifer was downgradient of the pumping wells on-site with minimal to no recirculation of groundwater to the nearest pumping well PW2 anticipated.

In March 2011, WYG placed automatic water level dataloggers in monitoring wells across the site together with the surface water at the Fox's Hollow weir to monitor for potential effects of the pumping test works. Dataloggers were placed in the following locations;

- existing bedrock monitoring wells (PW1, GW3, MW1, MW3, MW4)
- existing overburden monitoring wells (MW2, MW5, MW6)
- Cavern Abstraction Point
- Fox's Hollow (upstream and downstream of weir)
- Existing test wells (PW2, PW3, PW4)
- New test wells when drilled in March/April 2011 (PW5, PW6, PW7, PW8, PW9)
- Dungourney River Gauging Station April 2011

The groundwater levels were adjusted to the surveyed ordnance datum (OD) levels in order for the relative pumping test data to be compared between well locations. The locations of the on-site wells are presented in Figure 11.1. There are no known groundwater abstraction wells located in the immediate vicinity of the site. The rainfall data shown is obtained from the on-site weather station over the groundwater monitoring period.

A flow gauging station with automatic datalogger was placed in the adjacent Dungourney River that borders the south of the site. The flow and water level measurements were used to assess if there was an influence of the groundwater abstraction during the pumping test on the surface watercourses in the area.

### Pumping Test Results - Step Test

The step test graphs are presented in Appendix C for the eight test wells (PW2-PW9). PW2-PW4 step pumping test were undertaken in June 2010 with PW5-PW9 undertaken in March to May 2011. The step test results were analysed by examining the specific capacity of the well. The specific capacity is a measure of the efficiency of the aquifer by assessing the discharge rate divided by the corresponding drawdown.

### PW2 Step Test

The four steps undertaken on PW2 as outlined in Table 11.5a indicate that this well was efficient.

Table 11.5a - Step Test Results for PW2

PW2	Discharge (m <sup>3</sup> /d)	Actual Drawdown (m)	Specific Capacity (Sc) (m <sup>3</sup> /d/m)	Well Efficiency %
1	306	0.67	0.0022	97
2	568	1.33	0.0023	95
3	864	1.86	0.0022	93
4	1087	2.27	0.0021	91

### PW3 Step Test

The four steps undertaken on PW3 as outlined in Table 11.5b indicate that this well was efficient.

Table 11.5b - Step Test Results for PW3

PW3	Discharge (m <sup>3</sup> /d)	Actual Drawdown (m)	Specific Capacity (Sc) (m <sup>3</sup> /d/m)	Well Efficiency %
1	282	0.26	0.0009	85
2	576	0.71	0.0012	74
3	864	1.02	0.0012	65
4	1037	1.45	0.0014	61

### PW4 Step Test

The four steps undertaken on PW4 as outlined in Table 11.5c indicate that this well was efficient.

Table 11.5c - Step Test Results for PW4

PW2	Discharge (m <sup>3</sup> /d)	Actual Drawdown (m)	Specific Capacity (Sc) (m <sup>3</sup> /d/m)	Well Efficiency %
1	280	0.2	0.0007	88
2	576	0.41	0.0007	78
3	770	0.63	0.0008	72
4	849	0.74	0.0009	70

### PW6 Step Test

The efficiency of the bedrock well is good with a proposed sustainable yield for the 5-day constant rate pumping test of 25 m<sup>3</sup>/hr (600 m<sup>3</sup>/day).

Table 11.5d - Step Test Results for PW6

PW6	Discharge (m <sup>3</sup> /d)	Actual Drawdown (m)	Specific Capacity (Sc) (m <sup>3</sup> /d/m)	Well Efficiency %
1	540	8.46	0.0157	42
2	828	18.38	0.0222	32
3	1209	42.87	0.0355	24
4	684	22.17	0.0324	36

### PW7 Step Test

The efficiency of the bedrock/gravel well is good with a proposed sustainable yield for the 5-day constant rate pumping test of 25 m<sup>3</sup>/hr (600 m<sup>3</sup>/day).

Table 11.5e - Step Test Results for PW7

PW7	Discharge (m <sup>3</sup> /d)	Actual Drawdown (m)	Specific Capacity (Sc) (m <sup>3</sup> /d/m)	Well Efficiency %
1	417	1.9	0.0046	53
2	576	3.4	0.0059	45
3	734	6.23	0.0085	39
4	842	9.55	0.0113	36
5	979	16.89	0.0173	32
6	1108	27.93	0.0252	30
7	1209	38.83	0.0321	28

**PW8 Step Test**

The efficiency of the bedrock/gravel well is excellent with a proposed sustainable yield for the 5-day constant rate pumping test of 110m<sup>3</sup>/hr (2,640 m<sup>3</sup>/day).

**Table 11.5f - Step Test Results for PW8**

PW8	Discharge (m <sup>3</sup> /d)	Actual Drawdown (m)	Specific Capacity (Sc) (m <sup>3</sup> /d/m)	Well Efficiency %
1	878	0.39	0.000444	98
2	1454	0.66	0.000454	98
3	2001	1.05	0.000525	97
4	2563	1.35	0.000527	96
5	3283	2	0.000609	95

**PW9 Step Test**

The efficiency of the gravel well is good with a proposed sustainable yield for the 5-day constant rate pumping test of 25 m<sup>3</sup>/hr (600m<sup>3</sup>/day).

**Table 11.5g - Step Test Results for PW9**

PW9	Discharge (m <sup>3</sup> /d)	Actual Drawdown (m)	Specific Capacity (Sc) (m <sup>3</sup> /d/m)	Well Efficiency %
1	170	0.9	0.005294	57
2	381	1.76	0.004619	37
3	619	3.47	0.005606	27
4	864	5.09	0.005891	21
5	1051	6.8	0.006470	18
6	1281	20.43	0.015948	15

**Pumping Step Test Summary (PW5-PW9)**

Therefore the proposed combined yield from the eight test wells on site is as follows;

**Table 11.6 - Step Test Summary**

Test wells	Proposed Yield for 5-day Constant Rate Pumping Test	
	m <sup>3</sup> /day	m <sup>3</sup> /hr
<b>2010 Test wells</b>		
PW2	800	33
PW3	800	33
PW4	800	33
<b>2011 Test wells</b>		
PW5	1920	80
PW6	600	25
PW7	600	25
PW8	2640	110
PW9	600	25
<b>Total</b>	<b>8760</b>	<b>365</b>

**Pumping Test Results – Constant Rate Test**

The simultaneous constant rate pumping test on the existing three test wells (PW2, PW3 & PW4) together with the five new test wells (PW-5 to PW9) commenced on the 16th May 2011. After a day of operation there was a generator power failure. The 5-day test was therefore restarted on the 18th May and run until the 22nd May 2011. There was a temporary period of generator failure on the 20th May (3 hours) and 22nd May (6hours) which affected the pumping groundwater level temporarily in PW5, PW6, PW7 and PW9. The 5-day constant rate pumping test was carried out by Southern Pumps Ltd under the supervision of WYG. The constant rate pumping test graphs are presented in Appendix C.

The pumping tests graphs for PW2 to PW9 present;

- a) a linear graph of all the pumping tests groundwater level and discharge compared with rainfall and an indicator of the duration of the various pumping tests.
- b) A semi-log plot of drawdown and discharge over the duration of the pumping test.

- c) A semi-log plot of drawdown and discharge over the duration of the pumping test with extension to assess predicted drawdown for a drought period.
- d) Pumping Test Software Transmissivity calculations from the pumping test information.

**PW2 Constant Rate Test**

Based on the findings of the June 2010 and March 2011 pumping test works on this test well step the discharge rate for the constant rate test was set to 806m<sup>3</sup>/day for the five day test giving a final drawdown of approximately 2.3m below resting level. Steady state conditions were achieved during the May 2011 pumping test as presented in Appendix C. Given that steady state conditions were achieved relatively rapidly in PW2 indicates that this well has a sustainable yield of ~800m<sup>3</sup>/day.

**PW3 Constant Rate Test**

Based on the findings of the June 2010 and March 2011 pumping test works on this test well step the discharge rate for the constant rate test was set to 806m<sup>3</sup>/day for the five day test giving a final drawdown of approximately 1.3m below resting level. Steady state conditions were achieved during the May 2011 pumping test as presented in Appendix C. Given that steady state conditions were achieved relatively rapidly in PW3 indicates that this well has a sustainable yield of ~800m<sup>3</sup>/day.

**PW4 Constant Rate Test**

Based on the findings of the June 2010 and March 2011 pumping test works on this test well step the discharge rate for the constant rate test was set to 820m<sup>3</sup>/day for the five day test giving a final drawdown of approximately 1m below resting level. Steady state conditions were achieved during the May 2011 pumping test as presented in Appendix C. Given that steady state conditions were achieved relatively rapidly in PW4 indicates that this well has a sustainable yield of ~800m<sup>3</sup>/day.

**PW5 Constant Rate Test**

Based on the findings of the step test the discharge rate for the constant rate test was set to ~1,900m<sup>3</sup>/day for the five day test giving a final drawdown of approximately 1.5m below resting level. Steady state conditions were achieved during the pumping test as presented in Appendix C. Given that steady state conditions were achieved relatively rapidly in PW5 indicates that this well has a sustainable yield of ~1,900m<sup>3</sup>/day.

### PW6 Constant Rate Test

Based on the findings of the step test the discharge rate for the constant rate test was set to ~648 m<sup>3</sup>/day for the five day test giving a final drawdown of approximately 11m below resting level. Steady state conditions were achieved during the pumping test as presented in Appendix C. Given that steady state conditions were achieved relatively rapidly in PW6 indicates that this well has a sustainable yield of ~500 m<sup>3</sup>/day even though the drawdown was greater than the other pumping wells on-site.

### PW7 Constant Rate Test

Based on the findings of the step test the discharge rate for the constant rate test was set to ~612 m<sup>3</sup>/day for the five day test giving a final drawdown of approximately 4.2m below resting level. Pseudo steady state conditions were achieved during the pumping test as presented in Appendix C. Given that full steady state conditions were not achieved during the pumping test PW7 indicates that this well has a sustainable yield of ~400 to 500 m<sup>3</sup>/day.

### PW8 Constant Rate Test

Based on the findings of the step test the discharge rate for the constant rate test was set to ~2,620 m<sup>3</sup>/day for the five day test giving a final drawdown of approximately 2.2m. Steady state conditions were achieved during the pumping test as presented in Appendix C. Given that steady state conditions were achieved in PW8 indicates that this well has a sustainable yield of ~2,500 m<sup>3</sup>/day.

### PW9 Constant Rate Test

Based on the findings of the step test the discharge rate for the constant rate test was initially set to 468 m<sup>3</sup>/day for the five day test giving a final drawdown of approximately 4.6m. Pseudo steady state conditions were achieved during the pumping test as presented in Appendix C. Given that full steady state conditions were not achieved during the pumping test of PW9 indicates that the sustainable yield of this gravel well is ~300 m<sup>3</sup>/day.

### Sustainable Yield Calculation

The long term sustainable groundwater yield of a well can be determined from the constant rate pumping test results plotted on a semi-log graph of drawdown and time. The parameters used in calculating the sustainable yield of a well include;

- *The maximum permissible drawdown*
- *Pumping test data in relatively steady state conditions*
- *Maximum drought period for an area*

The maximum permissible drawdown is obtained from information on the well construction and groundwater strikes. It's generally recommended

that that the pumped water level does not drop below the bottom of the steel (unslotted) casing. This is to avoid the formation of biofilms on the screen. To be conservative the maximum permissible drawdown is taken at the maximum drawdown observed during the constant rate test.

**Table 11.7 - Sustainable Yield Calculations**

Test well	Predicted 200 day drought drawdown level (m)	Discharge Rate (m <sup>3</sup> /day)	Predicted Specific Capacity after 200 days (m <sup>2</sup> /day)	Maximum permissible drawdown (m)	Drought Period Sustainable Yield Calculation (m <sup>3</sup> /day)
PW2	3	806	269	2.3	618
PW3	1.7	806	474	1.3	616
PW4	1.3	820	631	1	631
PW5	2	1900	950	1.5	1425
PW6	12.3	648	53	11	580
PW7	4.8	612	128	4.2	536
PW8	2.8	2620	936	2.2	2059
PW9	5.1	468	92	4.6	422
<b>Total</b>		<b>8680</b>			<b>6886</b>

As seen in Table 11.7 the specific capacity after 200 days is obtained from discharge/drawdown on the pumping test graphs in Appendix C. A conservative sustainable yield for the test wells is therefore calculated by multiplying the maximum permissible drawdown by the specific capacity. Therefore this drought period total calculation of the sustainable yield is approximately 6,800 m<sup>3</sup>/day. IDL propose that the average daily abstraction from the groundwater well field will be in the order of 5,080 m<sup>3</sup>/day with a maximum proposed abstraction in any 24hour period of 6,120 m<sup>3</sup>/day. IDL wish to retain the option of abstracting cooling water from the underground cavern. In the event of water being abstracted from the cavern, the total abstraction from the wells and cavern will not exceed 6,120 m<sup>3</sup>/day.

### Pumping Test Discussion

In previous pumping test works the response to rainfall recharge was seen to be relatively rapid. During this phase of groundwater development works there was limited rainfall in the period prior to the 5-day pumping test in early May 2011 which shows a slight rise in the water table across the site. In the period over the pumping test there was limited rainfall on-site and therefore there was no significant recharge influence on the pumping test information. In general a sustained period of rainfall is required to cause an impact on the water table.

From the combined pumping test graph in Appendix C it can be seen that both PW6 and PW9 which are abstracting groundwater from the gravel aquifer in the eastern region of the site show a similar groundwater level during pumping. This indicates that the cone of depression extended to both of these pumping wells, as shown in Figure 11.5. Apart from the localised cone of depression created around PW6 for a groundwater pumping level of -7mOD the other bedrock wells showed a pumping drawdown of 1.5 to 3.2mOD.

The combined pumping test graph shows the surface water level in the Dungourney River over the duration of the pumping test of which there was no effect of the pumping test on the River. With no pumping on-site it can be seen that water table in all wells is above the river water level. During pumping test operation the groundwater levels decrease below the river water level in all wells apart from PW4. During sustained pumping operations over the 5-day simultaneous pumping test from all eight test wells at the abstraction rate (8,680 m<sup>3</sup>/day) of approximately twice the proposed groundwater abstraction rate, there was no impact on the river. The river flow monitoring information recorded flows of approximately 36,000 m<sup>3</sup>/day. The long term monitoring programme proposed and discussed in the mitigation measures in Section 11.16 below will examine the baseline river flow and level natural variations in order to assess the natural groundwater and surface interactions due to climatic/seasonal changes from which any groundwater abstraction impact, if it were to occur, can be ascertained.

### 11.6 Monitoring Well Water Level Monitoring

The monitoring of the groundwater levels in the bedrock and overburden wells as outlined above, together with surface water at the weir at Fox's Hollow and the Dungourney River over the duration of the pumping test works is presented in Appendix D with locations in Figure 11.3.

The individual graphs show the water elevation together with the water temperature. The groundwater temperatures are seen to be consistent across the site in the range of 9°C to 11°C apart from bedrock well PW1 which has a temperature of 15°C. This localised elevated groundwater temperature in the vicinity of PW1 is likely to be related to a building heat island effect. There are greater fluctuations in temperature in the surface water features from 5°C to 20°C at the weir to 9°C to 14°C in the Dungourney River.

When examining the combined groundwater level information from all monitoring points as presented in Appendix D, the relative groundwater elevations to ordnance datum correspond with the groundwater contour map showing a hydraulic gradient from the north east of the site to the lowest elevation at the cavern abstraction point in the south west of the site. There is seen to be a relatively rapid response to rainfall recharge in the wells from the limited rainfall events in early May 2011 prior to the pumping test works.

During the step test pumping works in test wells PW7 and PW8 in the eastern boundary of the Lower Field had an influence in monitoring wells MW5, MW1 and MW6. During the 5-day pumping test the influence on the water table was seen across the site, decreasing with distance from the pumping wells as expected. This water table influence from the pumping test varied from ~0.2m in MW3 to the west of the Lower Field to 1.3m in MW1 toward the centre of the lower field. This effect of the pumping test on the water table on-site shows the cone of depression for the pumping test abstraction rate extends across the lower field area from the upgradient pumping wells, as presented in the contour map in Figure 11.5.

One exception to the drawdown influence of the pumping test on the water table on-site is in PW1 downgradient of the pumping wells. As mentioned previously, the rise in groundwater in this well over the pumping test is due to leakage of the discharged groundwater from the adjacent mill stream.

The influence of the pumping test on the cavern abstraction well is difficult to determine given this is an active abstraction and there was some leakage to ground from the millstream upgradient. However, the monitoring information shows a drawdown influence of up to 0.5m on the cavern water level.

There was no observed impact of the pumping test which was undertaken at a significantly higher abstraction rate than the proposed abstraction (approximately 50%) on the surface water level in the Dungourney River or on the surface water discharge to the weir at Fox's Hollow. The peaks in water level in the flow to Fox's Hollow are related to controlled discharges of storm water in the on-site fire water retention pond.

The monitoring of surface water levels upstream and downstream of the weir are presented in Appendix D. There were no episodes of backup of the Fox's Hollow swallow hole feature for the period of monitoring from March to May 2011, which has occurred previously in periods of sustained rainfall. Previous tracer test works on the Fox's Hollow feature have indicated connection to the Dungourney River. When examining the river water level to the downstream weir water level it can be seen that these water levels are similar with the river being slightly lower, inferring a slight gradient from the swallow hole to the river.

### 11.7 Groundwater Use

Information from the IDL 2010 Annual Environmental Report indicates that the following annual water use for the IDL site;

- On-site groundwater cavern abstraction well 776,416 m<sup>3</sup> which is ~ 2,560 m<sup>3</sup>/day\* (Cooling Water).
- On-site abstraction from the Dungourney River 460,554m<sup>3</sup> which is ~ 1,520m<sup>3</sup>/day (Process Water).
- Mains water 51,806m<sup>3</sup> which is ~ 170m<sup>3</sup>/day (Potable Water).

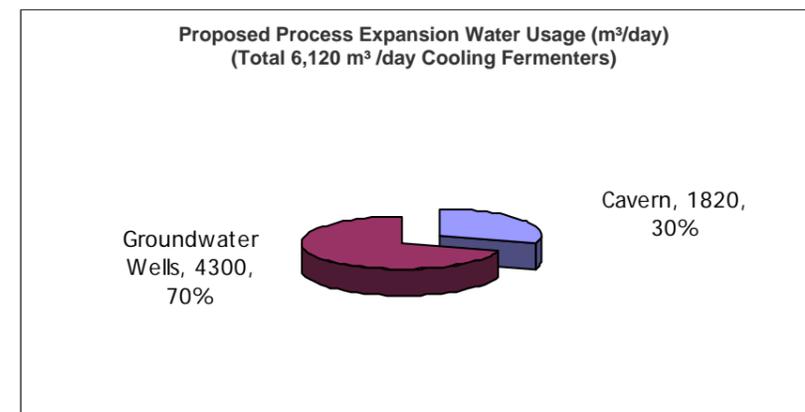
The predicted groundwater demand for the IDL site will be in the region of 6,120 m<sup>3</sup>/day. On the basis of maintaining the cavern water supply, the test well field would therefore require a combined abstraction of 4,300 m<sup>3</sup>/day. This test well field abstraction rate of 4,300 m<sup>3</sup>/day to satisfy the cooling water requirement while maintaining use of the cavern supply is approximately half the volume abstracted during the pumping test works undertaken in May 2011.

All test wells drilled and tested on-site (PW2-PW9) as part of the groundwater resource assessment for the site are currently finished with steel casing protruding above ground level and capped. The commissioning of these test wells for use as production wells would require well head works such as cutting the steel casing to ground level and securing would head caps with a concrete plinth around each well head. The well head works will also will have protective bollards around each well head if the well head is finished above ground level. As part of the commissioning works each well would be fitted with dedicated submersible pumps and associated electronic level probes and flowmeters in order to control the drawdown as specified for each proposed production well which is discussed further in Section 11.17. Each well would require an area of 5m radius to be cordoned off around each well head to prevent polluting activities, as discussed in Section 11.14.

In terms of groundwater quantity the pumping test results therefore indicate positive results in terms of sustainable groundwater yields from a well field. In terms of pumping regime it's proposed that once a groundwater demand is determined an abstraction operation programme from rotational use of the wells should be undertaken upon grant of permission. This will allow for down time of wells in the event of service/repairs etc.

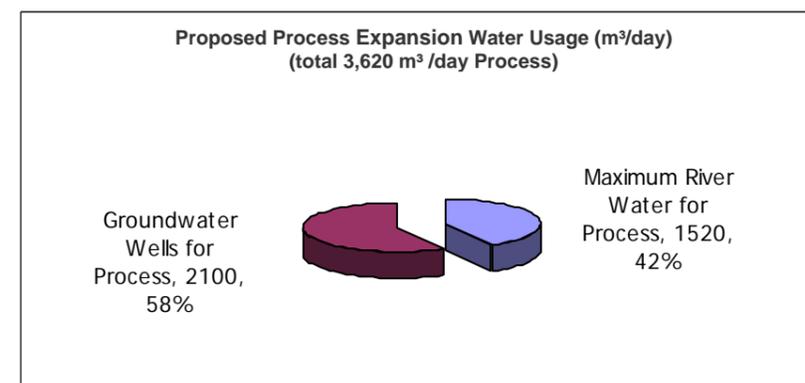
Currently there are different options being considered for water usage required for the proposed development works;

The groundwater from the test well field and the existing cavern supply would supply the fermenters to provide once through cooling. The groundwater from the test wells may then be returned to the water treatment plant for use in production process.



The groundwater from the cavern supply would not be returned to the water treatment plant as it is more vulnerable to contamination.

The current maximum surface water abstraction from the Dungourney River (1,520m<sup>3</sup>/hr) will be mixed with the groundwater from the test wells to supply the process water requirements. The surface water requires less treatment than the groundwater. The groundwater requirement for the process maybe obtained from the fermenters to reduce direct groundwater abstraction.



The projected increase on the current water demand will require approximately;

- 6,120m<sup>3</sup>/day for cooling the fermenters from groundwater
- 3,620m<sup>3</sup>/day for the process from river and groundwater re-use

Under the current water abstraction programme from the on-site cavern supply the water is normally returned to the Dungourney River via the mill stream. Occasionally, or depending on the water quality, some of the cavern water can be sent to the on-site wastewater treatment plant (WWTP) or discharged to industrial sewer. From the industrial sewer, water is sent to treated effluent pumping stations prior to discharge at Rathcoursey Point in Cork Harbour. The monitoring of the cavern water discharge from the site prior to discharge to the Dungourney River consists of continuous total organic carbon (TOC) readings, weekly pH readings and daily visual inspection in accordance with current IPPC Licence requirements.

There is currently no temperature restriction on the discharge of waters back to the Dungourney River from on-site cooling water usage. The proposed increase in the cooling water demand for the process expansion works will have a potential elevated temperature implication on the river from an increase in discharge waters. A detailed temperature modelling assessment of this predicted increase in water discharge impact on the Dungourney River is presented in the Hydrology and Ecology Chapters.

### 11.8 Groundwater Flow Direction

The direction of groundwater movement is principally influenced by topography and the groundwater table is generally a subdued reflection of the ground surface.

A GPS topographic survey was carried on the monitoring and test wells on-site in May 2011 to Malin Head Ordnance datum as presented in Table 11.8. The survey also obtained topographic levels from; the cavern abstraction point, the weir at Fox's Hollow together with a gauging board installed in the Dungourney River upstream of the surface water intake point, as shown in Figure 11.2. The survey information allows for groundwater contour maps to be compiled for the whole site while correlating with the surface watercourses on and off-site.

**Table 11.8 - Groundwater Well Survey (including weir and river)**

Easting	Northing	Location ID	Elevation (mAOD)	Reference point
<b>Test wells on Main Site</b>				
588627	573687	PW1	8.445	Top of Casing
588925	573761	PW2	8.950	Top of Casing
589002	573800	PW3	9.030	Top of Casing
589162	573815	PW4	8.135	Top of Casing
589194	573943	PW5	9.150	Top of Casing
589255	574104	PW6	8.180	Top of Casing
589242	574234	PW7	8.940	Top of Casing
589207	574401	PW8	6.883	Concrete Rim
589257	574125	PW9	8.780	Top of Casing
<b>Monitoring Wells on Main Site</b>				
588684	573645	GW2	5.805	Top of Casing
588998	574027	GW3	14.210	Upstand Pipe
589067	574146	GW4	16.436	Top of Casing
589071	574203	GW5	18.412	Upstand Pipe
<b>Cavern Groundwater Abstraction (level on concrete slab)</b>				
588466	573617	Cavern	3.544	Concrete Slab at Intake
<b>Foxes Hollow in Lower Field (level on top of wall at weir)</b>				
588861	574118	Foxes Hollow	4.555	Upstand Pipe Upstream of Weir
588861	574117	Foxes Hollow	5.230	Upstand Pipe Downstream of Weir
588861	574118	Foxes Hollow	4.510	Top of Wall at Weir
<b>Lower Field Monitoring Wells</b>				
589014	574272	MW1	6.135	Upstand Pipe
588836	574138	MW2	6.690	Upstand Pipe
588694	574209	MW3	7.545	Upstand Pipe
588887	574341	MW4	6.970	Upstand Pipe
589202	574402	MW5	6.580	Concrete Rim
589068	574251	MW6	5.280	Upstand Pipe
<b>Dungourney River (Gauge Board Upstream of Intake)</b>				
588941	573680	River	3.150	Water Level at 0.45 on River Gauge

Notes: mAOD means metres above Malin Head Ordnance Datum

All of these groundwater tests and monitoring wells together with cavern, on-site surface watercourse at the weir and adjacent Dungourney River were monitored for potential influence of the groundwater abstraction regime during operation of the pumping test works on-site.

Using the automatic datalogger information from the groundwater monitoring works groundwater level adjusted to Malin Head Ordnance datum for the same time were obtained to create a groundwater contour map prior to the pumping test on 16th May 2011 and during the pumping test on 20th May 2011, as outlined in Table 11.9 and presented in Figures 11.4 and 11.5 respectively.

