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APPROPRIATE ASSESSMENT OF KILSHEELAN CLOSED LANDFILL

Natura Impact Statement

Submitted to:
Ruth Hennessy
South Tipperary County Council
Environmental Section
County Hall
Clonmel
Co. Tipperary

REPORT

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1.0 INTRODUCTION

Golder Associates were retained by South Tipperary County Council (STCC) in January 2013 to carry out an Appropriate Assessment Stage 2 of the former landfill at Kilsheelan.

Kilsheelan landfill is located at Cloghercarrigeen to the east of Clonmel town in County Tipperary and just north of the Lower River Suir SAC.

This report forms the Natura Impact Statement (NIS) required for Appropriate Assessment Stage 2 and examines the potential for impacts on the River Suir SAC due to the presence of contaminated land at Kilsheelan, in combination with other plans and projects, and proposes the necessary mitigation required. The terms of reference of this report are set out below. This NIS is based upon the conclusions of the Draft Tier 3 Risk Assessment and Conceptual Site Model (Golder, 2012).

1.1 Terms of Reference

Directive 92/43/EEC on the Conservation of Natural Habitats and Wild Fauna and Flora – the 'Habitats Directive' - provides legal protection for habitats and species of European importance. Article 2 of the Directive requires the maintenance or restoration of habitats and species of European Community interest, at a favourable conservation status. Articles 3 - 9 provide the legislative means to protect habitats and species of Community interest through the establishment and conservation of an EU-wide network of sites known as *Natura 2000*. Natura 2000 sites are Special Areas of Conservation (SACs) designated under the Habitats Directive and Special Protection Areas (SPAs) designated under the Conservation of Wild Birds Directive (79/409/EEC).

Articles 6(3) and 6(4) of the Habitats Directive set out the decision-making tests for plans or projects affecting Natura 2000 sites. Article 6(3) establishes the requirement for Appropriate Assessment:

"Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public."

Article 6(4) deals with the steps that should be taken when it is determined, as a result of Appropriate Assessment, that a plan/project will adversely affect a European site. Issues dealing with alternative solutions, imperative reasons of overriding public interest and compensatory measures need to be addressed in this case.

Article 6(4) states:

"If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member States shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted.

Where the site concerned hosts a priority natural habitat type and/or a priority species, the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest."

The requirements of Articles 6(3) and 6(4) of the Habitats Directive have been transposed into Irish legislation by means of the Habitats Regulations, 1997 (S.I. No. 94 of 1997) and the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477/2011).

1.2 Appropriate Assessment

There are four Appropriate Assessment stages which are described as follows:

1.2.1 Stage 1 - Screening

This initial stage aims to identify the likely impacts of a project or plan on a Natura 2000 site, either alone or in combination with other projects or plans. The impacts are examined to establish whether these impacts are likely to be significant. Assessment of the significance of effects is carried out in consultation with the relevant nature agencies.

1.2.2 Stage 2 - Appropriate assessment

The aim of this stage is to identify the conservation objectives of the site and to assess whether or not the project or plan, either alone or in combination with other projects or plans, will result in adverse effects on the integrity of the site, as defined by the conservation objectives and status of the site. Stage 2 is carried out in consultation with the relevant nature agencies. Where it cannot be demonstrated that there will be no adverse effects on the site, it is necessary to devise mitigation measures to avoid, where possible, any adverse effects.

Assessment of the effects of the project on the integrity of the site incorporates the following steps:

- Description of the proposed plan/project;
- Collation of Information about the Natura 2000 Site including setting out the conservation objectives of the site;
- Description of how the project or plan, in combination with other projects/plans, will affect the Natura 2000 Site, its key species and habitats, and how the overall integrity of the site is likely to be affected; and
- Description of what mitigation measures are to be introduced to avoid or reduce the adverse effects on the integrity of the site, acknowledging uncertainties and any gaps in information.

1.2.3 Stage 3 - Assessment of alternative solutions

This stage examines alternative ways of implementing the project or plan that, where possible, avoid any adverse impacts on the integrity of the Natura 2000 site. If alternative solutions have been identified that will either avoid any adverse impacts or result in less severe impacts on the site, it will be necessary to assess their potential impact by recommencing the assessment at Stage One or Stage Two as appropriate. However, if it can be reasonably and objectively concluded that there is an absence of alternatives, it will be necessary to proceed to Stage Four of this assessment methodology.

1.2.4 Stage 4 - Assessment where adverse impacts remain

For sites that host priority habitats and species, it is necessary to consider whether or not there are human health or safety considerations or environmental benefits flowing from the project or plan. If such considerations do exist, then it will be necessary to carry out the Stage Four assessments of compensatory measures. If no such considerations exist, then it is necessary to establish whether there are other Imperative Reasons of Overriding Public Interest (IROPI) before carrying out the Stage Four assessments. Where IROPI exist, an assessment to consider whether compensatory measures will or will not effectively offset the damage to the site will be necessary before the project or plan can proceed.

Given the potential for significant impacts on the River Suir SAC, from Kilsheelan closed landfill, a Stage 2 Appropriate Assessment was carried out. This report is for Stage 2 only.

1.3 Study Limitations

Cumulative impact assessment is based upon available information. There is insufficient information on all discharges within the study area to make a quantitative cumulative impact assessment, therefore cumulative impacts are discussed in qualitative terms, based on available information, in this report.

2.0 STAGE 2 APPROPRIATE ASSESSMENT METHODS

2.1 Desktop Review, Data Collation and Consultation

A desktop review was conducted of available published and unpublished information, together with consultation with National Parks and Wildlife Services (NPWS) local staff, Inland Fisheries Ireland (IFI), and a review of data available on the NPWS http://www.npws.ie/en/ and National Biodiversity (NBDC) http://maps.biodiversityireland.ie/ web-based databases. Consultation also highlighted existing or proposed developments, and other possible sources of pollution, which should be considered in the assessment.

Desktop Review and Data Collation

The desktop study reviewed information relating to the hydrology and hydrogeology of the area, existing information on the surface and groundwater quality, features of the Lower River Suir SAC and potential pressures on the river.

Existing reports which were reviewed as part of the desk study include the following:

- UK Technical Advisory Group on the Water Framework Directive – Technical report on groundwater dependent terrestrial ecosystem (GWDTE) threshold values;
- South Eastern River Basin District Characterisation Report;
- Suir Main WMU Action Plan 2010 (WFD,2010):
- Water Framework Directive Annex IV Protected Areas: Water Dependent Habitat and Species, and High Status Sites (Mayes, 2008);
- Water Quality in Ireland 2001-2003 (EPA, 2005)
- The Clonmel GWB: Summary of Initial Characterisation (Geological Survey of Ireland);
- Water Framework Directive Full Report for the Rive Suir IE SE 16 4181 5 Surface water Body and
- Water Framework Directive Full Report for the Clonmel IE SE G 040 Groundwater Body.

3.0 CONSULTATION

The following were consulted and their comments have been taken into consideration in this appropriate assessment:

Date	Organisation	Staff
Email 04/01/13 and Phone Call 08/01/13	Inland Fisheries	Frank O'Donoghue
Phone Call 04/01/13	NPWS	Sean Breen – Local Ranger

3.1 Appropriate Assessment Methodology

Appropriate Assessment has been carried out with reference to the following documents:

- Assessment of plans and projects significantly affecting Natura 2000 sites: Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC (European Communities, 2002);

- Waste Water Discharge Licensing. Note on Appropriate Assessments for the purposes of the Waste Water Discharge (Authorisation) Regulations, 2007 (S.I. No. 684 of 2007) (Environmental Protection Agency);
- Managing Natura 2000 sites: the provisions of Article 6 of the 'Habitats Directive' 92/43/EC (European Communities, 2000);
- Appropriate Assessment of Plans and Projects in Ireland: Guidance for Planning Authorities (Dept. Environment Heritage and Local Government, December 2009);
- Guidelines for Ecological Impact Assessment (Institute of Ecology and Environmental Management, 2006); and
- Guidelines for Assessment of Ecological Impacts of National Roads Schemes (NRA, Revision 2, 1st June, 2009).

4.0 DESCRIPTION OF THE PROJECT

The historical landfill at Kilsheelan is located four miles east of Clonmel town on the N76 in the townland of Cloghcarrigeen West, adjacent to the Limerick – Rosslare rail line. The Site has been partially planted with trees and since 1987 it has been the location of a South Tipperary County Council Dog Pound. The Site was a former sand and gravel quarry.

It is understood that the landfill was operational from the early 1970's to the mid 1980's. The landfill was unlined and there are no records of waste disposal available for the Site. It is understood however, that domestic refuse was disposed of at the Site and there are also reports that waste was burned regularly on Site.

The Site has operated as a dog pound since 1987. Euthanized dogs were buried in the northern part of the Site during the first years of the dog pound's operation. This practise has reportedly ceased since. It was known by STCC that waste from the Dog Pound was confined to a certain location, and this area was excluded from the Tier 2 intrusive investigation carried out at the Site end of 2010 (Golder).

