FEHILY TIMONEY

CONSULTANTS IN ENGINEERING,
ENVIRONMENTAL SCIENCE &
PLANNING

TIPPERARY TOWN HISTORICAL LANDFILL REMEDIATION

APPROPRIATE ASSESSMENT SCREENING REPORT AND NATURA IMPACT STATEMENT FOR TIPPERARY TOWN HISTORICAL LANDFILL REMEDIATION

Prepared for:

Tipperary Town Council

Comhairle Contae Thiobraid Árann
Tipperary County Council

Date: **December 2022**

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TITLE OF REPORT

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Abstract: This document comprises the Stage One: Appropriate Assessment Screening Report and Natura Impact Statement for the Historic Landfill at Carrownreddy, Tipperary Town. Appropriate Assessment is required under Article 6 (3) of the Habitats Directive for any project or plan that may give rise to significant effects on a European (Natura 2000) site.

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1. INTRODUCTION

Fehily Timoney & Company (FT) was commissioned by Tipperary County Council to provide consultancy services in respect of the proposed Tipperary Town historical landfill remediation. The EPA issued a certificate of authorisation for the site on the 6th of February 2019 (Licence number: H0004-01, see Appendix 1). The proposed project is to implement the certification of authorisation to remediate a historic landfill site. The EPA prepared a Stage One Screening for Appropriate Assessment for the proposed project which determined that a Stage Two Appropriate Assessment was required for Lower River Suir SAC (see Appendix 2).

An Appropriate Assessment Screening Report (Section 6) and a Natura Impact Statement (NIS) (Section 7) have been prepared in respect of the proposed project, as required by Article 6 of Council Directive 92/43/EEC (Habitats Directive).

In compliance with the provisions of Article 6 of the Habitats Directive, as implemented by Part XAB of the Planning and Development Act 2000, as amended, in circumstances where a proposed plan or project is likely to have a significant effect on a European (Natura 2000) site, either individually or in combination with other plans or projects, an Appropriate Assessment (AA) must be undertaken by the competent authority, of the implications for the site in view of the site’s conservation objectives.

European sites comprise both Special Protection Areas (SPAs) for birds and Special Areas of Conservation (SACs) for habitats and species. The Habitats Directive formed a basis for the designation of SACs. Similarly, SPAs are legislated for under the Birds Directive (Council Directive 79/409/EEC on the Conservation of Wild Birds). In general terms, European sites are considered to be of exceptional importance in terms of rare, endangered or vulnerable habitats and species within the European Community.

Article 6 of the Habitats Directive envisages a two-stage process, which is implemented in some detail by the provisions of sections 177U and 177V of the Planning and Development Act. Screening for appropriate assessment in accordance with section 177U is the first stage of the AA process (Stage One), in which the possibility of there being a significant effect on a European site is considered. Plans or projects that have no appreciable effect on a European site are thereby excluded, or screened out, at this stage of the process. Where screening concludes that there is the potential for significant effects, then it is necessary to carry out an AA (Stage Two) for the purposes of Article 6(3), and a Natura Impact Statement (NIS) is produced. The NIS, which forms the basis of the AA, considers the impact of a project or plan on the integrity of a European site and on its conservation objectives, and where necessary, draws up mitigation measures to avoid/minimise negative impacts.

The competent authority is required to make an examination, analysis, evaluation, findings, conclusions and a final determination as to whether or not the proposed development would adversely affect the integrity of the relevant European site in view of its conservation objectives.

To evaluate the potential effects(s) of the proposed remediation on the European sites, all sites located within a 15km radius of the development or those which are ecologically linked were considered. Please note that while a 15km buffer is recommended for plans, there is no hard and fast rule for buffer size (DoEHLG, 2009). A 15km buffer was used in line with standard industry practice; however, the potential zone of influence can be considered to extend to European sites located outside the 15km buffer where potential links exist. In this case no such links were identified.

The first half of this report comprises the Stage One Screening Report (in Section 6) and associated information on the existing environment and project description to evaluate the potential impact(s) of the proposed Tipperary Town historical landfill remediation on the European sites located within a 15 km radius.

The second half comprises the stage two NIS (Natura Impact Statement) which considers the conservation objectives of potentially affected European sites 'screened in' at stage one in detail and specifies mitigation measures to avoid or reduce negative effects on these European sites.

The following European Sites are located within 15km of the proposed development:

- Lower River Suir SAC* (site code 002137) is located approximately 6.5 km from the historical landfill site; this European site lies to the northeast, east and south of the landfill site (Instream distance 18.2 km).
- Moanour Mountain SAC (Site Code 002257) is located approximately 8.3 km southwest of the historical landfill site.
- Philipston Marsh SAC (Site Code 001847) is located approximately 9.2 km north of the of the historical landfill site.
- Galtee Mountains SAC (Site Code 000646) is located approximately 9.3 km south of the historical landfill site.
- Lower River Shannon SAC (Site Code 002165) is located approximately 12.1 km northwest of the historical landfill site.

** At present most SACs in Ireland are currently 'candidate' SACs, and referred to as cSACs. The relevant Statutory Instruments for the cSACs in Ireland have not yet been made, however, these "candidate" sites must still be afforded the same level of protection as if they were SACs as designated in accordance with the EU Habitats Directive.*

1.1 Legislative Requirements

The requirements for an AA are set out in the Habitats Directive 92/43/EEC. Articles 6(3) and 6(4) of this Directive states:

6(3) Any plan or project not directly connected with or necessary to the management of the site (Natura 2000 sites) but likely to have 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.

6(4) 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 social or economic nature, the Member State 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 statutory agency responsible for European sites is the National Parks and Wildlife Service (NPWS) of the Department of Culture, Heritage and the Gaeltacht (DCHG). In December 2009 'Appropriate Assessment of Plans and Projects in Ireland: Guidance for Planning Authorities, Department of the Environment, Heritage and Local Government' was published with a minor amendment in February 2010 (DoEHLG, 2010).

This guidance document was prepared jointly by the NPWS and Planning Divisions of DoEHLG (now DCHG), with input from local authorities. Previously, in 2001, the European Commission issued a guidance document. This guidance document has been updated in the published European Commission (2018) "*Managing Natura 2000 sites the provisions of Article 6 of the 'Habitats' Directive 92/43/EEC*". This Appropriate Assessment Screening Report has been prepared in accordance with the relevant Irish and European Commission Guidance.

1.1.1 Regulatory Context

In 1997, the Habitats Directive was transposed into Irish National Law by the European Communities (Natural Habitats) Regulations, SI 94/1997 (as amended by S.I. 233/1998 & S.I. 378/2005). The European Communities (Birds and Natural Habitats) Regulations, 2011 (S.I. 477/2011) revoked the 1997 Regulations (and amendments) as well as the European Communities (Birds and Natural Habitats) (Control of Recreational Activities) Regulations 2010. The purpose of the 2011 Regulations was to address transposition failures identified in the Court of Justice of the European Union (CJEU) judgements.

Following additional amendments in 2013 (S.I. 499/2013) and 2015 (S.I. 355/2015) the regulations are now cited as the European Communities (Birds and Natural Habitats) Regulations 2011 to 2015.

The Regulations have been prepared to address several judgments of the CJEU against Ireland, notably cases C-418/04 (*Commission v Ireland*) and C-183/05 (*Commission v Ireland*), in respect of failure to transpose elements of the Birds Directive and the Habitats Directive into Irish law.

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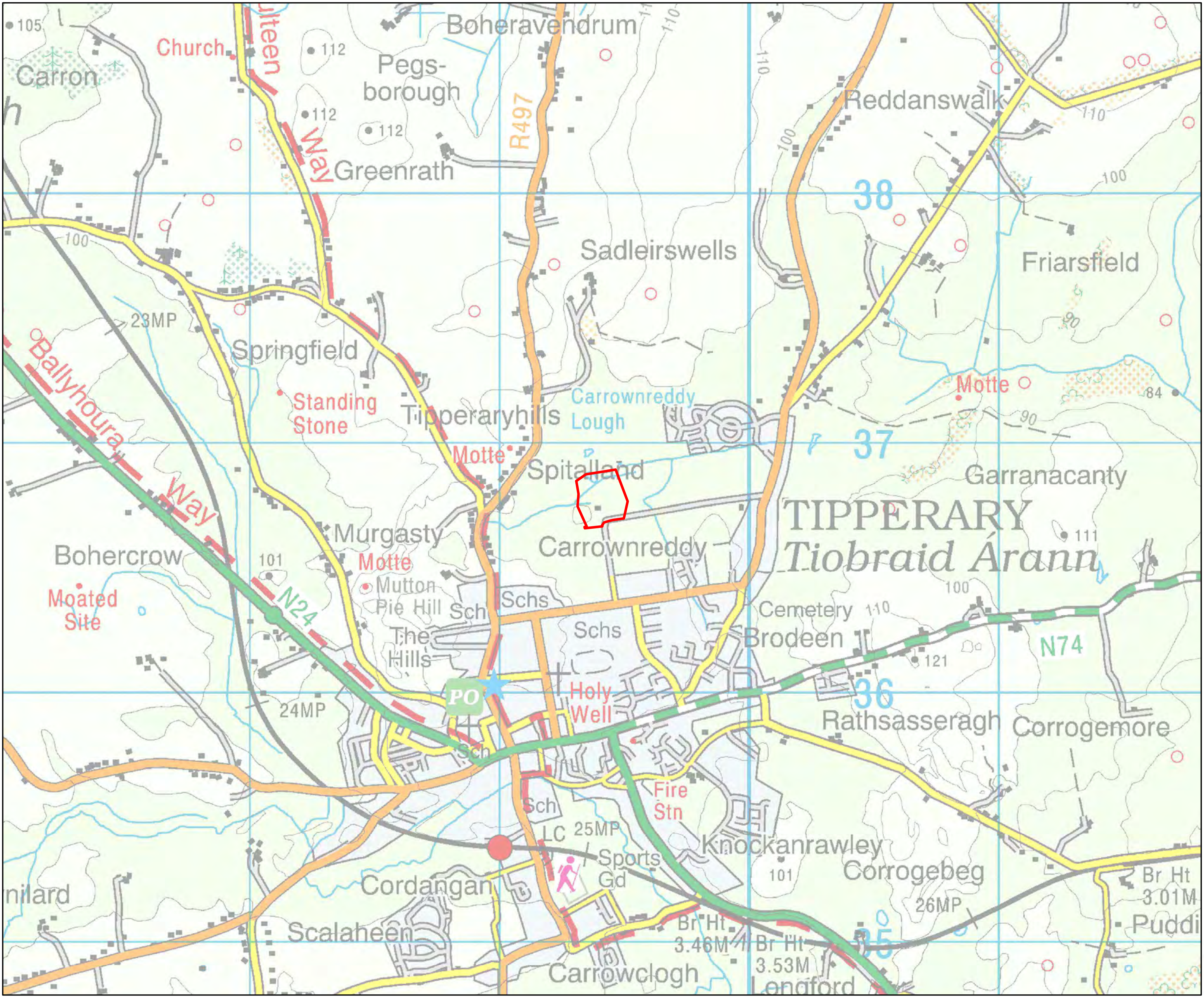