**Table 11.9 - Levels for Groundwater Contour Maps**

Well ID/River	Prior to Pumping Test 16/05/11 @ 11:00	During Pumping Test 20/05/11 @ 09:00
	Groundwater Levels (mAOD)	
PW1	3.36	4.02
PW2	3.45	1.61
PW3	3.41	2.24
PW4	4.18	3.27
PW5	3.85	2.2
PW6	4.01	-7.1
PW7	4.05	-0.1
PW8	3.98	1.79
PW9	4.38	-0.14
MW1	4.02	2.79
MW2	3.53	3.25
MW3	3.18	3.04
MW4	3.61	3.36
MW5	4.25	3.53
MW6	4.19	3.13
GW3	3.39	3.09
Cavern	2.49	1.96
River	3.2	3.17

It can be seen from Figure 11.4 that groundwater flows in a south west to westerly flow direction beneath the site which corresponds with the local and on-site topography. The hydraulic gradient to the eastern and central region of the site has a hydraulic gradient of 0.003 with a steeper gradient of 0.004 in the southwest area of the site towards the cavern groundwater abstraction point.

The trend of the karstic features on the northern boundary of the site follows a roughly northeast to southwest orientation. The surface stream that enters Fox's Hollow is known to be connected to the sites Cavern

water supply and it would be expected that the groundwater would naturally discharge into the Dungourney River and Ballynacorra Estuary.

A second groundwater contour map was created to show the influence of pumping from the test wells on-site, as presented in Figure 11.5. This groundwater contour map was created from groundwater levels taken from the automatic dataloggers present in the wells on-site on 20th May 2011 at 11:00 which was during day two of the five day pumping test. It can be seen that abstraction from the eight test wells (PW2 – PW9) draws groundwater towards the abstraction wells as expected. The pumping wells create two main cones of depression on site due to the interaction of the pumping wells. There is one cone of depression between the three test wells PW2 to PW4 along the southern site boundary and a second from PW4 to PW8 along the western site boundary. There is little to no impact from the pumping wells on the groundwater flow direction in the south western region of the site near PW1 and the cavern abstraction point.

Although the pumping groundwater level in PW2 and PW3 located near the Dungourney River is lower than the surface water level there was no effect of the 5-day pumping test on the surface watercourse. The larger cone of depression from pumping wells (PW5 to PW9) did not extend near the Dungourney River. If the proposed long term groundwater and surface water monitoring programme identifies a trend of groundwater abstraction impact on the river, appropriate mitigation measures will be implemented, as discussed below in Section 11.16 These mitigation measures include reduction in groundwater abstraction in wells causing an influence and increasing the abstraction in the groundwater test wells located further from an affected area, i.e. the very productive groundwater wells such as PW8 located in the Lower Field area.

## 11.9 Hydrochemistry

Groundwater samples were collected from the test well field on-site as follows;

- *PW2 to PW4, MW1, River (24/06/10) Full Drinking Water Suite*
- *PW2 to PW4 (19/10/10) Chemical & Bacteriological Suite*
- *PW2 to PW4 (08/12/10 & 09/12/10) Chemical & Bacteriological Suite*
- *PW2 to PW4, River (07/03/11 to 11/03/11) Chemical & Bacteriological Suite*
- *PW5 to PW9 (16/05/11, 18/05/11 to 21/05/11) Chemical & Bacteriological Suite*
- *PW7 to PW9 (19/05/11 to 21/05/11) VOCs, Alcohols & TPHs*

The above sampling from the groundwater test wells was undertaken during a period of pumping tests which ensured the boreholes were purged prior to sampling and therefore representative of the aquifer. Groundwater samples were sent to an accredited laboratory for a suite of

potable chemical and biological parameters and compared against the Drinking Water Standards S.I. No 278 of 2007 and Groundwater Regulation S.I. 9 of 2010. Groundwater samples were also issued to the Radiological Protection Institute of Ireland (RPII) for radon analysis during the initial sampling in June 2010. The 2010 groundwater and Dungourney River sampling and 2011 groundwater sampling works are presented in Appendix F.

The suite of parameters to be analysed from the sampling works of the groundwater test wells and Dungourney River were instructed by VWI who are designing the water treatment plant for the IDL site. In addition to the above analysis, jar samples were obtained and analysed directly by VWI, as part of their water treatment design.

### Test Well Groundwater Quality

Overall the chemical and bacteriological groundwater quality is very good in all eight test wells (PW2-PW9). There is a drinking water exceedance of manganese in the groundwater across the site with more elevated concentrations in the wells along the eastern site boundary (PW6-PW9). There is a gravel aquifer deposit overlying the bedrock at these borehole locations which may be giving rise to the elevated naturally occurring manganese in the groundwater. The highest dissolved manganese concentration of 2.2mg/l was recorded in PW9 which is a gravel well installation. High manganese levels are more of a nuisance for pipework, equipment, etc rather than being a health issue but will require treatment given the elevated concentrations detected.

Although there is not a drinking water standard for hardness, the EPA interim guideline value of 200mg/l was exceeded in all eight test wells on-site ranging in concentration generally between 200 to 350mg/l. This groundwater hardness is relatively high compared to the river water concentration of approximately 125mg/l and would need to be treated for the on-site production use.

Nitrate levels were generally <30mg/l in the southern boundary test wells (PW2-PW5) and <10mg/l in the eastern boundary wells (PW5 – PW9), with all below the drinking water limit of 50mg/l.

Ammonia exceeded the drinking water standard of 0.3mg/l and groundwater regulation of 0.175mg/l in wells PW2-PW4 in October 2010 but was less than these standards in June 2010 and March 2011. In May 2011 ammonia concentrations exceeded the drinking water regulations in PW5-PW9 intermittently and the drinking water standard in PW8 and PW9 over the pumping test works.

In June 2010 the chemical groundwater quality in PW2-PW4 had a drinking water exceedance of antimony which was suspected as a laboratory error given that subsequent analysis did not detect antimony.

In June 2010 the full drinking water suite on (PW2-PW4) had no detection of pesticides, herbicides, polycyclic aromatic hydrocarbons or volatile organic compounds from the groundwater samples above the

laboratory detection limits. In May 2011 there was no detection of VOCs, TPHs or alcohols above laboratory detection limits in the selected sampling of PW7, PW8 & PW9.

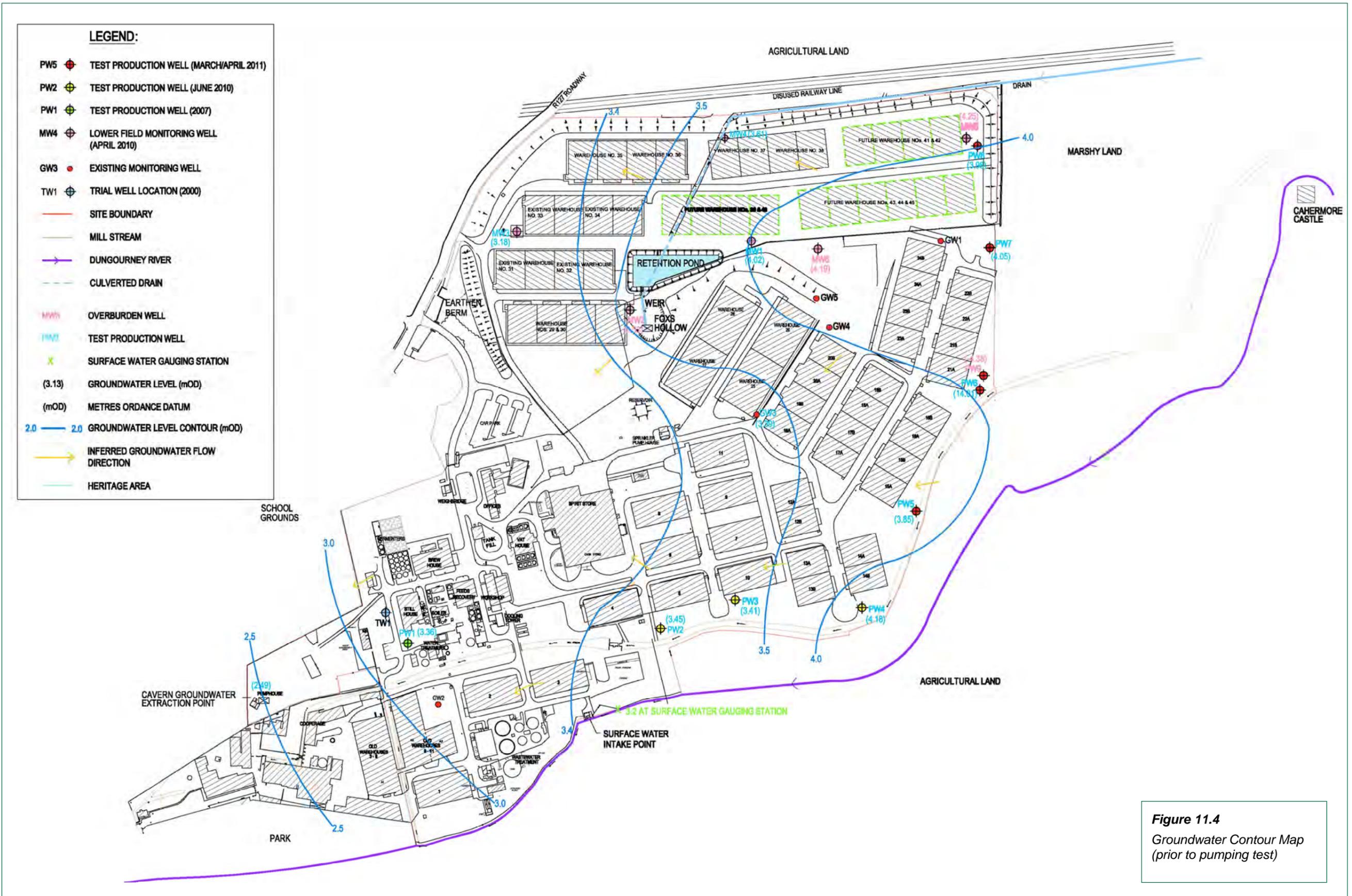
In June 2010 the radon analysis had low level detection (3.9 to 8.1Bq/l) in the three wells (PW2-PW4) at concentrations significantly lower than the 500Bq/l where the RPII recommend remediation works are undertaken.

In 2010 the microbiological analysis indicates there was faecal contamination present the three test wells sampled (PW2-PW4) with E.Coli concentrations ranging from undetected to 260mpn/100ml. The corresponding samples for the Dungourney River in June 2010 had an E.Coli concentration of 11,240mpn/100ml. In the March 2011 sampling works the faecal concentrations in these three test wells was significantly less with maximum E.Coli concentrations of 7mpn/100ml. The Dungourney River E.Coli concentration also had a significantly lower E.Coli concentration in March 2011 of 172mpn/100ml. This suggests a potential interconnection between the River and these three test wells whereby the River is losing water to groundwater in the winter period with potentially less loss to groundwater in the spring. Therefore the groundwater that is proposed to be used in process water would need to be treated for bacteriological contamination to ensure the water complies with the drinking water regulations.

There was no faecal contamination detected in the other test wells (PW5-PW9) along the eastern boundary of the site. These test wells are located further from the river with less groundwater and surface water interaction. This corresponds with the observed cone of depression from the pumping wells seen in Figure 11.5 where the cone of depression from PW2 & PW3 is close to the river unlike the influence around PW5-PW9.

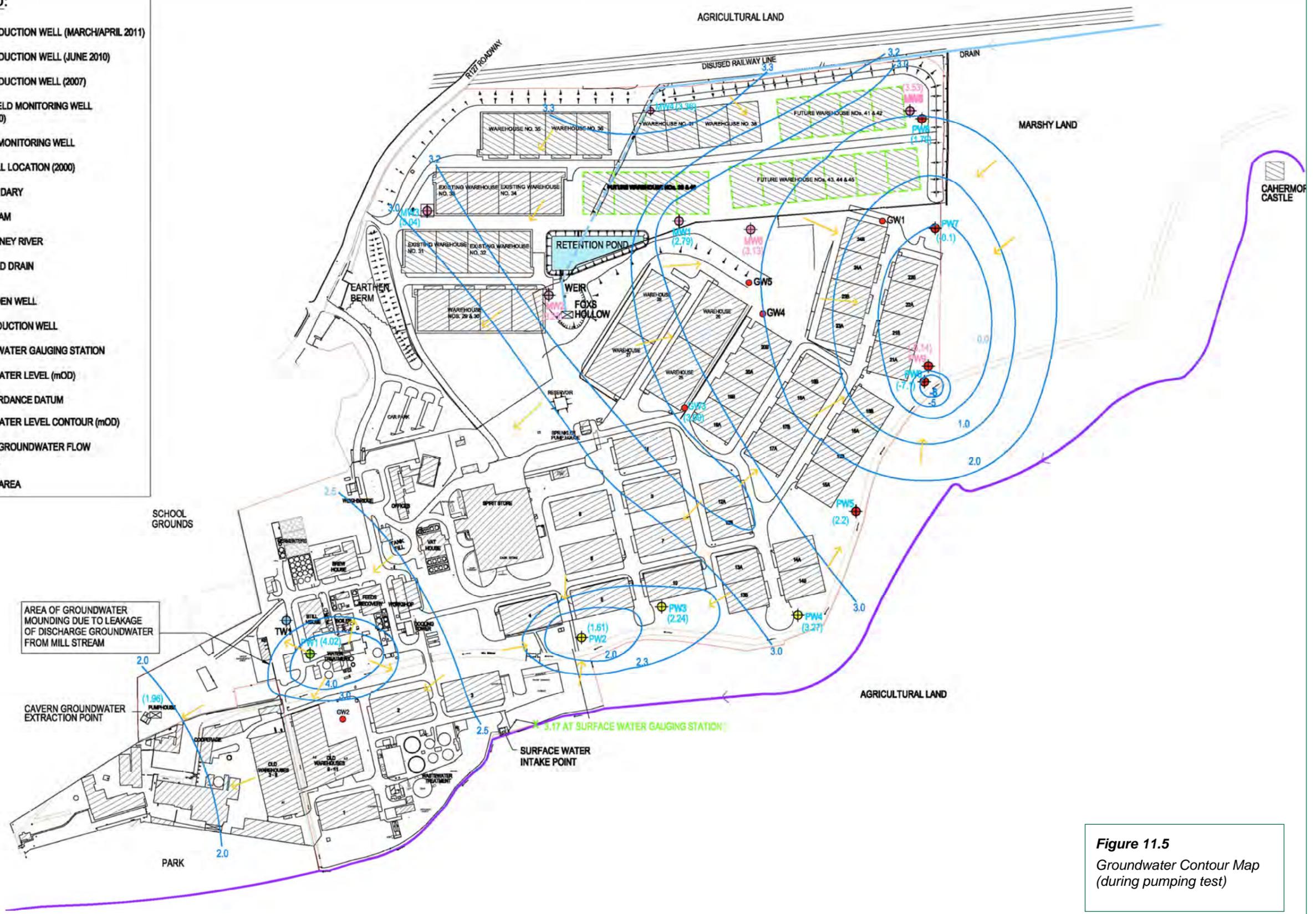
In general karst limestone aquifers such as that underlying the IDL site are vulnerable to contamination due to the relatively fast travel times in karst features such as caves. There is therefore likely to be a slight fluctuation in groundwater quality through the seasons due to surrounding agricultural land use changes together with potential surface water/groundwater interaction with the adjoining Dungourney River.

Field pH measurements of PW2 to PW9 from monitoring works in June 2010 to May 2011 are generally within the drinking water standard of 6.5 to 9.5 with most readings between 6.5 to 7.0. The pH reading for some monitoring rounds detected slightly acidic groundwater in PW3 (6.49), PW4 (6.38), PW5 (6.42) & PW9 (6.43). Electrical Conductivity (EC) readings are below the drinking water standards of 2,500µS/cm and groundwater regulations value of 1,875µS/cm.



**Figure 11.4**  
Groundwater Contour Map  
(prior to pumping test)

- LEGEND:**
- PW5 TEST PRODUCTION WELL (MARCH/APRIL 2011)
  - PW2 TEST PRODUCTION WELL (JUNE 2010)
  - PW1 TEST PRODUCTION WELL (2007)
  - MW4 LOWER FIELD MONITORING WELL (APRIL 2010)
  - GW3 EXISTING MONITORING WELL
  - TW1 TRIAL WELL LOCATION (2000)
  - SITE BOUNDARY
  - MILL STREAM
  - DUNGOURNEY RIVER
  - CULVERTED DRAIN
  - OVERBURDEN WELL
  - TEST PRODUCTION WELL
  - SURFACE WATER GAUGING STATION
  - (3.13) GROUNDWATER LEVEL (mOD)
  - (mOD) METRES ORDANCE DATUM
  - 2.0 GROUNDWATER LEVEL CONTOUR (mOD)
  - INFERRED GROUNDWATER FLOW DIRECTION
  - HERITAGE AREA



**Figure 11.5**  
Groundwater Contour Map  
(during pumping test)

The groundwater temperatures are generally with the range of 11 to 12°C for the eight test wells on-site as seen from the field readings during sampling together with the continuous temperature logging data presented in the pumping test graphs in Appendix C.

### Surface Water Chemical and Bacteriological Quality

A water sample was taken from the Dungourney River in June 2010 and March 2011 to determine if there were quality differences with the groundwater being abstracted from the test wells on-site.

As expected with surface watercourses being more vulnerable to water contamination than groundwater from surface runoff etc, the bacteriological water quality of the Dungourney River has very elevated total coliforms and faecal contamination compared to the groundwater as mentioned above.

The chemical water quality is good with no exceedance of the drinking water standards. The river water quality has significant differences to the groundwater as follows;

- *hardness ~120mg/l with is approximately half the groundwater concentrations detected.*
- *more alkaline water with pH >8 compared to groundwater of ~6.5 to 7.*
- *low manganese (<10µg/l) compared to several 100µg/l in many test wells and >2,000µg/l in PW9.*
- *calcium concentrations in March 2011 of <40mg/l compared to 80 to 100mg/l in groundwater.*
- *EC in the river of ~330µS/cm is less than the groundwater range of ~500 to 800µS/cm.*

The surface water temperature in the river ranged daily from as low as 9.5°C up to 14°C. The surface water in the weir at Fox's Hollow has a similar daily temperature fluctuation as expected from 5°C up to 20°C given this water can be very shallow and stagnant. The temperature monitoring for the weir monitoring and gauging station on the Dungourney River is presented in Appendix D.

As part of the water level monitoring programme, temperature readings were recorded for existing monitoring wells on-site together with unused test well (PW1) and Cavern groundwater abstraction point. The groundwater temperature across the site was generally from 10°C to 11°C with slightly lower temperature in MW2 (8.5°C to 10°C) which is installed in the overburden sediments. The temperature in PW1 is slightly elevated at ~16°C which is thought to be from the heat island effect from the buildings in the area.

### 11.10 Site Process Groundwater Quality Requirements

Based on the existing water quality analysis from the test wells the water may be used for either cooling or process water on-site. The suitability of the water and water treatment requirements is being assessed in detail by IDL. The advantage of using groundwater is the low suspended solids present allow direct use to cooling the fermenters, from which the water can be re-used as process water following treatment in the on-site water treatment plant. This has the advantage of reducing the process water demand of 3,620 m<sup>3</sup>/day. The disadvantage of the groundwater use is the treatment requirement for elevated hardness, iron, manganese and organic matter.

The current new water treatment plant is being designed to cater for both groundwater and river water use.

The various options for using water for on-site cooling and process needs can come from various sources once the actual demand is determined. Depending on demand and local conditions, water will be taken from; the existing cavern abstraction point, surface water intake, new groundwater test wells and potable mains water.

As discussed in Section 11.7 an assessment of the potential impact of elevated temperatures from the cooling discharge water from the fermenters has been carried out and is included in the Hydrology and Ecology Chapters.

### 11.11 Groundwater Abstraction Impact and Legislation

There is currently no licensing requirement for drilling and testing groundwater for potable or commercial use in Ireland.

Under the Local Government (Water Pollution) Act 1977 (S.I. No 117 of 1977) a comprehensive Register of abstraction greater than 25 m<sup>3</sup>/day is required and administered by individual Local Authorities. Based on this the Local Authority should be made aware of the proposed groundwater abstraction for the site as it the case for the existing cavern groundwater abstraction and surface water abstraction on-site.

Based on information supplied by McCutcheon Mulcahy Chartered Planning Consultants, under Section 10 (l) of Schedule 5 of the Planning and Development Regulations, 2001 specifies that ground water abstraction where the annual volume of water exceeds 2 million cubic metres (5,479 m<sup>3</sup>/day) requires an Environmental Impact Statement (EIS). Given that IDL currently abstract groundwater from the cavern water supply the proposed development could be deemed to be a change or extension of development. Section 10 (l) of Schedule 5 covers this and states that any change/extension resulting in bringing a development over the thresholds for an EIS or results in an increase in size/quantity greater than 25% of the existing or an amount equal to 50%

of the appropriate threshold (whichever is greater) requires an EIS. Based on this information, and the proposed groundwater demand for the site, an EIS is required as part of the site expansion works.

Under Article 11.3(e) of the Water Framework Directive(WFD) requires “controls over the abstraction of fresh surface water and groundwater, and improvement of fresh water, including a register or registers of water abstractions and a requirement for prior authorisation for abstraction and impoundment. These controls shall be periodically reviewed and, where necessary updated. Member states can exempt from these controls, abstractions and impoundments which have no significant impact on water status”.

The current practice of “prior authorisation”, through EIS and planning laws, do not fully satisfy the WFD requirements. This abstraction requirement under the WFD is likely to be implemented in the near future by means of a licencing system.

### WFD Characterisation of Groundwater Abstraction Pressures

The assessment of the potential hydrogeological impacts of the proposed IDL production expansion development was undertaken with reference to the requirements and objectives of the EU Water Framework Directive (2000/60/EC), the subsequent EU Groundwater Directive (2006/118/EC) and Draft River Basin Management Plans (RBMPs) for the South Western River Basin District (SWRBD) 2009 – 2015. The fundamental objective of the Water Framework Directive aims at maintaining the “high status” of waters where it exists, preventing any deterioration in the existing status of waters (including groundwater) and achieving at least “good status” in relation to all waters by 2015. This is achieved through the implementation of management plans for each River Basin District (RBD). There are no Groundwater Bodies within the study area which are classified as being at “poor status”.

As part of the WFD there is a requirement for characterisation of pressures from significant water abstractions to be carried out for all types of water bodies in Ireland. An initial characterisation of abstraction pressures study undertaken by the EPA in 2005 identified a total of 757 groundwater bodies in Ireland of which six water bodies were at risk (1a) and 36 water bodies were probably at risk (1b) from meeting the environmental status objectives, as defined by the WFD, by year 2015. The GSI Groundwater Body (GWB) delineation for the Midleton area is shown in Figure 11.6. The Midleton Town GWB of which the IDL site is located on its eastern boundary had an abstraction risk of 2a (probably not at risk) with the adjoining Midleton GWB which includes the eastern side of the IDL site with an abstraction risk of 2b (not at risk), as presented in Appendix G.

In 2008 an updated groundwater abstraction risk assessment was undertaken using a series of individual risk assessment methodologies

developed by the GSI supported through the National Groundwater Working Group which examined three elements;

### 1) Abstraction Rates vs Recharge Rates

This summed abstraction rates against computed long-term average recharge across each GWB in Ireland. From this work a total of eight GWBs are highlighted as “at risk” of which one is the Midleton GWB due to groundwater dewatering activities at a JA Wood Quarry near Carrigtwohill. The Midleton 2 GWB is located to the west of Midleton Town and not in the immediate vicinity of the Midleton Distillery site. This groundwater abstraction was reported at 30,423 m<sup>3</sup>/day from the same regionally important aquifer as that beneath the IDL site, although in a different catchment area.

### 2) Saline Intrusion

This considered groundwater abstraction close to the coastline. The closest at-risk groundwater abstraction identified from the risk assessment methodology was the Carrigtwohill, Co Cork quarry site as identified above. The abstraction rate of 20,000 m<sup>3</sup>/day from one JA Wood quarry at Carrigtwohill located approximately 2km from the coastline identified that any saline impact from this abstraction would be localised on the sea-ward side of the quarry.

The IDL site test wells are located approximately 1.1 to 1.7 km from the Ballynacorra River Estuary with groundwater abstraction catchment area located upgradient of the site away from the coastline. The water quality information does not suggest any saline impact on the IDL site.

### 3) Potential Impact on Groundwater Receptors

Impacts on surface water bodies are usually in the form of reduced baseflow to rivers and streams with more complex potential impacts to GWDTES/SAC (flow, water on levels, chemistry). The potential moderate impact of long term groundwater abstraction on the baseflow to the Dungourney River may affect flows and water quality of this watercourse which discharges into the SAC of Cork Harbour.

### Groundwater Bodies

Groundwater Bodies are the management unit under the WFD that are necessary for the subdivision of large geographical areas of aquifer in order for them to be effectively managed. These are divided into those that are “not considered to be at risk” and those considered “at risk” and therefore require further characterisation. The groundwater risks consist of chemical status and quantitative status. The overall groundwater status is presented in individual colour coded groundwater body maps. The Midleton GWB as defined by the GSI and presented in Appendix G, occupies the floor of an east west trending valley in east Cork stretching from Lough Mahon in the west to Youghal Bay in the East.

This GWB consists of the regionally important aquifer as under the IDL site and less productive locally important aquifers. The sandstone ridges to the north and south of this GWB provide abundant runoff which recharges the limestone aquifer in the valley with a potential for through flow from the sandstone to the limestone aquifers. This GWB has several existing reported well yields from Carrigtwohill area quarry dewatering (>20,000 m<sup>3</sup>/day), Dawn Meats Midleton (ceased December 2009) abstraction of ~1,200 m<sup>3</sup>/day) to the Dower Spring water supply abstraction of 4,545 m<sup>3</sup>/day.

There is an existing Source Protection for the Dower Spring located in the Midleton Groundwater Body.