The Tier 1 assessment (STCC) identified a possible linkage between leachate and groundwater (SPR 5) and migration of landfill gas (SPR 10 and SPR 11). The Tier 2 assessment (Golder, 2010) confirmed the identified SPR linkage between leachate, landfill gas and human receptors and further confirmed the risk classification as Class B (Moderate Risk).

The site was visited by Golder ecologist on January 11th 2013. The site is considered of low ecological value and comprises a small building and track edged by amenity grassland and planted ash trees in the southern part of the site.

5.0 NATURA 2000 SITE DESCRIPTION

5.1 Lower River Suir SAC

The Lower River Suir SAC (Site code: 002137) is located directly south of Kilsheelan historical waste disposal Site as shown in Figure 1.

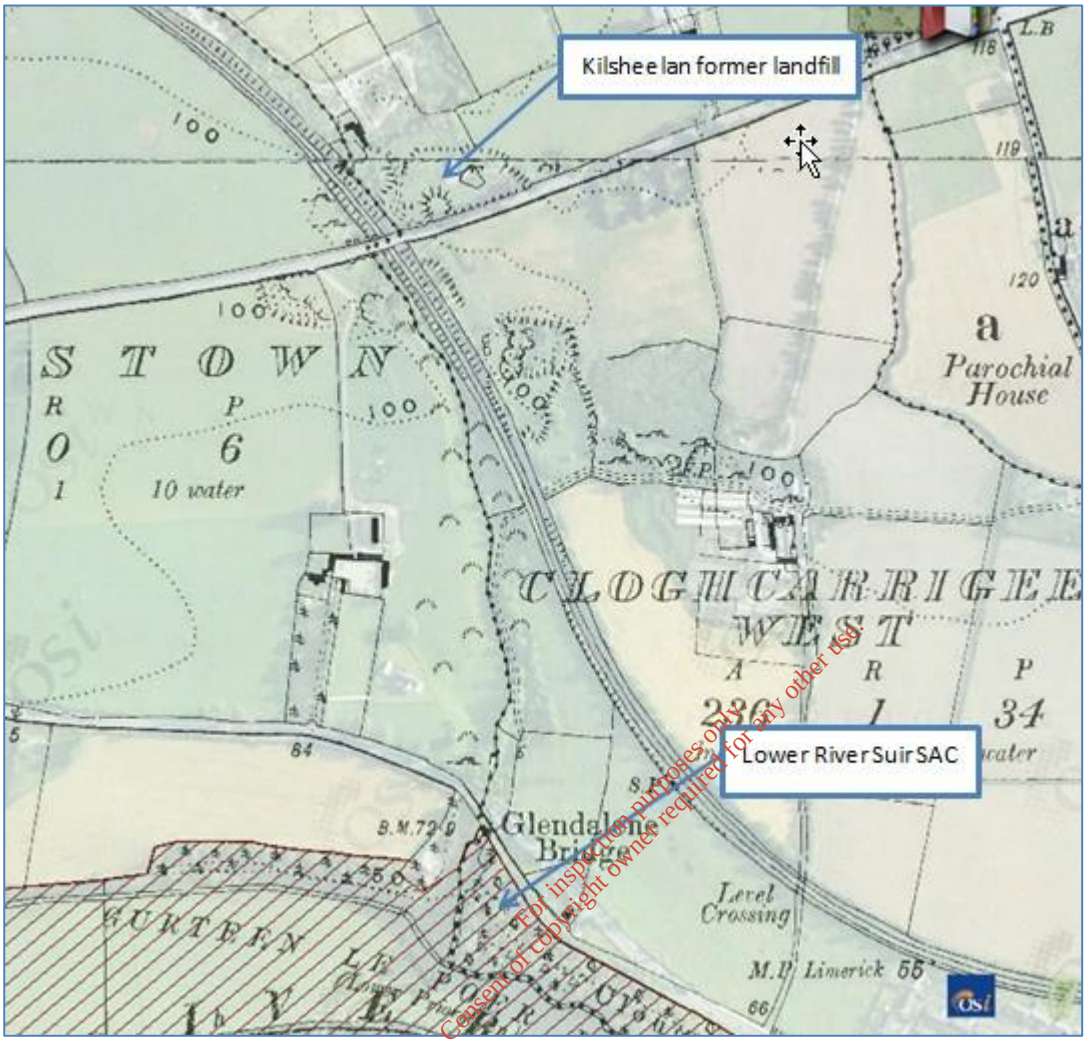

Figure 1: Lower Suir SAC location (http://www.npws.ie).

The Lower Suir SAC consists of the freshwater stretches of the River Suir immediately south of Thurles, the tidal stretches as far as the confluence with the Barrow/Nore immediately east of Cheekpoint in Co. Waterford and many tributaries including the Clodiagh in Co. Waterford, the Lingaun, Anner, Nier, Tar, Aherlow, Multeen and Clodiagh in Co. Tipperary.

The River Suir and its tributaries flow through the counties of Tipperary, Kilkenny and Waterford. Upstream of Waterford city, the swinging meanders of the Suir crisscross the Devonian sandstone rim of hard rocks no less than three times as they leave the limestone-floored downfold below Carrick In the vicinity of Carrick-on-Suir the river follows the limestone floor of the Carrick Syncline. Upstream of Clonmel the river and its tributaries traverse Upper Palaeozoic Rocks, mainly the Lower Carboniferous Visean and Tournaisian. The freshwater stretches of the Clodiagh River in County Waterford traverse Silurian rocks, through narrow bands of Old Red Sandstone and Lower Avonian Shales before reaching the carboniferous limestone close to its confluence with the Suir. The Aherlow River flows through a Carboniferous limestone valley, with outcrops of Old Red Sandstone forming the Galtee Mountains to the south and the Slievenamuck range to the north. Glacial deposits of sands and gravels are common along the valley bottom, flanking the present-day river course. A list of the features of interest of the Lower Suir SAC follows:

Features of Interest:

- Freshwater pearl mussel (*Margaritifera margaritifera*) [1029];

- White-clawed crayfish (*Austropotamobius pallipes*) [1092];
- Sea lamprey (*Petromyzon marinus*) [1095];
- Brook lamprey (*Lampetra planeri*) [1096];
- River lamprey (*Lampetra fluviatilis*) [1099];
- Allis shad (*Alosa alosa*) [1102];
- Twaite shad (*Alosa fallax fallax*) [1103];
- Salmon (*Salmo salar*) [1106];
- Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330];
- Otter (*Lutra lutra*) [1355];
- Mediterranean salt meadows (*Juncetalia maritimi*) [1410];
- Water courses of plain to montane levels with the *Ranunculion fluitantis* and Callitricho-Batrachion vegetation [3260];
- Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430];
- Old sessile oak woods with *Ilex* and *Blechnum* in British Isles [91A0;]
- Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae) [91E0]; and
- *Taxus baccata* woods of the British Isles [91J0].

The above list was taken from National Parks & Wildlife Services (NPWS) Conservation Objectives for this SAC (*www.npws.ie* 2011).

The NPWS site synopsis is given in Appendix A.

5.2 Lower River Suir SAC in the vicinity of the site

The River Suir occurs south of the site at Kilsheelan and a walkover of the riverside was also carried out. The river is edged by woodland, residential properties and agricultural lands at Kilsheelan. The woodland is a mixed broadleaved woodland with species including oak, beech, hawthorn, holly, ash, and an understorey of bramble, holly and bracken in places. There is a walkway along the river edge which comprises amenity grassland. Further west beyond the woodland there is a large agricultural field of improved grassland along the river where the walkway continues towards Clonmel. There are no wetlands or groundwater dependent wetlands edging the river. However, it is possible that the habitats and species of the river could be impacted by groundwater discharging to the river.

The Lower Suir SAC is designated for a number of aquatic species, some of which occur in the vicinity of Kilsheelan. For example, salmon, crayfish and sea lamprey are noted along the river at Clonmel downstream of Kilsheelan (Inland Fisheries, Frank O'Donogue*, pers comm*.). Other important Annexed species also noted from this area include Annex I bird species Kingfisher, which rely on good water quality for fishing.

6.0 POTENTIAL IMPACTS

This SAC is designated for a number of aquatic species and others listed above, some of which occur in the vicinity of Kilsheelan.

Groundwater monitoring at downstream locations of the Kilsheelan former disposal Site have indicated elevated organic parameters (ammonia, chloride, MRP, coliforms, calcium and potassium), some elevated metals (aluminium, barium, cadmium, chromium, copper, iron, lead, manganese and zinc) and volatile compounds (dichloromethane) when compared against the EPA IGV (*Environmental Protection Agency 2003 - Towards Setting Guideline Values for the Protection of Groundwater in Ireland, Interim Report*) and SI No. 9 of 2010 (*Statutory Instruments. S.I. No.9 of 2010 - European Communities Environmental Objectives (Groundwater) Regulations, 2010*).

Taking into account the location of Lower River Suir SAC and the assumed groundwater flow from the Kilsheelan former disposal Site towards the River Suir there is a potential for these pollutants to impact on the water quality of the SAC in the vicinity of Kilsheelan. Impacts on water quality have the potential to affect the aquatic features of the SAC.