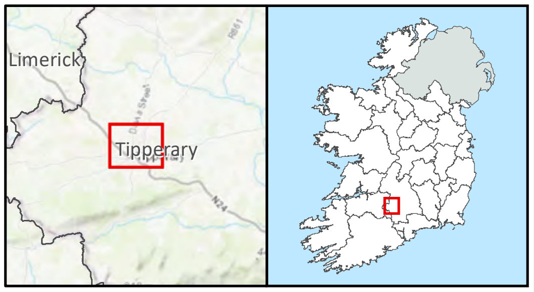

Landfill Boundary

Kilometers
0 0.25 0.5 1

TITLE:
Site Location

PROJECT:
Tipperary Town Historical Landfill Remediation

FIGURE NO: 1.1
CLIENT: Tipperary County Council
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1.2 Relevant Experience and Expertise of Assessor

Jon Kearney of Fehily Timoney and Company was responsible for completing both the Appropriate Assessment Screening and Stage 2 Appropriate Assessment / Natura Impact Statement in this case. Jon is a Principal Ecologist working as part of the Waste and Environment Team at Fehily Timoney and Company.

Jon is a specialist planner and ecologist with over 14 years' experience in both the UK and Ireland. His skills include an extensive knowledge of planning environmental law and planning requirements for ecology and biodiversity. Jon's experience spans ecology survey techniques and methodology, ornithological surveys, mitigation design, water quality assessment, Appropriate Assessment and Ecological Impact Assessment. Jon has completed ecological assessments, EcIAs, Environmental Impact Assessment Reports (EIAR) and Appropriate Assessments for a wide variety of projects in Ireland and the UK. He has considerable experience of EIS/EIAR and ecological constraints work, which often includes extensive reference to, and interpretation of, Article 6 of 'The Habitats Directive', and to other EU, UK and Irish conservation legislation.

2. METHODOLGY

2.1 Stages of Appropriate Assessment

The Habitats Directive promotes a hierarchy of avoidance, mitigation and compensatory measures to be addressed in the AA process. Firstly, a project should aim to avoid any negative effects on European sites by identifying possible effects early in the project and should design the project in order to avoid such effects.

There are four stages in an AA, as outlined in the European Commission Guidance document (2001). The following is a brief summary of these steps:

- Stage One - Screening: This stage examines the likely effects of a project either alone or in combination with other projects upon a European Site and considers whether it can be objectively concluded that these effects will not be significant.
- Stage Two - Appropriate Assessment: In this stage, the effect of the project on the integrity of the European site is considered with respect to the conservation objectives of the site and to its structure and function. Mitigation measures should be applied to the point where no adverse effects on the site(s) remain.
- Stage Three - Assessment of Alternative Solutions: Should the Appropriate Assessment determine that adverse effects are likely upon a European site, this stage examines alternative ways of implementing the project that, where possible, avoid these adverse effects.
- Stage Four - Assessment where no alternative solutions exist and where adverse effects remain: Where imperative reasons of overriding public interest (IROPI) exist, an assessment to consider whether compensatory measures will or will not effectively offset the damage to the Natura site will be necessary. European case law highlights that consideration must be given to alternatives outside the project area in carrying out the IROPI test. It is a rigorous test which projects are generally considered unlikely to pass.

In the preparation of this assessment therefore regard has been given to the Habitats Directive and the European Communities (Birds and Natural Habitats) Regulations 2011, and with reference to the relevant guidance, in particular:

- 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 Commission 2001.
- *Appropriate Assessment of Plans and Projects in Ireland:* Guidance for Planning Authorities. National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin 2010.
- European Commission (2018). Managing Natura 2000 sites. *The provisions of Article 6 of the Habitats Directive 92/43/EEC.* Brussels, 21.11.2018 C (2018) 7621 final.

2.1.1 Impact Assessment

The first step in the screening process is to develop a list of European sites potentially affected by the proposed development. Each European site is reviewed to establish whether or not the proposed development is likely to have a significant effect on the integrity of the site, as defined by its structure and function, and its conservation objectives. The qualifying interests of each European site are identified, and the potential threats are summarised into the following categories for the screening process, and described within the screening matrix as follows:

- Direct effects refer to habitat loss or fragmentation arising from land-take requirements for development or agricultural purposes. Direct effects can be as a result of a change in land use or management, such as the removal of agricultural practices that prevent scrub encroachment.
- Indirect and secondary effects do not have a straight-line route between cause and effect, and it is potentially more challenging to ensure that all the possible indirect effects of the plan (or project) – in combination with other plans and projects - have been established. These can arise when a development alters the hydrology of a catchment area, which in turn affects the movement of groundwater to a site, and the qualifying interests that rely on the maintenance of water levels. Deterioration in water quality can occur as both an indirect or direct consequence of development, which in turn changes the aquatic environment and reduces its capacity to support certain plants and animals. The introduction of invasive species can also be defined as an indirect effect, which results in increased movement of vectors (humans, fauna, surface water), and consequently the transfer of alien species from one area to another.
- Disturbance to fauna can arise directly through the loss of habitat (e.g., bat roosts) or indirectly through noise, vibration and increased activity associated with construction and operation.

2.2 Desktop Study

To complete the Screening for Appropriate Assessment certain information on the existing environment is required. A desk study was carried out to collate available information on the site’s natural environment. This comprised a review of the following publications, data and datasets:

- South Tipperary County Development Plan 2009
- North Tipperary County Development Plan 2009
- South Tipperary Biodiversity Action Plan 2010-2015
- Draft North Tipperary Local Biodiversity Action Plan 2007
- Tipperary County Council Planning Enquiry System
- National Parks and Wildlife Service (NPWS) website and metadata (www.npws.ie)
- OSI Aerial photography and 1:50,000 mapping
- National Biodiversity Data Centre (NBDC) (on-line map-viewer)
- Environmental Protection Agency (EPA) water quality data.

2.3 Field Assessments

Terrestrial ecological surveys were carried out by FT at the historical landfill site on the 3rd of May 2018 and the 2nd of June 2020. Surveys of invasive species stands are undertaken on a bi-annual basis (Spring and Autumn) since autumn 2018 and are currently ongoing. These surveys are undertaken to monitor the effectiveness and progress of invasive species eradication measures which are ongoing at the historical landfill site.

Aquatic surveys of the receiving environment (including watercourses downstream) of the subject site were carried out by an aquatic ecology specialist on the 18th and 19th of May 2020. These surveys extended from the landfill site to the Ara-Aherlow confluence c. 18 km downstream of the landfill site.

2.3.1 Habitats and Flora Investigation

Habitat surveys were carried out to categorise the habitats within the site according to Fossitt (2000) A Guide to the Habitats in Ireland. The results of the habitat surveys are described in Section 3.1. All floral species found during the walkover surveys of the site were identified using the following identification keys:

- Parnell, J: Curtis, T; and Cullen, E. (2012): Webb's an Irish Flora.
- Rose, F. (2006) The Wild Flower Key
- Press & Hosking (1992) Trees of Britain and Europe.
- Fitzpatrick, U., Weekes, L., Wright, M. (2016) Identification Guide to Ireland's Grasses.

2.3.2 Faunal Surveys

Terrestrial ecological surveys also encompassed mammals, bats and birds. Live sightings of animals were recorded, and field signs were searched for. Surveys were undertaken in accordance with the guidance document Ecological surveying techniques for protected flora and fauna during the planning of National Road Schemes – Version 2 (NRA 2008).

2.3.3 Invasive Species Surveys

The invasive non-native plant species present onsite were identified and mapped. Initial mapping was carried out onsite in May 2018, with inspections of invasive species stands conducted on a bi-annual basis from autumn 2018 which are currently ongoing. The status of invasive species and success of eradication measures is recorded during each bi-annual monitoring survey, and mapping is updated as required.

2.3.4 Aquatic Ecology Surveys

The habitats present along the hydrological network downstream of the site were classified according to Fossitt (2000) and adhered to Best Practice Guidance for Habitat Survey and Mapping (Smith et al., 2011) to gather information regarding habitat composition, species presence and ecological conditions. Aquatic plant species were recorded, and a search was carried out for the presence of any plant species listed in the Flora Protection Order (2015).