### 11.12 Surface Water and Rainfall Recharge

The site lies within the catchment of the Dungourney River which is the most significant tributary of the Owennacurra River and has a catchment area of 52 km<sup>2</sup>. The annual average rainfall for the river catchment is 1,116mm. The Dungourney River rises north of Ardglass, has a main river length of approximately 18km and joins the Owennacurra River at Midleton. Both rivers flow through undulating landscape with narrow river valleys in the upper catchment opening out to wide flat floodplains towards the town of Midleton. The ground levels vary in the catchment from 244mAOD in the northeast of the catchment to approximately 5mAOD at Cork Harbour.

The 30 year (1961 – 1990) average annual rainfall (R) from Met Eireann for the Whitegate area is approximately 1,100mm/yr. The annual evapotranspiration (AE) is estimated at 46% of the average annual precipitation which gives 460mm/yr. The potential recharge or effective rainfall can then be calculated as (R – AE = ER) which gives an effective rainfall figure of 594mm/yr.

The effective rainfall (ER), 594mm/yr, will be partitioned between surface water runoff and groundwater recharge in a ratio that depends on the depth and permeability of the overburden material. This ratio is determined by the estimated permeability of the overburden material (in Table 4 of the Water Framework Directive Pressures and Impacts Assessment Methodology Guidance on the assessment of the impact of groundwater abstractions, document no. GW5, GWPI 5, 2004).

According to the guidance document, based on an extreme to high vulnerability rating at the site and moderate permeability subsoil overlain by well drained soil, a recharge coefficient of 70% of effective rainfall is used. This recharge coefficient results in a recharge for the site of 416mm/yr. However, given that the majority of the catchment area of the Dungourney River (~70%) is underlain by a locally important aquifer that is moderately productive only in local zones, the maximum recharge cap of between 150 – 200mm/yr is used as outlined in the guidance document. A recharge cap of 200mm/yr is applied to the sandstone and mudstone bedrock aquifer up-gradient of the site.

It is common in a karst aquifer environment that a river flowing over the aquifer can lose water to the aquifer in the summer when groundwater levels are seasonally low. At the IDL site the minimum water table elevation is likely to be tied into the sea-level which is not far from the site as reflected in the water level in the cavern abstraction wells of ~2mOD.

Information on the flow gauging station present on the Dungourney River has a dry weather flow (DWF) of 0.03m<sup>3</sup>/s. Taking into account the course of the river over the bedrock aquifers the river is likely to be gaining groundwater baseflow from the locally important sandstone aquifer. At approximately 4km upstream of the IDL site the bedrock aquifer contact changes to the karstic limestone where the Dungourney River is likely to be losing surface water to groundwater depending on the groundwater levels. Therefore this indicates that there is additional recharge to the aquifer during low flow than is calculated from rainfall recharge alone.

The up-stream river catchment area of the Dungourney River at the site is approximately 52 km<sup>2</sup>. Taking account that approximately 70% of the catchment area is underlain by a locally important aquifer and 30% by the regionally important karstic aquifer that following recharge estimations are;

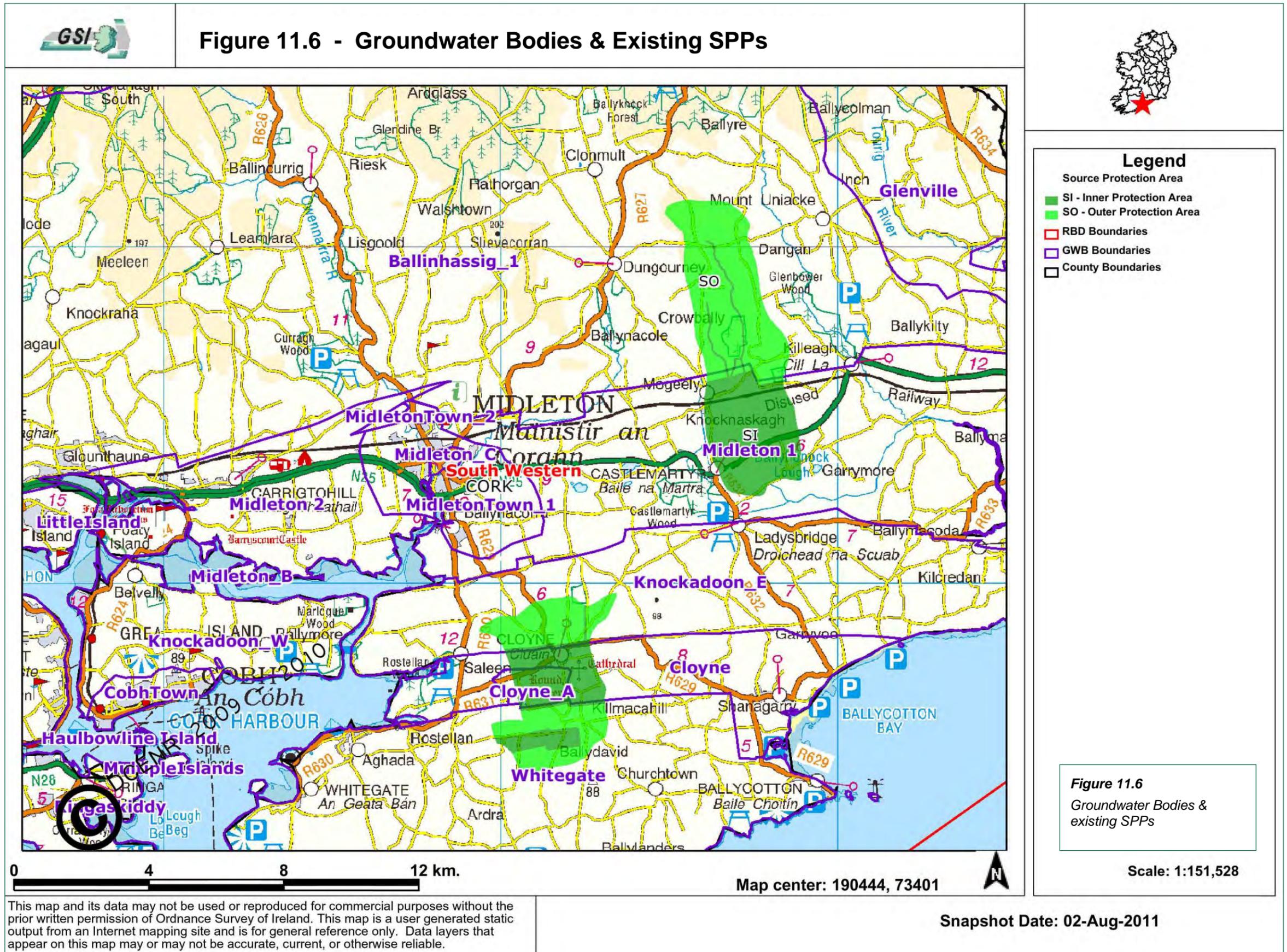
- 70% of Catchment 36.4 km<sup>2</sup> @ 200mm/yr = 19,945 m<sup>3</sup>/d
- 30% of the catchment 15.6 km<sup>2</sup> @ 416mm/yr = 17,771 m<sup>3</sup>/d

Therefore the annual recharge volume over the Dungourney catchment area of 13,766,480 m<sup>3</sup> which is equal to approximately 37,700 m<sup>3</sup>/d.

Based on the GSI well search information shown in Figure 11.7 below there are wells in the Midleton area abstracting in excess of 2,000 m<sup>3</sup>/day. However, these larger abstractions are located downgradient of the IDL site and closer to the catchment of the Owennacurra River. The main existing groundwater abstraction in the catchment area of the IDL site is ~2,560 m<sup>3</sup>/day from the cavern supply on the IDL site.

There are in the region of 20 individual domestic/agricultural wells reported in the in the catchment area. The majority of the yields are located in the locally important sandstone and mudstone aquifer in the catchment area with reported yields to be <50 m<sup>3</sup>/day giving a total abstraction of approximately 1,000 m<sup>3</sup>/day. This combined with the cavern abstraction in the regionally important limestone aquifer gives a combined abstraction of approximately 3,560 m<sup>3</sup>/day.

With a proposed abstraction of another maximum of 3,560 m<sup>3</sup>/day would give a total groundwater abstraction from the catchment in the region of 7,100 m<sup>3</sup>/day. In Ireland the recent Groundwater Quantitative Risk Assessment under the Water Framework Directive defined risk based on groundwater abstraction as a percentage of recharge as outlined in Table 11.10.





**Table 11.10 - Groundwater Abstractions Impact Potential on Rivers and Large Lakes**

GWABS/Average Recharge	Average Specific Yield or Storage of GW Screening Unit	
	Low Storage (<5%)	High Storage (>=10%)
>30%, i.e., if groundwater abstraction is greater than 30% of long term average recharge	High Potential Impact	High Potential Impact
20 to 30%	High Potential Impact	Mod Potential Impact
10 to 20%	Mod Potential Impact	Low Potential Impact
2 to 10%	Low Potential Impact	Low Potential Impact
<2%	No Potential Impact	No Potential Impact

The guidance provided suggests long term groundwater abstraction of 20% to 30% of recharge within a water body represents a moderate to high impact potential on the Dungourney River. The proposed groundwater abstraction of up to 7,100 m³/day is approximately 19% of the catchment recharge calculation which indicates there would be a moderate impact potential on the Dungourney River. This calculated impact on the bedrock aquifer would need to be assessed by a period of monitoring of the proposed abstraction over several months.

As mentioned previously in the winter period there is likely to be increased recharge to the limestone aquifer by natural flow from the Dungourney River to the aquifer and thereby reducing the potential abstraction impact of the aquifer which has not been taken into account in the above calculations.

The proposed groundwater use will consist of process and cooling water. Ultimately some cooling water will be discharged back to the Dungourney River following use on-site, thereby reducing impact on this watercourse in terms of water quantity. The Hydrology Chapter examines in more detail these increases in water discharges to the Dungourney River and associated impacts.

The river flows were monitored in the Dungourney River at a gauging station location setup upstream of the surface water intake and downgradient of the pumping wells, as presented in Figure 11.3. A flowmeter was used to take flowmeter readings prior to, during and after the groundwater pumping test works on-site. The River flows varied from 0.3 m³/sec (26,179 m³/day) to 0.426 m³/sec (36,806 m³/day), as presented in Appendix E. The water level monitoring over the pumping test duration shows the river is responsive to rainfall runoff as expected but there is seen to be no impact on the Dungourney River level for the period of the 5-day pumping test at the higher than proposed groundwater abstraction rate of 8,690 m³/day, as presented in Appendix E.

### 11.13 Cooling Water Discharge to Dungourney River

There is currently no water temperature restriction on the discharge of waters back to the Dungourney River from on-site cooling water usage. With the proposed increase in cooling water required for the fermenter

expansion works there is going to be an increase in the volume of water being returned to the Dungourney River. The volume of water discharge increase and associated impact from slightly elevated water temperatures on the river are examined in detail in the Hydrology and Ecology Chapters.

### 11.14 Source Protection Plan

#### Introduction

This Source Protection Study for the proposed production well field has been carried out in accordance with the DoELG/EPA/GSI (1999) guidelines. The Plan aims to protect the quality of the groundwater source from potentially polluting activities in the general area. It is also intended to control such activities over the wider aquifer, thereby protecting potential groundwater sources and groundwater quality generally.

The guidelines issued by the DoELG/EPA/GSI (1999) recommend that a source protection plan has two primary protection elements:

- (i) Inner Protection Zone (SI) based on the 100 day time of travel (TOT);
- (ii) Outer Protection Zone (SO) based on the zone of contribution (ZOC) to the wells.

The study involved assessing the groundwater flow direction and gradient at the site, and the aquifer characteristics such as transmissivity and porosity. Source protection zones were then delineated, comprising a 100 day time of travel (TOT) as the inner protection zone (SI) and the zone of contribution to the well as the outer protection zone (SO).

The following information is used or considered in the compilation of the source protection zones:

- *Well yield (m³/d) - the amount of water that can be abstracted from the well in a sustainable manner;*
- *Transmissivity (m²/d) - potential rate at which water could flow through a unit height of aquifer;*
- *Aquifer thickness (m) - as determined by drilling;*
- *Effective porosity - the pore space fraction of the rock which allows water flow;*
- *Hydraulic gradient - the rate of change in water level per unit distance;*
- *Recharge (mm/yr) - the volume of water entering the aquifer.*

The available information is interpreted to provide a best estimate of the zone of contribution (and the protection zones) to the well. The plan is intended as a planning and decision making aid with which planning decisions can be made in the context of the protection of the water

supply well on the site. The accuracy of the delineation of the zones is dependent on the level of data available. In this case the aquifer parameters were calculated using data collected from the wells and from published information in hydrogeological literature. Should more data become available at any point in the future, the plan should be modified and amended accordingly.

#### Source Protection Zones

The above outlines that according to the DoELG/EPA/GSI (1999) guidance document, the source protection plan consists of two source protection zones for each well:

- (i) Inner Protection Zone (SI) based on the 100 day time of travel (TOT);
- (ii) Outer Protection Zone (SO) based on the zone of contribution (ZOC) to the well.

As a further protection measure, it is recommended that the Source Sites are also afforded a degree of protection, ideally a fenced area 5m in radius around the proposed abstraction wells (PW2 to PW9). A cordon sanitaire should be maintained within this zone and all potentially polluting activities, such as the parking of vehicles should be prohibited.

#### Inner Protection Zone (SI)

The inner protection zone is usually delineated using the 100 day travel time capture zone. It is designed to protect against the effects of human activities that might have an immediate impact on the source, and in particular, against microbial pollution. It is estimated that faecal bacteria can survive for up to 50 days in groundwater and so the 100 day TOT is used as a conservative period in which no faecal bacteria should survive.

The USEPA WHPA model, based on the uniform flow equation, was used in conjunction with the information obtained from the drilling, pumping tests and surveying, to delineate the source protection zones. The 5-day simultaneous pumping test on all eight test wells on-site in May 2011 had a combined abstraction rate of ~8,680m³/d where steady state conditions were being achieved in the wells as seen in the combined pumping test graph in Appendix C. Currently this combined groundwater abstraction rate is not required for the site operations and the proposed maximum groundwater abstraction rate for the site is in the region of ~5,000m³/d.

In order to account for variations in pumping rate and to protect against prolonged dry spells the abstraction rate used to calculate the inner protection zone was taken as one and a half times the proposed average daily abstraction rate (i.e. 5,000m³/d x 150% = 7,500m³/d) as outlined in Table 11.11.

Table 11.11 - Test Production Well Discharge Rates for SPP Model Parameters

Test Well	Well Yield with overall combined 50% safety factor	Aquifer Transmissivity average from pumping test software and graph calculations	Aquifer Thickness - Length of borehole without grouted casing	Effective Porosity	Hydraulic Gradient
	Q (m <sup>3</sup> /day)	T (m <sup>2</sup> /day)	m		
PW2	800	325	10	0.02	0.003
PW3	800	492	12	0.02	0.003
PW4	800	808	16	0.02	0.003
PW5	1600	933	30	0.02	0.003
PW6	350	140	49.5	0.02	0.003
PW7	400	267	80	0.02	0.003
PW8	2450	1332	12	0.02	0.003
PW9	300	269	9	0.02	0.003
<b>Total</b>	<b>7500</b>				

The following values outlined in Table 11.12 were used in the model:

- Well yield – (proposed maximum abstraction yield with an additional 50%)
- Transmissivity – (Calculated from pumping test data using AquiferWin32 software)
- Aquifer thickness – (Length of borehole without grouted casing)
- Effective porosity - (Estimate from literature)
- Hydraulic gradient - (Calculated from static water levels in the wells)
- Recharge – (Calculated in Section 11.12)

Table 11.12 - SPP Model Input Parameters

Test Well	During Pumping Test	Initial Proposed maximum abstraction of ~5,000m <sup>3</sup> /day from a well field rotation	Overall ~50% increased abstraction rate for SPP model from proposed 5,000m <sup>3</sup> /day abstraction
	Q (m <sup>3</sup> /day)	Q (m <sup>3</sup> /day)	Q (m <sup>3</sup> /day)
PW2	806	750	800
PW3	806	off	800
PW4	820	750	800
PW5	1900	1300	1600
PW6	648	300	350
PW7	612	off	400
PW8	2620	1900	2450
PW9	468	off	300
<b>Total</b>	<b>8680</b>	<b>5000</b>	<b>7500</b>

The SPP inner protection zone length, width across at its widest point and null point values from the model are presented in Table 11.13.

Table 11.13 - SPP Model Protection Zone Information

Test Well	SO (INNER)		Null Point (m)	SI (Outer)
	Length (m)	Width (m)		Area km <sup>2</sup>
PW2	890	580	132	0.702
PW3	923	481	86	0.702
PW4	989	277	53	0.702
PW5	771	448	92	1.405
PW6	231	204	86	0.307
PW7	198	178	66	0.351
PW8	2133	547	107	2.151
PW9	666	290	59	0.263

The null point of the 100 day travel time capture zone represents the point beyond which water will not be drawn back upgradient to the well during pumping.

### Outer Protection Zone (SO)

The outer protection zone covers the remainder of the zone of contribution (ZOC) of the source. It is defined as the area needed to support an abstraction from long term groundwater recharge and is the area outside the inner protection zone that forms the ZOC. In order to take account of the variations in abstraction rates, aquifer parameters, expansion of the ZOC during dry periods and errors in estimating groundwater flow direction and gradient, a safety margin is included. The abstraction rate was taken as one and a half times of the proposed abstraction rate from the well.

The ZOC is primarily controlled by the pumping rate, the groundwater flow direction and gradient, the aquifer permeability and the recharge available to the area. The ZOC is delineated using hydrogeological mapping and the recharge equation. The individual SO area is presented in Table 11.13.(SPP Protection Zone) Information Due to the overlap of the ZOC zones the combined outer protection zones for the proposed abstraction wells is 6.58km<sup>2</sup>. Therefore the ZOC is conservatively estimated to be 1.9km in width at the widest section and up to 4km in length.

Figure 11.8 shows the inner and combined outer protection zones for the proposed groundwater abstraction wells.



**Figure 11.8**  
SPP Inner and Outer Protection Zones

### 11.15 Potential Pollution Sources

The ease at which an aquifer may become contaminated will depend on its vulnerability and on potential contamination sources within its vicinity. The proximity and nature of potentially contaminating activities is also important in determining aquifer quality.

The existing land use in surrounding upgradient area of the site is dominated by agriculture. The source protection plan can only be used as mitigation against risks posed by future developments or activities. The vulnerability of the site is seen to be high to moderate from on-site drilling data encountering bedrock at 4 to 30mBGL. This indicates that there is a moderate level of natural protection of the underlying aquifer from surface activities, increasing in thickness moving north-westwards towards the Lower Field area.

#### Agriculture

The main sources of agricultural pollution are farmyard runoff percolating to ground in surface runoff. Land spreading of agricultural wastes, if not managed correctly, can also lead to contamination. S.I. 101 of 2009 Code of Practice states that organic fertiliser or soiled water shall not be applied to land within 200m of the abstraction point of any surface watercourse, borehole, spring or well used for the abstraction of water for human consumption in a water scheme supplying 100m<sup>3</sup> or more of water per day, or serving more than 500 persons.

The lands to the east of the Lower Field are marshy and not suitable for landspreading activity. The lands to the south and east of the IDL site are not intensively worked and current landspreading activities are unknown. The analytical results of the groundwater sampling on-site indicates that nitrates are not exceeding drinking water standards and the faecal contamination is low and significantly less than in the Dungourney River. Therefore there does not appear to be a landspreading issue affecting the nitrate groundwater concentrations beneath the site.

#### Foul Sewer and Effluent Treatment Systems

The GSI Groundwater Protection Response for on-site Wastewater Systems in the inner protection zones, where the vulnerability is high (H) and low (L) is an R24 classification. These responses indicate that septic tanks are acceptable subject to normal good practice with no on-site treatment system to be located within 60m of a water supply well in the inner protection zone.

The outer protection rating for on-site Wastewater Systems is R23 for areas of high and moderate vulnerability is acceptable subject to normal good practice. One condition is that the groundwater quality information indicates that the accumulation of significant nitrate and/or microbiological contamination is unlikely. The current groundwater quality information indicates that the septic tanks located within the outer protection zone of the proposed test wells shown in Figure 11.8 are not causing significant impact on the nitrate/microbial groundwater quality.

### Roadways, Vehicles, Fuel

Runoff from road surfaces can be contaminated with hydrocarbon compounds, mineral oils, metals, greases and suspended solids. Any spills (of oil, chemicals) along roadways should be dealt with immediately and measures should be taken to ensure no contaminated material enters the aquifer. Parking of vehicles of any associated maintenance should not be permitted within the 5m cordon sanitaire of the well.

### 11.16 Predicted Impacts

#### Impact Assessment Methodology

An analysis of the predicted impacts of the proposed distillery production expansion on hydrogeology during construction and operation is presented in the following sections, using the considerations outlined in Section 11.2.

The resulting impact assessment for construction and operational phases are outlined below and are summarised in Tables 11.14 and 11.15. The impact assessments outlined in this section are pre-mitigation impacts. Residual impacts are described in Section 11.17. The assessment considered hydrogeological features identified within and surrounding the vicinity of the proposed development.

#### Potential Impact on Groundwater Resources

##### Potential Impacts on Groundwater Resources – Construction Phase

The expansion of the existing production areas on-site including a new water treatment plant will not require deep excavations as part of the construction works other than standard shallow foundation excavations in the overburden. Bedrock is not anticipated to be encountered as part of these excavation works. However, the proposed new fire water retention pond as part of the development works in the area of the existing Warehouse A3 will involve excavation of up to 6mBGL into the overburden material. In the areas of construction cuts in the subsoils and underlying bedrock dewatering is likely to be required to allow excavation in a “dry” environment given that the presence of perched groundwater and potential for large groundwater ingress in the proposed area of rock cut as described in the Soils/Geology Chapter 9.0.

##### Perched Groundwater (Overburden)

Information from the geotechnical boreholes drilled in the area of the proposed fire water retention pond shows the overburden primarily consists of clay and sand material generally present between 5.7 to 8mBGL underlain by glacial gravel to the top of bedrock. There is some perched groundwater seepage observed during drilling within the upper overburden sediments which were seen to be of low permeability. The underlying gravels are likely to be higher permeability and in hydraulic

connection with the underlying bedrock aquifer, as seen in other areas of the IDL site.

There is likely to be some requirement for dewatering of perched groundwater from the overburden sediments during construction. The significance of the perched groundwater impact is considered to be (Imperceptible), given that; the dewatering is likely to be minimal, the radius of influence from the dewatering is unlikely to be very extensive and any drained water will be discharged to on-site wastewater treatment plant or adjacent mill stream where time will be allowed for suspended solids to settle out prior to discharge to the Dungourney River.

#### Regionally Important Karstified Bedrock Aquifer

The limestone bedrock in the area of the proposed fire water retention pond is indicated from the geotechnical site investigation report to be between 5.4mBGL in the north to 15mBGL in the south of the proposed excavation.

There is a potential for significant groundwater inflow into the excavation from the bedrock excavation that is likely to be required in the northern region of the fire water retention pond. It is common for groundwater to be present near the top of weathered bedrock especially in a karstic regionally important karstified limestone bedrock aquifer. In the nearby groundwater test well (PW1) as presented in Figure 11.3 the bedrock was encountered at 9mBGL with a large groundwater strike encountered by 9.5mBGL in a limestone fracture near the top of bedrock.

There is a potential that more extensive dewatering will be required in areas where there maybe a cut below the water table for some area of the fire water retention pond. The significance of the impact from dewatering will be defined by the depth and length of the cut section below the water table and the aquifer characteristics. In locations of high water table within cuttings, slopes need to be examined during the works to determine if there is any instability of subsoils due to groundwater seepage.

As this proposed fire water retention pond is located upgradient of the existing Cavern abstraction supply the groundwater impact is considered to be Moderate/Slight.

#### Existing Groundwater Wells

There is an existing trial well (TW1) located between the new still house and new fermenters. This well should be uncovered to prevent potential accidental damage to well head or spillages which could enter the well and form a potential migration route to the aquifer. Once uncovered the well should be either cordoned off during site construction works or decommissioned.

Groundwater test well (PW1) is located in the vicinity of the proposed extension of the new distillation columns and tankfarm. The well which encountered limestone bedrock at 9mBGL is 96mBGL in depth and

contains a submersible pump but is not in use. This well may need to be decommissioned by removing the pump and sealed with a bentonite/cement grout mixture under the guidance document such as "Decommissioning Redundant Boreholes and Wells, Environment Agency".

There are also two monitoring wells located in the area of the proposed new fire water retention pond on-site. One of these groundwater wells (GW2) is an IPPC licenced monitoring well and would need to be replaced. The EPA should be informed of such works prior to decommissioning in order for the replacement well location and installation details to be agreed.

The significance of decommissioning the wells and replacing the IPPC monitoring wells is considered to be imperceptible, once they are decommissioned to best practice guidelines and the IPPC monitoring well is replaced in the area to the same installation details as the decommissioned well (GW2) to the satisfaction of the EPA.

### Potential Impacts on Groundwater Resources - Operation Phase

The significance of the impact on the groundwater resource as a result of groundwater seepage/discharge from areas of overburden/weathered rock cut excavations during the operational phase is considered to be imperceptible. This is because the only deep excavation as part of the process expansion works is the new fire water retention pond which will require an engineering design to prevent groundwater ingress during pond construction to ground level.

### Potential Impacts on Water Quality

The water quality of an aquifer may be impacted during the construction and operational activities of the proposed process expansion development. The GSI vulnerability classification of the aquifer can be used to assess the risk of activities on the water quality. As outlined in Section 11.3, the vulnerability is based on the thickness and permeability of the unsaturated material above the water table which varies from High to Moderate in the redevelopment areas of the site.

The vulnerability of the site may change locally in the area of the fire water retention pond from high to extreme. However, the potential water quality impact from the fire water retention pond will be minimised by the use of a properly engineering system in the pond design.

### Potential Impact on Water Quality - Construction Phase

During the construction phase, the water quality of an aquifer can be negatively affected. The significance of this impact is highly dependent on the thickness and permeability of the unsaturated zone (i.e. the vulnerability). Potential impacts on water quality could be caused by:

- *Water quality can be impacted by the spillage of hydrocarbon fuels or cleaning fluids of machinery on site through accidental spillage or leakage of tanks. The excavation of some areas of the site to bedrock will be extremely vulnerable to contamination.*
- *Rainfall runoff from areas of the site has the potential to contain high suspended solids.*

Generally the significance of these impacts is considered to be Significant/Moderate given that excavation will involve a cut into bedrock for the fire water retention pond construction where the regionally important bedrock aquifer will be exposed and is located upgradient of the Cavern groundwater abstraction point.