Threshold values have yet to be determined for groundwater concentrations of pollutants, if exceeded would indicate a pressure that could be (or is) causing damage to GWDTE. As the Lower River Suir occurs downgradient of the former landfill and within the same groundwater body i.e. Clonmel GWB, it is necessary to establish if the impacts of the elevated organic substances recorded will have a significant effect on the designated features of the Lower River Suir SAC. In the absence of threshold concentrations for GWDTE the results are compared to Groundwater Quality thresholds.

7.0 GROUNDWATER QUALITY

7.1 Hydrogeology

The GSI data (www.gsi.ie) indicates that the former landfill is located within a Regionally Important Aquifer – Karstified as shown in Fig 2. The aquifer vulnerability is described as High to Extreme with rock near the surface/karst in the area of the former landfill as shown on Fig 3.

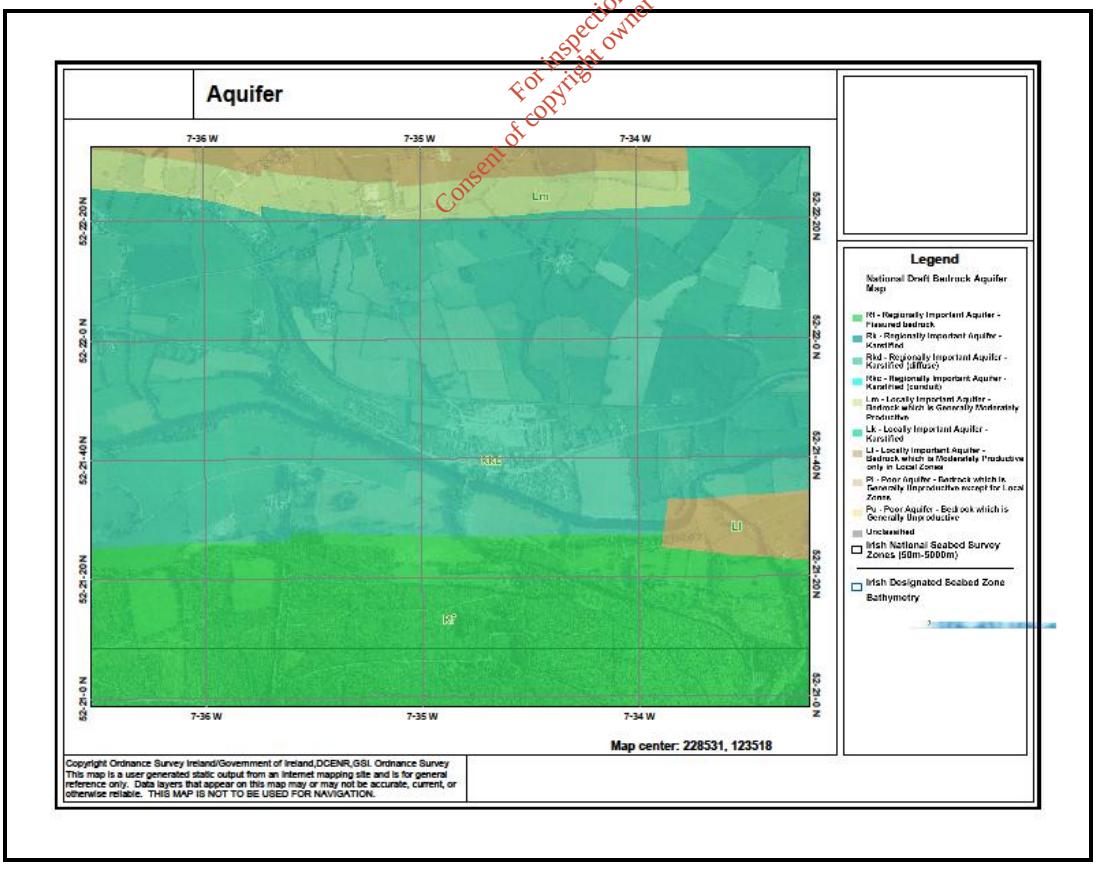

Figure 2 Description of aquifer at Kilsheelan

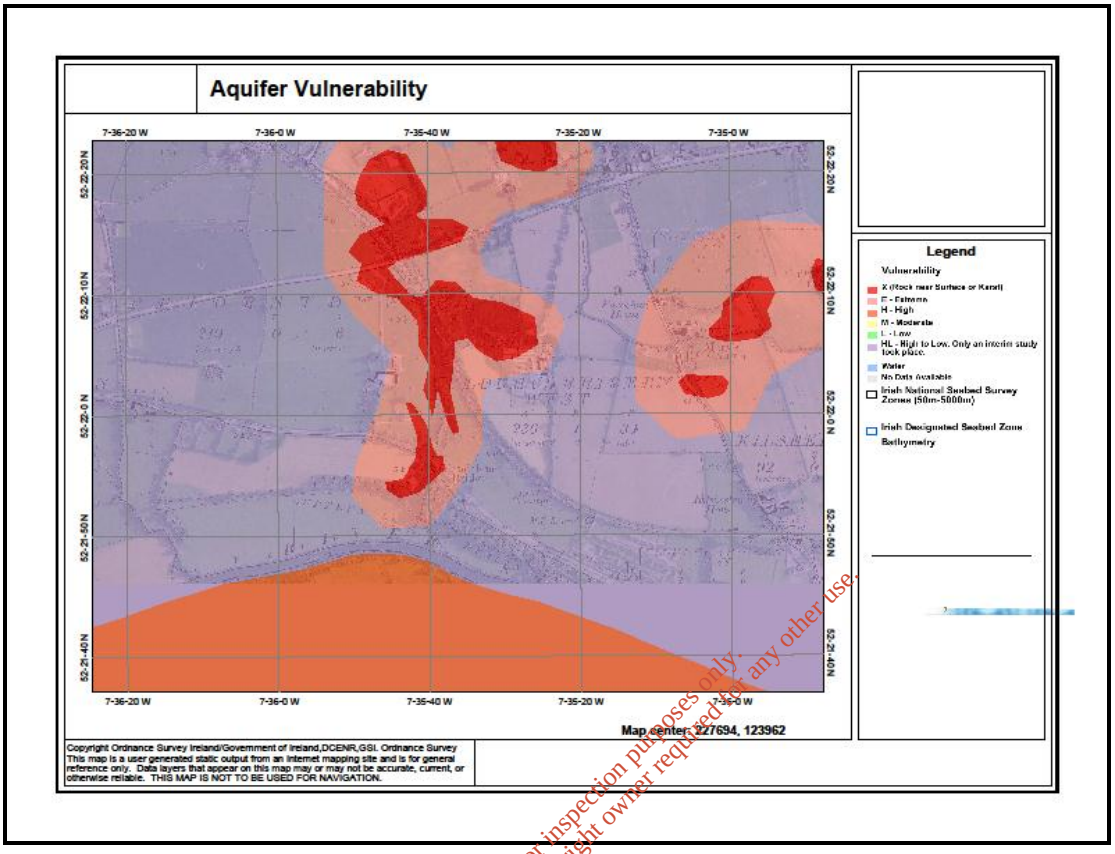

Figure 3 Aquifer Vulnerability

7.2 Water framework directive status

The current status of the Clonmel groundwater body associated with the River Suir SAC, is rated as *Good*. under the Water Framework Directive reporting. The main risk identified in the report is associated with nutrient loadings to rivers and transitional and coastal waters.

7.3 Tier 3 Risk Assessment - Summary of Results

For the Tier 3 assessment groundwater quality data was assessed from three (3 No) on site groundwater monitoring wells (GW1 to GW3). The following Table 1 depicts details of these groundwater monitoring wells, including associated groundwater elevations.

Table 1: Details of On and Off-Site Groundwater Monitoring Locations

ID	Top of Cap Level	Ground Elevation	Groundwater Elevation 16 July 2012	Bedrock Elevation	Relative to the Site
GW1	99.58	98.89	91.65	96.39	Down stream
GW2	93.37	98.78	91.07	97.78	Down stream
GW3	97.15	96.64	91.80	92.04	Upstream

The following Table 2 from the Tier 3 Risk Assessment depicts observed elevated concentrations within groundwater monitoring locations GW1, GW2 and GW3 when compared against the IGVs (EPA, 2003) and SI No 9 of 2010. Results of the initial groundwater monitoring event carried out on 1 November 2010 have been added to the Table 2 for comparison purposes.