The status of protected aquatic and semi-aquatic species potentially occurring in or alongside the River Ara for 1km downstream of the drain from the historical landfill site (see Appendix 2 of Aquatic Ecology Report in Appendix 3 of this document), at five bridges further downstream on this river (see Appendix 4 of Aquatic Ecology Report in Appendix 3 of this document) and in the Aherlow River downstream of the confluence was assessed as follows:

- The presence of the freshwater pearl mussel (Margaritifera margaritifera) was checked for by a survey carried out under a Stage 1/2 licence (Licence No. C15/2020) from the National Parks and Wildlife Service. The riverbed was searched visually, using a Perspex-bottomed viewer.
- Available records on the wider distribution of the freshwater pearl mussel (Margaritifera margaritifera) in the Suir catchment were checked.
- A licensed survey (Licence No. C29/2020) was carried out to check for the white-clawed crayfish (Austropotamobius pallipes), following the methodology of Peay (2003). The habitat quality for this species was assessed, based on the criteria outlined by Holdich (2003). Available records were checked and information on the current state of crayfish plague in the Suir catchment was sought.
- The habitat quality for salmonids (Salmo salar and Salmo trutta) was assessed, based on the criteria outlined by Kennedy (1984) and by Bardonnet and Baglinière (2000) for the physical instream requirements of these species for spawning, nursery and adult habitat.
- The habitat quality for of lamprey species, was assessed, based on the criteria outlined by Maitland (1980) and by Johns (2002) for the physical instream requirements of these species for spawning, nursery and adult habitat. Where suitable nursery habitat was found, sand/silt was dredged with a hand-net (mesh size 2mm) to check for ammocoete lamprey presence. Available data on lamprey species in the River Ara and in the lower Suir catchment were checked. 5
- The habitat quality for kingfisher (Alcedo atthis), a species listed on Annex I of the EU Birds Directive, was assessed, based on the criteria outlined by Boag (1982) and by Morrison (1989). Visual evidence of the presence of this species was noted.
- The suitability of the habitats for dipper (Cinclus cinclus) and grey wagtail (Motacilla cinerea) was assessed by the criteria of Morrison (1998) and possible nest sites were searched and visual evidence of the presence of this species was noted.
- The presence of the otter (Lutra lutra) was checked for by a survey of the riverbank for holts or couching sites and an examination of hard bankside surfaces for the presence of spraints and bankside mud/sand for imprints. A Bushnell HD trail camera was set overnight on 18/05/2020 at the first bridge downstream on the River Ara, with a view of the river and riverbanks. The habitat quality for otters was assessed, based on the criteria outlined by Chanin (2003).

In addition, the biological water quality of the River Ara was assessed using Q-scheme methodology (EPA, 2019) at a suitable sampling location downstream of the confluence of the drain from the subject site (see Appendix 2 of Aquatic Ecology Report in Appendix 3 of this document).

2.3.5 Water Quality Sampling

The results of water quality sampling (surface water and leachate sampling points) carried out after the Tier 3 Risk Assessment on the historical landfill site included in this assessment were sampled by Tipperary County Council and the EPA; dates and sampling categories are detailed below.

Tipperary County Council carried out surface water and leachate sampling on 17/08/10, and surface water sampling only on 09/12/11, 18/01/12, 04/04/12, 19/09/12, 11/12/12, 24/01/13, 08/05/13, 26/09/13, 12/12/13, 22/01/14 and 14/05/14.

Surface water and leachate sampling were carried out by the EPA on 01/10/14 and 21/09/15.

Published past EPA biological water quality monitoring data for the River Ara were also examined.

Water sampling locations are shown in Figure 3-2 within this report

3. BRIEF DESCRIPTION OF THE EXISTING SITES

3.1 Description of the Existing Site

The landfill is a historic landfill having received waste from Tipperary Town from the 1940's to c. 1990. Waste deposited at the site is understood to comprise of municipal and commercial wastes to depths of approximately 9 m to 12 m.

The historical landfill site is in the townland of Carrownreddy immediately north of Tipperary town, partially within a wetland surrounded by agricultural lands adjacent to the town. The site is accessed from the east via the Carrownreddy road, which is a cul de sac accessed from the R661.

The historical landfill consists of a mound which rises out of a natural hollow, part of which has been infilled with waste. The land to the west, east and north is noticeably lower, with the mound of waste which is now mainly capped with spoil and rubble falling steeply towards the surrounding wetland at its edges.

The basin is fed from the west by the Fidaghta stream. Surface water accumulates in the basin surrounding the landfill mound, which is dominated by marsh and alder woodland. Part of the area now occupied by the landfill is shown on historical 6 inch mapping (1837 – 1842) as a waterbody with emergent vegetation called Carrownreddy Lough.

EPA hydrology mapping depicts the Fidaghta stream continuing east from the eastern side of the wetland and being joined by the Spital-land stream flowing north from the town. Surveys onsite have confirmed this is not the case and the Spital-Land drain does not flow into the Fidaghta but instead flows south to join the River Ara (see 3-2 and Figure 6-1).

The outflow from the eastern side of the wetland joins the course of the Spital-land watercourse, but this channel flows south, rather than north as depicted on EPA hydrology mapping. The Spital-land is a small, slow flowing channel of relatively low capacity (wet width c. 0.6m depth c. 0.1m). The channel continues across a field to the south of the landfill and is then culverted for c. 1 km before emerging from under the N24 in the south-eastern part of Tipperary Town.

The channel then flows along a field boundary for c. 100 m before entering the Ara River to the south. The Ara in turn joins the Aherlow, which flows into the Lower River Suir SAC c. 18.2 km downstream of the historical landfill site.

The soil underlying and surrounding the landfill mound is peat varying between 1-3m deep; beneath this, a stratum of clay forms an impermeable layer.

3.1.1 Habitats Within and Immediately Adjacent to the Existing Site

The habitat types (according to the Fossitt, 2000 classification system) identified during the ecological surveys conducted at the site on the 3rd May of 2018 and the 2nd of June 2020 are outlined below, and presented in Figure 3.1.

Improved agricultural grassland (GA1)

Improved agricultural grassland (GA1) is present in several fields bounding the landfill mound. Species recorded included perennial rye-grass Lolium perenne, dandelion Taraxacum Agg., creeping thistle Cirsium arvense, meadow buttercup Ranunculus acris, docks Rumex spp. and ribwort plantain plantago lanceolata. The fields to the east and south of the landfill are used to graze horses, rather than the more widespread and intensive land use associated with dairy production.

Dry meadows and grassy verges (GS2)

Sections of the landfill mound support this habitat type, with cock's foot Dactylis glomerata and false oat-grass Arrhenatherum elatius dominating. Creeping and meadow buttercup R.repens and R.acris, dandelion, and nettle Urtica dioica were also present. The ground in these areas is more level and less disturbed than in other areas of the landfill.

Wet grassland (GS4)

A low-lying portion of the field bounding the south-eastern corner of the landfill which fringes swamp supports vegetation more characteristic of wet grassland (GS4), with yellow iris pseudacorus, cuckooflower Cardamine pratensis and hard rush Juncus inflexus recorded in this area.

Improved agricultural grassland/Recolonising bare ground (GA1/ED3) Mosaic

Spoil has been deposited over a large area to the east of the reed swamp fringing the eastern side of the landfill. This has raised the level of the land creating open fields with a densely compacted and dry topsoil. Perennial rye-grass, docks, ribwort plantain and daisy Bellis perennis, species commonly found in agricultural habitats were recorded. Rye-grass indicates re-seeding for agriculture, and close cropped sward and heavy poaching indicates the area is used to graze horses. The recolonising bare ground element is evident in the compacted soil surface and sparseness of vegetation present.

Drainage ditches (FW4)

The channel mapped as the section of the Spital-Land watercourse flowing from south-west (channel to east of landfill marked DD in Figure 3-2) to north-east is not a stream. The channel is wide, with little to no flow of water, and is dominated by marsh vegetation; bulrush Typha liatifolia, with fool's watercress Apium nodiflorum in shallower fringing areas is the dominant vegetation type.

This channel is also impeded at one point by an earth bridge linking the two fields of improved agricultural grassland/recolonising bare ground (GA1/ED3) mosaic described above. To the south-west of this point, water from this drainage ditch flows south-west to join a flow of water exiting the swamp surrounding the landfill, which flows south-east and then south along the course of the channel mapped as the Spital-land. As previously noted the actual direction of flow for this channel is in a north-south direction the opposite direction to that indicated in EPA hydrology mapping.

The outflow of the swamp to the east joins the Spital-land channel to flow south-east before being culverted under the landfill access road, and continuing south-east through agricultural land (channel identified as Spital-land with SW 1 and SW2 marked in Figure 3-2).

The stream then enters a culvert at the edge of a housing estate, and from this point on flows underground. The drain emerges again to the south of Tipperary Town before entering the River Ara.

The channel has a sandy/muddy substrate and is overshadowed by a hedgerow made up of elder Sambuscus nigra, alder Alnus glutinosa and hawthorn Crataegus monogyna along part of its length. Nettles Urtica dioica and ivy Hedera helix fringe the banks along this stretch. The remainder of the channel running through agricultural land is more open, with only occasional short sections of hedgerow fringing.

Hard rush and fool's watercress are common along banks on this section. The channel is shallow, with gently sloping banks allowing access for livestock.

A second drainage channel on the western side of the landfill feeding into the swamp surrounding the landfill is also present. This channel runs from south east to north west and was dry during surveys. It drains the surrounding agricultural land into the swamp.

Lowland/depositing rivers (FW2)

The swamp is fed by a short watercourse named the Fidaghta which runs downhill from the west for c. 260m before entering the swamp surrounding the landfill at its western end. This channel is fringed by a hedgerow along its length.

Reed and large sedge swamps FS1

The areas of standing water around the landfill mound are dominated by bulrush Typha latifolia and yellow flag Iris pseudacorus; marsh horsetail Equisetum palustre was present in many areas, greater tussock sedge Carex paniculata was locally common. Meadowsweet Filipendula ulmaria was present in fringing areas, and a shallow outlying area at the southwestern corner of the swamp was dominated by bogbean Menyanthes trifoliata.

Duckweed Lemna sp. forms a film over areas of open water. The characteristic swamp vegetation present within these areas is indicative of permanent waterlogging and represents a relatively undisturbed natural habitat.