The potential volume of water required for dewatering the bedrock cut in the excavation may be significant and it may require an attenuation measure for suspended solids or other parameters prior to discharge to ground and surface watercourses or potentially the on-site WWTP, depending on the groundwater quality from the excavation.

### Potential Impact on Water Quality - Operation Phase

- *Water quality can be impacted by the spillage of hydrocarbon fuels or cleaning fluids of machinery on site through accidental spillage or leakage of tanks. The excavation of some areas of the new fire water retention pond to bedrock will be extremely vulnerable to contamination.*
- *Slight increase in rainfall runoff from extended hardstanding areas from the building expansion.*
- *In the event of a fire at the process development expansion there is a potential for alcohol liquid to be released to ground. Again, the significance of the impact on the water quality will be dependent upon the thickness and permeability of the unsaturated zone. However, there are existing fire fighting procedures in place at the site to deal with such instances.*
- *Increased volume in cooling water that will be discharged to the Dungourney River. The quantity of water being discharged back to the river depends on whether the cooling water is returned back to the new water treatment plant for use as process water.*

The significance of the above impacts are considered to be imperceptible given that the existing overburden has a slow infiltration rate and there is extensive drainage and fire fighting measures in place at the IDL site. The duration of the above impacts can range from short to long term depending on the level of contamination that occurs.

As discussed in Section 11.13 there is currently no temperature restriction on the discharge of cooling waters from the site back to the Dungourney River. The proposed increase in the cooling water demand for the process expansion works was examined using a detailed model as outlined in the Hydrology Chapter. This model assessment examined

the potential temperature implication from an increase in discharge waters to the Dungourney River.

### Potential Impacts on Water Supply

The existing groundwater abstraction for the site comes from the cavern karst feature located within 100m of the proposed development works. The production well field of eight proposed wells (PW2 to PW9) are located upgradient of the distillery expansion works and fire water retention pond development. The new water treatment plant is located around the location of test well PW3.

The existing surface water abstraction on the Dungourney River is also located upgradient of the main distillery expansion works and fire water retention pond. The proposed upgraded wastewater treatment plant is located approximately 300m upgradient of the surface water intake location.

Potential impact on water supplies result from a reduction in the water quality or abstraction rate. Cuts of the overburden to bedrock are proposed with minor cuts of the underlying Regionally Important aquifer and therefore are not expected to have much of an impact on the wells on and off-site during construction.

### Potential Impacts on Water Supply - Construction Phase

There is potential for some contamination and disruption of the groundwater regime in the existing on-site cavern groundwater supply and surface water during the construction phase. The significance of this impact is considered to be imperceptible given there was little impact from the pumping test abstraction on the Cavern with significantly less groundwater abstraction anticipated as part of the potential bedrock excavation dewatering works for the fire water retention pond.

Test well PW3 located in the area of the proposed new water treatment plant is installed with steel casing grouted into the bedrock as per best practice to minimise the potential for surface water ingress into the well in the event of potential contamination incidents from surface activities. It is not anticipated that this production well will be in use subject to planning until after the water treatment plant is constructed.

The potential impact of groundwater dewatering on existing and off-site groundwater abstraction wells is considered Imperceptible given the distance to these wells in the Middleton town area.

### Potential Impacts on Water Supply - Operational Phase

The potential impacts on water supplies identified above during construction due to potential dewatering will not apply to the operational phase.

One of the main drivers for the EIS comes from the proposed increase in groundwater abstraction from the site from the proposed groundwater

production well field (PW2 to PW9) on-site. As discussed in Section 11.11 under the Planning and Development Regulations, 2001 it specifies that groundwater abstraction where the annual volume of water exceeds 2,000,000 m<sup>3</sup>/annum (~5,479 m<sup>3</sup>/day) requires an EIS.

The current groundwater (776,416m<sup>3</sup>/annum ~2,127m<sup>3</sup>/day) and surface water (460,554m<sup>3</sup> ~1,262m<sup>3</sup>/day) use on site of ~3,389m<sup>3</sup>/day is anticipated to increase to a use of ~6,000m<sup>3</sup>/day with the proposed expansion of the existing groundwater well field. This potential additional groundwater abstraction requirement based on predicted demand and maintaining use of the cavern supply is less than half the volume abstracted during the pumping test works undertaken in May 2011.

There was no impact on the water level or flow in the nearby Dungourney River over the duration of the 5-day pumping test at a rate approximately twice the proposed use. The sustainable capacity of the aquifer indicates that there would be no long term effect of groundwater abstraction on the river and any existing off-site groundwater abstraction wells. This will be confirmed by a long term monitoring programme during commissioning and operation of the proposed well field.

Therefore, the significance of the operational impacts of existing wells in the vicinity of the site is considered to be Moderate given that the groundwater abstraction impact assessment of the well field on the Dungourney River catchment area was seen to be Moderate using the WFD guidance documents. However, the Dungourney river provides additional recharge to the bedrock aquifer in periods of high flow which are not taken into account in this assessment.

### 11.17 Mitigation Measures

Mitigation measures are summarised in Tables 11.14 and 11.15. Mitigation Measures are set out to mitigate against the predicted hydrogeological impacts arising from the proposed process expansion development.

#### Proposed Mitigation Measures on Groundwater Resources

In order to protect the aquifer both in terms of groundwater resources and water quality, mitigation measures will be put in place during the construction and operational phases of the development.

#### Proposed Mitigation Measures for the Construction Phase

During the construction phase cuts in the overburden will require minimal dewatering and the significance of the residual impact will be imperceptible. In areas of shallow cuts in areas of weathered/competent bedrock there is a potential for significant groundwater ingress and the residual impact Moderate/Slight. In locations of high water table within cuttings, slopes need to be examined during the works to determine if there is any instability of subsoils due to groundwater seepage. A geotechnical slope stability investigation will be undertaken of the

exposed cuts if required. If any suspected contaminated material is encountered during excavation construction works it will be analysed and disposed of in an appropriate manner and in line with current Waste Management legislation.

The onsite existing well (PW1) and two monitoring wells (GW2 & other) in the area of the proposed fire water retention pond will be decommissioned using the Environment Agency guidance document or equivalent. The IPPC licenced monitoring well (GW2) will be replaced in the area once the location and installation details are agreed with the EPA. This will allow continued monitoring of the groundwater quality beneath this area of the site as per the site's IPPC licence requirements. The existing trial well (TW1) will be located and either cordoned off or decommissioned during the on-site construction works.

#### Proposed Mitigation Measures for the Operational Phase

Once the process expansion works are complete and the area of excavation is constructed with an engineered fire water retention pond there are no anticipated operational impacts on the groundwater resources as there is no on-going dewatering activity anticipated and the existing wells in the development areas will either be decommissioned and/or replaced.

#### Proposed Mitigation Measures on Water Quality

#### Proposed Mitigation Measures for the Construction Phase

In order to mitigate against the impacts on water quality during the construction phase an environmental operating plan will be implemented. Onsite welfare facility will be used by construction personnel.

Good construction practices will also be used during the construction phase of the proposed process expansion development. Such practices will include adequate bunding for oil containers, wheel washers, dust suppression on site roads, and regular plant maintenance. The Construction Industry Research and Information Association, (CIRIA) provides guidance on the control and management of water pollution from construction sites in their publication Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors (Masters-Williams et al, 2001). A contingency plan for pollution emergencies will also be developed by the appointed contractor prior to work and regularly updated, which will identify the actions to be taken in the event of a pollution incident.

The CIRIA document (2001) recommends that a contingency plan for pollution emergencies should address the following:

- *Containment measures;*
- *Emergency discharge routes;*
- *List of appropriate equipment and clean-up materials;*

- *Maintenance schedule for equipment;*
- *Details of trained staff, location, and provision for 24-hour cover;*
- *Details of staff responsibilities;*
- *Notification procedures to inform the relevant environmental protection authority;*
- *Audit and review schedule;*
- *Telephone numbers of statutory water undertakers and local water company;*
- *List of specialist pollution clean-up companies and their telephone numbers.*

Good housekeeping (daily site clean-ups, use of disposal bins, etc.) on the project site, and the proper use, storage and disposal of many substances used on construction sites, such as lubricants, fuels and oils and their containers can prevent groundwater contamination. Any oil storage tanks will be bunded appropriately. Smaller quantities of these substances will be stored in suitable, secure buildings or enclosures with an impermeable floor surface. Measures will be put in place to minimise the risk of soil/water contamination from re-fuelling of vehicles, e.g., re-fuelling to be undertaken in designated areas with drained hard standing surfaces, and spill kits in place. Storage tanks will either be double-skinned or stored in bunded areas.

Where overburden is excavated and removed during the construction process, the storage of chemicals and construction materials will be restricted to areas where contaminants will not be discharged to the exposed bedrock stratum should a spill occur. Temporary facilities to trap any accidental spillage will also be put in place.

Groundwater being abstracted as part of the excavation dewatering works will be assessed physically and analytically to determine the water quality prior to discharge. The groundwater could be discharged to the adjacent mill stream prior to entering the Dungourney River or may need to be directed to the on-site WWTP /a temporary attenuation pond, if the water quality is unsuitable for discharge to the river.

#### Proposed Mitigation Measures for the Operational Phase

The impacts on the water quality during the operational phase will be as per the existing infrastructure and fire fighting measures currently in place on the IDL site. The drainage system for the process extension works will be extended where necessary. The potential for contaminated surface water to enter the groundwater regime will be limited by the design of a collection system that will contain and direct all surface water through to the on-site drainage system.

All groundwater being abstracted from the proposed well field will be treated where necessary by the proposed new on-site water treatment plant.

During commissioning of the groundwater supply wells for use as cooling water an assessment will be undertaken on temperature of the water prior to discharge into the adjacent Dungourney River. Appropriate mitigation measures to deal with increased volume of discharge water from on-site cooling to ensure that the receiving water is not negatively impacted is discussed in detail in the Hydrology Chapter.

### Proposed Mitigation Measures on Water Supply

#### Proposed Mitigation Measures for the Construction Phase

Construction compounds will not be located within the Source Protection Areas of the proposed groundwater abstractions wells for the site.

#### Proposed Mitigation Measures for the Operational Phase

Although there was seen to be no impact from the groundwater simultaneous 5-day pumping test on the proposed well field of eight test wells (PW2-PW9) on the nearby Dungourney River for approximately twice the proposed abstraction rate, the following mitigation measures are to be implemented;

- Install a permanent river level gauging station on the Dungourney River both upstream and downstream of the IDL site prior to any groundwater abstraction commissioning works to obtain baseline information on the river levels. The downstream gauging station will reflect any existing surface water variations as a result of the direct surface water abstraction from the river adjacent to the site and any natural losses or inputs from the aquifer to the river over this part of the catchment. These gauging stations will be used to monitor continuous river water levels prior to and after the commissioning of the groundwater abstraction wells programme on the IDL site. The surface water monitoring gauging stations will be designed to measure levels and determine river flows and will be installed several months prior to groundwater abstraction commissioning works to assess natural seasonal groundwater/surface water interactions.
- Each of the proposed groundwater abstraction wells will be installed with;
  - a) A suitably sized variable speed drive submersible pump to cater for the individual proposed groundwater abstraction sustainable yields as determined from the pumping test works.
  - b) An electronic flowmeter, level probe sensor and transmitter with sends real time data to an on-site programmable logical controller (PLC) computer on-site to control the variable speed

drive pumps in each individual well. This system will control the individual production well groundwater abstraction rate so that the yield does not exceed the programmed maximum safe sustainable yield calculated for each well. This will also ensure that there is No excessive drawdown of the groundwater levels.

- c) Routine analysis of the abstracted water will be carried out to monitor for water quality parameters such as (EC) electrical conductivity. In the case of the IDL site the EC readings in the groundwater are in the range of 400µS/cm to 1,000µS/cm compared to 300µS/cm to 350µS/cm in the river. Therefore, if the groundwater quality readings from the pumping wells provide a signature of water chemistry indicative of surface water influence more detailed analysis will be undertaken whereby parameters such as bacteriological, hardness and temperature would help to determine potential surface water/groundwater interaction. The potential surface water/groundwater interaction would need to be carefully examined in conjunction with the river monitoring flow data and seasonal/climatic influences given that there are natural periods during the year when groundwater is fed by surface water such as high rainfall periods.
  - In the event of one or more of the abstraction wells showing a potential influence on the Dungourney River the required groundwater abstraction yield for site processes can be obtained from other areas of the groundwater production well field, given that the wells are proven to have a greater individual capacity than proposed for simultaneous groundwater abstraction. As seen in the pumping test works for sustainable groundwater discharge rates of twice the proposed groundwater abstraction rates there were two main cones of depression on site due to the interaction of the pumping wells. There is one cone of depression between the three test wells PW2 to PW4 along the southern site boundary and a second from PW5 to PW9 along the western site boundary. The larger cone of depression from pumping wells (PW5 to PW9) did not extend near the Dungourney River during the pumping test and therefore is not anticipated to reach the river for the lower abstraction rates proposed for the site operations. In the event of the cone of depression around PW2 to PW4 extending to the river as assessed from the long term monitoring programme the abstraction from this groundwater resource can be reduced and moved to the wells located further from the Dungourney River, if required.
  - A groundwater pumping regime for the production well field will be implemented to allow for pump downtime by use of a rotational well system. This allows for pump repair and maintenance works while also allowing abstraction in one area of the site to be removed or reduced temporarily if required as discussed above.

Therefore, overall the proposed monitoring programme in the river and production well field will ensure that there will be no adverse impact on flow volumes in the Dungourney River as a result of the proposed groundwater abstraction on-site. If the proposed 50% of the proven groundwater yield from the site is seen to cause adverse affect on the Dungourney River from the continuous monitoring programme, a reduced groundwater abstraction regime will be implemented.

In the unlikely requirement for a reduction in groundwater abstraction due to impact on the Dungourney River the required water shortfall will be obtained from;

- increased abstraction from the cavern supply down stream of the river and/or
- the re-use of the cooling water and/or re-injection to the bedrock on-site will be examined in more detail instead of it being discharged to the Dungourney River.

### 11.18 Residual Impacts

The residual impacts are those that will occur after the proposed mitigation measures have taken effect and are shown in Tables 11.14 and 11.15 below.

#### Residual Impacts for the Construction Phase

The more significant predicted impacts on hydrogeological features during the construction phase arise from the potential for contamination of groundwater through accidental spillages and from any excavation dewatering. The predicted impacts before mitigation measures are considered are rated to be; imperceptible for the potential overburden dewatering, Moderate/Slight for potential dewatering from the bedrock cut where there will be direct exposure to the bedrock aquifer and Profound/Significant for potential groundwater contamination from the fire water retention pond excavation upgradient of the cavern groundwater supply on-site.

The mitigation measures relating to the potential for groundwater contamination described above, e.g. the implementation of an environmental operating plan, safe storage of contaminants etc, will ensure the risk of groundwater contamination is minimal. Therefore, predicted residual impacts on hydrogeological features after these mitigation measures are put in place are further reduced and rated as Imperceptible for the dewatering activities with Moderate/Slight for potential contamination impact on the Cavern Supply during construction.

The presence of existing groundwater development wells and IPPC monitoring well in the vicinity of the proposed development works are considered to have a Profound/Significant impact. However, the mitigation measure of cordoning off or decommissioning and/or replacing the wells where required will reduce this to Imperceptible.

**Residual Impacts for the Operational Phase**

The predicted impacts before mitigation are rated to be Moderate impact of the proposed groundwater abstraction on the potential long term impact on the nearby Dungourney River flows and levels together with potential impact on existing groundwater abstraction wells in the vicinity of the site. The mitigation measures described above e.g. long term groundwater and surface water monitoring will further reduce the potential impacts in most cases with all identified impacts having a residual impact rating of Moderate/Slight.

**Summary of Impact Assessment**

An assessment of the predicted impacts, mitigation measures and residual impacts during construction and operational phases are shown in Table 11.14 and Table 11.15 below.

There are no likely negative significant hydrogeological impacts predicted as result of the proposed process expansion development. However, a long term monitoring programme of the groundwater and river water level and flows needs to be established and assessed for both the groundwater and nearby Dungourney River surface water during the commissioning and operation works. The surface water monitoring gauging stations will be designed to measure levels and determine river flows and will be installed several months prior to groundwater abstraction commissioning works. This long term monitoring will assess natural seasonal groundwater/surface water interactions to examine trends in the data from which any unlikely groundwater abstraction impacts can be ascertained and appropriate mitigation measures implemented.

An assessment of the potential impact of an increase in the discharge of cooling waters to the Dungourney River is assessed in detail in the Hydrology and Ecology Chapters.

**Table 11.14 - Impact Assessments – Operational phase**

Constraint			Operational Phase				
Name	Importance	Magnitude of Impact	Criteria for Impact Assessment	Significance of Impact	Duration of Impact	Mitigation Measure	Residual Impact
Regionally Important Aquifer	High	Small Adverse	Groundwater seepage/discharge from areas of overburden	Imperceptible	Permanent	Permanent drainage system in place to drain to the on-site drainage system.	Imperceptible
Regionally Important Aquifer	High	Small Adverse	Potential for contamination of aquifer due to on-site accidental spillages and surface runoff	Imperceptible	Short	Good operational practices are in place on-site to ensure that no contamination reaches groundwater. No materials will be stored within the inner protection area to the well. Drainage design will ensure suitable drainage on-site.	Imperceptible
Regionally Important Aquifer	High	Moderate Adverse	Significant increase to groundwater abstraction from the aquifer beneath the site from production well field and discharge of cooling water to the river. Potential moderate impact on the Dungourney River.	Moderate	Long	Implementation of long term automated monitoring programme of flow and water levels in production well field and Dungourney River, together with discharge water temperature assessment.	Slight
Regionally Important Aquifer	High	Moderate Adverse	Potential for effect on yield of existing groundwater abstraction wells surrounding the site within the groundwater body.	Moderate	Long	Monitoring programme on-site will assess potential long term drawdown effect across the site providing information on potential off-site resource impacts in the groundwater body.	Slight

**Table 11.15 - Impact Assessments – Construction phase**

Constraint			Construction Phase			
Name	Importance	Magnitude of Impact	Criteria for Impact Assessment	Significance of Impact	Mitigation Measure	Residual Impact
Perched Groundwater (Overburden)	Low	Small Adverse	Excavation in overburden material. Any perched groundwater in exposed soils will need to be drained.	Imperceptible	Dewatering where necessary to the on-site water treatment works or mill stream to ensure sufficient water quality prior to discharge to a surface watercourse.	Imperceptible
Regionally Important Aquifer	High	Small Adverse	Cut in weathered and potentially competent bedrock for fire water pond. Any groundwater in excavated bedrock will need to be drained.	Moderate/Slight	Dewatering where necessary to the on-site water treatment works or mill stream to ensure sufficient water quality prior to discharge to a surface watercourse.	Imperceptible
Regionally Important Aquifer	High	Small Adverse	In construction excavations. Potential for contamination of aquifer through accidental spillage during construction and rainfall runoff.	Imperceptible	Good construction practices will be put in place to ensure that no construction contamination reaches groundwater and suitable drainage is in place for the site. Fenced off area will be clearly marked and restricted during construction. No fuels will be stored within the inner protection area to the well	Imperceptible
Existing monitoring wells on-site	High	Large Adverse	Existing Wells including IPPC well GW2 in construction area	Profound/Significant	IPPC monitoring well to be replaced and existing wells in the development area to be decommissioned properly under EA or other guidance documents.	Imperceptible
Existing Cavern Supply on-site	High	Large Adverse	Construction works will be taking place upgradient of this groundwater abstraction supply.	Profound/Significant	Good construction practices will be put in place to ensure that no construction contamination reaches groundwater.	Moderate/slight

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## 12 Hydrology

### 12.1 Introduction

This chapter of the Environmental Impact Statement consists of an assessment of the proposed expansion of the production capacity of the Midleton Distillery site under the heading of hydrology. The chapter sets out the methodology that was used (Section 12.2), describes the existing hydrological environment including the proposed discharge condition (Section 12.3), details flood flow estimation (Section 12.4), describes the model selection including findings on the temperature and flood assessment (Section 12.5), the likely hydrological impacts associated with the increase of discharge water due to the proposed development (Section 12.6).

Chapter 6 of the EIS assesses the impact on Hydrology during the construction phase of the project and proposes mitigation measures.

Potential impacts in terms of stormwater drainage and runoff are assessed in Chapter 10 of the Water & Aqueous Emissions Chapter.

### 12.2 Methodology

#### Overview

A desktop study was undertaken on the Dungourney River catchment with particular focus on the hydrological features of the proposed development site. This consisted of Environmental Protection Agency (EPA) monitoring data, Water Framework Risk Assessment data, OPW gauging station records and historical flood databases, Environmental Designation Database and Soil mapping.

A hydraulic model has been developed for a section of the Dungourney River and its confluence with the Owennacurra River, which has been used to provide a suitably detailed assessment in terms of temperature impact and flooding.

Flood flow calculations are required for the Dungourney River at Midleton in order to assess the impact of the proposed site discharge during flood conditions. A brief review of the gauging station data at Buckley's Bridge showed that there is insufficient data to adopt for statistical analysis. As a result, standard flow estimation techniques for un-gauged catchments have been utilised and details are presented in Section 12.4.

#### Environmental Protection Agency Guidance

The Environmental Protection Agency (EPA) of Ireland outlines the process of preparation and the content required for an EIS in two guidance documents:

- *EPA Guidelines on the Information to be contained in Environmental Impact Statements, March 2002;*
- *EPA Advice Notes on Current Practice (in the preparation of Environmental Impact Statements) September 2003.*

The hydrological impact assessment process utilises the principles and guidance of both of these documents in conjunction with specific guidance to assess the potential impacts of the proposed development on the existing hydrological environment and provides a suite of mitigation measures to negate or minimise these potential impacts.

#### Literary Resource Review

Background information on the hydrological assessment and the Dungourney River catchment and its vulnerabilities and status was obtained from an array of documents and online references. References included the Environmental Protection Agency's (EPA) online Water Quality database and electronic mapping suites and a range of supplementary documents available from the South Western River Basin District Authority website (SWRBDA).

#### Consultation

Consultation was undertaken by the design team with the Inland Fisheries Ireland in relation to the proposed groundwater abstractions and process water discharge. The EPA were consulted with regard to the definition of the elevated temperature mixing zone in the river due to the process water discharge.

#### Legislation and Guidance

The following section describes the legislative context of the assessment in relation to surface water quality and quantity.

Water Framework Directive 2000/60/EC and SI 722 of 2003 European Communities (Water Policy) Regulations 2003 - 2005

The EU Water Framework Directive 2000/60/EC came into force on 22nd December 2000, and enacted into Irish legislation through SI 722 of 2003 European Communities (Water Policy) Regulations 2003. This legislation and regulation is a significant piece of legislation for water policy, as it provides a co-ordinated approach across Europe for all water policies, establishing a management structure for future water policy. A few key objectives of the Directive are to:

- *protect all waters, including rivers, lakes, groundwater, transitional and coastal waters;*

- *achieve "good status" in all waters by 2015, and maintaining "high status" where the status already exists*
- *have water management based on River Basin Districts (RBD)*

Under the Water Framework Directive 2000/60/EC, and SI 722 of 2003 European Communities (Water Policy) Regulations 2003, the water quality of River Basin Districts is assessed biologically, physically and chemically. Assessment using surveys is predominately conducted by the EPA and local authorities, and complemented by other government bodies including the Fisheries Board. Table 12.1 summarises the quality classes used to establish and monitor the condition of rivers and streams in Ireland.

**Table 12.1** - *River and Stream Water Quality Classes (Clabby et al., 2004; Clabby et al., 2005)*

Biotic Indices	Community Diversity	Quality Status	Condition
Q5	High	Good	Satisfactory
Q4	Reduced	Fair	Satisfactory
Q3	Low	Doubtful	Unsatisfactory
Q2	Very Low	Poor	Unsatisfactory
Q1	Little / None	Bad	Unsatisfactory

Where 'Condition' refers to the likelihood of interference with beneficial or potential beneficial uses. The intermediate values (Q1-2, 2-3, 3-4 etc.) below denote transitional conditions.

Biotic Indices	Quality Status	Quality Class
Q5, Q4-5, Q4	Unpolluted	Class A
Q3-4	Slightly polluted	Class B
Q3, Q2-3	Moderately polluted	Class C
Q2, Q1-2, Q1	Seriously polluted	Class D

Where biotic indices or Quality (Q) value indicates specified groups of macro-invertebrates sensitivity to pollution, with:

- Q5 = Mostly pollution sensitive, a few to numerous less pollution sensitive, a few pollution tolerant, and no very pollution tolerant or most pollution tolerant macro-invertebrate species

- Q4 = At least one pollution sensitive, few to numerous less pollution sensitive, numerous pollution tolerant, and a few or no very pollution tolerant or mostly tolerant macro-invertebrate species
- Q3 = No pollution sensitive, few or no less pollution sensitive, dominant in pollution tolerant, a few to common in very pollution tolerant, and few or no most pollution tolerant macro-invertebrate species
- Q2 = No pollution sensitive or less sensitive, few or no pollution tolerant, dominant in very pollution tolerant, and few to common in most pollution tolerant macro-invertebrate species
- Q1 = No pollution sensitive, less sensitive, and pollution tolerant, a few to no very pollution tolerant, and dominant in most pollution tolerant macro-invertebrate species

Where a toxic effect is apparent or suspected, the suffix 0 is added to the biotic indices, for example Q2/0.