Table 2: Summary of Groundwater Monitoring

Date				GW1				GW2				GW3			
Parameter	Units	SI No.9 2010	EPA IGV Groundwater	01-Nov-10	26-Mar-12	21-May-12	16-Jul-12	01-Nov-10	26-Mar-12	21-May-12	16-Jul-12	01-Nov-10	26-Mar-12	21-May-12	16-Jul-12
Conductivity @25°C	µs/cm	800-1875	1000	1310	867	949	855	754	1201	1199	1226	880	766	827	766
Ammonia	mg/l N	0.065-0.175	0.117	0.5	0.05	0.09	0.2	0.1	2.7	1.3	1.7	0.1	0.12	0.06	0.06
Chloride	mg/l Cl	24-187.5	30	100.1	58	65	55	19.2	55	56	56	20.5	15	14	16
MRP as P (Molybdate Reactive Phosphorus)	ug/l	35		388				492				227			
Total coliforms	no./100mls		0		nr	1	55		nr	0	37		100	0	1986
E Coli	no./100mls		0		nr	0	4		nr	0	9		nr	0	236
Calcium	mg/l Ca		200	137.2	330	260	110	137	360	380	49	159.8	250	320	75
Potassium	mg/l K		5	6.3	1.9	2.5	3	3	13	15	1.5	5	0.5	1	3.2
Aluminium	µg/l Al	150	200		1400	990	<25		1200	540	<25		590	330	54
Barium	µg/l Ba		100		700	63	240		870	74	28		490	41	76
Cadmium	µg/l Cd	3.75	5	<0.5	<0.5	<0.5	<0.5	<0.5	5.2	1.9	<0.5	<0.5	0.6	<0.5	<0.5
Chromium	µg/l Cr	37.5	30	<1.5	50	3.1	2.4	<1.5	43	1.7	2.2	<1.5	32	2.4	3.9
Copper	µg/l Cu	1500	30	<7	22	13	1.1	<7	43	19	0.7	<7	11	4.8	1.7
Iron	µg/l Fe		200	<20	1800	1700	160	<20	4000	11000	37	<20	790	370	230
Lead	µg/l Pb	18.75	10	<5	5.1	1.6	0.5	<5	86	52	<0.5	11	47	5.4	<0.5
Manganese	µg/l Mn		50	64	950	610	53	12	1800	1000	<25	26	380	120	59
Zinc	µg/l Zn		100	64	190	19	67	6	740	88	<3	7	200	14	10
Dichloromethane	µg/l		0.04		<0.5	<0.5	4		<0.5	<0.5	0.6		<0.5	<0.5	1.5

1) *Environmental Protection Agency 2003. Towards Setting Guideline Values for the Protection of Groundwater in Ireland, Interim Report.*
2) *Statutory Instruments. S.I. No.9 of 2010. European Communities Environmental Objectives (Groundwater) Regulations, 2010.*
3) *Nr – Not Recorded*

7.3.1 Surface water

The current status of the River Suir (Main) at Kilsheelan is rated as *Moderate*.

A summary of E.U. Annex II Habitats and EU Annex IV Species sensitivity to changes in groundwater is provided in Appendix B.

8.0 IMPACT ASSESSMENT

8.1 Assessment Methods

The evaluation, impact and significance criteria used in this Impact Assessment are given below:

Habitats were assessed in accordance with the guidance contained in the document *Guidelines for Ecological Impact Assessment in the United Kingdom* (IEEM, 2006), with reference to *Guidelines for Assessment of Ecological Impacts of National Roads Schemes* (NRA, 2009).

The evaluation, impact and significance criteria used in this Impact Assessment are given below:

Evaluation criteria

Table 3: Criteria for establishing receptor sensitivity/importance

Importance	Ecological Valuation

Importance	Ecological Valuation
International	Sites, habitats or species protected under international legislation e.g. Habitats and Birds Directive. These include, amongst others: SAC's, SPA's, Ramsar Sites, Biosphere Reserves, including sites proposed for designation, plus undesignated sites that support populations of internationally important species.
National	Sites, habitats or species protected under national legislation e.g. Wildlife Act 1976 and amendments. Sites include designated and proposed NHAs, Statutory Nature Reserves, National Parks, plus areas supporting resident or regularly occurring populations of species of national importance (e.g. 1% national population) protected under the Wildlife Acts, and rare (Red Data List) species.
Regional	Sites, habitats or species which may have regional importance, but which are not protected under legislation (although Local Plans may specifically identify them) e.g. viable areas or populations of Regional Biodiversity Action Plan habitats or species.
High Local/County	Areas supporting resident or regularly occurring populations of protected and red data listed-species of county importance (e.g. 1% of county population), Areas containing Annex I or II habitats or species not of international/national importance, County important populations of species or habitats identified in county plans, Areas of special amenity or subject to a Tree Preservation Order.
Moderate Local	Areas supporting resident or regularly occurring populations of protected and red data listed-species of local importance (e.g. 1% of local population), Undesignated sites or features which enhance or enrich the local area, Sites containing viable area or populations of local Biodiversity Plan habitats or species, local Red Data List species etc.
Low Local	Undesignated sites or features, which enhance or enrich the wildlife resource at a Parish or neighbourhood level.

8.1.1 Significance criteria

An impact's significance is measured bearing in mind the site's evaluation for nature conservation. An impact of severe significance is one which is likely to cause a considerable drop in the biodiversity value of a site that is extremely important for nature conservation. An impact of major significance will also impinge on an important nature conservation site or species but the impact will be less marked. An impact of moderate significance will cause a significant loss in biodiversity on a site but is unlikely to impinge on statutory sites or species. A minor impact will have only a very limited impact on biodiversity whereas an impact that is termed negligible/not significant is one that is most unlikely to impact in any way on biodiversity.

IEEM (2006, review 2011) define an ecologically significant impact as an impact (negative or positive) on the integrity of a defined site or ecosystem and/or the conservation status of habitats or species within a given geographic area. The integrity of a site is the coherence of its ecological structure and function, across its whole area, which enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified.

Best scientific professional judgement has been used in some cases, to assess the significance of predicted effects. The significance criteria are expressed on a six point scale, including both adverse and beneficial effects, as described in Table 4.

Table 4: Criteria for Assessing Significance of Predicted Impacts

Impact Level	Description
Severe Impact	Ecological effects of a scale or magnitude which would result in permanent, total loss of an irreplaceable species or habitat of international or national importance (occasionally of local importance), or which would result in the substantial loss of a protected/rare habitat or a population of a protected/rare species. They represent key factors in the decision-making process. Typically, mitigation measures would be unlikely to remove such effects.
Major Impact	These effects are likely to relate to permanent impacts at a regional or local level, or temporary impacts at an international or national level, and could be potential concerns to the project depending upon the relative importance attached to the issue during the decision making process. The effects are likely to be large in scale or magnitude, and result in substantial medium term loss of protected/rare species or habitats. Mitigation and detailed design work are unlikely to entirely eliminate all ecological effects.
Moderate Impact	These effects are usually only at local or regional level, and may be short or medium term only, or temporary impacts on a small part of an international site. However, the cumulative effects of such issues may lead to an increase in the overall effect on ecological features. They represent issues where effects will be experienced, but mitigation measures and detailed design work may ameliorate/enhance some of the consequences upon affected interests, but some residual effects will still arise.
Minor Impact	These effects are likely to be local issues only; or small magnitude impacts at the regional and national level, they are usually temporary, and are unlikely to be of importance in the decision making process. However, they are of relevance in enhancing the subsequent design of the development and consideration of mitigation measures.
Not Significant/No Impact	No perceivable impacts on ecological features (habitat or species). Impacts may be beneath levels of perception, within normal bounds of variation, within the margin of forecasting error, or impacting on exceptionally poor baseline conditions.
Beneficial/Positive Impact	These effects are those, which through implementation, would be anticipated to benefit the ecology of the site. They may advance the objectives of local, national or international species or habitats.

8.1.2 Impact characteristics

Direct and Indirect Impacts - An impact can be caused either as a direct or as an indirect consequence of a project.

Magnitude - Magnitude measures the size of an impact, which is described as high, medium, low or very low.

Extent - The area of which the impact occurs, where the receptor is a habitat, magnitude and extent may become synonymous.

Level - An impact is assessed based on whether it is of international, national, regional or local importance (Refer to Table 3). This has a direct bearing on its magnitude and significance.

Duration - The time for which the impact is expected to last prior to recovery or replacement of the resource or feature.

- Short Term: The effects would be of short duration and would not last more than 2-5 years from the commencement of development.
- Medium Term: The effects would take 5-15 years to be mitigated.
- Long Term: The effects would be reasonably mitigated over a long period of time (15 years or more).

Reversibility – An irreversible/permanent impact is one from which recovery is not possible within a reasonable timescale, while a reversible/temporary impact is one from which spontaneous recovery is possible.

Likelihood

- Near Certain: >95% chance of occurring as predicted
- Probable: 50-95% chance as occurring as predicted
- Unlikely: 5-50% chance as occurring as predicted
- Extremely Unlikely: <5% chance as occurring as predicted

8.2 Site Evaluation

The former landfill at Kilsheelan lies within the GWB catchment of Lower River Suir SAC. It has the potential to affect the groundwater quality of the Clonmel GWB which discharges to the river, and subsequently affect species present in the river and aquatic habitats. The site is of 'International' ecological value according to the criteria outlined in Table 3.

8.3 Potential Impacts

The main impact under consideration in this report – is that of contamination to groundwater from Kilsheelan former landfill, in close proximity to the River Suir which could result in a deterioration of water quality and subsequent impacts on Habitats Directive protected species of the Lower River Suir SAC. Potential impacts of water quality deterioration on the habitats, for which the site is designated, are also considered.