Wet willow-alder-ash woodland (WN6)

Parts of the swamp support small areas of woodland dominated by alder Alnus glutinosa, with willow Salix sp. occasional in the interior, and more common around the edges. The reed and large sedge swamp vegetation as described above is present under the trees in these areas; marsh marigold Caltha palustris was common in some areas shaded by trees.

Similarly, to the swamp habitat described above, these areas of wet woodland represent natural habitats of higher ecological value.

Treelines/ Hedgerows (WL1/WL2)

The linear boundaries separating agricultural fields surrounding the site are marked by hedgerows and/ or treelines, with tree species including ash Fraxinus excelsior, alder, and hawthorn Crataegus monogyna, being common. Bramble Rubus fruticosus Agg., ivy Hedera helix and dog rose Rosa canina occurring in the understory.

Scrub (WS1)

Areas of scrub have developed on parts of the landfill mound, both on top, and on the steep banks running down to the surrounding land. Willow is the main constituent, with bramble and the non-native invasive butterfly bush Buddleija davidii also being common.

Spoil and bare ground ED2

An area of sparsely vegetated bare ground is present near the entrance to the landfill site; soil, gravel, and demolition waste form the surface, with occasional plants including hairy bittercress Cardamine hirsuta, red dead nettle Lamium purpureum, wild turnip Brassica napa, and cornsalad Valerianella locusta present.

Recolonising bare ground/ Spoil and bare ground (ED2/ED3) Mosaic

Parts of the landfill mound are covered in a mosaic of recolonising bare ground as well as spoil and bare ground. These habitats are the result of historical soil dumping and disturbance, as well as ongoing disturbance. A large number of ruderal, generalist and colonising species are present including colt's foot Tussilago farfara, ragwort Senecio jacobaea, ground elder Aegopodium podagraria, teasel Dipsacus fullonum, yarrow Achillea millefolium, dandelion Taraxacum Agg., spear thistle Cirsium vulgare, herb-robert Geranium robertianum and ribwort plantain Plantago lanceolata.

A number of non-native invasive plant species are also present, with areas of winter heliotrope Petasites fragrans and Japanese knotweed Fallopia japonica onsite. Butterfly bush Buddleija davidii is also common. Himalayan honeysuckle Leycesteria Formosa, old man's beard Clematis vitalba and snowberry Symphoricarpus albus are also present.

Scrub/ Recolonising bare ground (ED3/WS1) Mosaic

Part of the landfill mound supports a mosaic of these habitat types as described above, with the lack of coherent and adequately sized areas of one type making mapping of individual types unfeasible.

Buildings and artificial surfaces BL3

The concrete yard areas and corrugated metal building at the historical landfill site entrance conform to this habitat type.

3.1.2 Non-native Invasive Plant Species at Existing Site

As previously noted, a number of invasive species are present onsite. A number of these are currently subject to ongoing eradication measures. These measures which commenced in autumn 2018 are being carried out by Invasive Plant Solutions Ltd. on behalf of Tipperary Co. Council. Reports and memoranda detailing the progress of these measures are included in Appendix 4.

A number of Japanese knotweed stands are present. These are currently being stem-injected twice per year (at the beginning and end of the growing season).

As of June 2020, most areas showed no signs of regrowth following 4 rounds of treatment. The exceptions were growth of several small shoots near one area, growth of larger stems (to 2m) in a 25 x 25 cm area within a treated stand, and several small patches of regrowth within the large stand at the south-western corner outside the site. Japanese knotweed is legally restricted (Schedule III listed) and as such cannot be spread or removed from the site except under licence.

Winter heliotrope is present at five locations. A total of three of these are confirmed to be undergoing treatment as of June 2020.

Butterfly bush is present at nine locations. This species is not currently subject to treatment measures.

Snowberry is present at one location and is not currently subject to treatment measures.

Two species were newly recorded in autumn 2018 and 2019, (respectively) Himalayan honeysuckle Leycesteria Formosa and old man's beard Clematis vitalba. These are still present as of June 2020.

A total of three invasive species have been eradicated since the original survey in 2018: Spanish bluebell, cherry laurel and montbretia. As Spanish bluebell is Schedule III listed and therefore cannot be removed from the site without a licence, excavated plant material is being retained onsite in secure containers. Other potentially invasive plant material is being of stored and disposed of according to best practice by an invasive plant control specialist.

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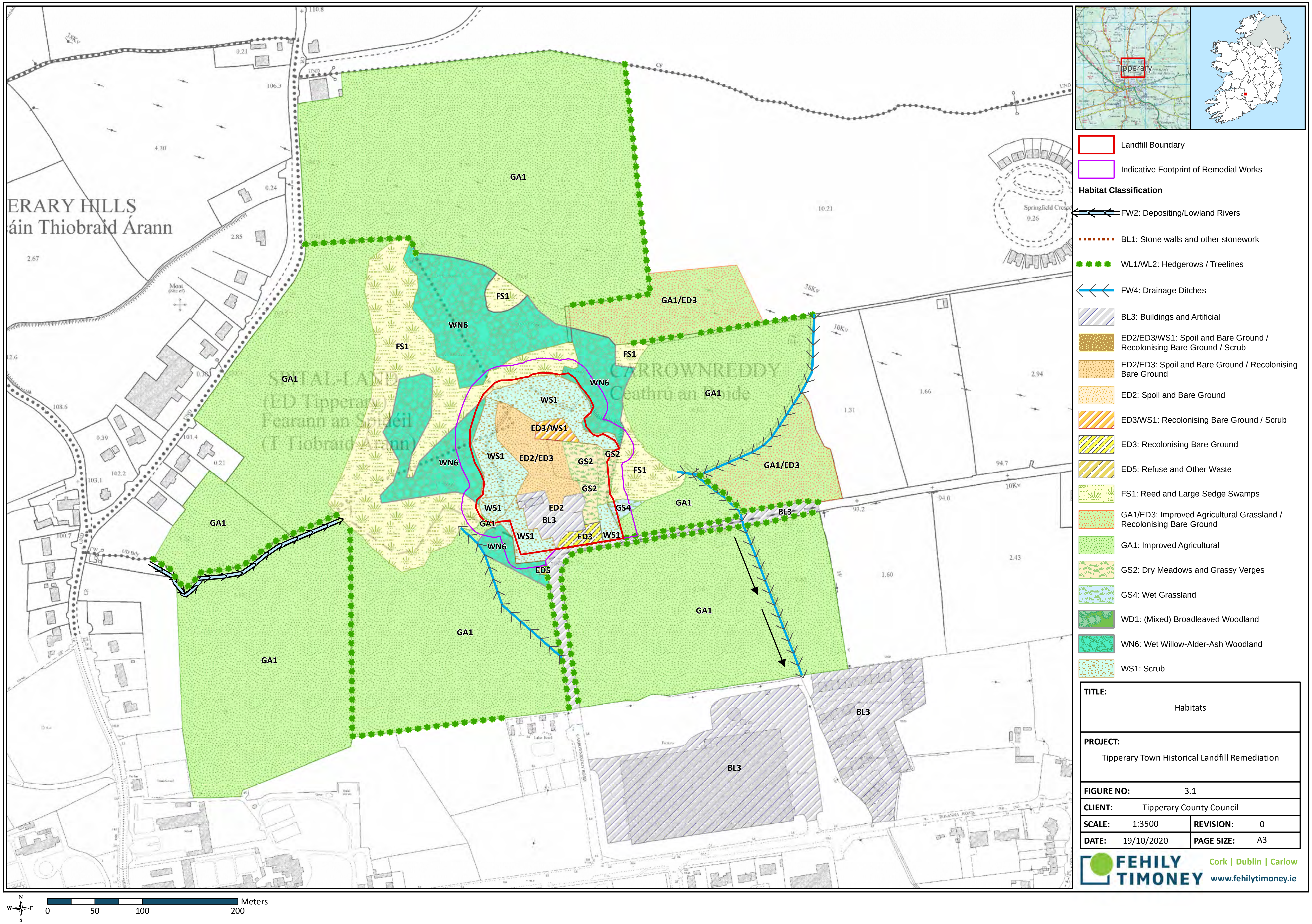

TITLE:

Habitats

PROJECT:

Tipperary Town Historical Landfill Remediation

FIGURE NO:	3.1		
CLIENT:	Tipperary County Council		
SCALE:	1:3500	**REVISION:**	0
DATE:	19/10/2020	**PAGE SIZE:**	A3

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Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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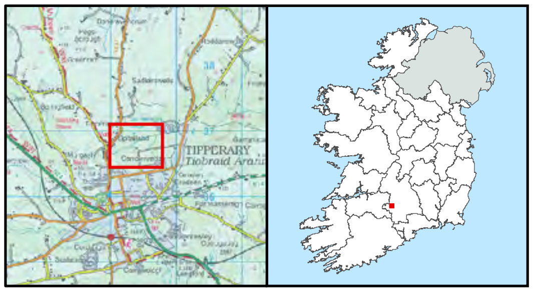

▭	Landfill Boundary
●	Leachate Sampling Points
●	Surface Water Sampling Points
⟿	Drainage Ditches
⇚	Depositing/Lowland Rivers

TITLE:
Surface Water and Leachate
Sampling Points

PROJECT:
Tipperary Town Historical Landfill Remediation

FIGURE NO:	3.2		
CLIENT:	Tipperary County Council		
SCALE:	1:2500	**REVISION:**	0
DATE:	19/10/2020	**PAGE SIZE:**	A3

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4. MONITORING

4.1 Monitoring (2009)

Site investigation and monitoring was undertaken in 2009 as part of Tier 2 Risk Assessment and included the following elements:

- Geophysical Survey
- 17 No. Trial pit excavations
- Waste and Soil Characterisation
- Waste Testing
- Surface Water Monitoring
- Installation of 1 No. borehole to the bedrock
- Installation and monitoring of 3 No. combined leachate/landfill gas monitoring wells in the waste body
- Installation of 3 No. groundwater monitoring wells in the subsoils.
- Installation of five gas monitoring wells outside the waste body, of which 3 No. also suitable for groundwater monitoring.
- Topographical Survey.