Quality classes relate to the potential beneficial use of a water body, with:

- A = Highest water quality, suitable for abstraction, game fisheries, very high amenity value, orthophosphate ~ 0.015 mg P/L, dissolved oxygen close to 100%, maximum BOD is < 3mg/L
- B = Variable water quality, potential problems for abstraction, game fish at risk, considerable amenity value, orthophosphate ~ 0.045 mg P/L, dissolved oxygen <80% to >120%, maximum BOD is occasionally elevated
- C = Doubtful water quality, advanced treatment of abstracted water, coarse fisheries, reduced amenity value, orthophosphate ~ 0.070 mg P/L, dissolved oxygen is very unstable with potential fish kills, maximum BOD is high at times
- D = Poor to bad water quality, low grade to limited abstraction, fish usually absent, low or no amenity, orthophosphate >0.1 mg P/L, dissolved oxygen is low to zero, maximum BOD is usually high to very high

### EC Freshwater Fish Directive (2006/44/EC)

The EC Freshwater Fish Directive (2006/44/EC) was originally adopted on 18 July 1978 but consolidated in 2006. The Directive seeks to protect those fresh water bodies identified by Member States as waters suitable for sustaining fish populations. For those waters it sets physical and chemical water quality objectives for salmonid waters and cyprinid waters. The Directive will be repealed in 2013 by the EC Water Framework Directive.

The Freshwater Fish Directive requires that designated stretches of fresh water (rivers, lakes and reservoirs) meet standards that enable fish to live

and breed. The directive identifies two categories of water: those suitable for salmonid fish and those for cyprinid fish. It also distinguishes 'Imperative Standards', which must be met in order to comply with the directive, from 'Guideline Standards' which should be met 'where possible'. Table 12.2 shows the Imperative Standards for temperature. There are no Guideline Standards for temperature.

There is an additional (upper limit) temperature standard of 10°C for salmonid waters during the spawning season. This seeks to protect species that need cold water for reproduction. A provision is also made that sudden variations in temperature should be avoided. A key aspect of the standards for temperature is that they apply where there are thermal discharges, and they are not used generally in assessing all waters.

**Table 12.2 - Details of Temperature mixing estimation**

Imperative Standards from the Freshwater Fish Directive		
1	The temperature measured downstream of a point of thermal discharge (at the edge of the mixing zone)* must not exceed the unaffected temperature by more than the following:  Salmonid: 1.5°C Cyprinid: 3°C	Caveat: sudden variations in temperature should be avoided
2	The following temperature should not be exceeded at the edge of the mixing zone, for more than 2% of the time:  Salmonid: 21.5°C Cyprinid: 28°C	Caveat: species that require cold water for reproduction are protected by an upper limit of 10°C during breeding season

\*The definition of the mixing zone, based on indicative guidance received from the EPA, is that elevated temperatures of greater than 1.5 °C degrees or above 21.5 °C should not extend beyond 25% of the river channel width or length. (US EPA Clean Water Act 1972).

### European Communities Environmental Objectives (Surface Waters) Regulations 2009

These regulations have been devised as a more complete and stringent set of surface water quality regulations which covers the requirements of the Water Framework Directive and the Dangerous Substances Directive. These regulations have been adopted by the Government and came into force on the 30th July 2009.

### SI 293 of 1988 European Communities (Quality of Salmonid Waters) Regulations 1988

The Salmonid Regulations set water quality standards for salmonid waters, with identification of salmonid waters, water quality standards, and frequencies of sampling and methods of analysis and inspection.

### Local Government (Water Pollution) Acts 1977 - 1990

The Act is the main legislation for the prevention and control of water pollution, including the general prohibition of polluting matter to waters, licensing discharges, fines and prosecution, water quality standards and management plans.

### SI 258 of 1998 Water Quality Standards for Phosphorus Regulations 1998

As part of the Water Pollution Acts, these regulations require water quality to be maintained or improved, with reference to the biological quality river rating system as assigned by the Environmental Protection Agency between 1995 to 1997.

## 12.3 Existing Environment

### Introduction

The IDL site is located to the north east of the town of Midleton and the Dungourney River forms part of the south eastern site boundary. Please refer to Figures 1.1 and 1.2 of Chapter 1 for a site location plan.

### Characteristics of the Proposal

The proposed development entails expanding the existing process plant. The expansion consists of new fermenters, still house and tankfarms together with a new fire water retention pond, water treatment plant and waste water treatment plant. Please refer to Figure 1.4 of Chapter 1 for a proposed development layout.

The existing water supply for cooling and process demand on the site is provided by a combination of surface water from the Dungourney River and groundwater. The surface water is primarily used in the process system and requires approximately a supply of 1,500m<sup>3</sup>/day while groundwater is used in the cooling system and requires a supply of 2,000 to 3,000 m<sup>3</sup>/day. The proposed expansion entails an increase in the abstraction, leading to a discharge of approximately 4,020m<sup>3</sup>/day and it is this increase in the proposed coolant water discharge that has the potential to impact on the existing water quality and flood characteristics of the Dungourney River.

### Hydrological Catchment

The Dungourney River is the most significant tributary of the Owennacurra River and has a catchment area of 52 km<sup>2</sup>. The annual average rainfall for the river catchment is 1,116mm. The Dungourney

River rises north of Ardglass, has a main river length of approximately 18km and joins the Owennacurra River at Midleton. Both rivers flow through undulating landscape with narrow river valleys in the upper catchment opening out to a floodplain towards the town of Midleton. The ground levels vary in the catchment from 244mAOD in the northeast of the catchment to approximately 5mAOD in the area where the river joins the Owennacurra Estuary at Cork Harbour. The upper reaches of the Dungourney River have been identified as very good salmonid spawning and as a nursery habitat. The Dungourney River joins the Owennacurra River approximately 500m downstream from the IDL site and the tidal section of the Owennacurra River Estuary is classified as a Special Area of Conservation (SAC). More information on the SAC classification can be found in Chapter 13 Ecology.

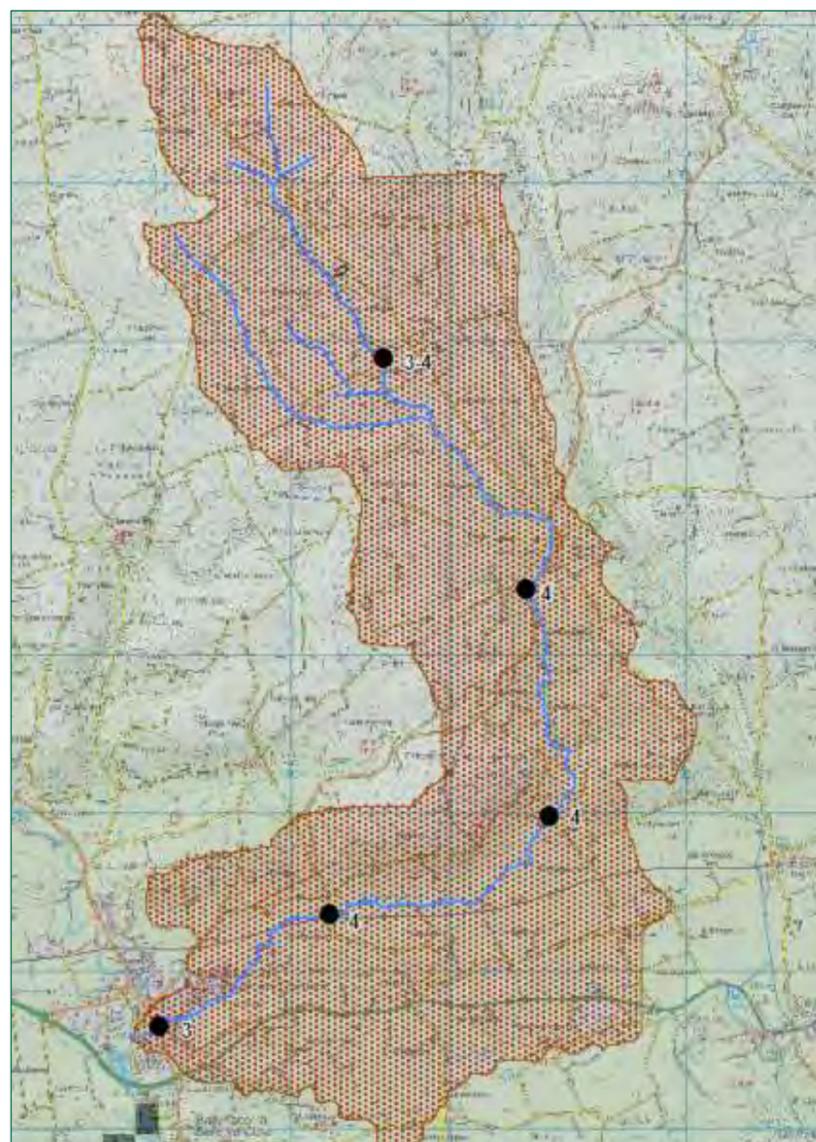


Figure 12.1 - Dungourney Catchment showing latest EPA water quality rating (see Table 12.3)

The Winter Rainfall Acceptance Potential (WRAP) classification provides information on the runoff potential for any site in the UK & Ireland and this is based on a theoretical consideration of soil hydrological processes and makes use of four main soil and site properties. According to the Flood Studies Report 1975 (NERC, 1975) the subject site is classified as WRAP type 2, which is considered as a High WRAP with little runoff in the existing condition and this would also be expected considering the vegetative cover and soil characteristics. Please refer to Chapter 9 on Soils/Geology for more information on the geology of the site and Chapter 11 Hydrogeology for more information on the hydrogeological details of the site.

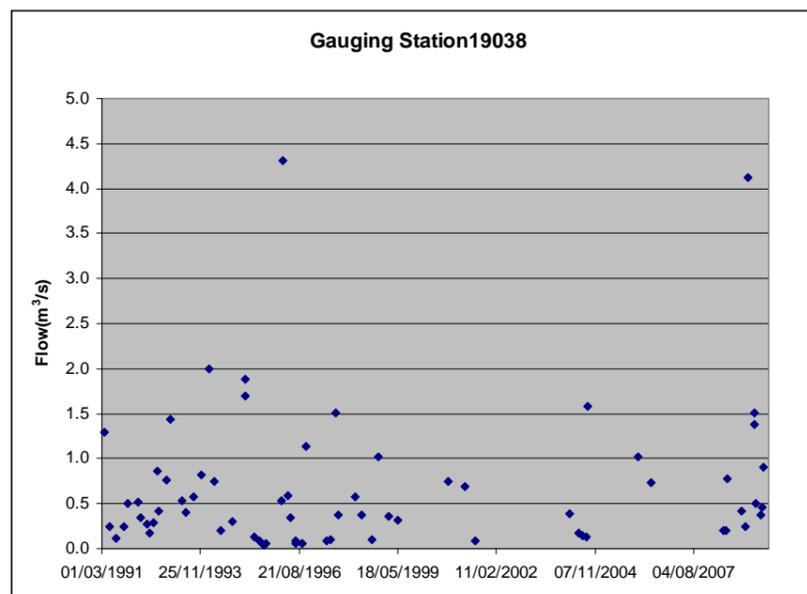
### Abstractions & Licensed Facilities

According to the online EPA database, there is one water abstraction within the Dungourney River catchment, which is an active IPPC license, granted to Irish Distillers in Midleton for commercial distilling. The license has been in operation since 1999. Groundwater abstractions are outlined in Chapter 11 - Hydrogeology Section 3.

### Hydrometric Monitoring

There are two hydrometric stations in the Dungourney Catchment, 19038 and 19005. Station 19038 is located at Dungourney and is being maintained by Cork County Council and the EPA undertakes data collection and flow measurements. It is a staff gauge and spot measurements are presented in Figure 12.2.

Figure 12.2 - Gauging Station data at Dungourney

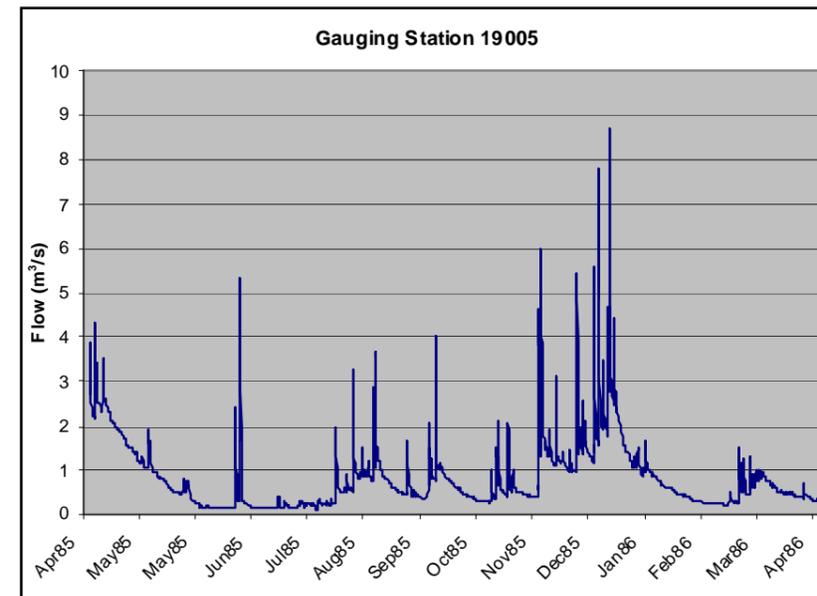


Station 19005 at Buckley's Bridge (Midleton) was owned by Irish Distillers Ltd and continuous water level recordings were available from June 1975 until May 1986. There were some major problems with the stability of the site in terms of developing a rating curve and a timber weir was installed

on 25th Sep 1980, which improved the calibration. Flow data has been processed from 25th Sep 1980 until recording ceased on 30/04/1986.

A mill race bypasses the station, however it is mostly dry and is not thought to affect flow estimates significantly. Irish Distillers abstracts water from the Dungourney River in the vicinity of the gauging station and use part of the mill race to discharge cooling water before it rejoins the river downstream of the site. Figure 12.3 provides the data available for station 19005.

Figure 12.3 - Gauging Station data at Buckley's Bridge



### Baseline Monitoring

Temperature and water level monitoring was undertaken of the cooling water discharge and the Dungourney river at a number of locations in September and early October 2011 including: (1) the discharge pipe on the IDL site near where it meets the Mill Race, (2) at the point where the Mill Race meets the river, (3) at the Mill Race just before it joins the river and (4) at up stream and (5) down stream locations from the discharge point. This monitoring was completed for a period of time when the river had moderately low flows measured at 342 l/s, (which is above 95%-ile conditions). The results indicated that the pipe temperature had dropped by about 1.5 °C to 2.5 °C in the old mill race before it discharged to the river. The upstream and down stream monitoring indicated that overall river temperatures were not elevated above 1.5 °C above background at a midstream location about 100m downstream of the discharge. Refer to Graph 1 in the Appendix.

Water level monitoring of the discharge pipe, mill race and river locations upstream and downstream of the discharge over the same period as the temperature monitoring indicates a consistent discharge of water from the IDL site as well as a consistent water level up steam, as there were no rainfall events. The down stream monitoring confirmed the tidal influence

to within 100m of the discharge with water level rises of up to 60cm recorded over the spring tide period. Refer to Graph 2 in Appendix.

Initial monitoring of temperature across the river width in the area immediately at and down stream of the mill race discharge identified that the warmer water stays close to the right bank (as you look down river) as the water flows downstream. With a discharge temperature of 20.5°C entering the river, which had a background temperature of 13.5 °C, elevated temperatures were only evident within about a metre of the bank. Initial temperatures of 18 to 19 °C five metres down stream had reduced to 14.75 to 16 °C after 20m. Refer to Figure 12.4.

Preliminary monitoring of Dissolved Oxygen (DO) in the mill race before it entered the river indicated DO levels of about 60% saturation with the water of about 20.5 °C and at ~83% saturation in the river with a temperature of about 13.5 °C. No discernable impact of the discharged DO level was evident in the river. Refer to Figure 12.5.

Spot flow and water quality monitoring was undertaken in the vicinity of the proposed discharge location as part of the baseline data gathering assessment for the existing hydrological environment. Spot flow monitoring was undertaken on five occasions from April to May 2011 and flows ranged from 0.3 to 0.42 m³/s.

Water quality sampling was carried out in situ and measurements included the following;

**Field Measurements** (Temperature, pH, Electrical Conductivity)

**Microbiological Parameters**<sup>1</sup> (Total Coliform Count, Escherichia Coli Count, Clostridium Perfringens, Enterococci)

**Chemical Parameters**<sup>2</sup> (Total Alkalinity, Colour (Apparent), Colour (True), Hardness, Total Iron, Total Manganese, pH, Total Dissolved Solids, Total Organic Carbon, Turbidity, Aluminium, Ammoniacal Nitrogen as N, Ammonium, Antimony, Bromide, Dissolved Calcium, Chloride, Conductivity, Dissolved Organic Carbon, Dissolved Iron, Magnesium, Dissolved Manganese, Nickel, Nitrate, Nitrite, Phosphorus, Sodium, Sulphate, Sulphite, Total Suspended Solids)

It should be noted that the proposed development will not entail discharge of any chemical or biological pollutants and that the only potential impact on the hydrological environment is associated with the increased discharge rate of warm water.

The baseline monitoring provides detailed information about the physical-chemical characteristics of the Dungourney River at the proposed discharge location and findings are presented in the following section.

<sup>1</sup> Analysed in accredited Laboratory  
<sup>2</sup> Analysed in accredited Laboratory

### River Water Quality

Water quality of rivers in Ireland is assessed by the EPA using biological and physicochemical data. Physicochemical monitoring measures the causes of pollution and the quantity of pollutants while biological monitoring measures the effects of pollution on the ecological status of the water body.

The Q-value system describes the relationship between water quality and the macroinvertebrate community in numerical terms. Q5 waters have high diversity of macroinvertebrates and good water quality, while Q1 have little or no macroinvertebrate diversity and bad water quality. Intermediate values, Q1-2, 2-3, 3-4 etc denote transitional conditions. Please refer to Table 12.1 for definition of the Q-values.

The EPA currently operates five water quality monitoring points in the Dungourney River catchment. The proposed development is located in the lower reaches of the Dungourney River and all five EPA water quality monitoring points have been included in this assessment – results of which are detailed in Table 12.3.

**Table 12.3 - Dungourney River Biological Quality Ratings (Clabby et al., 2006)**

Biological Quality Rating (Q Value)						
Reference	EPA WQMP Location	Year				
		1994	1997	2003	2005	2008
WQ-01	Br SW of Rathorgan	4	4	4	3-4	4
WQ-02	Br d/s Dungourney	4	4-5	4	4	
WQ-03	Br at Ballynascary	4	4-5	4-5	4	4
WQ-04	Br E of Killeagh House	4	4	4	4	
WQ-05	Br in Midleton	4	4	3	3	3

The most recent EPA assessment of the Dungourney River in 2008 reported that the river was unpolluted along its middle and upper reaches and moderately polluted along its lower reaches. Anthropogenic influences in the town of Midleton are thought to be the cause for the deterioration in water quality at WQ-05, which is located at the bridge in Midleton.

Biological Water quality assessment of the Dungourney River completed by WYG in 2009 identified that water quality immediately upstream of IDL facility had a Q3 rating. It was concluded that the deterioration of the

water quality from the middle to the lower reaches up stream of IDL and Midleton town was due to diffuse pollution from agricultural activity along the river.

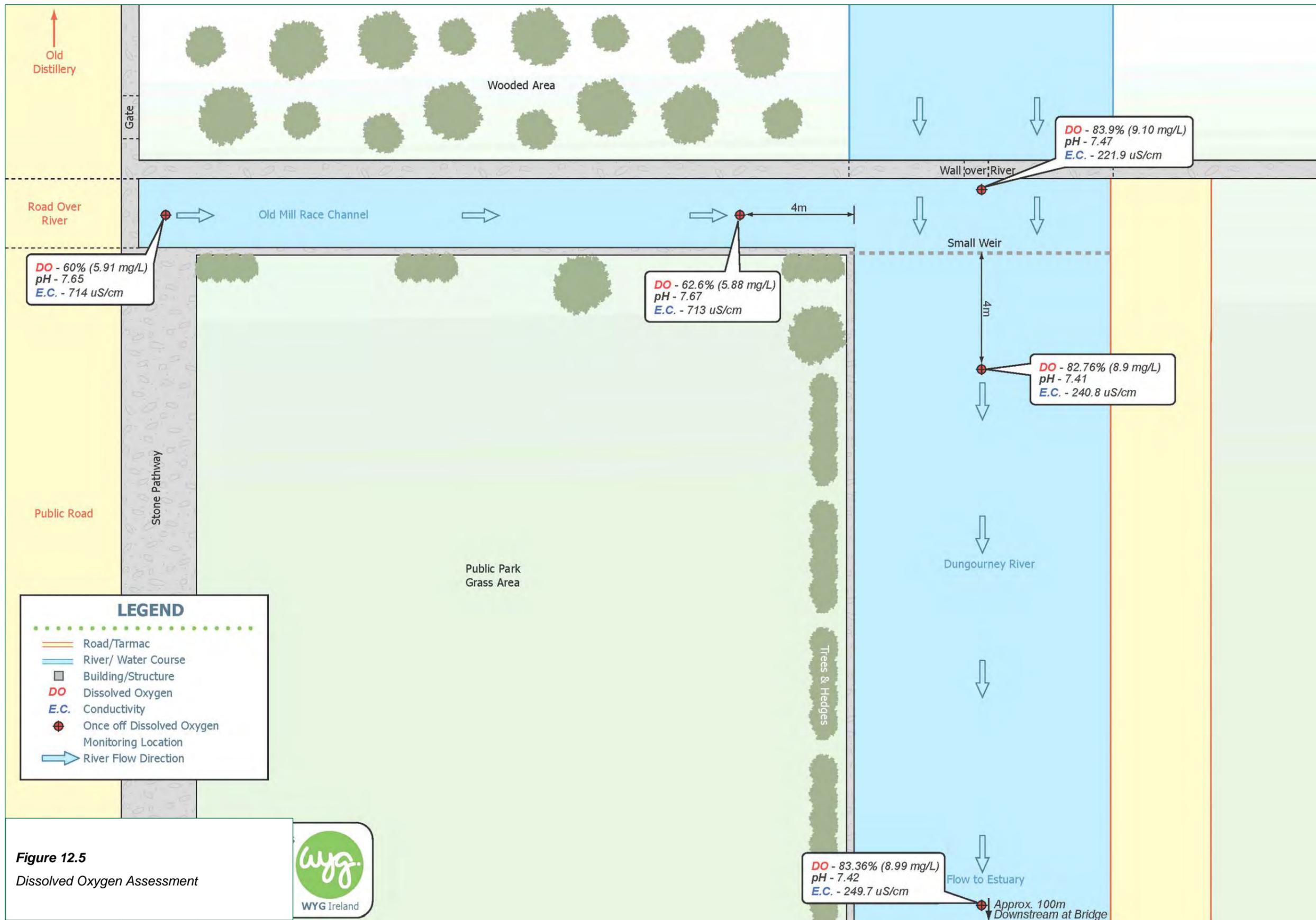
Table 12.4 presents details of the baseline monitoring results for physicochemical parameters. The water quality of the Dungourney River can be described from this sampling suite as in moderate condition with some influence from the surrounding land practices and some human impact. Nutrient parameters assessed indicate good water quality with relatively low levels of phosphate and nitrate. The elevated microbiological sampling results however suggest anthropogenic impact potentially due to farming activities or other human influences and this is confirmed by the WFD assessment, which classifies the Dungourney River as being of poor status at Midleton.

The WFD plan does not mention the Dungourney River directly but the Dungourney River is assessed as a tributary to the Owennaccura River. The vulnerability status is as a result of pressures identified in the catchment relating to agriculture and potential expansion of urban development. The groundwater vulnerability within the Dungourney River catchment is in a slightly better position and has been classified as being of good status. Further information on the groundwater assessment can be found in Chapter 11 - Hydrogeology.



**Figure 12.4**  
River Temperature Assessment





**Figure 12.5**  
Dissolved Oxygen Assessment



Table 12.4 - Physio-chemical analysis results - Dungourney River

PARAMETER	UNITS	7 <sup>th</sup> Mar 2011	8 <sup>th</sup> Mar 2011	9 <sup>th</sup> Mar 2011	10 <sup>th</sup> Mar 2011	11 <sup>th</sup> Mar 2011	Drinking Water Standards S.I. No. 278 of 2007
<b>FIELD MEASURED PARAMETERS</b>							
pH	pH units	6.54	8.15	6.93	7.58	8	6.5 - 9.5
Electrical Conductivity	µS/cm	323	325	356	332	344	2,500
Temperature	°C	8.70	8.30	8.20	9.10	9	-
<b>MICROBIOLOGICAL</b>							
Total Coliform Count	mpn/100ml	-	-	<b>1553</b>	-	<b>866</b>	0
Escherichia Coli Count	mpn/100ml	-	-	<b>172</b>	-	<b>98</b>	0
Clostridium Perfingens	cfu/100ml	-	-	<b>8</b>	-	<b>22</b>	0
Enterococci (intestinal)	cfu/100ml	-	-	<b>38</b>	-	<b>37</b>	0
<b>CHEMICAL PARAMETERS (5 Consecutive Days)</b>							
Total Alkalinity	mg/l Ca CO <sub>3</sub>	92	135	84	151	90	-
Colour (Apparent)	PCU	<15	<15	<15	<15	<15	Acceptable to consumers & No Abnormal Change
Colour (True)	PCU	<15	<15	<15	<15	<15	-
Hardness	mg/l	121	114	117	118	120	200*
Total Iron	ug/l	88	<20	38	36	22	-
Total Manganese	ug/l	34	<2	6	5	7	-
pH	-	7.49	8.12	8.24	8.13	7.95	6.5 - 9.5
Total Dissolved Solids	mg/l	<35	217	217	267	218	-
Total Organic Carbon	mg/l	6	6	6	6	7	-
Turbidity	NTU	1.6	0.6	0.6	0.7	0.8	-
<b>CHEMICAL PARAMETERS (3 out of 5 days)</b>							
Aluminium	ug/l	-	23	-	<20	<20	200
Ammoniacal Nitrogen as N	mg/l	-	<0.03	-	<0.03	0.02	-
Ammonium	mg/l	-	<0.03	-	<0.03	0.03	0.3
Antimony	ug/l	-	<2	-	<2	<2	5
Bromide	mg/l	-	0.19	-	0.19	0.53	-
Dissolved Calcium	mg/l	-	36.3	-	37.5	38.3	200
Chloride	mg/l Cl	-	28.1	-	28.1	28.5	250
Conductivity	µS/cm	-	330	-	318	337	2,500
Dissolved Organic Carbon	mg/l	-	6	-	6	6	-
Dissolved Iron	ug/l	-	<20	-	<20	<20	200
Magnesium	mg/l	-	5.6	-	5.8	5.8	50
Dissolved Manganese	ug/l	-	<2	-	2	3	50
Nickel	ug/l	-	<2	-	<2	<2	20
Nitrate as NO <sub>3</sub>	mg/l NO <sub>3</sub>	-	19.8	-	5.9	12.0	50
Nitrite as NO <sub>2</sub>	mg/l NO <sub>2</sub>	-	<0.02	-	<0.02	<0.02	0.5
Phosphorus	ug/l	-	<5	-	5.0	12.0	-
Sodium	mg/l	-	14.8	-	15.2	15.5	200
Sulphate	mg/l SO <sub>4</sub>	-	19.84	-	5.90	11.39	250
Sulphite	mg/l	-	<0.5	<0.5	<0.5	<0.5	250
Total Suspended Solids	mg/l	-	<10	-	<10	<10	-
*EPA Interim Guideline Value							
Results are in bold where they exceed their relative EPA parametric value							
"- " = not analysed							

## 12.4 Flood Flow Estimation

A number of typical flood flow estimation techniques have been applied in the absence of suitable gauging station records and details are presented in the following subsections.