Potential direct and indirect impacts of the discharge are as follows:

- Direct effect on SAC habitats due to groundwater quality or deterioration of groundwater, resulting in changes in the vegetation community of the river;
- Direct effect on SAC species such as fish, from potential groundwater quality deterioration and of the River Suir; and
- Indirect effect on Otter or Kingfisher as their prey species have specific water quality requirements and any decline in water quality in the river could have significant indirect impacts on the otter populations using the river.

8.3.1 Cumulative Impacts

The Site occurs in the Suir Main Water Management Unit (WMU). The report indicates that the River Suir is at risk from diffuse sources of nutrient input mainly from agriculture, unsewered industry and Waste water treatment plants. There are other potential cumulative pressures from quarries and septic tanks in the catchment. The main pressures are listed in Table 5.

Table 5: Pressures and Risks to the Suir (WMU Action Plan)

Pressures/Risks	Description
Nutrient sources	Most TP is diffuse (85%) mainly from agriculture (58%), unsewered industry (17%). 15% is comes from WWTP.
Point pressures	■ 17 WWTP - Ardfinnan, Boherlahan, Cahir, Cashel, Clonmel, Golden, New Inn, Newcastle South, Ballymacarbry, Bawnfune, Fourmile Water, Kimacomma, Ballylooby, Clonoulty, Kilcash, Ballypatrick, Grange ■ 11 Section 4s: 3 Hotels, Woollen Mill, Dairy Factory, 2 Private Companies, College, Cottage, Inn, School. ■ 13 IPPC – 2 Pharmaceutical Production Companies, Installation Manufacturers, Meat Plant, Retail shop, Meat Plant, Quarry, 4 Private Companies, Protein Production Company, Research Center. ■ 7 WTPs - Cahir Resovir, Springmount, Glenary WTP, Poulavanogue, Kilcash WTP, Graigue WTP, and Kilroe WTP.
Wastewater Treatment Plants (WWTP) and Industrial Discharges	■ WWTP at risk: ■ Ardfinnan ■ Grange ■ Cashel ■ Cahir ■ Ballylooby Golden ■ Boherlahan Ballypatrick Clonmel ■ Newcastle New Inn ■ Ballymacarbry - An increase in treatment capacity to 600 pe is estimated to be required for future populations ■ Section 4s: 2 at risk ■ IPPCs: 2 at risk
Quarries, Mines & Landfills	There are 51 quarries within the WMU. There are no landfills or mines within the WMU.
Agriculture	There are 22 waterbodies at risk from Agriculture within the wMU: SE_1 6_3843, SE _16 _520, SE _16 _3534, SE _16 _3060, SE _16 _3076, , E _16 _3135, SE _16 _3394, SE _16 _3434, SE _16 _3352, SE _16 _4135, SE _16 _3419, SE _16 _4099, SE _16 _3041, SE _16 _3001, SE _16 _3786, SE _16 _3928, SE _16 _2997, SE _16 _3420, SE _16 _3235, SE_1 6_3845, SE_1 6_3893, SE_1 6_4181

On-site systems	There are 6327 septic tanks in this WMU, none of them are posing a risk to water quality due to their density, location and unsuitable hydrogeological conditions.
Forestry	There are no waterbodies within the WMU at risk from Forestry.
Dangerous substances	There are no waterbodies at risk from dangerous substances within the WMU.
Morphology	There are no waterbodies at risk.
Abstractions	There is one waterbody at risk from abstraction within the WMU: SE_1 6_3845.

8.4 Assessment of Impacts

Golder hydrogeologists have carried out modelling for the down hydraulic gradient groundwater concentrations resulting from the Kilsheelan former landfill (Appendix C).

Elevated groundwater concentrations of ammonia, chloride, calcium, potassium, some metals (including aluminium, barium, cadmium, chromium, copper, iron, lead, manganese and zinc) and dichloromethane have been encountered in the boreholes installed at the downstream site boundary (BH1 and BH2), compared with the Environmental Protection Agency (EPA) Interim Guideline Values (IGVs), (Attachment 1). An understanding is required of the migration of these concentrations further down hydraulic gradient and in the direction of the Lower Suir Special Area of Conservation (SAC). The River Suir is located around 1 km to the south of the site.

The recorded groundwater quality at the downstream boundary of the site will be subject to further dilution from recharge in the downstream catchment area as it migrates from the site. Any contaminants deriving from the landfill will additionally disperse during transport through the Carboniferous Limestone bedrock.

8.4.1 Results

The impact of dilution down hydraulic gradient of the site was simulated for two contaminants: ammonia, which had a high ratio of maximum concentrations to IGV (Appendix C), and chloride, which is a conservative unretarded contaminant. It is understood that the metal concentrations were provided as total concentrations since the laboratory do not filter before analysis. As such it is not considered appropriate to compare these to the IGV, which should apply to dissolved concentrations only.

Appendix C provides graphs of the reduction in groundwater concentration due to dilution alone with distance from the site. The concentrations predicted at nine years travel time (993 m down hydraulic gradient from the site) are given in Table 6.

Table 6: Dilution Assessment Results Prior to Discharge to the River Suir

Contaminant	Initial Concentration (mg/l)	Predicted Diluted Concentration at 993 m (mg/l)	IGV (mg/l)	European Environmental Objective (mg/l)*
Ammonia	2.7	0.57	0.117	0.14
Chloride	100.1	21	30	-

* From European Communities Environmental Objectives (Surface Water) Regulations 2009.

The contaminants will be subject to dispersion within the aquifer, with ammonia also subject to retardation and aerobic degradation; as such the predicted diluted groundwater concentrations are considered to be

conservative. It is considered that with dispersion, retardation and degradation in groundwater included, and with the groundwater input diluted further in the River Suir, the concentration of ammonia predicted will be reduced further below the European surface water environmental objective.

A conservative approach is taken in this assessment of the potential impact of the former landfill at Kilsheelan and it is considered Minor. Remediation will reduce this further to Not Significant.

Please see Section 9.0 for remediation measures and the remediation plan of the Tier III Risk Assessment for the Site.

Table 7: Potential Impacts from Kilsheelan on the River Suir

Description of Impact	Direct/Indirect	Magnitude	Level	Duration & Reversibility	Likelihood	Significance
Changes in water quality of groundwater (caused by contaminants to groundwater body from the closed landfill) resulting in: Possible changes to water quality of the River Suir and associated habitats and species.	Direct and Indirect Impacts on habitats and species of the river.	Low - Monitoring of groundwater indicates groundwater quality is currently rated as *Good* (WFD). However the River Suir surface water is rated as *Moderate* (WFD).	The impact is considered at the International level for the EU designated - Lower River Suir SAC.	At least short-term temporary impact.	Possible as the closed landfill is located in the groundwater body (Clonmel Groundwater body) that discharges to the River Suir.	Minor Potential for Negative Impact following groundwater monitoring and modelling which indicate minor impacts.

9.0 MITIGATION

Measures to reduce further the infiltration of rainwater and surface water through the Site should be implemented through the planting of native trees similar to those that occur in the surrounding area and that are typical of the county.

Willows would be a preferred tree, as it grows quickly and willows are known for their deep roots and ability to absorb large volumes of water and are among the most common tree species used in remediation. They remove a variety of organic and inorganic contaminants, as well as herbicides, pesticides and radionuclides. In many countries, large-scale willow plantings are used to treat municipal wastewater, landfill leachate, and sewage sludge. Willow roots prevent spread of contaminated water, and the willow can be pruned back hard, yielding wood for use.

The use of native tree species is important to ensure that no non-native or invasive species are introduced to the area. Tree selection and planting design should be carried out in consultation with Parks Section and a suitably qualified ecologist.

9.1 Benefits of woodland on contaminated lands

'Phytoremediation' and 'phytostabilisation' use plants to immobilise, convert or remove contaminants. Conventional 'clean-up' methods involve the removal or isolation of contaminated soil but these are very expensive. Phytoremediation and phytostabilisation using trees are comparatively inexpensive, in situ approaches that do not rely on the isolation or transport of contaminated material to other sites. Trees have the potential for restricting or preventing wind erosion, leaching, surface water runoff and erosion and thus weakening pollutant linkage between the site and likely receptors.

Vegetation is very effective at reducing erosion by wind and water. Under trees, soil is retained and protected by the presence of roots and foliage while the input of organic matter through leaf senescence increases the binding capacity and therefore the stability of soil.

10.0 RESIDUAL

Residual impacts once mitigation measures are implemented would be Not Significant on the Lower River Suir SAC.

11.0 MONITORING

Continued monitoring is recommended to ascertain the value of the remediation over the following 2 to 3 years.

12.0 CONCLUSION

Once the remediation plan is implemented and monitored by a suitably qualified ecologist, then potential significant impacts from Kilsheelan former landfill on the Lower River Suir SAC are unlikely.