Groundwater, landfill gas and surface water quality monitoring were undertaken as part of the Tier 2 Risk Assessment. Groundwater quality monitoring was undertaken four boreholes within the site on the 23rd November 2009. Three rounds of landfill gas monitoring were undertaken (23rd November, 2nd and 10th December 2009) at all eight boreholes on site. A surface water sample was obtained from the Spital-land channel downstream, approximately 50m east of the landfill site. For monitoring parameters and results please see Appendix 5.

The wastes in the northern, western and eastern edges of the site consist of mainly Construction and Demolition (C&D) waste comprising soils and stone, with minor amounts of rubble. The central section contains more domestic and commercial types. The municipal waste comprises a mix of plastic and glass bottles, occasional empty flattened steel drums, empty plastic drums, concrete pipes, steel, papers, tyres, tyre tubes, timber and trees, all of which were supported by a sandy gravelly clay matrix. It ranged from damp to dry with some minor seeps of water in the upper 2m. It is assumed that the sandy clay was used as cover material when the site was operational, but no discrete layers were noted. There was no evidence of any significant amounts of hazardous waste (e.g. oils, solvents), staining or odours. Strong putrescible odours were only detected in two trial pits TP-9 and TP-10 in the western section of the site. The area north of the on-site building and road maintenance materials is covered in soils and stone mixed with minor amounts of what appears to be C&D waste. This material is on average 1.5m to 2.5m thick. This material appears to have been brought onto site after the facility officially closed and has not been graded.

Groundwater monitoring detected elevated levels of Ammonia, Manganese, Chloride and Electrical conductivity (in exceedance of interim guideline values published by the EPA as relevant at the time of Tier 2 Assessment), which are indicative of leachate contamination were detected in the shallow gravel/clay zone.

The levels decrease in concentration moving from MW-8 located east of the waste body to MW-4, approximately 150m east of the landfill approximately 10m west of the Spital-land channel. Threshold values for Ammonia and Manganese are not included in the Groundwater Regulations (S.I. No.9 of 2010).

Chloride exceeded the upper threshold value at one location (MW8), while electrical conductivity at all three testing locations was between the lower and upper threshold values.

Surface water monitoring was conducted at the Spital-land channel downstream, approximately 50m east of the landfill site. With the exception of ammonia (1.7mg/l), all of the parameters were less than the relevant EQS and there was no evidence of leachate contamination. It should be noted however that the sampling took place after a period of very wet weather, when dilution was significant.

Gas monitoring wells MW-1, MW-2 and MW-3 are all located within the waste body. Carbon dioxide and methane were detected in all three wells ranging from 31.5% to 56% for methane, and 1.5% to 16% for carbon dioxide. Oxygen levels ranged from 0.8% to 1.4% for oxygen. MW-4, MW-5, MW-6, MW-7 and MW-8 are all located outside the waste body. Methane was only detected in one of the wells, MW-8 along the eastern site boundary where the concentrations ranged from 0.8% to 1.3%. Carbon dioxide was detected in all of the wells, with the concentrations ranging from 0% to 5%. The oxygen levels ranged from 2.9% to 22.6%, with the lowest level detected in MW-8.

4.2 Water Quality Monitoring (2010-2015)

The EPA and Tipperary County Council carried out surface water and leachate sampling onsite at various dates between 2010-2015.

Surface water was sampled at locations both upstream and downstream of the historical landfill. Leachate was sampled from three wells bored within the landfill. Groundwater sampling was also undertaken at a number of points to the south of the landfill by both parties, however the results presented here are focused on surface water and leachate sampling given their importance in terms of potential connections with European sites.

The surface water monitoring locations are SW1, SW2 and SW3. SW3 is upstream of the historical landfill. This point is located along the Fidaghta watercourse/drain where it enters the marsh to the west of the landfill. SW2 is located at the outflow of the marsh on the western side, at the beginning of the Spital-land watercourse/land drain. SW1 is located downstream of this point to the south, downstream of the Carrownreddy Road underpass.

Three leachate monitoring wells MW1, MW2 and MW3 are located within the landfill. The locations of leachate wells (MW1, MW2 & MW3) and surface water sampling points (SW1, SW2 & SW3) are shown in Figure 3-2.

Monitoring results were not available for some monitoring locations due to low water levels on the day of sampling. The list of parameters analysed by the EPA and Tipperary Co. Council varied between monitoring events.

Comparison of surface water parameters up and downstream is possible where data was available for all three surface water monitoring points. Surface water monitoring results were compared against the relevant EQS values to indicate the condition of surface water exiting the swamp surrounding the landfill.

4.3 Monitoring Results

The following section provides a comparison of leachate and surface water monitoring results with reference values. Comprehensive summaries of monitoring are included in Appendix 5.

Reference values are included below in 5.1.3.

4.3.1 Leachate Sampling Results

Leachate monitoring was carried out by Tipperary County Council/EPA at locations MW2 and MW3 in October 2014 and at locations MW1 and MW2 in September 2015.

While small variations are noted, the results obtained in these two sampling rounds are generally below the minimum overall range of methanogenic leachate composition as outlined in Table 7.2 of the EPA's Landfill Operational Practice Guidance Manual, 1997. These results indicate that leachate quality is typical of weak leachate sampled from large landfills, as outlined in the Landfill Operational Practices Guidance Manual, EPA 1997 and EPA Manual on Landfill Site Design (2000).

4.3.2 Surface Water Sampling Results

Surface water sampling was carried out by Tipperary County Council at locations SW1, SW2 and SW3 on various dates between 2011 – 2014. Surface water sampling was carried out by the EPA at location SW1 in October 2014 and at SW1 and SW2 in September 2015.

Results for pH and Conductivity were within limit values for all regulations throughout the monitoring period.

BOD levels were above the limit values for all regulations at upstream location SW3 on four occasions in December 2011 (44.1 mg/l), January 2012 (31.2 mg/l), April 2012 (6.07 mg/l) and December 2013 (5.03 mg/l). In all instances BOD levels at downstream sampling points were lower on the same dates (and within limit values except in January 2012 where 6.42 mg/L was recorded at SW 2).

BOD levels were above the limit values for all regulations at downstream location SW1 in October 2014 (6.5 mg/l) and September 2015 (5.6 mg/l). No upstream samples were taken on these dates.

BOD levels were above the limit values for all regulations at downstream location SW2 in January 2012 (6.42 mg/l as noted above). In September 2013 BOD levels were above the limit values for all regulations at downstream location SW2 (7.49 mg/l). On this date BOD levels were lower at the upstream location (SW3). On all other dates (6 in total) where upstream and downstream samples were taken, BOD values varied less between sampling points and were within limit values for all regulations.

COD levels were above the Surface Water Regulations Limits at upstream location SW3 in December 2011 (310.2 mg/l) and January 2012 (191 mg/l). COD levels on these dates were lower and within limit values at downstream sampling points. COD levels were above the Surface Water Regulations Limits at downstream location SW1 in October 2014 (51 mg/l) and September 2015 (41 mg/l), and at downstream location SW2 in September 2013 (66 mg/l) and September 2015 (44 mg/l). COD for the upstream sample taken in September 2013 was lower than the downstream value given above for that month. No upstream samples were taken during the other sampling periods (October 2014 and September 2015).

Ammoniacal Nitrogen levels were above the Salmonid Regulations limit values at all three sampling locations (SW1-SW3) in September 2012 (1.41, 2.73 & 2.94 mg/l respectively). decreasing from upstream to downstream.

Ammoniacal Nitrogen levels were above the Salmonid Regulations limit values at SW3 upstream (1.36 mg/l) and SW2 downstream (1.83 mg/l) in December 2012. SW1 further downstream was below limit values during this sampling period.

Ammoniacal Nitrogen levels were above the Salmonid Regulations limit values at downstream location SW1 on seven occasions from 2011 to 2015 (1.16 – 3.7 mg/l). During one sampling period (September 2012) levels for this parameter were higher upstream at SW3. In all other instances when samples were taken upstream and downstream on the same date, levels for this parameter were lower at upstream at SW3 than downstream at SW1. Ammoniacal Nitrogen levels were below the Salmonid Regulations limit values at downstream location SW1 on three occasions between 2012 – 2014.

Ammoniacal Nitrogen levels were above the Salmonid Regulations limit values at downstream location SW 2 on eight occasions from 2011 to 2015 (1.25 – 4.52 mg/l). On five of these occasions, values for this parameter were lower than at SW 3 upstream. On two occasions no sample was taken at SW3 upstream, and on one occasion the reading was higher at SW3. On four occasions levels for this parameter were below Salmonid Regulations limit values at all points sampled on those occasions.

As such, a higher number of instances of Ammoniacal Nitrogen levels increasing from upstream to downstream were recorded. Results at all locations exhibit a downward trend with the highest results returned during the winter months. This suggests that inundation of the surrounding area, resulting in increased runoff from agricultural land and slower dispersion downstream may be a contributing factor in the results achieved.

Suspended Solids levels were above the Salmonid Regulations limit values at upstream location SW3 in December 2011 (260 mg/l), April 2012 (216 mg/l) and December 2013 (100 mg/l). Levels for the same parameter were lower and within Salmonid Regs limit values downstream on the same dates. Suspended Solids levels were above the Salmonid Regulations limit values at downstream location SW1 in October 2014 (49 mg/l). No upstream sample was taken during this monitoring period.

Ortho-phosphate, conductivity, chloride, Iron, Manganese levels were below the respective regulations limits for all upstream and downstream monitoring locations throughout the monitoring period.

On occasions were upstream and downstream samples were taken, BOD was higher upstream on four occasions and lower upstream on one occasion. On six occasions BOD was within the limit values for all regulations at all sampling points. COD was higher upstream than downstream on two occasions where upstream and downstream samples were taken on the same day, and lower upstream on one occasion.

Ammoniacal Nitrogen levels were typically higher downstream than upstream.