### FSR - Traditional Methods

The Flood Study Report (FSR) techniques are the most widely used flow estimation methods in Ireland and the FSR six-variable equation as well as the FSR Unit Hydrograph approach were used in comparison to the Institute of Hydrology (IH124) Method.

### FSR Six-Variable Equation (1975)

The FSR six-variable catchment characteristic regression equation for Ireland to estimate the mean annual maximum flood is as follows:

$$QBAR = C \text{ AREA}^{0.95} FS^{0.22} SOIL^{1.18} SAAR^{1.05} S^{1085} L^{0.16} (1+LAKE)^{-0.93}$$

where the multiplier C = 0.00042 for Ireland.

AREA is the catchment area (km<sup>2</sup>).

FS (stream frequency) is the number of stream junctions per km<sup>2</sup> on a 1:25,000 scale map.

S<sup>1085</sup> is the slope of the main channel between 10% and 85% of its length measured from the catchment outlet (m/km).

SAAR is long-term mean annual rainfall amount in mm

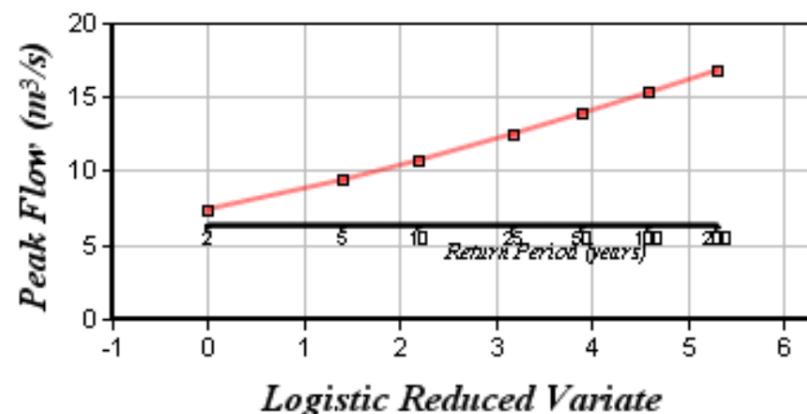
SOIL is an index of how the soil may accept infiltration and is a measure of the Winter Rainfall Acceptance Potential (WRAP). The index is based on only five classifications (very high, high, moderate, low and very low WRAP) and the mapping scale and number of categories are regarded as providing a very coarse measure of catchment runoff potential.

LAKE is an index defined as the fraction of catchment draining through lakes or reservoirs and the areas contributing to lakes whose surface area exceeds 1% of the contributing area is recorded.

The FSR equation has a standard factorial error of 1.456

Figure 12.6 provides the flood frequency curve using the FSR 6-variable equation at the IDL site.

Figure 12.6 - FSR Statistical Method - Flood Frequency Curve



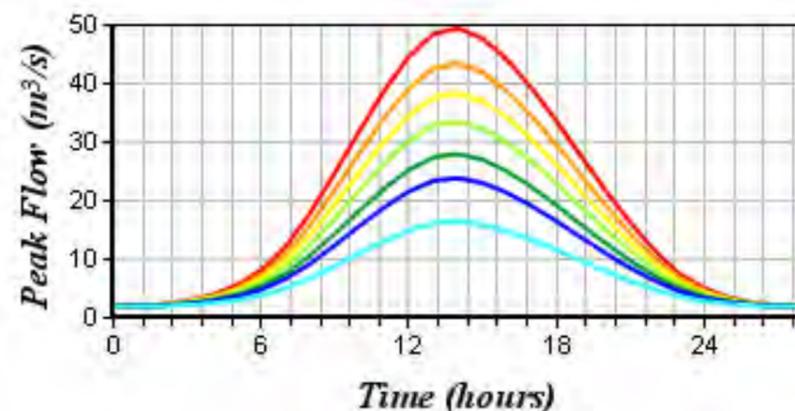
**Rainfall Runoff (Unit Hydrograph)**

The unit hydrograph method estimates the design flood hydrograph, describing the timing and magnitude of flood peak and flood volume. The method requires the catchment response characteristics, design rainstorm characteristics and runoff / loss characteristics to be input.

The instantaneous triangular unit hydrograph is defined by a time to peak,  $T_p$ , a peak flow in cumecs/100 km<sup>2</sup>,  $Q_p = 220/T_p$ , and a base length  $T_B = 2.52T_p$ . The rainstorm profile used in this analysis is the FSR 75% Winter Profile for Ireland.

The unit hydrograph describes the theoretical response of the catchment to an input of a unit depth of rainfall over a unit of time. Figure 12.7 provides results from the FSR RR method at the IDL site.

Figure 12.7 - FSR Rainfall-Runoff Method Hydrograph



**Institute of Hydrology Report No. 124**

$$Q_{bar} = 0.00108 \times A^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$$

Where:

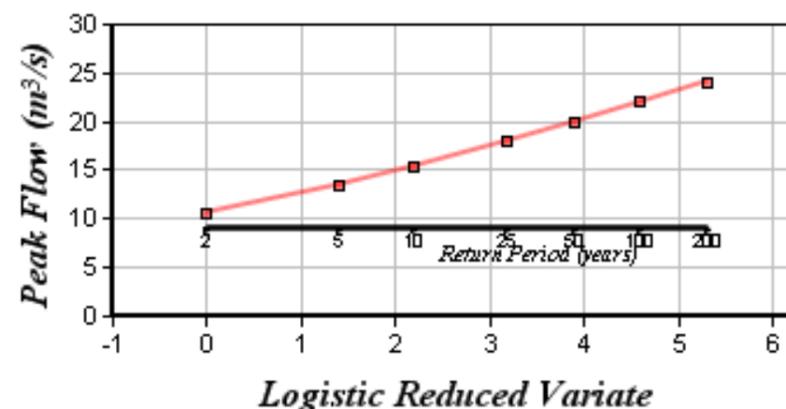
A is the catchment area

SAAR is the standard annual rainfall

SOIL is the soil index

Figure 12.8 provides the flood frequency curve using the IH124 method at the IDL site.

Figure 12.8 - IH 124 Method- Flood Frequency Curve



**Gauging Station Data 19005**

Gauging station 19005 is located on the Dungourney River in close proximity to the proposed discharge point. While the record length does not lend itself to derive design flood flow estimates, annual maximum records can be used as a comparison with the 2 year return period flows.

The annual maximum series have been extracted from record length at gauging station 19005 and the results are presented in Table 12.5.

Table 12.5 - Annual Maximum Series Gauging Station 19005

Year	Annual Maximum (m³/s)
1981	3.857
1982	5.746
1983	7.547
1984	5.041
1985	6.117
1986	8.907
1987	8.722

The annual maximum record varies between 3.9 and 8.9 m<sup>3</sup>/s with an average of 6.6 m<sup>3</sup>/s and this is similar to the FSR 6-variable 2 year return period flow, providing some confidence in the flow estimation.

**Catchment Descriptors and Results Comparison**

Table 12.6 presents the catchment characteristic parameters that were used for the different flood flow estimation methods. Figure 12.9 and Table 12.7 present a comparison of the results, showing that the Rainfall Runoff methods would result in the most conservative flood flow estimation.

The IH124 and FSR 6 would typically be applied and have been tested in the hydraulic model for the existing and proposed condition. The model development is described in Section 12.5 and modelling results are presented here.

Table 12.6 - Catchment characteristic parameters

	Parameter	At IDL Site
FSR 6	MSL (km)	18.85
	M5-1Day (mm)	55.41
	Time To Peak (hours)	5.859
	Timestep (hours)	1
	Storm Duration (hours)	13
	ARF (hours)	0.943
	SMDBAR (mm)	7
	RSMD (mm)	45.25163
	RSMD Source	Calculated
	Stream Frequency (Junctions/km <sup>2</sup> )	0.23
	Stream Slope (S1085) (m/km)	9.2
	SOIL	0.3
	LAKE	0
IH 124	SOIL	0.3
	AREA (km <sup>2</sup> )	51.1
	SAAR (mm)	1135
FSR RR	Qbar (m <sup>3</sup> /s)	11.249
	AREA (km <sup>2</sup> )	20.62
	RSMD	50.79
	SOIL	0.3
FSR RR	FN	1
	Qbar (m <sup>3</sup> /s)	7.30

Figure 12.9 - Comparison of Method - Flood Frequency Curve

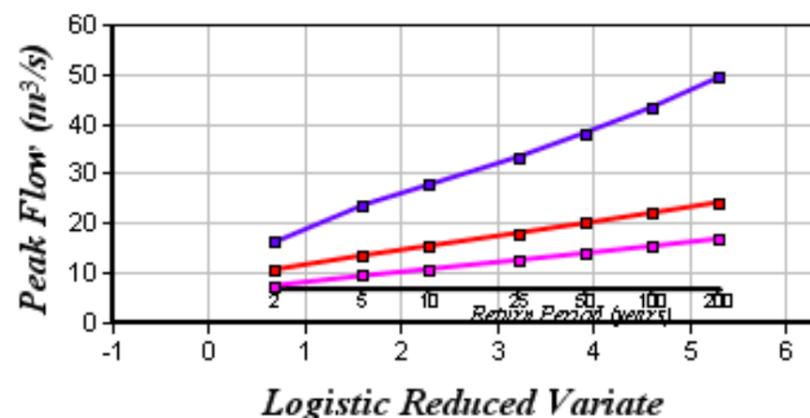


Table 12.7 - Comparison of Method - Peak Flows

Return Period	IH124	FSR Stat	FSR RR
	m³/s	m³/s	m³/s
2	10.66	7.42	16.23
5	13.47	9.37	23.65
10	15.41	10.73	27.78
25	17.98	12.51	33.30
50	19.97	13.89	38.15
100	22.01	15.31	43.27
200	24.11	16.78	49.00

### 12.5 Model Selection

HEC-RAS is an integrated software solution for simulating flows in rivers, channels and floodplains. HEC-RAS implements a one-dimensional model of river flow (depth and width averaged) and can solve for water elevation under steady conditions and in the most recent version gradually varying unsteady flows solving the full Saint Venant equations. HEC-RAS takes account of the conveyance and storage effects of floodplains in a one-dimensional manner only (i.e. in the longitudinal direction of flow). It does not resolve the possibly complex two-dimensional aspects of floodplain flow or secondary flow caused by a structure.

It is designed by the US Army Corps of Engineers and performs one-dimensional hydraulic calculations for a full network of natural and constructed channels. The software includes full solution modelling of open channels, floodplains, embankments and hydraulic structures and provides a water quality module to undertake impact assessment at of point discharge.

It should be noted that HEC-RAS provides flow and water quality analysis for the one dimensional environment and assumes full mixing

across the cross section width. As a result, the modelling output is provided for each cross section with no distinction of the 2nd (y direction) or 3rd (z-direction) dimension. No information is given on temperature variation across the stream but given the relative size of the discharge and river flow this is only likely to be significant in the immediate vicinity of the discharge.

### Model Input

The following information outlines the model input data:

- topographical river section survey by Murphy Survey (11.10.2011) of a section of the Dungourney River and Owennacurra River to enable hydraulic model development. This model covers a river length of approximately 1km and includes three river crossings. The survey data is provided in Appendix A;
- model layout map is shown as shown in Appendix B;
- upstream flow boundary conditions representing the recorded daily mean flow and low flow condition (95%-ile flow) as taken from gauging station data and assessed by the Environmental Protection Agency;
- downstream boundary condition, taken as normal depth boundary and set according to the river slope;
- channel and flood plain roughness coefficients were set to typical values of 0.04 and 0.06, respectively;
- arbitrary constant river temperature of 4°C as initial conditions for winter profile and 18 °C for the summer profile;
- proposed discharge flow of 4,020 m³/day at 23°C during summer condition and 22°C during winter condition;
- existing discharge flow at the river, allowing for ~12% loss through evaporation and percolation to ground along the Mill Race, of 2,246 m³/day at 23°C during summer condition and 22°C during winter condition;
- the dispersion coefficient was calculated by HEC-RAS to be approximately ranging from 0.04 m²/s for the Dungourney River and up to 60 m²/s for the Owennacurra River, based on the shear velocity, river width and depth
- arbitrary hourly hydrometric data were applied for winter and summer conditions for the following parameters:
  - o Air Temperature
  - o Humidity
  - o Sun wave Radiation
  - o Wind Speed

### Model Set-Up

A baseline model run was set up for the daily mean flow profile (DMF) and the low flow profile (95%- ile flow). Modelling results for the existing condition and proposed condition were obtained out and compared to the baseline condition (without site discharge). The section below provides an overview of the modelling runs.

Table 12.8 - Model Run Overview

Run	River Profile			Name	Discharge Profile			Season
	River Flow Dungourney (m³/s)	River Flow Owennacurra (m³/s)	Water Temp °C		Discharge Rate (l/s)	Water Temp °C	Name	
1	1.135	3.5	4	DMF	26	22	Existing	Winter
2	1.135	3.5	4	DMF	46.5	22	Proposed	Winter
3	1.135	3.5	4	DMF	0	NA	Baseline	Winter
4	1.135	3.5	18	DMF	26	23	Existing	Summer
5	1.135	3.5	18	DMF	46.5	23	Proposed	Summer
6	1.135	3.5	18	DMF	0	NA	Proposed	Summer
7	0.06	0.135	18	Q95	26	23	Existing	Summer
8	0.06	0.135	18	Q95	46.5	23	Proposed	Summer
9	0.06	0.135	18	Q95	0	NA	Baseline	Summer
13	0.06	0.135	18	Q95	46.5	19	Optioneering	Summer
14	0.06	0.135	18	Q95	46.5	20	Optioneering	Summer
15	0.06	0.135	18	Q95	46.5	21	Optioneering	Summer
16	0.06	0.135	18	Q95	46.5	21.5	Optioneering	Summer

### Model Results - Water Temperature

The existing water discharge from the IDL site to the Old Mill race is 2,560 m³/day, however flow monitoring at the point where it enters the river indicates potential loss of flow due to evaporation and percolation to ground, is calculated at 2,246 m³/day which is equivalent to 26 litres per second. The Dungourney River, during low flow conditions (95%-ile flow) is 60 litres per second providing a dilution factor of just over two. It would therefore be expected that the coolant water would result in some temperature rise of the Dungourney River.

The worst case condition in terms of absolute temperature and temperature rise is during the summer when low flow conditions typically occur and this is assessed using Model Runs 7, 8 and 9. The edge of the mixing zone is defined as the location where the increase in water temperature has dropped to a maximum of 1.5°C (see Table 12. 2) and this is achieved at the confluence with the Owennacurra River, 500m downstream from the discharge point, as the additional flow from Owennacurra River results in an immediate assimilation of the elevated river temperature. (Note that potential tidal effects in the Dungourney River to about 80m downstream of the discharge location have not been considered in the model).

Figure 12.10 presents the time series plot at the discharge point from the IDL site. Results show that the water temperature of the river displays a diurnal pattern that is strongly influenced by the hydrometric data input and particularly the sun wave radiation. The increase in water temperature due to the existing discharge ranges up to 1.5 °C during the worst case condition. The additional discharge flow would result in an

increase of up to 2.2 °C (i.e. a rise of 0.7°C compared to existing worst case).

Figure 12.11 shows a spatial profile plot of Run 7, 8 and 9, 6 days after the start of coolant water discharge. Results show that the increase in water temperature is maintained over the 500m of river length along the Dungourney and reduces to its background temperature at the confluence with the Owennacurra, (not accounting for tidal influences).

Results also show a very similar temperature profile of the proposed condition in comparison to the existing condition during daily mean flow with a slight increase due to the proposed water discharge (Figure 12.12 and Figure 12.13). The average increase in water temperature during winter and summer condition is predicted to be 0.3°C and 0.8°C, respectively. The maximum increase in water temperature during winter and summer condition is predicted to be 0.32 °C and 0.9°C, respectively.

Appendix C presents results of the remaining model runs. In addition to the modelling results presented in this report, a number of sensitivity tests were carried out to provide confidence in the modelling predictions and this consisted of increasing the proposed discharge flow rate and varying the model parameters, such as the dispersion coefficient, model time step and water quality cell lengths. The current discharge rate from the Mill Race to the river is estimated at 2,246 m<sup>3</sup> per day, which is equivalent to 26l/s.

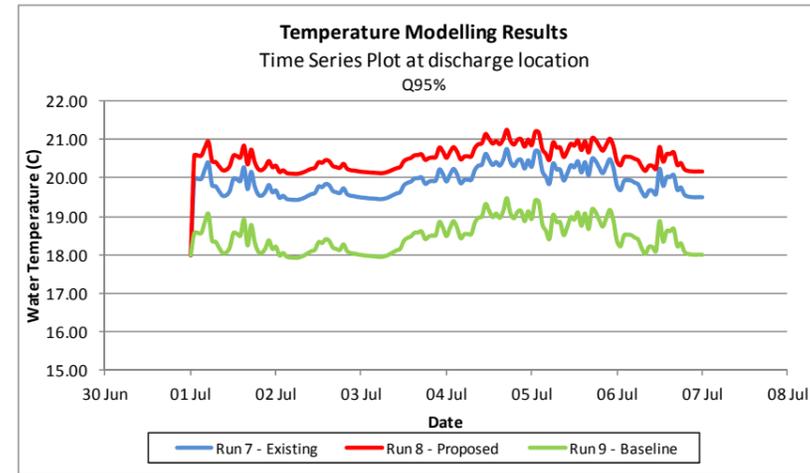
Calculations were also completed for the low flow (95%-ile) and dry weather flow (DWF) (98%-ile) conditions as outlined in Table 12.9. These results indicate temperatures over 1.5 °C above an 18 °C background temperature for discharge temperatures >21.5 °C during low flow conditions and >19.5 °C during DWF. Note that these low flow conditions would be 1 in 20 to 1 in 50 year events.

**Table 12.9 - Extreme Low Flow and Dry Weather Flow (DWF) Conditions Overview**

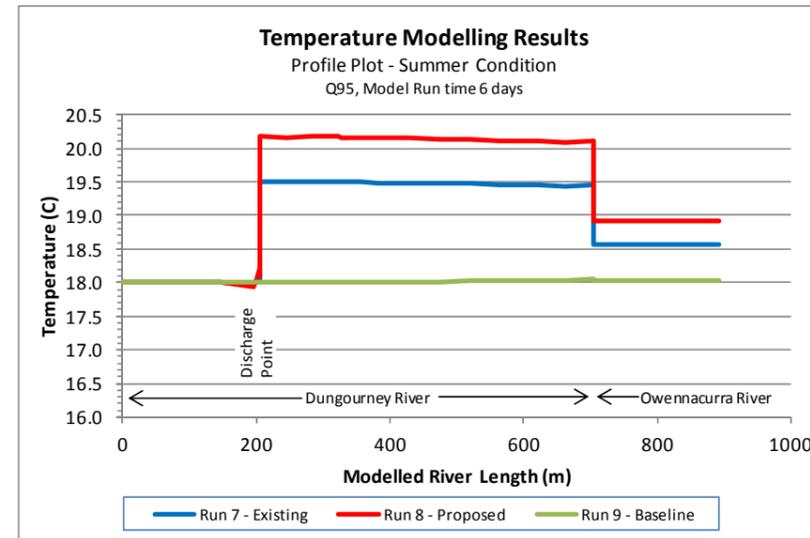
Name	River Profile			Discharge Profile		Impact Assessment	
	River Flow Dungourney	River Flow Owennacurra	Water Temp	Discharge Rate	Water Temp	Temperature at Discharge Point	Temperature at Confluence with Owennacurra
(-)	(m <sup>3</sup> /s)	(m <sup>3</sup> /s)	°C	(l/s)	°C	°C	°C
Existing, Q95	0.06	0.135	18	26	23	19.5	18.6
Proposed, Q95	0.06	0.135	18	46.5	23	20.1	18.9
Baseline, Q95	0.06	0.135	18	0	NA	18	18
Existing, DWF	0.03	0.108	18	26	23	20.32	18.8
Proposed, DWF	0.03	0.108	18	46.5	23	21.04	19.3
Baseline, DWF	0.03	0.108	18	0	NA	18	18
Optioneering, Q95	0.06	0.135	18	46.5	19	18.4	18.2
Optioneering, Q95	0.06	0.135	18	46.5	20	18.9	18.4
Optioneering, Q95	0.06	0.135	18	46.5	21	19.3	18.6
Optioneering, Q95	0.06	0.135	18	46.5	21.5	19.5	18.7
Optioneering, DWF	0.03	0.108	18	46.5	19	18.9	18.3
Optioneering, DWF	0.03	0.108	18	46.5	20	19.9	18.5
Optioneering, DWF	0.03	0.108	18	46.5	21	20.8	18.8
Optioneering, DWF	0.03	0.108	18	46.5	21.5	21.3	18.9

Note: Temperature results for DWF is estimated based on mass balance calculation only.

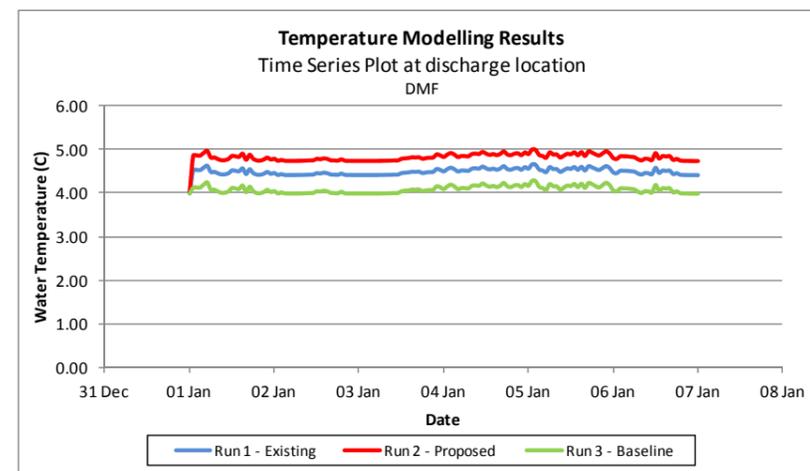
**Figure 12.10 - Time Series Plot downstream of discharge point, Section 0.528 - low flow (Run 7 - 9)**



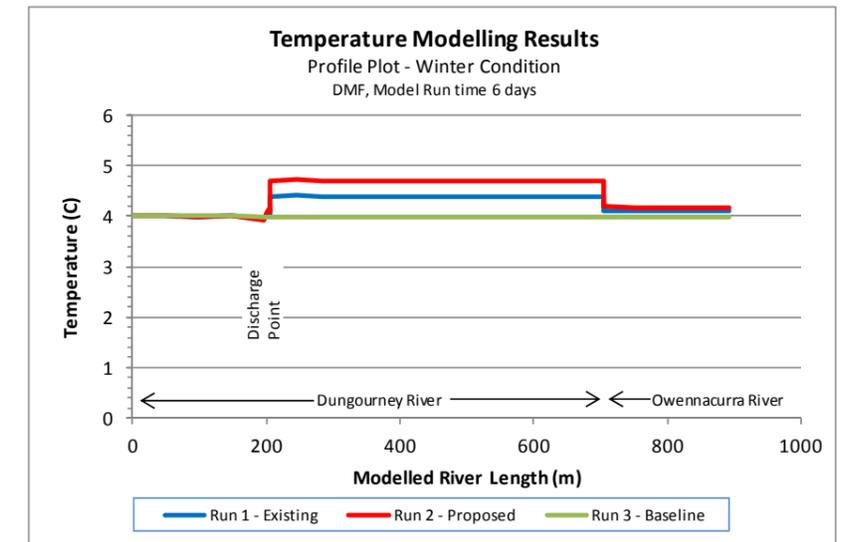
**Figure 12.11 - Results after 6 days - DMF Summer Condition (Run 7 - 9)**



**Figure 12.12 - Time Series Plot downstream of discharge point, Section 0.528 - mean flow (Run 1 - 3)**



**Figure 12.13 - Results after 6 days - Winter Condition (Run 1 - 3)**



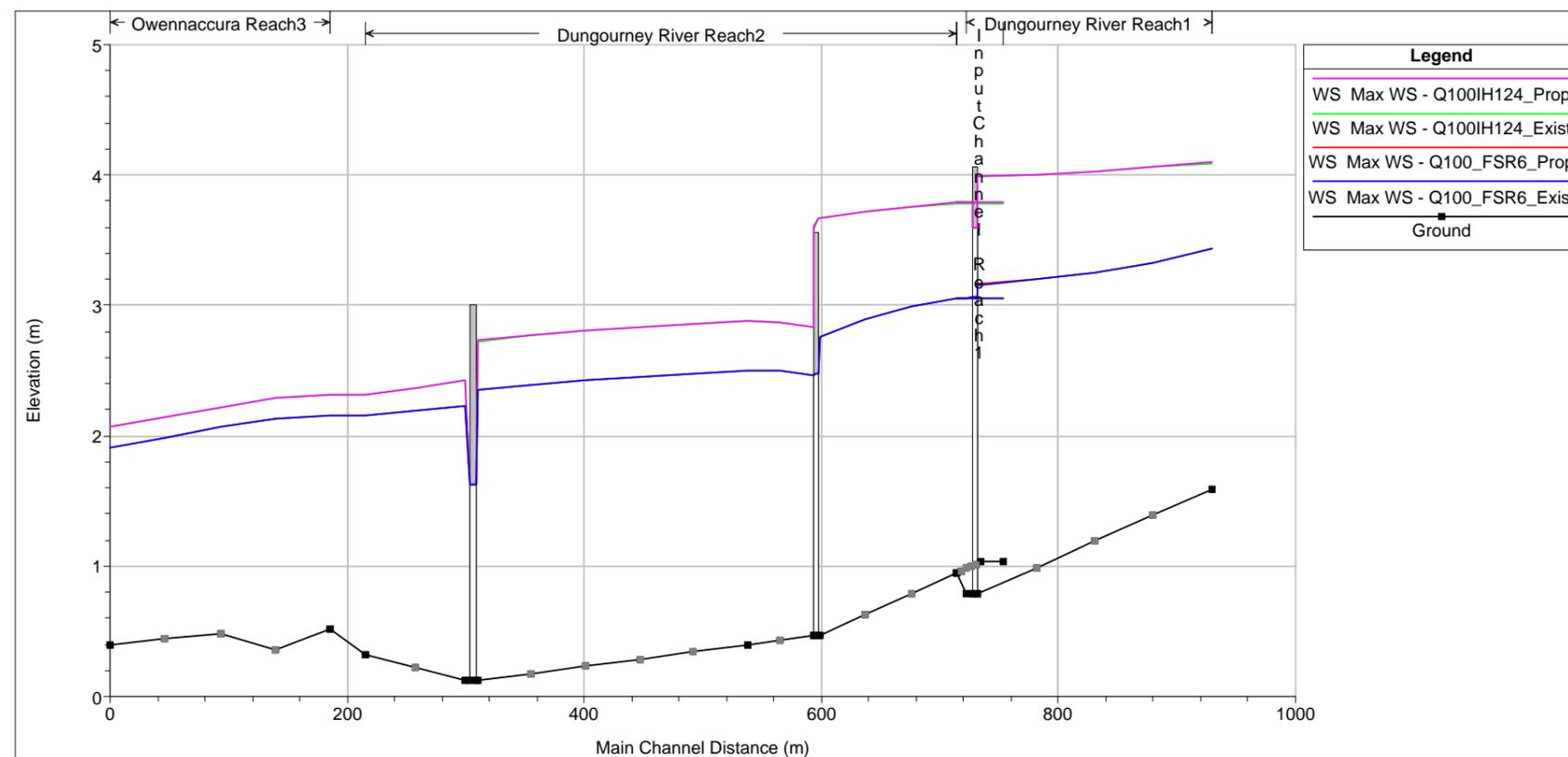
**Model Results - Flooding**

The flood flow estimation shows that the 100 year design flows are estimated to be between 15.3 m<sup>3</sup>/s and 22 m<sup>3</sup>/s for the FSR 6 and IH124 method, respectively. This peak flow is more than 300 times larger than the proposed discharge rate. As a result the potential impact is estimated to be very small.