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GOLDER ASSOCIATES IRELAND LIMITED

Anne Murray BSc MIEEM
Senior Ecologist

Thomas Vainio-Mattila
Senior Consultant

AM/TVM/am

Registered in Ireland Registration No. 297875
Town Centre House, Dublin Road, Naas, Co. Kildare, Ireland
Directors: M. Gilligan, A. Harris (British)
VAT No.: 8297875W

APPENDIX A

NPWS Site Synopsis

SITE NAME : LOWER RIVER SUIR

SITE CODE : 002137

This site consists of the freshwater stretches of the River Suir immediately south of Thurles, the tidal stretches as far as the confluence with the Barrow/Nore immediately east of Cheekpoint in Co. Waterford and many tributaries including the Clodiagh in Co. Waterford, the Lingaun, Anner, Nier, Tar, Aherlow, Multeen and Clodiagh in Co. Tipperary. The Suir and its tributaries flows through the counties of Tipperary, Kilkenny and Waterford. Upstream of Waterford city, the swinging meanders of the Suir crisscross the Devonian sandstone rim of hard rocks no less than three times as they leave the limestone-floored downfold below Carrick In the vicinity of Carrick-on-Suir the river follows the limestone floor of the Carrick Syncline. Upstream of Clonmel the river and its tributaries traverse Upper Palaeozoic Rocks, mainly the Lower Carboniferous Visean and Tournaisian. The freshwater stretches of the Clodiagh River in Co. Waterford traverse Silurian rocks, through narrow bands of Old Red Sandstone and Lower Avonian Shales before reaching the carboniferous limestone close to its confluence with the Suir. The Aherlow River flows through a Carboniferous limestone valley, with outcrops of Old Red Sandstone forming the Galtee Mountains to the south and the Slievenamuck range to the north. Glacial deposits of sands and gravels are common along the valley bottom, flanking the present-day river course.

The site is a candidate SAC selected for the presence of the priority habitats on Annex I of the E.U. Habitats Directive - alluvial wet woodlands and Yew Wood. The site is also selected as a candidate SAC for floating river vegetation, Atlantic salt meadows, Mediterranean salt meadows, old oak woodlands and eutrophic tall herbs, all habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive - Sea Lamprey, River Lamprey, Brook Lamprey, Freshwater Pearl Mussel, Crayfish, Twaite Shad, Atlantic Salmon and Otter.

Alluvial wet woodland is declining habitat in Europe as a result of drainage and reclamation. The best examples of this type of woodland in the site are found on the islands just below Carrick-on-Suir and at Fiddown Island. Species occurring here include Almond Willow (*Salix triandra*), White Willow (*S. alba*), Grey Willow (*S. cinerea*), Osier (*S. viminalis*), with Iris (*Iris pseudacorus*), Hemlock Water-dropwort (*Oenanthe crocata*), Angelica (*Angelica sylvestris*), Pendulus Sedge (*Carex pendula*), Meadowsweet (*Filipendula ulmaria*) and Valerian (*Valeriana officinalis*). The terrain is littered with dead trunks and branches and intersected with small channels which carry small streams to the river. The bryophyte and lichen floras appear to be rich and require further investigation. A small plot is currently being coppiced and managed by National Parks and Wildlife. In the drier areas the wet woodland species merge with other tree and shrub species including Ash (*Fraxinus excelsior*), Hazel (*Corylus avellana*), Hawthorn (*Crataegus monogyna*) and Blackthorn (*Prunus spinosa*). This adds further to the ecological interest of this site.

Eutrophic tall herb vegetation occurs in association with the various areas of alluvial forest and elsewhere where the flood-plain of the river is intact. Characteristic species of the habitat include Meadowsweet (*Filipendula ulmaria*), Purple Loosestrife (*Lythrum salicaria*), Marsh Ragwort (*Senecio aquaticus*), Ground Ivy (*Glechoma hederacea*) and Hedge Bindweed (*Calystegia sepium*).

Old oak woodlands are also of importance at the site. The best examples are seen in Portlaw Wood which lies on both sides of the Clodiagh River. On the south-facing side the stand is more open and the Oaks (mainly *Quercus robur)* are well grown and spreading. Ivy (*Hedera helix*) and Bramble (*Rubus fruticosus*) are common on the ground, indicating relatively high light conditions. Oak regeneration is dense, varying in age from 0-40 years and Holly (*Ilex aquifolium*) is fairly common but mostly quite young. Across the valley, by contrast, the trees are much more closely spaced and though taller are poorly grown on average. There are no clearings; large Oaks extend to the boundary wall. In the darker conditions, Ivy is much rarer and Holly much more frequent, forming a closed canopy in places. Oak regeneration is uncommon since there are as yet few natural clearings. The shallowness of the soil on the north- facing slope probably contributes to the poor tree growth there. The acid nature of the substrate has induced a “mountain” type Oakwood community to develop. There is an extensive species list present throughout including an abundance of mosses, liverworts and lichens. The rare lichen *Lobaria pulmonaria,* an indicator of ancient woodlands, is found.

Inchinsquillib Wood consists of three small separate sloping blocks of woodland in a valley cut by the young Multeen River and its tributaries through acidic Old Red Sandstone, and Silurian rocks. Two blocks, both with an eastern aspect, located to the north of the road, are predominantly of Sessile oak (*Quercus petraea*) and Hazel, with Downy Birch (*Betula pubescens*), Ash and Holly. The ground flora is quite mixed with for example Wood sedge (*Carex sylvatica*), Bluebell (*Hyacinthoides non-scriptus*), Primrose (*Primula vulgaris*), Wood-sorrel (*Oxalis acetosella*), Pignut (*Conopodium majus*) and Hard fern (*Blechnum spicant*). The base poor nature of the underlying rock is, to some extent masked by the overlying drift. The third block, to the south of the road, and with a northern aspect, is a similar although less mature mixture of Sessile Oak, Birch and Holly the influence of the drift is more marked, with the occurrence of Wood anemone (*Anemone nemorosa*) amongst the ground flora.

Floating river vegetation is evident in the freshwater stretches of the River Suir and along many of its tributaries. Typical species found include Canadian Pondweed (*Elodea canadensis*), Milfoil (*Myriophyllum* spp.), Fennel Pondweed (*Potamogeton pectinatus*), Curled Pondweed (*P. crispus*), Perfoliate Pondweed (*P. perfoliatus*), Pond Water-crowfoot (*Ranunculus peltatus*), other Crowfoots (*Ranunculus* spp.) and the moss *Fontinalis antipyretica.* At a couple of locations along the river, Opposite- leaved Pondweed (*Groenlandia densa*) occurs. This species is protected under the Flora (Protection) Order, 1999.

The Aherlow River is fast-flowing and mostly follows a natural unmodified river channel. Submerged vegetation includes the aquatic moss *Fontinalis antipyretica* and Stream Water-crowfoot (*Ranunculus pencillatus*), while shallow areas support species such as Reed Canary-grass (*Phalaris arundinacea*), Brooklime (*Veronica beccabunga*) and Water

Mint (*Mentha aquatica*). The river bank is fringed in places with Alder (*Alnus glutinosa*) and Willows (*Salix* spp.).

The Multeen River is fast flowing, mostly gravel-bottomed and appears to follow a natural unmodified river channel. Water Crowfoots occur in abundance and the aquatic moss *Fontinalis antipyretica* is also common. In sheltered shallows, species such as Water-cress (*Rorippa nasturtium-a quaticum*) and Water-starworts (*Callitriche* spp.) occur. The river channel is fringed for most of its length with Alder, Willow and a narrow strip of marshy vegetation.

Salt meadows occur below Waterford City in old meadows where the embankment is absent, or has been breached, and along the tidal stretches of some of the in-flowing rivers below Little Island. There are very narrow, non-continuous bands of this habitat along both banks. More extensive areas are also seen along the south bank at Ballynakill, the east side of Little Island, and in three large salt meadows between Ballynakill and Cheekpoint. The Atlantic and Mediterranean sub types are generally intermixed. The species list is extensive and includes Red Fescue (*Festuca rubra*), Oraches (*Atriplex* spp.), Sea Aster (*Aster tripolium*), Sea Couch Grass (*Elymus pycnanthus*), frequent Sea Milkwort (*Glaux maritima*), occasional Wild Celery (*Apium graveolens*), Parsley Water-dropwort (*Oenanthe lachenalii*), English Scurvygrass (*Cochlearia anglica*) and Sea Arrowgrass (*Triglochin maritima*). These species are more representative of the Atlantic sub-type of the habitat. Common Cord-grass (*Spartina anglica*), is rather frequent along the main channel edge and up the internal channels. The legally protected (Flora (Protection) Order, 1999) Meadow Barley (*Hordeum secalinum*) grows at the landward transition of the saltmarsh. Sea Rush (*Juncus maritimus*), an indicator of the Mediterranean salt meadows, also occurs.

Other habitats at the site include wet and dry grassland, marsh, reed swamp, improved grassland, coniferous plantations, deciduous woodland, scrub, tidal river, stony shore and mudflats. The most dominant habitat adjoining the river is improved grassland, although there are wet fields with species such as Yellow Flag (*Iris pseudacorus*), Meadow Sweet (*Filipendula ulmaria*), Rushes (*Juncus* spp.), Meadow Buttercup (*Ranunculus acris*) and Cuckoo Flower (*Cardamine pratensis*).