Overall, the results of surface water monitoring are inconclusive in determining the impact of the landfill on surrounding water bodies. The results suggest that while there is some evidence of contamination at locations downstream of the historical landfill, there is also evidence to suggest that run-off from the surrounding agricultural land is impacting on water quality at monitoring locations upstream and downstream of the landfill.

4.3.3 Reference Values

A number of commonly tested surface water limit values including those relevant in particular to aquatic lifeforms were selected to aid in characterising the surface waters in and around, and draining the landfill, and to inform the assessment of potential for effects on aquatic species in the Lower River Suir SAC (002137) downstream. Table 4-1 presents the limits for the Salmonid, Surface Water and Drinking Water Regulations.

Table 4-1: Surface Water Reference Values

Parameter	Regulations		
	Salmonid	Surface Water	Drinking Water
Cond. (µs/cm)		1,000	2,500
BOD (mg/L)	≤ 5	5	
COD (mg/L)		40	
Ammoniacal Nitrogen (mg/L)	< 1	4	0.5
Chloride (mg/L)		250	250
Iron (µg/L)		2 (mg/L)	200
Manganese (µg/L)		1 (mg/L)	50
Ortho-Phosphate PO4 (mg/L)		0.7	
pH	> 6-< 9	5.5-9.0	> 6.5-< 9.5
Suspended Solids (mg/L)	< 25	50	
Total Suspended Solids (mg/L)		50 (A1)	

Source: EPA

4.4 Management and Monitoring specified in the Certificate of Authorisation

The requirements for the remediation and monitoring of the site are set out in condition 3 of the certification of authorisation (see Appendix 1).

5. PROJECT DESCRIPTION

5.1 Overview of the Proposed Project

The proposed development works are as follows:

- Development of a temporary site compound on the proposed engineered capped development and a temporary office location removed from the engineered cap within the site boundary.
- Demolition of existing structures including an existing agricultural building, concrete walls and post and wire fencing.
- Clearance of vegetation and tree felling.
- Grading/Profiling of Existing Profile.
- Installation of an engineered landfill capping system to include: a landfill gas venting system, an LLDPE Barrier, a sub-surface drainage system, a geogrid layer, sub-soil and topsoil layers, a surface water drainage system, an access track and a shared access way to adjoining third party lands, fencing, a car park area, temporary works/mitigation measures security fencing, landfill gas/leachate management infrastructure, landscaping and an anchor trench/gas barrier.

The following will be carried out on-site following on from completion of the proposed development works.

- Ongoing Environmental monitoring.
- Oxidation of Methane in Landfill Gas.
- Maintenance of engineered cap on-site.
- Maintenance of surface water drainage system on-site.

The application site defined by the red line boundary in accompanying drawings is 3.57 ha in size. The proposed capping area within the application site proposed is 22.86 ha in size.

5.2 Description of the Project

A description of the proposed project is contained in Section 2.2 of the Planning and Environmental Report which accompanies this Section 177AE Planning Application to the Board. To avoid reiteration and the possibility of conflicting information being presented within the application, the reader is advised to refer to the aforementioned section/report to develop an understanding of the project. The Appropriate Assessment (*Natura Impact Statement*) undertaken and reported upon in this document has had regard to this project description

6. STAGE ONE – SCREENING REPORT

For the purposes of this AA Screening the unmitigated effects of the proposed works are only being considered. This AA Screening report does not consider measures included to reduce and or avoid potential significant effects to a European site.

6.1 Brief Description of the European Sites within 15 km of the Development

The following five European Sites are located within 15km of the historical landfill site, these are

- Lower River Suir SAC (site code 002137) is located approximately 6.5 km from the historical landfill site; this European site lies to the northeast, east & south of the landfill site.
- Moanour Mountain SAC (Site Code 002257) is located approximately 8.3 km southwest of the historical landfill site.
- Philipston Marsh SAC (Site Code 001847) is located approximately 9.2 km north of the of the historical landfill site.
- Galtee Mountains SAC (Site Code 000646) is located approximately 9.3 km south of the historical landfill site.
- Lower River Shannon SAC (Site Code 002165) is located approximately 12.1 km northwest of the historical landfill site.

The Lower River Suir SAC (site code 002137), is connected hydrologically (in-stream distance 18.2 km) to the site via the Spital-land, Ara and Aherlow rivers (see 3-2 and Figure 6-1).

The wetland surrounding the landfill mound drains from the south-western side into the Spital-land watercourse, which flows south towards Tipperary town for c. 265 m before being channelled underground at the northern boundary of Rosanna Close housing estate. This channel flows underground for c. 1 km before emerging from underneath the N24 in the south-eastern part of Tipperary Town, after which it flows along a field boundary to join the River Ara c. 100 m downstream. The River Ara joins the River Aherlow, which flows into the Lower River Suir SAC c. 18.2 km downstream of the historical landfill site.

The drainage onsite does not correspond with EPA watercourse mapping, which indicates the Spital-Land flows from south to north to join the Fidaghta watercourse.

Full site synopses are included in Appendix 6.

Table 6-1: European Sites within the zone of influence

Designated Site	Qualifying Interests	Conservation Objectives	Threats	Distance from Historical Landfill Site
Lower River Suir SAC (Site Code 002137)	• Atlantic salt meadows (Glauco-Puccinellietalia maritimae) [1330] • 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 the British Isles [91A0] • Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) [91E0] • *Taxus baccata* woods of the British Isles [91J0]	To maintain or restore the favourable conservation condition of the Annex I habitats and Annex II species for which the SAC has been selected	• J02.01.02 Reclamation of land from sea, estuary or marsh (low) (inside) • B Silviculture, forestry (low) (outside) • E03 Discharges (high) (both) • D03.01 Port areas ((low) (both) • H01 Pollution to surface waters (limnic, terrestrial, marine & brackish) (high) (both) • A08 Fertilisation (high) (outside) • J02.01 Landfill, land reclamation and drying out, general (medium) (both) • J02.12.02 Dykes and flooding defence in inland water systems (high) (inside) • A01 Cultivation (low) (inside) • I01 Invasive non-native species (low) (inside) • E01 Urbanised areas, human habitation (high) (both)	6.5 km at closest point; lies to the northeast, east & south of landfill site 18.2 km in-stream

Designated Site	Qualifying Interests	Conservation Objectives	Threats	Distance from Historical Landfill Site
	• *Margaritifera margaritifera* (Freshwater Pearl Mussel) [1029] • *Austropotamobius pallipes* (White-clawed Crayfish) [1092] • *Petromyzon marinus* (Sea Lamprey) [1095] • *Lampetra planeri* (Brook Lamprey) [1096] • *Lampetra fluviatilis* (River Lamprey) [1099] • *Alosa fallax* (Twaite Shad) [1103] • *Salmo salar* (Salmon) [1106] • *Lutra* (Otter) [1355]			
Moanour Mountain SAC (Site Code 002257)	• Northern Atlantic wet heaths with *Erica tetralix* [4010] • European dry heaths [4030]	To maintain or restore the favourable conservation condition of the Annex I habitats for which the SAC has been selected	• B Silviculture, forestry (high) (outside) • A04 grazing (medium) (inside) • A04 grazing (medium) (outside) • G01.02 walking, horse riding and non-motorised vehicles (low) (inside)	8.3 km southwest
Philipston Marsh SAC (Site Code 001847)	• Transition mires and quaking bogs [7140]	To maintain or restore the favourable conservation	• B Silviculture, forestry (low) (outside) • A08 Fertilisation (low) (outside)	9.2 km north

Designated Site	Qualifying Interests	Conservation Objectives	Threats	Distance from Historical Landfill Site
		condition of the Annex I habitat for which the SAC has been selected	• A04 grazing (low) (inside) • A04 grazing (medium) (outside)	
Galtee Mountains SAC (Site Code 000646)	• Northern Atlantic wet heaths with *Erica tetralix* [4010] • European dry heaths [4030] • Alpine and Boreal heaths [4060] • Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas (and submountain areas, in Continental Europe) [6230] • Blanket bogs (* if active bog) [7130]	To maintain or restore the favourable conservation condition of the Annex I habitats for which the SAC has been selected	• A10.01 Removal of hedges and copses or scrub • J01 Fire and fire suppression • G01.04.01 Mountaineering & rock climbing • A04.01.02 Intensive sheep grazing • G01.02 Walking, horse-riding and non-motorised vehicles • J02.11 Siltation rate changes, dumping, depositing of dredged deposits • G01.03.02 Off-road motorized driving	9.3 km south

Designated Site	Qualifying Interests	Conservation Objectives	Threats	Distance from Historical Landfill Site
	• Siliceous scree of the montane to snow levels (*Androsacetalia alpinae* and *Galeopsietalia ladani*) [8110] • Calcareous rocky slopes with chasmophytic vegetation [8210] • Siliceous rocky slopes with chasmophytic vegetation [8220]			
Lower River Shannon SAC (Site Code 002165)	• Sandbanks which are slightly covered by sea water all the time [1110] • Estuaries [1130] • Mudflats and sandflats not covered by seawater at low tide [1140] • Coastal lagoons [1150]	To maintain or restore the favourable conservation condition of the Annex I habitats and Annex II species for which the SAC has been selected	• I01 Invasive non-native species (low) (inside) • A08 Fertilisation (medium) (outside) • E01 Urbanised areas, human habitation • H04 Air pollution, air-borne pollutants • A08 Fertilisation (medium) (inside) • E03 Discharges • D01.01 Paths, tracks, cycling tracks • K02.03 Eutrophication (natural) • G01.01 Nautical sports • B Silviculture, forestry (low) (inside)	12.1 km northwest