The hydraulic model has been utilised to test proposed discharge rates for the existing and the proposed condition and modelling results are presented in Figure 12.14.

Results show that the additional discharge flow would result in negligible impact on the flood characteristics.

Figure 12.14 - Comparison of water surface profile for existing and proposed condition during the 100 year return period event (IH124 and FSR6)



## 12.6 Impact Assessment

### Construction Phase

Chapter 6 of the EIS assesses the impact on Hydrology during the construction phase of the project and proposes mitigations measures.

### Operational Phase

This impact assessment has focused on the potential impact in terms of water quality and flooding associated with the additional process water discharge. Any other typical impacts associated with the expansion of the IDL site, such as accidental spillage, fire fighting runoff, warehouse runoff and road runoff will be contained by the site's operational drainage control systems.

The potential impact of groundwater abstractions on the local hydrology is addressed in Chapter 11 - Hydrogeology.

### Process Water Discharge

No potential impact has been identified for the normal Mean flow conditions by the proposed additional process water discharge to the Dungourney River. While there would be some elevated temperatures in the immediate area and downstream of the discharge point these

will be confined to the right bank and would be diluted rapidly in the river.

During 1 in 20 year summer low flows (95%-ile) and 1 in 50 year extreme drought flow (98%-ile) conditions the modelling of the additional process water indicates that it has the potential to impact on the aquatic ecosystem of the receiving watercourses by elevating water temperatures beyond the guideline limits during these infrequent periods. This exceedance of 1.5 °C above the background was found to occur during low flow conditions only when a high water discharge volume and worst case scenario discharge temperature is applied. The potential impact on the aquatic ecosystem is discussed in the Ecology Chapter 13.

While the site monitoring indicates that the elevated temperatures are likely to initially stay on the right hand side of the river, the one dimensional model indicates that there is a potential increase of up to 2.2 °C in the water body down to the Owennacurra River. In order to be conservative the positive influence of the tide on the water temperature in the majority of the river channel down gradient of the discharge location was not considered in the modelling.

### Flood Risk

The small increase in the surface water runoff from the construction of hardstanding areas and potential risk of flooding will be mitigated by the construction of drainage controls and the new fire water retention pond as discussed in Section 12.7 The additional process water discharge is not at a volume which is considered to increase the potential risk of flooding.

### Potential Impact

Table 12.10 outlines the impact assessment for the proposed development.

Table 12.10 - Potential Impacts on the Dungourney River (without mitigation)

Potential Impacts	Permanent/Temporary	Impact Rating
Impact due to increased water temperature	Permanent	Moderate Adverse
Increase in flood risk due to increased peak flow	Permanent	Negligible

The adverse impacts as outlined in Table 12.10 can be negated and re-evaluated as imperceptible impacts on the basis that the operational mitigation measures outlined below are implemented.

### Mitigation Measures

The impact assessment in terms of flooding has shown that the proposed cooling water discharge rate of 46l/s will have negligible impact during flood conditions and no mitigation measures are required.

The temperature assessment has shown that the proposed condition would result in an acceptable level of temperature increase for most (95%) of the time. It is only during drought summer low flow conditions of the Dungourney River that the background water temperature would be exceeded by more than 1.5°C to about 2.2 °C (an increase of 0.7°C) assuming a worst case scenario of a 23 °C discharge temperature and full volume of discharge.

There are a number of mitigation measures that could be adopted during these worst case conditions and these are:

- Cease surface water abstraction from the river by recycling water and using more groundwater as process water,
- Discharge volumes can to be reduced to the existing levels by diverting process waters to the site's effluent discharge.

- *Alternatively, additional onsite cooling to reduce the discharge temperature from 23°C to below 21.0°C for low flow or 19°C for drought conditions.*

Control of the cooling water discharge to the river will be automatically managed as the river flow rate and temperature is being automatically monitored and there will also be a temperature monitor in the mill race near the discharge to the river, so periods of low flow and elevated water temperatures will be identified. During these periods if the monitored cooling waters are found to be above the 21.5°C during low flow or 20.0 degrees for DWF conditions then the surface water abstraction will cease and the additional cooling water will automatically be diverted to the waste water discharge system. Management of the temperature increase will also mitigate any risk of a reduction of the rivers DO occurring during low flow periods.

Prior to the increased discharges commencing further summer time flow, tidal influence, temperature and DO monitoring will be completed to allow more background data to be gathered from the section of the river below the cooling water discharge point.

### **Residual Impacts**

If the recommended remedial or reductive measures are implemented, the proposed development will not give rise to any significant residual adverse impact.

## 13 Ecology

### 13.1 INTRODUCTION

The purpose of the chapter is to assess the potential impacts on flora, fauna and habitats, of the proposed works within Midleton Distillery. A summary of the proposed works is provided in Section 13.3 of this Chapter. A detailed description of works is provided in Chapter 4 Project Description and Chapter 10 Water and Aqueous Emissions. In addition to the buildings and structures the proposed works involve the felling of trees and will include culverting approximately 40m of the currently dry channel of the old mill stream which runs through the site. Provision is also made for:

- Abstraction of groundwater from the underlying gravel aquifer through a series of eight new groundwater wells
- Increased discharge of cooling water to the Dungourney River
- Increased discharge of treated effluent to Cork Harbour.

As the proposed development will result in an increase in coolant water discharging to the Dungourney River, which is approximately 500m upstream of two Natura 2000 sites, Special Area of Conservation 001058 (Great Island Channel SAC) and Special Protection Area 004030 (Cork Harbour SPA) and the site itself is located approximately 1 km from the Natura Sites, a Natura Impact Statement (NIS) in accordance with European Communities (Birds and Natural Habitats) Regulations 2011 has been prepared and accompanies the planning application.

The NIS assesses the likely significant impacts of an increase in the volume of the treated effluent discharge and the likely impacts of an abstraction from and a discharge to the Dungourney River on the Conservation Objectives of Natura 2000 Sites. The NIS provides relevant material to inform a decision by the public authority as to whether the proposed development is likely to have any significant impacts on the Conservation Objectives of the Natura 2000 sites.

### 13.2 METHODOLOGY

#### Desk Study

The potential presence of habitats and species, was initially assessed by a combination of consultations, prior knowledge of the area by the author of this report and a review of available literature and data.

#### Consultations

Cyril Saich, District Conservation Officer with the National Parks and Wildlife Service (NPWS), was contacted by telephone on 28 June, 2011. Patricia O'Connor, Senior Environmental Officer with Inland Fisheries Ireland (IFI), was contacted by telephone on 19 July, 2011. Dr. Jervis Good, Regional Ecologist, NPWS, was contacted by telephone on 28 October, 2011. Michael McPartland, Senior Environmental Officer, IFI, was contacted by telephone on 28 October, 2011. The main points raised in these telephone conversations are presented in Appendix A. Michael McPartland also discussed issues relating to potential impacts on fish at an on-site meeting on 16 November, 2011.

#### Surveys

The site of the proposed development was assessed in terms of:

- the nature and quality of habitats within the site of the proposed development;
- the presence within the site of the proposed works of any species protected under the Wildlife Act (1976) and Wildlife Amendment Act (2000), or under the Flora Protection Order (1999).
- the presence within the site of the proposed works of any species listed in Irish Red Data Books 1 & 2;
- the usage of the site of the proposed works by any red or amber listed birds in the current list of Birds of Conservation Concern in Ireland;
- the conservation status of habitats and species occurring within the site of the proposed development;
- the biological water quality of the Dungourney River;
- The habitats occurring in the vicinity of the treated effluent outfall in Cork Harbour.

#### Terrestrial Surveys

Field work was carried out on 12th & 13th July, 2011. A general assessment of the site was carried out in line with the Heritage Council draft Guidelines for Survey of Habitats (Draft 2, April 2005) and habitats were classified to level 3 of the Fossitt (2000) classification system. The main plant species were recorded and the presence of any plant species listed in the Flora Protection Order (1999) was checked for. To illustrate the general habitat quality, photographs were taken using a digital camera. Photographs are presented in Appendix D. Habitats and species occurring within the site were evaluated in terms of ecological significance, based on their occurrence on lists for protection (EU Habitats Directive; EU Birds Directive; Wildlife Act) or lists of rarity or

concern, in particular the Irish Red Data lists (Curtis & McGough, 1988; Whilde, 1993) and the Birds of Conservation Concern in Ireland red or amber lists.

The status of protected species at the site of the proposed works was assessed as follows:

- All bats found in Ireland are listed in Annex IV of the EU Habitats Directive and are Red Data Book species. The possible presence of bats in the structure of warehouse 2 and warehouse A3 was checked for by examination of the buildings, inside and outside for suitable crevices, using a hand torch, and by checking cobwebs for bat droppings. The structures were then observed on 12/07/11 for 2.5 hours from sunset (9.40 pm to 12.20 am) to check for bats exiting and again for 2.5 hours before sunrise (3.00 pm to 5.30 am) the following morning to check for bats returning, with the use of a Stag Electronics BATBOX III heterodyne bat detector. Trees to be removed were examined for suitable bat roosts and notes were taken of trees with sufficient ivy cover for bat usage.
- Built structures to be demolished and the trees and bushes to be removed were checked for the presence of nesting birds.
- Bird species at the site were recorded by direct observation, or by song at the dawn chorus.

#### Freshwater Aquatic Survey

Field work was carried out by Niamh Sweeney M.Sc. on 12th October, 2011. The biological water quality of three sites on the Dungourney River (EPA Code 19/D/07) was assessed. Two of these sites are at EPA sampling stations: Site 1 is at EPA Site 0600 (Br. SE of Killeagh House) and is the nearest EPA site upstream of the IDL plant. Site 3 is at EPA Site 0700 (Br. in Midleton) and is the only EPA site downstream of the IDL plant. Site 2 is a short distance upstream of the IDL plant, where site KS3 was established in a previous biological water quality assessment by White Young Green Ireland (WYG) in 2009. Because the WYG assessment indicated a fall of a full Q-value in the stretch of river between the EPA Site 0600 and KS3 further investigations were undertaken to try to identify sources of contamination along this stretch of river. The riverbank from EPA Site 0600 to the IDL site was walked and the invertebrate fauna of a small watercourse flowing from Churchtown was sampled, as this would appear to be the most likely source of contamination. Photographs are presented in Appendix D and sampling site details are presented in Appendix E.

The biological water quality assessment was carried out by the Q-scheme methodology used by the EPA (Toner et al, 2005). At each site,

a kick sample was taken using a hand-net (mesh size 1mm.). The contents of the sample net were checked for protected species and any found were immediately returned to the water. The sample was live sorted for a half hour and macroinvertebrates were preserved in alcohol. Macroinvertebrates were identified using an Olympus dissecting microscope. A list of taxonomic keys used for identification is given in Appendix 8. Based on the relative abundance of indicator species, a Q-value was determined for each river site. The small watercourse flowing from Churchtown was found to be unsuitable for the Q-scheme methodology, but a qualitative assessment could be made, based on known habitat and oxygen regime preferences of the components of the macroinvertebrate fauna.

### Marine Aquatic Survey

Field work was carried out on 31st October, 2011. The section of Cork Harbour in the vicinity of Rathcoursey Point was examined and habitats were classified to level 3 of the Fossitt (2000) classification system. The habitat on the western side of the channel, along the edge of Bagwell's Hill Wood, was assessed by the author of this report in June 2006, as part of biodiversity survey carried out for Coillte Teo. Photographs are presented in Appendix D.

## 13.3 EXISTING ENVIRONMENT / RESULTS

### Overview of proposed abstraction and resultant increase in discharge to the Dungourney River

As described in Chapter 10 of the EIS, Water and Aqueous Emissions, the water demand for the production of 27.67 million litres of alcohol in 2009 / 2010 was, on average, 4250 m<sup>3</sup>/day, divided between Process Water (1,520 m<sup>3</sup>/day), Cooling Water (2,560 m<sup>3</sup>/day) and Potable Water (170 m<sup>3</sup>/day). The water used is currently derived from a combination of an abstraction from the Dungourney River, abstraction from the underground cavern source beneath the site and water from Cork County Council supply main. In 2009 / 2010, the average daily water intake was 2560 m<sup>3</sup>/day from ground water, 1520 m<sup>3</sup>/day from river water and 170 m<sup>3</sup>/day from mains water.

The two discharges from the IDL site to surface waters are the SWE1 cooling water discharge to the Dungourney River and the SE FINAL discharge of treated effluent via a Cork County Council sewer, to Cork Harbour. An average of 20 m<sup>3</sup>/day goes by foul sewer to Midleton Waste Water Treatment Plant (WWTP). Other water outputs are to product, to spent grains and to the atmosphere. Surface water runoff from the production area is combined with the treated waste. In 2009 / 2010 the average discharge of cooling water to the Dungourney River was 2560 m<sup>3</sup>/day. At times of excess cavern water or when high Total Organic Carbon (TOC) is detected by continuous monitoring, cooling water is diverted to the treated effluent line. The SE FINAL discharge in 2009 / 2010 was on average 1240 m<sup>3</sup>/day.

For the proposed development, the river water abstraction will remain as at present. Mains water usage will increase from 170 m<sup>3</sup>/day to 400 m<sup>3</sup>/day on average. Cavern and bore hole water usage will increase from 2560 m<sup>3</sup>/day to 6120 m<sup>3</sup>/day on average. This additional water usage would result in a predicted increase of cooling water discharge to 4020 m<sup>3</sup>/day. The predicted SE FINAL discharge would be 2980 m<sup>3</sup>/day.

### Designated Sites

Proposed demolition and construction works are not within any site designated, or proposed for designation, under national or European legislation for the protection of habitats or species. At the closest point to the site of the proposed development, the area designated for both the Great Island Channel Special Area of Conservation (Site Code 001058) and the Cork Harbour Special Protection Area (Site Code 004030) starts at the confluence of the Dungourney and Owennacurra Rivers, where conditions are tidal and saline. This is approximately one kilometre from the site of the proposed demolition/construction works and 500m from the discharge point of the cooling water to the Dungourney River as illustrated in Figure 13.1. The outfall of the treated effluent off Rathcoursey Point is on the southern boundary of SAC 001058 and is also within 200m to the south of SPA 004030.

The Site Synopses for the Great Island Channel SAC and Cork Harbour SPA are presented in Appendix 2 and the NPWS Draft Conservation Objectives for these sites are presented in Appendix C. The designated area covers approximately 12km<sup>2</sup>, extending from Middleton westwards along the channel on the northern side of Great Island, to Glounthaune. Two habitats, listed in Annex I of the EU Habitats Directive, and sixteen species listed in Annex I of the EU Birds Directive are presented in the Draft Conservation Objectives as being the Qualifying Interests, which must be maintained in favourable conservation status.

### Terrestrial Habitats and Species within the Site of the Proposed Development

#### Habitats

As the proposed works are located within an existing industrial site, no natural or semi-natural habitats occur in the footprint. The following habitat types, as illustrated in Figure 13.2 Habitats Map, as defined by Fossitt (2000), occur. A photographic record of the habitat types and features is included as Appendix D. This includes 16 photographs, numbered 1-16 and a sample of these are reproduced below to illustrate the habitats and features described in this section.

**BL3 (Buildings and artificial surfaces).** This habitat is found at the locations of the proposed fire water retention pond, the additional fermenters, new still house and the new distillation columns and tankfarms. The types of structures are varied. Warehouses A3 and 2 are dealt with in more detail in Section 13.2, Terrestrial Surveys.

**GA2 (Amenity grassland).** This habitat is found at the locations of the fire water retention pond (Photo 1) and the new stillhouse. Grasses dominate, mainly Yorkshire fog (*Holcus lanatus*) and rye grass (*Lolium* sp.), with some red fescue (*Festuca rubra*) and cocksfoot (*Dactylis glomerata*). Common weeds, such as dock (*Rumex obtusifolius*), creeping buttercup (*Ranunculus repens*), creeping thistle (*Cirsium arvense*), soft rush (*Juncus effusus*), red clover (*Trifolium pratense*), white clover (*Trifolium repens*), creeping cinquefoil (*Potentilla reptans*), black medick (*Medicago lupulina*) and birds-foot trefoil (*Lotus corniculatus*) are frequent throughout.



Photo 1. Grassland at location of proposed fire water retention pond

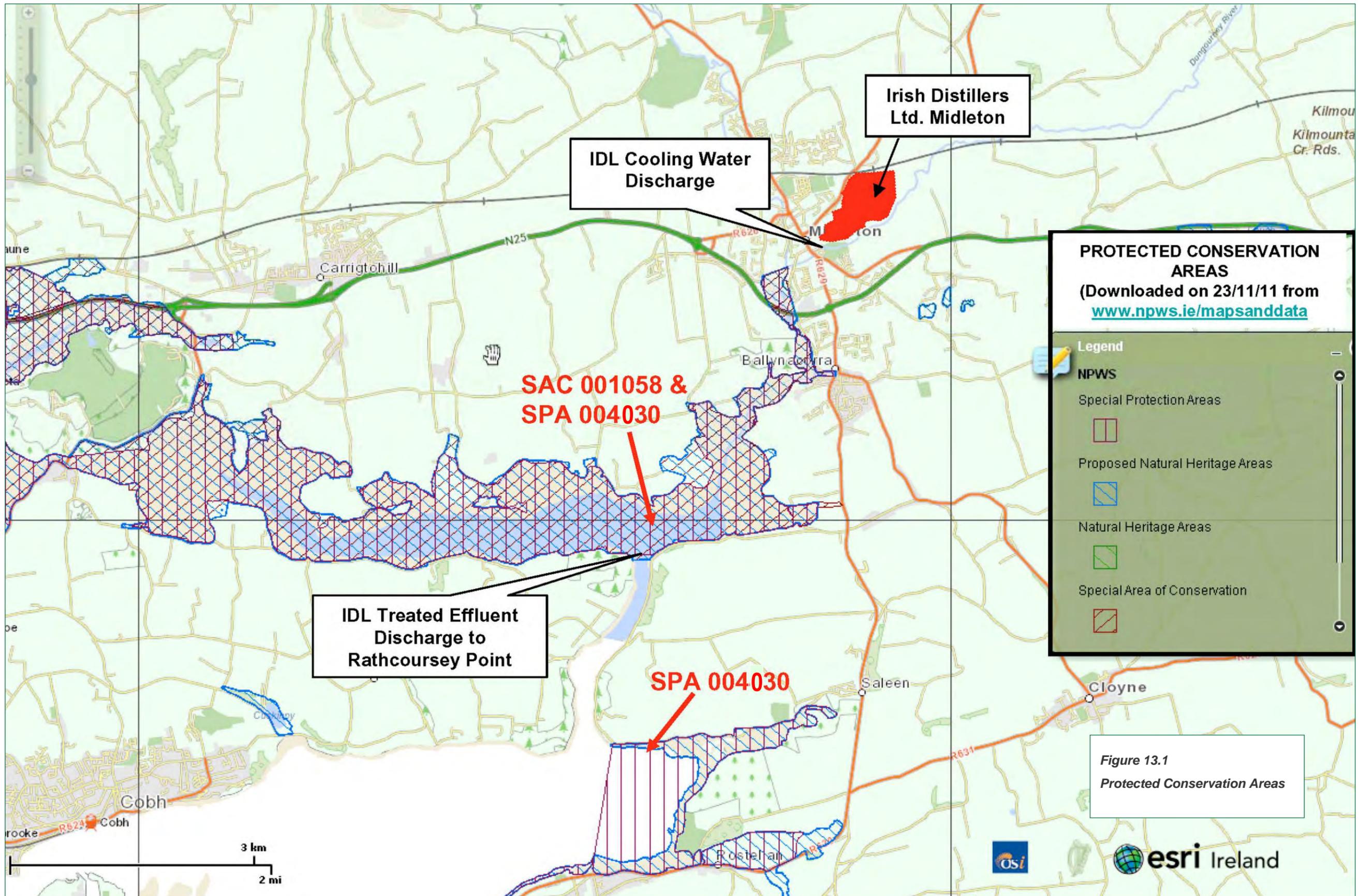
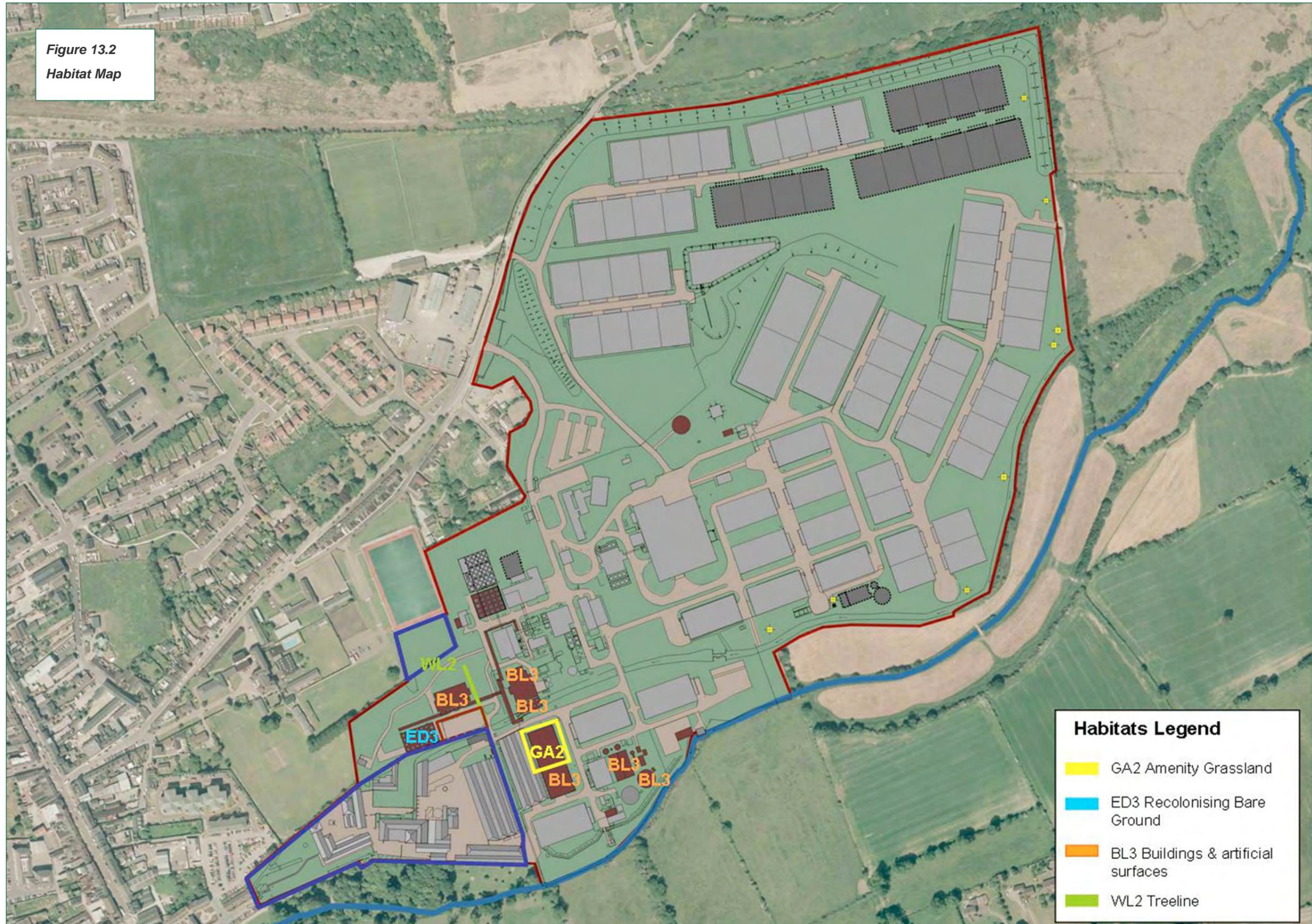


Figure 13.1  
Protected Conservation Areas

Figure 13.2  
Habitat Map



**ED3 (Recolonising bare ground)** occurs at the location of the new receiver tankfarm (Photo 3). The habitat of the old mill stream channel is also best classified as this habitat type. This channel, which was drained several years ago, now receives some occasional storm runoff from the site, but is mostly dry and does not convey water. The amount of plant growth within the channel varies. Towards the eastern end of the site, adjacent to the proposed new water treatment plant, it is mostly covered by willow, bramble and grasses (Photo 4). Towards the western end of the site, there is less growth within the channel, particularly where it is heavily shaded, or where the base is more stony (Photo 5).