Cabragh marshes, just below Thurles, lie in a low-lying tributary valley into which the main river floods in winter. Here there is an extensive area of Common Reed (*Phragmites australis*) with associated marshland and peaty fen. The transition between vegetation types is often well displayed. A number of wetland plants of interest occur, in particular the Narrow-leaved Bulrush (*Typha angustifolia*), Bottle Sedge (*Carex rostrata*) and Blunt-flowered Rush (*Juncus subnodulosus*). The marsh is naturally eutrophic but it has also the nutritional legacy of the former sugar factory which

discharged into it through a number of holding lagoons, now removed. Production is high which is seen in the size of such species as Celery-leaved Buttercup (*Ranunculus sceleratus*) as well as in the reeds themselves.

Throughout the Lower River Suir site are small areas of woodland other than those described above. These tend to be a mixture of native and non-native species, although there are some areas of semi-natural wet woodland with species such as Ash and Willow. Cahir Park Woodlands is a narrow tract of mixed deciduous woodland lying on the flat- lying floodplain of the River Suir. This estate woodland was planted over one hundred

years ago and it contains a large component of exotic tree species. However, due to original planting and natural regeneration there is now a good mix of native and exotic species. About 5km north west of Cashel, Ardmayle pond is a long, possibly artificial water body running parallel to the River Suir. It is partly shaded by planted Lime (*Tilia* hybrids), Sycamore (*Acer pseudoplatanus*) and the native Alder. Growing beneath the trees are shade tolerant species such as Remote sedge (*Carex remota*).

The site is of particular conservation interest for the presence of a number of Annex II animal species, including Freshwater Pearl Mussel (*Margaritifera margaritifera* and *M. m. durrovensis*), Freshwater Crayfish (*Austropotamobius pallipes*), Salmon (*Salmo salar*), Twaite Shad (*Alosa fallax fallax*), three species of Lampreys - Sea Lamprey (*Petromyzon marinus*), Brook Lamprey (*Lampetra planeri*) and River Lamprey (*Lampetra fluviatilis*) and Otter (*Lutra lutra*). This is one of only three known spawning grounds in the country for Twaite Shad.

The site also supports populations of several other animal species. Those which are listed in the Irish Red Data Book include Daubenton's Bat (*Myotis daubentoni*), Natterer's Bat (*M. nattereri*), Pipistrelle (*Pipistrellus pipistrellus*), Pine Marten (*Martes martes*), Badger (*Meles meles*), the Irish Hare (*Lepus timidus hibernicus*), Smelt (*Osmerus eperlanus*) and the Frog (*Rana temporaria*). Breeding stocks of Carp are found in Kilsheelan Lake. This is one of only two lakes in the country which is known to have supported breeding Carp. Carp require unusually high summer water temperatures to breed in Ireland and the site may therefore support interesting invertebrate populations.

Parts of the site have also been identified as of ornithological importance for a number of Annex I (EU Birds Directive) bird species, including Greenland White-fronted Goose (10), Golden Plover (1490), Whooper Swan (7) and Kingfisher. Figures given in brackets are the average maximum counts from 4 count areas within the site for the three winters between 1994 and 1997. Wintering populations of migratory birds use the site. Flocks are seen in Coolfinn Marsh and also along the reedbeds and saltmarsh areas of the Suir. Coolfinn supports nationally important numbers of Greylag Geese on a regular basis. Numbers between 600 and 700 are recorded. Other species occurring include Mallard (21), Teal (159), Wigeon (26), Tufted Duck (60), Pintail (4), Pochard (2), Little Grebe (2), Black-tailed Godwit (20), Oystercatcher (16), Lapwing (993), Dunlin (101), Curlew (195), Redshank (28), Greenshank (4) and Green Sandpiper (1). Nationally important numbers of Lapwing (2750) were recorded at Faithlegg in the winter of 1996/97. In Cabragh marshes there is abundant food for surface feeding wildfowl which total at 1,000 or so in winter. Widgeon, Teal and Mallard are numerous and the latter has a large breeding population - with up to 400 in summer. In addition, less frequent species like Shoveler and Pintail occur and there are records for both Whooper and Bewick's swans. Kingfisher, a species that is listed on Annex I of the EU Birds Directive, occurs along some of the many tributaries throughout the site.

Landuse at the site consists mainly of agricultural activities including grazing, silage production, fertilising and land reclamation. The grassland is intensively managed and the rivers are therefore vulnerable to pollution from run-off of fertilisers and slurry. Arable crops are also grown. Fishing is a main tourist attraction on stretches of the Suir and some of its tributaries and there are a number of Angler Associations, some with a number of beats. Fishing stands and styles have been erected in places. Both commercial and leisure fishing takes place on the rivers. The Aherlow River is a designated Salmonid

Water under the EU Freshwater Fish Directive. Other recreational activities such as boating, golfing and walking are also popular. Several industrial developments, which discharge into the river, border the site including three dairy related operations and a tannery.

The Lower River Suir contains excellent examples of a number of Annex I habitats, including the priority habitat Alluvial Forest. The site also supports populations of several Annex II animal species and a number of Red Data Book animal species. The presence of two legally protected plants (Flora (Protection) Order, 1999) and the ornithological importance of the river adds further to the ecological interest of this site.

6.10.2006

APPENDIX B

EU Annex I Habitats and EU Annex II Species sensitivity to changes in groundwater

Surface water ecosystems and terrestrial ecosystems directly dependent on groundwater. * Indicates priority habitats (after Mayes, 2008)

EU Habitat Code	EU Annex I Habitat	Number of SACs	Type	Sensitivity to changes in Groundwater Quantity	Sensitivity to changes in Groundwater Quality
1150	* Coastal lagoons	25	SW	low - high	Moderate - high
1330	Atlantic salt meadows *(Glauco-Puccinelietalia maritimae)*	38	GWDTE	low - moderate	low
1410	Mediterranean salt meadows *(Juncetalia maritimi)*	33	GWDTE	low - moderate	low
2170	Dunes with *Salix repens* ssp. *argentea (Salicion arenariae)*	11	GWDTE	high	high
2190	Humid dune slacks	15	GWDTE	high - extreme	high - extreme
21A0	Machairs (* in Ireland)	19	GWDTE	high - extreme	moderate - high
3110	Oligotrophic waters containing very few minerals of sandy plains *(Littoreletalia uniflorae)*	32	SW	moderate	extreme
3130	Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*	9	SW	moderate	high
3140	Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.	18	SW	high	high-extreme
3150	Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation	9	SW	moderate	moderate
3160	Natural dystrophic lakes and ponds	10	SW	low	extreme
3180	* Turloughs	43	GWDTE	high	moderate - extreme
3260	Watercourses of plain to montane levels with the *Ranunculion fluitantis* and *Calitricho-Batrachion* vegetation	21	SW	moderate	moderate
3270	Rivers with muddy banks with *Chenopodion rubri* p.p. and *Bidention* p.p.	1	GWDTE	moderate	low
4010	Northern Atlantic wet heaths with *Erica tetralix*	37	GWDTE	low - (extreme)	high
6410	*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils *(Molinion*	13	GWDTE	low - moderate	low - moderate
6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine	3	GWDTE	moderate	moderate
7110	* Active raised bogs	51	GWDTE	low - (extreme)**	low -(high)**
7120	Degraded raised bogs still capable of natural regeneration	53	GWDTE	low - (extreme)**	low -(high)**
7130	Blanket bog (* if active bog)	50	GWDTE	low - (extreme)**	low -(high)**
7140	Transition mires and quaking bogs	16	GWDTE	extreme	moderate
7150	Depressions on peat substrates of the *Rhynchosporion*	62	GWDTE	low	moderate
7210	* Calcareous fens with *Cladium mariscus* and species of *Caricion davalianae*	17	GWDTE	extreme	high
7220	* Petrifying springs with tufa formation *(Cratoneurion)*	19	GWDTE	extreme	extreme

EU Habitat Code	EU Annex I Habitat	Number of SACs	Type	Sensitivity to changes in Groundwater Quantity	Sensitivity to changes in Groundwater Quality
7230	Alkaline fens	39	GWDTE	extreme	high
8310	Caves not open to the public	9	GWDTE	extreme	high
91D0	* Bog woodland	11	GWDTE	extreme	low
91E0	*Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior (Alno-padion, Alnion incanae, Salicion*	23	GWDTE	moderate	low - high

GWDTE – Groundwater Dependent Terrestrial Ecosystem; SW – Surface Water, Aquatic Ecosystem; ** when fen present

Table 2: Species directly dependent on groundwater (after Mayes, 2008)

EU Species Code	EU Annex II Species	Number of SACs	Sensitivity to changes in Groundwater Quantity	Sensitivity to changes in Groundwater Quality
1013	*Vertigo geyeri*	10	extreme	extreme
1014	*Vertigo angustior*	11	high	high
1016	*Vertigo moulinsiana*	7	high	high
1092	*Austropotamobius palipes*	13	high	moderate
1393	*Drepanocladus vernicosus*	7	extreme	extreme
1528	*Saxifraga hirculus*	4	extreme	extreme

APPENDIX C

Down hydraulic gradient groundwater concentrations

Introduction

Elevated groundwater concentrations of ammonia, chloride, calcium, potassium, some metals (including aluminium, barium, cadmium, chromium, copper, iron, lead, manganese and zinc) and dichloromethane have been encountered in the boreholes installed at the downstream site boundary (BH1 and BH2), compared with the Environmental Protection Agency (EPA) Interim Guideline Values (IGVs), (Attachment 1). An understanding is required of the migration of these concentrations further down hydraulic gradient and in the direction of the Lower Suir Special Area of Conservation (SAC). The River Suir is located around 1 km to the south of the site.