Designated Site	Qualifying Interests	Conservation Objectives	Threats	Distance from Historical Landfill Site
	• Large shallow inlets and bays [1160] • Reefs [1170] • Perennial vegetation of stony banks [1220] • Vegetated sea cliffs of the Atlantic and Baltic coasts [1230] • *Salicornia* and other annuals colonising mud and sand [1310] • Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330] • Mediterranean salt meadows (*Juncetalia maritimi*) [1410]		• F01 Marine and Freshwater Aquaculture • F03.01 Hunting • C01.01.02 Removal of beach materials • E03 Discharges • C01.03.01 Hand cutting of peat • A04 Grazing (medium) (inside) • J02.12.01 Sea defence or coast protection works, tidal barrages • J02.01.01 Polderisation • J02.10 Management of aquatic and bank vegetation for drainage purposes • J02.01.02 Reclamation of land from sea, estuary or marsh	

Designated Site	Qualifying Interests	Conservation Objectives	Threats	Distance from Historical Landfill Site
	• Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260] • *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) [6410] • Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0] • *Margaritifera margaritifera* (Freshwater Pearl Mussel) [1029] • *Petromyzon marinus* (Sea Lamprey) [1095]			

Designated Site	Qualifying Interests	Conservation Objectives	Threats	Distance from Historical Landfill Site
	• *Lampetra planeri* (Brook Lamprey) [1096] • *Lampetra fluviatilis* (River Lamprey) [1099] • *Salmo salar* (Salmon) [1106] • *Tursiops truncatus* (Common Bottlenose Dolphin) [1349] • *Lutra* (Otter) [1355]			

indicates a priority Annex I habitat

Path: R:\Map Production\2020\P2246\Workspace\AA Screening\P2246_GIS_Fig6-1_EuropeanSitesWithin15km_A3.mxd

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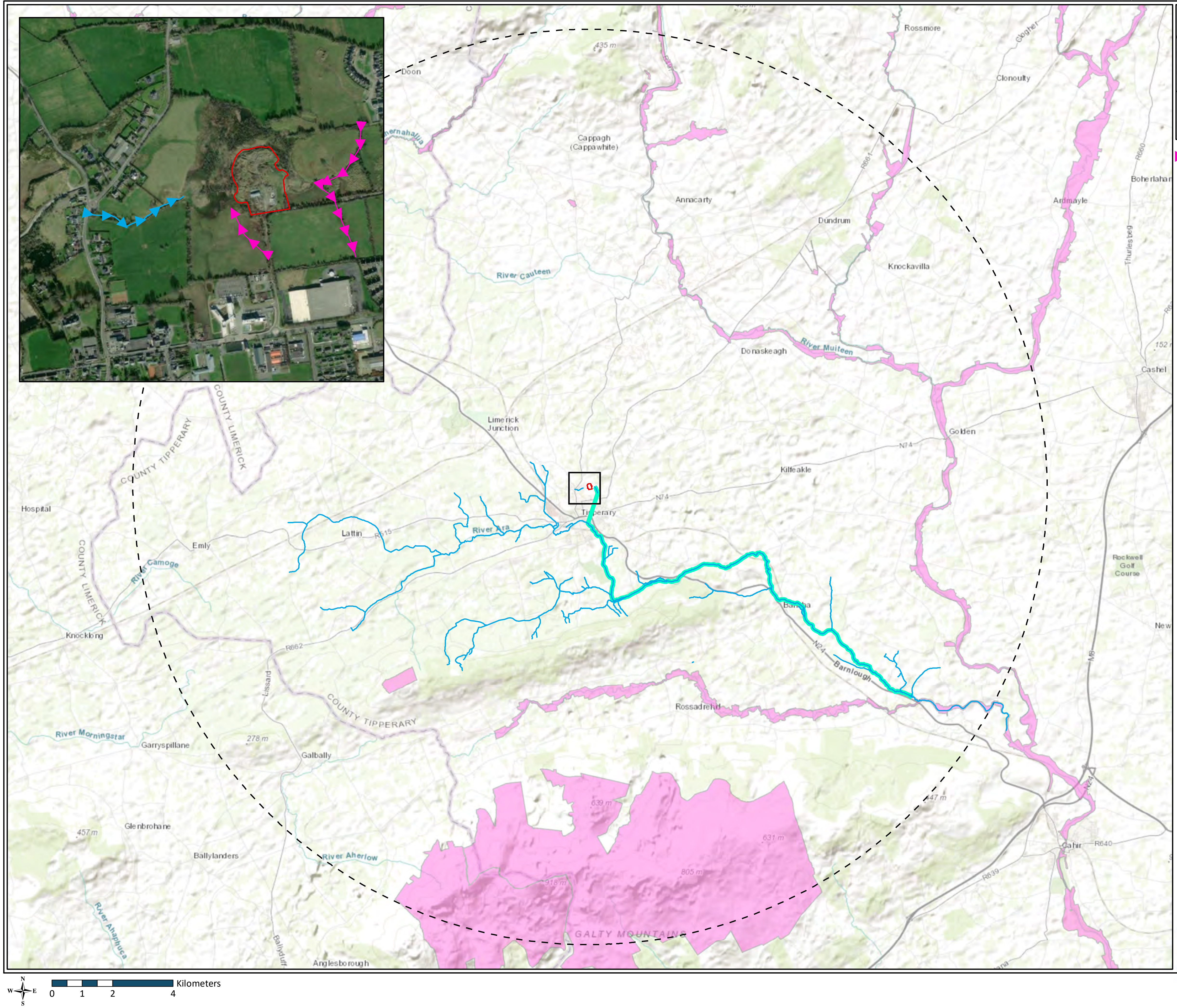

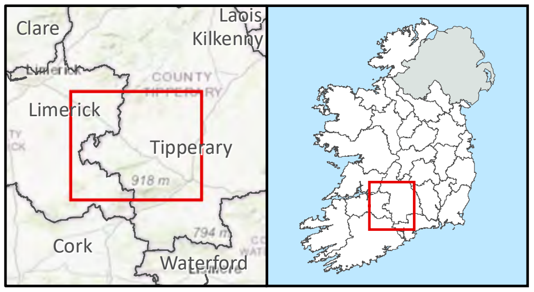

- ▶▶ Drainage Ditches
- Watercourses
- Hydrological Connection (18.2km)
- 🟥 Landfill Boundary
- ⬚ 15km Distance from Site Boundary
- ▨ Special Area of Conservation (SAC)

Site Code, Site Name, Distance (km)

000646, Galtee Mountains, 9.3

001847, Philipston Marsh, 9.2

002137, Lower River Suir, 6.5

002165, Lower River Shannon, 12.1

002257, Moanour Mountain, 8.3

TITLE:
European Designated Sites Within 15km
of the Proposed Development

PROJECT:
Tipperary Town Historical Landfill Remediation

FIGURE NO:	6.1		
CLIENT:	Tipperary County Council		
SCALE:	1:120000	**REVISION:**	0
DATE:	19/10/2020	**PAGE SIZE:**	A3

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6.2 Conservation Objectives

To inform the assessment of potential impacts on European (Natura 2000) sites, the conservation objectives (where available) for these sites require examination in conjunction with the characteristics of the proposed project or development to identify any qualifying interests such as species or habitats which by virtue of their sensitivity and/or location would have the potential to be impacted by actions undertaken in completion of the project.

According to the Habitats Directive, the conservation status of a natural habitat will be taken as 'favourable' within its biogeographic range when:

- its natural range and areas it covers within that range are stable or increasing, and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- the conservation status of its typical species is favourable as defined below.
-

The conservation status of a species means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations. The conservation status will be taken as 'favourable' within its biogeographic range when:

- population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

The specific conservation objectives for each European (Natura 2000) site is available on www.npws.ie. These have been accessed for the sites listed in Table 6.1 above on the 2nd of September 2020.

Detailed site-specific conservation objectives have been produced for all European sites within 15 km:

- Lower River Suir SAC (002137)
- Philipston Marsh SAC (001847)
- Galtee Mountains SAC (000646)
- Lower River Shannon SAC (002165)
- Moanour Mountain SAC (002257)

The following conservation objectives supporting documents were available:

- Lower River Suir SAC (002137) Conservation objectives supporting document – Coastal habitats [Version 1] (March 2017)
- Galtee Mountains SAC (000646) Conservation objectives supporting document - Upland habitats [Version 1] (July 2016)
- Lower River Shannon SAC (002165) Conservation objectives supporting document – marine habitats [Version 1] (March 2012)
- Lower River Shannon SAC (002165) Conservation objectives supporting document – coastal habitats [Version 1] (May 2012)
- Lower River Shannon SAC (002165) Conservation objectives supporting document – lagoon habitats [Version 1] (May 2012)
- Lower River Shannon SAC (002165) Conservation objectives supporting document – water courses [Version 1] (June 2012)
- Lower River Shannon SAC (002165) Conservation objectives supporting document – woodland habitats [Version 1] (March 2012).

A conservation management plan was available for Galtee Mountains SAC (000646); management plans have not been produced for the remainder of the European sites within 15 km of the proposed development.

All conservation objectives together with other designated site information are available on http://www.npws.ie/protectedsites.

6.3 Potential Cumulative Effects

In considering whether the remediation of the historic landfill, either on its own or in combination with other plans and projects, has the potential to affect the conservation objectives of the designated sites within 15 km of the proposed development, permitted and proposed projects in the vicinity of the development were considered.

A planning search limited to applications submitted within the previous 5 years was carried out on 17th August 2020 using the online planning enquiry system at: http://www.eplanning.ie/TipperaryCC/searchtypes for the townlands overlapping the proposed development site and those abutting the same (listed below).

Townlands encompassing the proposed development site and surrounding area:

Carrownreddy

Spital-land

Part of Spital-land/Tipperary East Urban Electoral District)

- Tipperary Hills
- Sadleirswells
- Garranacanty
- Brodeen
- Gortavalla
- Knockanrawley

- Town Lot
- Murgasty.

A number of small-scale developments have been permitted in the townlands overlapping and surrounding the landfill site.