**Photo 3.** Recolonising ground at location of proposed receiver tankfarm



**Photo 4.** Dry mill stream channel, eastern end



**Photo 5.** Dry mill stream channel, eastern end

**WL2 (Treeline).** Behind the existing Supervisor’s Office, there is a line of mature trees (10 sycamore, 3 elm and one beech). Some of these at the southern end (Photo 6 in Appendix) occur within the footprint of the new still house. There are 24 rowan trees and 2 ash trees around the north, south and east sides of Warehouse 2 (Photo 7). Along the southern side of the mill stream, north of the proposed new fire water retention pond, there is a line of mostly ornamental trees and shrubs that could be affected by the proposed development.



**Photo 7.** Line of rowan trees by Warehouse 2

Protected Species

**Plants**

No plant species listed in Annex II of the EU Habitats Directive, or protected under the Flora (Protection) Order (1999), or listed in the Red Data Book was recorded, nor are there any known records of rare or protected plant species from within the site of the proposed works.

**Invertebrates**

There are no records of rare or protected invertebrate species within the site of the proposed works.

**Bats**

Warehouse A3 (Photo 8) has solid concrete external walls, with stone where it joins warehouse 2A, on the western side. The roof is constructed of timber and flat tiles. Internally, there is a single space, with no attic, nor cellar. Warehouse 2 (Photo 9) is of newer construction, with twin-leaf concrete walls and a roof of sandwich panel cladding. Internally, there is a single space, with no attic, nor cellar. No crevices, suitable for bats were found in either building. No bat droppings were found on cobwebs within or outside the buildings. The very strong smell of alcohol within these warehouses might be a deterrent to bats.



**Photo 8.** Warehouse A3

No bats were detected with the bat detector, emerging from or returning to either warehouse. The night of the survey was mild and dry, with little wind. Common pipistrelle (*Pipistrellus pipistrellus*) and soprano pipistrelle (*Pipistrellus pygmaeus*) were recorded flying in the general area, mainly along the line of ornamental trees to the north of the warehouses. No rare species of bat was recorded. The level of bat activity in the area indicates that, if bats were roosting within the structure of either warehouse, they would have emerged. It can be concluded that bats are not roosting in either of these warehouses.



Photo 9. Warehouse 2

Bats were recorded around the trees behind the existing supervisor’s office. Several of these trees were heavily laden with ivy and could have been supporting roosting bats. Since the survey was undertaken the trees designated to be removed have been stripped of all ivy (in November 2011) and are no longer considered suitable of support roosting bats.

**Other Mammals**

No other species of protected mammal was recorded at the site. The only other mammal recorded was rabbit (*Oryctolagus cuniculus*).

**Birds**

The following bird species, all of which are protected under Wildlife Act (1976) and Wildlife Amendment Act (2000), were recorded in the vicinity of the proposed development: Robin, Dunnock, Wren, Blackbird, Swallow and Jackdaw. Of these, only swallow (*Hirundo rustica*) is on the amber list of Birds of Conservation Concern in Ireland. No nests of swallow, or any other species, were found attached to built structures that would be affected by the proposed development. No bird nests were found in trees and bushes that might be removed for the proposed works. However, due to the difficulty of finding nests hidden in dense growth, it is possible that nests were present, but not found.

**Freshwater Habitats and Species**

**Results of Biological Water Quality Analysis – Dungourney River**

The list of macroinvertebrate taxa identified to the level required for the Q-scheme and numbers recorded in 30 minutes sorting at each site are presented in Appendix 6. Figure 13.3, illustrates the locations of the following monitoring sites along the Dungourney River.

Macroinvertebrate Community Analysis by Site is outlined below:

**Site 1.** The fauna is dominated by Group C (Relatively Pollution Tolerant) species, with the freshwater shrimp, *Gammarus duebeni*, and the beetle, *Elmis aenea*, being the most abundant. Group A (Very Pollution Sensitive) is represented by low numbers of the flat mayfly, *Ecdyonurus* sp. Group B (Relatively Pollution Sensitive) species is poorly represented. Group D (Very Pollution Tolerant) and Group E (Most Pollution Tolerant) are absent. With a low Group A representation and dominance of Group C, this fauna warrants a Q-value of Q3-4.

**Site 2.** A greater dominance of Group C is evident here than is the case at the upstream site, with *Gammarus duebeni* very abundant. Group A is absent and Group B is not well represented. Group D is represented by a single specimen of the wandering snail, *Radix balthica* (formerly called *Lymnaea peregra*). Group E is absent. This faunal composition indicates a Q-value of Q3.

**Site 3.** As at site 2, Group C is very dominant here. At this site the main species is *Gammarus zaddachi*, which indicates a slight brackish influence here. Group A is absent and Group B is not well represented. Group D is represented by a single specimen of the water slater, *Asellus aquaticus*. Group E is absent. This faunal composition indicates a Q-value of Q3.

**Site 4.** While the physical characteristics of the small tributary flowing from the direction of Churchtown make it unsuitable for the application of the Q-scheme, examination of the species composition indicates that it is not in a polluted state. The most abundant taxon is the family of aquatic worms, Lumbriculidae, which are very commonly found in such slow flowing muddy conditions, but are not very tolerant of depleted oxygen levels. In more polluted waters, these Lumbriculidae would be replaced by the more tolerant members of the family Naididae, such as *Tubifex tubifex*. The fauna of this stream is therefore indicative of unpolluted conditions.

**Conclusions of Biological Water Quality Analysis – Dungourney River**

The biological water quality of the Dungourney River declines upstream of the IDL plant. Since 1999, the results of EPA Q-value assessments show a decline from Q4 at the nearest EPA site assessed upstream of the IDL plant to Q3 downstream (Appendix 7). In 1999, 2003 and 2005, the nearest upstream site assessed was Site 0600 (Site 1 of the current survey). In 2008 and 2011, the nearest upstream site was Site 0500, c. 4km further upstream. In 2009, a survey by WYG Ireland recorded a drop in biological water quality from Q4 at Site 0600 to Q3 a short distance upstream of the IDL plant (Site 2 of the present survey). In 2011, EPA sampling was carried out one week before the survey for the present report. Combining the results of these two October 2011 surveys, the biological water quality of the Dungourney River is summarised in the table below:

Table 13.1 - Biological Water Quality of the Dungourney River

Sites of EPA and Sweeney Consultancy	Site 0500, EPA	Site 0600, EPA. Site 1, SC	Site 2, SC	Site 0700, EPA. Site 3, SC
Sampled by	John Lucey, EPA	Niamh Sweeney, Sweeney Cons.	Niamh Sweeney, Sweeney Cons.	John Lucey, EPA. Niamh Sweeney, Sweeney Cons.
Q-value Oct 2011	Q4	Q3-4	Q3	Q3
Ecological Status*	Good	Moderate	Poor	Poor

\*As defined by the European Communities Environmental Objectives (Surface Waters) Regulations 2009

As the invertebrate community composition indicates that the tributary flowing from Churchtown is unpolluted and as no other point sources were evident, it would appear that the decline in water quality of the Dungourney River upstream of the IDL plant is due to diffuse pollution. These results do not indicate any negative impact by IDL on the biological water quality of the Dungourney River.

**Protected Fish Species in the Dungourney River**

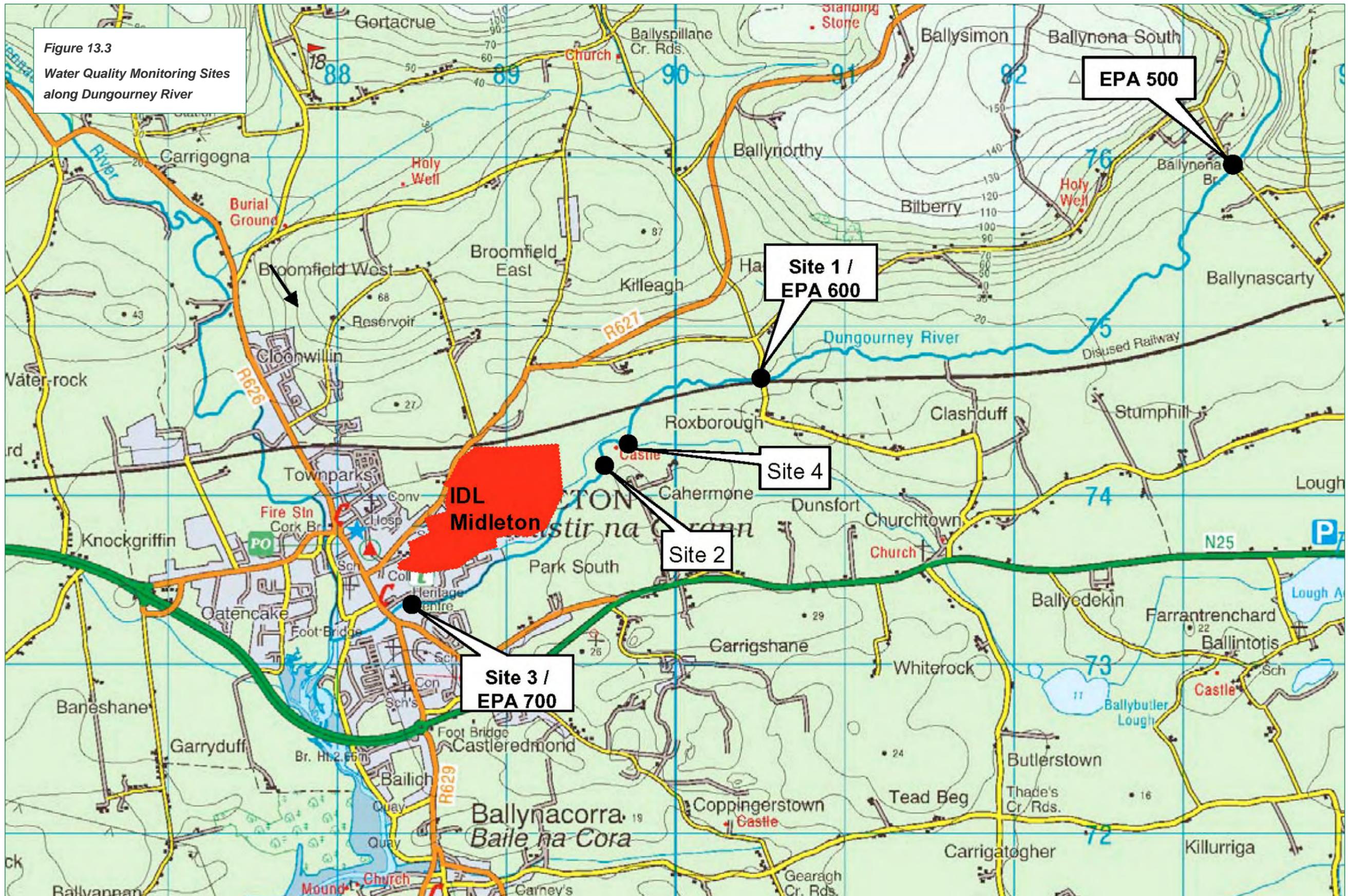
The Dungourney River, which flows to the south of the site of the proposed development, and to which the cooling water is discharged, via the final section of the channel of the old mill stream, contains populations of salmon and sea trout, which are protected under Fisheries Acts.

**Marine Habitats**

The channel to the eastern side of Great Island in Cork Harbour, to which the treated effluent discharges, off Rathcoursey Point (W862 694) (Figure 13.1) is saline and tidal. The shorelines on either side of the channel (Appendix D: Photo 14, 15, 16) are classified as Mixed Substrata shores (Habitat Code LR4), with a mixture of rock and sediment that includes gravel, sand and some mud. The outfall is below water level at low tide.

**Ecological Value**

In accordance with NRA Guidelines (2009) and on the basis that the site of the proposed development predominantly consists of artificial and highly modified habitats with low species diversity and low wildlife value, it is classified as being of Rating E – Low Value, locally important.



As the Dungourney River contains populations of Atlantic salmon, sea/brown trout, European eel, lamprey and stickleback species, all of which are included in the Red List for Amphibians, Reptiles & Freshwater Fish (King et al., 2011), this river is classified as being of Rating B – Nationally important.

As the North Channel of Cork Harbour is designated as both an SAC and SPA, it is classified as being of Rating A – Internationally important.



Photo 14: Shoreline south of Rathcoursey Point (view North)



Photo 15: Shoreline at Rathcoursey Point (view West)



Photo 16: Shoreline at Bagwell's Hill

### 13.4 POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

Potential impacts are assessed, based on drawings supplied by PM Group, information on river flows and temperature as presented in Chapter 12 Hydrology and data collected for the present survey.

#### Potential Impacts

##### Do-Nothing Scenario

###### Designated Sites

If the proposed new fire water retention pond is not built, there will be an ongoing slight risk of a significant quantity of alcohol reaching the Great Island Channel SAC and Cork Harbour SPA sites in the event of a fire. Ethanol can have a direct toxic effect on aquatic life. Oxygen is consumed in the breakdown of alcohol by micro-organisms, which can result in oxygen depletion of waterbodies. While the extent of such an impact within the designated area would depend on the quantity of alcohol involved, if it were to happen, such an event could have negative impacts on the two habitats listed as Qualifying Interests of the SAC and could also negatively impact on the bird species for which the SPA is designated through an impact on invertebrate species on which they feed.

###### Terrestrial Habitats and Species within the Site of the Proposed Development

The Do-Nothing Scenario would not affect habitats or protected species within the site of the proposed development.

###### Freshwater Habitats and Species

If the proposed new fire water retention pond is not built, there will be an ongoing slight risk of a significant quantity of alcohol reaching the Dungourney River in the event of a fire and having a direct negative effect on salmon and sea trout through toxic impacts and oxygen depletion of the water.

###### Construction Impacts

###### Designated Sites

The Conservation Objectives of the Great Island Channel SAC and Cork Harbour SPA sites would not be affected by construction impacts from the proposed works. These works are outside the designated area and there will be no discharges resulting from construction to waters upstream of the designated area.

###### Terrestrial Habitats and Species within the Site of the Proposed Development

As the habitats within the site of the proposed development are of low ecological value, they would not be significantly negatively impacted by the proposed development at construction phase.

If trees and bushes were felled during the bird nesting season, there could be a significant negative impact.

###### Freshwater Habitats and Species

If care is not taken to prevent potential contaminants which could negatively impact on salmonids being spilled in the channel of the old mill stream, there could be a negative impact on salmon and sea trout in the Dungourney River. The potential contaminants of particular concern are petrochemicals (fuels and oils used by machinery in the construction process).

###### Operational Impacts

###### Designated Sites

A Natura Impact Statement which assesses the likely significant impacts of an increase in the volume of the treated effluent discharge and the likely impacts of an abstraction from and a discharge to the Dungourney River on the Conservation Objectives of Natura 2000 Sites accompanies the planning application as a separate document.

As Chapter 12 Hydrology indicates that any elevation of temperature in the Dungourney River caused by the discharge of cooling water immediately dissipates at the confluence with the Owennacurra River (the point where the Natura 2000 sites start as illustrated in Figure 13.1), it can be concluded that the cooling water discharge will not negatively impact on the Conservation Objectives of these Natura 2000 sites.

The mass emissions for all parameters in the treated effluent discharge will stay within the limits set by the current IPPC Licence P0442-01. The habitats listed as Qualifying Interests of SAC 001058 do not occur in proximity to the treated effluent outfall at Rathcoursey Point and there will be no increased level of toxins affecting the bird species listed as Qualifying Interests of SPA 004030. It can therefore be concluded that, provided that the process waste waters are adequately treated, as at present within IPPC Licence emission limit values, the treated effluent discharge will not negatively impact on the Conservation Objectives of these Natura 2000 sites.

#### Terrestrial Habitats and Species within the Site of the Proposed Development

As the habitats within the site of the proposed development are of low ecological value, they would not be significantly negatively impacted by the proposed development at operational phase.

A reduction in bushes and trees on the site would have a slight negative impact on the amount of available habitat for some species of common passerine birds.

#### Freshwater Habitats and Species

The aquatic ecology assessment carried out for this report did not find the IDL plant to be causing any decrease in Q-values in the Dungourney River. Provided that strict control is maintained in line with IPPC Licence requirements, to prevent contaminants reaching the Dungourney River, there will be no impact on the biological water quality of the river, as a result of the operational phase of the proposed expansion. If care is not taken to prevent potential contaminants reaching the river, this could negatively impact on fish species, particularly salmonids.

The proposed expansion of the IDL plant at Midleton includes an increased groundwater abstraction to supply the additional cooling water required for the fermentation process. Other than a slight increase in temperature, this cooling water is the same quality as when abstracted from the ground and is suitable for return to the Dungourney River. The volume of cooling water discharged to the Dungourney River will increase from the current rate of approximately 2560 m<sup>3</sup>/day to 4020 m<sup>3</sup>/day. As reported in Chapter 12 Hydrology, a plume of warmer water was found to run along the right hand side of the river, downstream of the cooling water discharge point. As the plume of warmer water is not fully mixed with the river water until further downstream, this section of the river could be regarded as the mixing zone, dependant on the width of the band of warmer water in relation to the entire river width. This point is dealt with in Chapter 12 Hydrology. The hydraulic model developed for the section of the Dungourney River from the cooling water discharge point to the confluence with the Owennacurra River, shows that, in the absolute worst case scenario, the maximum temperature increase, resulting from the proposed discharge of the cooling water from IDL at 95%ile flow would be 2.2°C above ambient water temperature. At the

confluence with the Owennacurra River, the increase in temperature is immediately assimilated. The model does not account for tidal influence.

Within a short distance downstream of the cooling water discharge point, a saline influence is noticeable in the invertebrate fauna. At Site 3, Gammarus zaddachi, a brackish water species was found to make up 88% of the fauna. Combined with this, Chapter 12 Hydrology shows a tidal influence at the bridge in Midleton. This estuarine influence would indicate that the lower part of the Dungourney River, downstream of IDL is unsuitable for spawning and nursery of freshwater fish species. The unmixed flow of river water on the left hand side of the river channel allows salmon and sea trout to migrate upstream in natural river water. Highest temperatures in the river will occur at lowest flows, in which conditions salmon and sea trout would not be migrating upstream.

The effects of the proposed increase in volume of the cooling on the temperature of the Dungourney River, as far as the Owennacurra confluence is not seen as being deleterious to fish. However, mitigation measures are proposed to prevent increases in water temperature of more than 1.5°C during low flow conditions.

The surface water abstracted from the Dungourney River is primarily used in the process system and is to remain similar to the current abstraction rate of 1,520 m<sup>3</sup>/day. In Chapter 11 Hydrogeology, it is reported that, over the duration of the 5-day pumping test at a rate approximately twice the proposed use, the abstraction of groundwater had no observable impact on the water level or flow on the nearby Dungourney River. This would indicate that the proposed increase in groundwater abstraction will have no negative impacts on habitats or species in the river. Nonetheless, as described in Chapter 11 Hydrogeology, it is proposed to monitor flow rates in the Dungourney River at two points, one upstream and one downstream of the IDL plant. Future monitoring and mitigation measures identified in Chapter 11 Hydrogeology will ensure that there will be no adverse impact on the river from ground water abstraction activities.

#### Estuarine/Marine Habitats and Species

As Chapter 12 Hydrology indicates that any elevation of water temperature caused by the discharge of cooling water immediately dissipates at the confluence with the Owennacurra River, it can be concluded that the cooling water discharge will not have a significant negative impact on estuarine habitats or species.

The River Basin Management Plan for the South Western River Basin District classifies Cork Harbour as being of Moderate Status.

Nutrients in the IDL treated effluent discharge add slightly to the overall impact on water quality in the general harbour area from all the various sources. The habitats in the vicinity of the outfall are not very sensitive to enrichment. As stated in the Site Synopsis for SPA 004030, polluted conditions may not impact negatively on birds. Indeed organic

enrichment of sediments can initially stimulate the production of benthic invertebrate communities, which while different in composition from pre-enrichment conditions, can provide significant food supplies for birds (Cardoni et al., 2011).

Shellfish, (both commercially produced and wild) are vulnerable to bacterial contamination because of their filtering habit. The process waste waters of IDL do not include any domestic/foul effluent, which is directed to the Midleton WWTP. IDL have installed an ultra violet treatment step for bacteriological destruction at the point of discharge, resulting in the measured concentrations of faecal coliforms in the SE Final discharge being consistently close to zero. Consequently, the IDL treated effluent is not responsible for any problems with bacterial contamination of shellfish in Cork Harbour.

#### Proposed Mitigation Measures

The mitigation measures listed below should be fully incorporated into the design of the proposed development.

#### Mitigation Measures at Construction Phase

##### Bats

To compensate for the loss of potential bat roost sites, it is recommended that five bat boxes/tubes be attached to other trees without ivy which are not to be felled, or to suitable buildings in the vicinity, following the felling of the trees. The 1FR Bat Tube, made by Schwegler is recommended. Details are given in Appendix 9.

##### Birds

Only the minimum number of trees and bushes necessary for construction works should be cleared. Felling of trees is not to take place during the bird nesting season (March to August, inclusive), unless specific permission is given by the National Parks and Wildlife Service.

To compensate for the loss of passerine bird habitat, it is recommended that bushes and trees, equivalent in number and area to those removed, be planted in some other part of the site.

#### Biological Water Quality and Fish Species in the Dungourney River

When works are being carried out within or adjacent to the channel of the old mill stream, fuels, lubricants and hydraulic fluids for equipment used on the construction site, as well as any solvents and oils, should be carefully handled to avoid spillage, properly secured and provided with spill containment. Fuelling and lubrication of equipment should not be carried out close to the channel. Any spillage of fuels, lubricants or hydraulic oils should be immediately contained and the contaminated soil removed from the site and properly disposed of.

## Mitigation Measures at Operational Phase

### Biological Water Quality and Fish Species in the Dungourney River

Surface water runoff from the 'production area catchment' is to be collected and pumped off site, to be combined with the treated effluent for discharge to Cork Harbour via the Rathcoursey outfall.

Continuous monitoring of the cooling water for TOC, as at present, will ensure that contamination will be detected, allowing diversion of cooling water to the treated effluent line and prevention of contamination of the Dungourney River from this potential source.

The installation of a new fire water retention pond will ensure that, in the event of an extreme emergency, alcohol will not flow to the Dungourney River.

The extent of the mixing zone has been determined out of consultation with the EPA. The mitigation measures for this aspect have been presented in Chapter 12 Hydrology.

### Discharge to Cork Harbour

To minimise possible impacts on the Qualifying Interests of the Natura 2000 sites, future discharges of processed waste waters from the IDL plant at Midleton must be treated to maintain the current quality of the discharge in line with current IPPC Licence emission limit values. The volume of treated effluent discharge is to stay within the limit of the current licence. UV treatment for bacteriological destruction at the point of discharge will remain in place to ensure the measured concentrations of faecal coliforms in the SE Final discharge remains consistently close to zero.

### Residual Impacts Following Mitigation

If all mitigation measures are fully implemented and are effective, there will be no significant negative ecological impact arising from the proposed development.

### Worst Case Scenario

#### Failure of Mitigation Measures for Bats

Provided the bat boxes are properly installed, if bats do not choose to use them, it will not be a failure of the mitigation measure, which is aimed at maintaining the current level of available roost sites.

#### Failure of Mitigation Measures for Birds

Mitigation measures which are based on the timing of works cannot fail.

If bushes and trees, planted to compensate for the loss of passerine bird habitat, fail to grow, there will be slightly less suitable habitat available than at present.

In the worst case scenario, a slight decrease in suitable habitat will not significantly affect passerine bird populations.

### Failure of Mitigation Measures for Protected Fish Species in the Dungourney River

If mitigation measures to prevent contaminants in the mill stream channel from reaching the Dungourney River were to substantially fail, or if the cooling water were to become significantly contaminated, there could be a significant negative impact on salmon and trout in the lowermost freshwater section of the river.

The most likely serious contamination risk is from petrochemicals which could result from spillage during refuelling or from lubricating oil leaks from machinery. In unmodified form these are liquid, virtually insoluble and lighter than water. Some hydrocarbons exhibit an affinity for sediments and thus become entrapped in deposits from which they are only released by vigorous erosion or turbulence (Luker & Montague 1994). Harmful effects of oil and petroleum compounds include:

- *The prevention of gaseous exchange at the water surface, leading to reduced dissolved oxygen in the underlying water (Solbe 1988)*
- *In the case of turbulent waters the oil becomes dispersed as droplets into the water. In such cases, the gills of fish can become mechanically contaminated and their respiratory capacity reduced (Svobodova et al 1993).*

Oil products may contain various highly toxic substances, such as benzene, toluene, naphthenic acids and xylene which are to some extent soluble in water; these penetrate into the fish and can have a direct toxic effect. It is generally agreed that the lighter oil fractions (including kerosene, petrol, benzene, toluene and xylene) are much more toxic to fish than the heavy fractions (heavy paraffins and tars) (Svobodova et al 1993).

The likelihood of a significant spill of a toxic contaminant is, however, considered to be very slight.

### Failure of Mitigation Measures for Adequate Treatment of Process Waste Waters

If treatment of process waste waters were to fail temporarily, there would be a slight temporary increase in nutrient levels in the part of the harbour near the outfall at Rathcoursey Point. If this were to occur during the spring or summer, it could help trigger an algal bloom, which could, in turn negatively impact other marine species.