The recorded groundwater quality at the downstream boundary of the site will be subject to further dilution from recharge in the downstream catchment area as it migrates from the site. Any contaminants deriving from the landfill will additionally disperse during transport through the Carboniferous Limestone bedrock.

Dilution Calculation Approach

In order to constrain the impact of dilution alone the following approach has been adopted:

The groundwater underflow beneath the site is calculated using Darcy's Law:

$$Q = K*A*i$$

Where Q is the flow (m^3/s), K is the aquifer hydraulic conductivity (m/s), A is the flow area (m^2), which is equal to the mixing zone thickness multiplied by the width of the site in the direction of groundwater flow (80 m), and i is the hydraulic gradient of the groundwater beneath the site (m/m);

The groundwater velocity is calculated using the following equation:

$$V = Ki/n_e$$

Where V is the velocity (m/s) and n_e is the effective porosity of the bedrock (fraction);

The down gradient recharge to the bedrock (R in m^3/year) is calculated for each year of travel by assuming 60% of effective rainfall (estimated at 550 mm/year) infiltrates an area equal to the distance groundwater travels in a year, calculated from the groundwater velocity, multiplied by the width of the site; and

The diluted concentration is calculated using the following equation:

$$C_d = (C_o*Q)/(Q+R)$$

Where C_d is the concentration at distance d (mg/l) and C_o is the maximum concentration reported in the down hydraulic gradient boreholes (mg/l).

Attachment 2 provides these calculations and justification for the input values applied.

Results

The impact of dilution down hydraulic gradient of the site was simulated for two contaminants: ammonia, which had a high ratio of maximum concentrations to IGV (Attachment 1), and chloride, which is a conservative unretarded contaminant. It is understood that the metal concentrations were provided as total concentrations since the laboratory do not filter before analysis. As such it is not considered appropriate to compare these to the IGV, which should apply to dissolved concentrations only.

Attachment 2 provides graphs of the reduction in groundwater concentration due to dilution alone with distance from the site. The concentrations predicted at nine years travel time (993 m down hydraulic gradient from the site) are given in Table 1.

Table 1: Dilution Assessment Results Prior to Discharge to the River Suir

Contaminant	Initial Concentration (mg/l)	Predicted Diluted Concentration at 993 m (mg/l)	IGV (mg/l)	European Environmental Objective (mg/l)*
Ammonia	2.7	0.57	0.117	0.14
Chloride	100.1	21	30	-

* From European Communities Environmental Objectives (Surface Water) Regulations 2009.

The contaminants will be subject to dispersion within the aquifer, with ammonia also subject to retardation and aerobic degradation; as such the predicted diluted groundwater concentrations are considered to be conservative. It is considered that with dispersion, retardation and degradation in groundwater included, and with the groundwater input diluted further in the River Suir, the concentration of ammonia predicted will be reduced further below the European surface water environmental objective.

Maximum Groundwater Concentration to IGV Ratio

Parameter	Units	EPA IGV	Max. downstream conc. (from Figure 2)	Ratio of Max to IGV
Electrical Conductivity	uS/cm	1000	1301	1.30
Ammonia	mg/l	0.117	2.7	**23.08**
Chloride	mg/l	30	100.1	**3.34**
Calcium	mg/l	200	380	1.9
Potassium	mg/l	5	15	3
Aluminium	ug/l	200	1400	7
Barium	ug/l	100	870	8.7
Cadmium	ug/l	5	5.2	1.04
Chromium	ug/l	30	50	1.67
Copper	ug/l	30	43	1.43
Iron	ug/l	200	11000	**55**
Lead	ug/l	10	86	8.6
Manganese	ug/l	50	1800	36
Zinc	ug/l	100	740	7.4
Dichloromethane	ug/l	0.04	1	25

Although not reported on lab. sheets, it is considered that metal concentrations are 'total' rather than 'dissolved' since the laboratory have confirmed they do not filter the samples prior to analysis.

A sediment contribution is therefore likely to be included in the analysis results and it is not appropriate to compare to IGV values

Groundwater Quality Dilution Assessment

Parameter	Code	Unit	Value	Justification/source of value
Groundwater Underflow Calculation				
Aquifer hydraulic conductivity	K	m/s	1.00E-05	middle of the hydraulic conducitivty range reported for the Limestone bedrock in EPA, 2011
Mixing zone thickness	b	m	20	estimated maximum waste thickness presented from geophysics data, plus 7 m in underlying bedrock
pathway width	w	m	80	width of the site in the direction of groundwater flow
Aquifer hydraulic gradient	i	-	0.014	hydraulic gradient measured from groundwater levels in July 2012
Aquifer flow	Q	m^3/s	2.24E-04	Calculated: Q=Kbwi
		m^3/yr	7.06E+03	
Groundwater Velocity Calculation				
Aquifer effective porosity	n_e	fraction	0.04	4% porosity taken towards high end of limestone effective porosity in Domenico and Schwartz, 1998
Groundwater velocity	v	m/s	0.0000035	Calculated: v=ki/ne
		m/yr	110.376	
Recharge Calculation				
Infiltration	Inf	mm/yr	330	60% of effective rainfall - consistent with values given in EPA, 2011

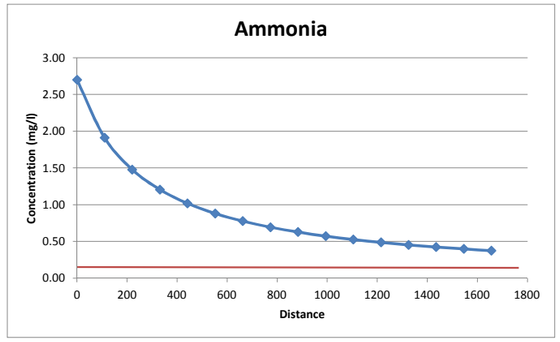
Dilution Calculation

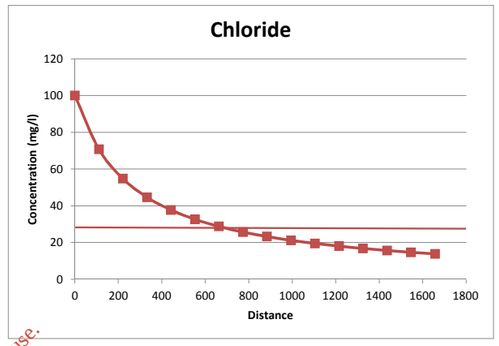
Initial concentrations

Ammonia	Co	mg/l	2.7	maximum recorded in BH1 and BH2
Chloride		mg/l	100.1	maximum recorded in BH1 and BH2

			Year															
Parameter	Code	Unit	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Groundwater Distance travelled	d	m	0	110.38	220.75	331.13	441.50	551.88	662.26	772.63	883.01	993.38	1103.76	1214.14	1324.51	1434.89	1545.26	1655.64
Recharge Volume	R	m^3/yr		2913.93	5827.85	8741.78	11655.71	14569.63	17483.56	20397.48	23311.41	26225.34	29139.26	32053.19	34967.12	37881.04	40794.97	43708.90
Diluted Concentration - Ammonia	C_d	mg/l	2.7	1.91E+00	1.48E+00	1.21E+00	1.02E+00	8.82E-01	7.77E-01	6.95E-01	6.28E-01	5.73E-01	5.27E-01	4.88E-01	4.54E-01	4.24E-01	3.99E-01	3.76E-01
Diluted Concentration - Chloride	C_d	mg/l	100.1	7.09E+01	5.48E+01	4.47E+01	3.78E+01	3.27E+01	2.88E+01	2.57E+01	2.33E+01	2.12E+01	1.95E+01	1.81E+01	1.68E+01	1.57E+01	1.48E+01	1.39E+01

Justification/source of value
Calculated: d = v*year
Calculated: R = d*Inf*w
Calculated: C_d = (Co*Q)/(Q+R)





Red line shows IGV value

EPA, 2011 - A Review of Groundwater Levels in the South-East of Ireland on website http://www.epa.ie/downloads/pubs/research/water/kteddinterim/
Domenico and Schwartz, 1998 - Physical and Chemical Hydrogeology, second edition

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Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ireland Limited
Town Centre House
Dublin Road
Naas
Co. Kildare
Ireland
T: +353 45 87 4411

Golder Associates