A number of commercial and public projects were also permitted. These include:

- Construction of a cancer support centre, including car parking area, also alterations to previously approved entrance;
- Construction of a light engineering factory in an existing industrial estate including connection to public sewerage system;
- Change of use of a warehouse to veterinary hospital;
- Demolition of existing buildings and construction of a nursing home, including connections to public utilities;
- Construction of Industrial storage unit in Tipperary Business and Technology Park

These do not have the potential to contribute appreciably to cumulative effects.

In addition, development consisting of a Childcare facility and 84 no. two storey dwellings is proposed for Dundrum Road in the townland of Brodeen. This application is currently on hold pending submission of further information. If permitted, there would be potential for this development to contribute to cumulative effects due to ingress of suspended solids into the drainage network at construction stage.

Other Historic Landfills

A total of 12 historic landfills are present in the Suir catchment within Co. Tipperary, including Tipperary Town landfill.

The 11 other sites (excluding Tipperary Town) are at: Brittas Road and Monanearla, Thurles; Convent Cross, Dundrum; Coole, Clonmel; Connawarries, Carrick on Suir; Caherabbey and Killeigh, Cahir; Deansgrove, Cashel; Kilsheelan; Kiltillane, Templemore and Templeree, Templetuohy.

The Brittas Road site is adjacent to the river Suir, c. 6 km upstream of the Lower River Suir SAC. The Monanearla site is located c. 450m from the Kilkillahara watercourse, which is a tributary of the Suir with its source c. 8 km upstream of the Brittas Road site and 12 km upstream of the Lower River Suir SAC. The Aherlow/Suir confluence is c. 45 km downstream of the Brittas Road site.

The historic landfill site at Convent Cross, Dundrum is located c. 420 m from the river Multeen which is within the Lower River Suir SAC. The Aherlow/Suir confluence is c. 23 km downstream of the Convent Cross site.

The historic landfill site at Coole near Clonmel is located c. 370m from the River Suir and c. 220 m from the Lower River Suir SAC. The River Suir at this point is c. 30 km downstream of the Aherlow/Suir confluence (c. 52 km downstream of Tipperary Town historic landfill).

The historic landfill site at Connawarries is on the southern bank of the Suir downstream of Carrick on Suir and is partly overlapped by the Lower River Suir SAC. The River Suir at this point is c. 58 km downstream of the Aherlow/Suir confluence (c. 80 km downstream of Tipperary Town historic landfill).

A historic landfill site is present at Caherabbey, Cahir. This area is on the western bank of the River Suir and parts of it are overlapped by the SAC. The River Suir at this point is c. 3 km downstream of the Aherlow/Suir confluence (c. 25 km downstream of Tipperary Town historic landfill). Another historic landfill is present on the eastern outskirts of Cahir, in the townland of Killeigh. This townland is c. 0.4 km east of the Lower River Suir SAC. There are no EPA mapped watercourses in this area.

A historic landfill site is present in the townland of Deansgrove, Cashel. This townland is c. 2.4 km from the Lower River Suir SAC. The Stone stream which is a tributary of the Black stream (tributary of the Suir) flows along the southern boundary of the townland of Deansgrove. The in-stream distance between Deansgrove and the Lower River Suir SAC along this pathway is c. 4.5 km. The Aherlow/Suir confluence is c. 19 km downstream of the Black Stream/Suir confluence.

A historic landfill site is also present at Kilsheelan downstream of Clonmel. Kilsheelan village and townland are adjacent to the Lower River Suir SAC. The River Suir at Kilsheelan is c. 45 km downstream of the Aherlow/Suir confluence (c. 67 km downstream of Tipperary Town historic landfill).

A historic landfill site is present at Kiltillane on the eastern outskirts of Templemore. This townland is bounded to the east by the River Suir, which is c. 21 km upstream of the Lower River Suir SAC at this point. The Aherlow/Suir confluence is c. 54 km downstream of Templemore.

A historic landfill site is present in the civil parish of Templeree, Temlpehuohy. This area lies along the eastern bank of the Suir east of Templemore. As such, instream distances between this area and the Lower River Suir SAC at this point and the Aherlow/Suir confluence are broadly similar to Kiltillane above.

Risk assessments for these sites have not been completed, and as such site-specific remediation measures have not been recommended to date. A high-level assessment based on remedial works of some sort being carried out at these sites can be made in the context of the locations of these historical landfill sites relative to the Tipperary Town site. However, the level of detail required for a robust consideration of potential cumulative effects arising from remediation of other historical landfill sites is not possible in the absence of more detailed information.

Assuming a worst-case scenario where sediment was generated during remedial works at these sites and entered the river network, some potential for cumulative effects could exist. This could occur even if works were separated by a long period since the build-up of silt in gravel beds is a persistent problem. It is noted the same areas of the Lower River Suir SAC would not be affected due to the distance between the sites, but that effects on the SAC as a whole could occur.

It is noted that due to the later initiation of the risk assessment process for these sites, if authorised, the remediation works at Tipperary Town historical landfill would be likely to have been completed before the initiation of remediation works at these sites.

Other plans or activities

The dominant land use in the surrounding region is pastoral agriculture. This activity is likely to result in inputs of nutrients into the river network through the spreading of animal wastes and fertilisation. Drainage works, land improvement, reseeding as well as access of rivers by livestock is likely to result in combined sediment and nutrient inputs. As such, agricultural activities within the catchment have the potential to contribute to cumulative effects.

There are some forestry plantations in the vicinity of the landfill, however these appear to be predominantly broadleaved plantations of recent origin. There are requirements for isolated drainage and watercourse setbacks for modern plantations. These, coupled with the use of good-quality land for afforestation (and therefore limited or no requirement for fertilisation), mean forestry activities in the area are unlikely to result in negative environmental impacts. There are mature forestry plantations on the Galtees and Moanour mountain with connectivity to the Lower River Suir SAC (streams draining these slopes feed into the Aherlow River which is within the SAC).

These are upstream of the Ara/Aherlow confluence. Harvesting activities in the mature upland plantations could potentially generate sediment inputs which could contribute to cumulative effects.

There are two quarries around Tipperary Town. One is located in the townland of Murgasty, uphill of the Fidaghta watercourse which flows towards the landfill. Aerial imagery indicates this quarry is no longer active, however there is the possibility that sediment from this pit may be washed into the Fidaghta channel thereby potentially contributing to cumulative effects.

The second quarry straddles the townlands of Corrogemore and Corrogebeg and aerial imagery indicates it is active. This site is located on a hilltop to the east of Tipperary Town and is not located near any watercourses. As such it is unlikely to have the potential to contribute to cumulative effects.

Tipperary Co-Operative Creamery is located c. 0.5km upstream of the point where the channel draining the landfill site enters the River Ara. The creamery is licensed to discharge trade effluent; however, exceedances of BOD and COD limits have been recorded (SV18909, EPA 2020). It is noted that a discharge was stopped from 18th December 2019 and diverted to the wastewater treatment plant (SV18909, EPA 2020). Indications that the plant's wastewater treatment plant requires upgrading were also recorded (SV18181, EPA 2019). Discharge of trade effluent to a sewer not covered by the licence (P0801-01) was discovered incidentally by a technician working on the town's sewers on 5th May 2020 (SV20210, EPA 2020). A pollution incident which affected the River Ara linked to Tipperary Creamery is also noted in the Aquatic Ecology Report (Appendix 3). While the activities of this facility are regulated, occurrences such as those noted above indicate the possibility of cumulative effects requires consideration.

The cumulative effects of other projects and plans is considered in 6.5 Screening Matrix below.

6.4 Screening Assessment Criteria

Throughout this section the line items in italics refer to suggested instructions for information to be contained in a screening assessment, and in an appropriate assessment from the guidance document '*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 Commission, 2001). The standard 'Screening Matrix' and 'Finding of No Significant Effects Report Matrix' in Annex 2 of this guidance document are also followed.

As set out in NPWS guidance (DoEHLG, 2010), the task of establishing whether a plan or project is likely to have an effect on a European site(s) is based on an evaluation using available information and data (e.g., water quality data), supplemented as necessary by local site information and ecological surveys. This results in a determination by the competent authority as to whether there may be a significant effect on the designated site. A precautionary approach is required.

Some examples given in the NPWS guidance (DoEHLG, 2010) of effects that are likely to be significant are:

1. Any effect on an Annex I habitat,
2. A reduction in the area of a habitat of conservation interest in a European site or a reduction in the area of a European site,
3. Direct or indirect damage to the physical quality of the environment (e.g., water quality and supply, soil compaction) in the European site,
4. Serious or ongoing disturbance to species or habitats for which the European site is selected (e.g., increased noise, illumination and human activity),
5. Direct or indirect damage to the size, characteristics or reproductive ability of populations in the European site,
6. Interference with mitigation measures put in place for other plans or projects.

6.5 Screening Matrix

Assessment Criteria	Discussion of Potential Effects
Describe any likely direct, indirect or secondary impacts [effects] of the project (either alone or in combination with other plans or projects) on the Natura 2000 site by virtue of: • Size and scale; • Land-take; • Distance from Natura 2000 site or key features of the site; • Resource requirements; • Emissions; • Excavation requirements; • Transportation requirements; • Duration of construction, operation etc.; • Other.	**Size and scale** **Potential effects:** None Remediation works will be undertaken within a single parcel of land and remediation works will cover an area of c. 2.3 ha. Remediation works will involve the use of topsoil and subsoil spread over a barrier system which will require vertical cut-offs on all boundaries (outside the interred waste) and limited excavation (will not disturb interred waste body) will be required for the installation of landfill gas management elements located on the surface of the cap. No effects will occur on any European site due to size and scale. **Land-take** **Potential Effects:** None. The historic site is not located within any European site and there will therefore be no land-take of any European site. **Distance from Natura 2000 (European) sites** **Potential Effects:** None.

Assessment Criteria	Discussion of Potential Effects
	Moanaour Mountain SAC (002257), Philipston Marsh SAC (001847), Galtee Mountains SAC (000646) and Lower River Shannon SAC (002165) are not in close proximity to the proposed development site; in addition, these sites are designated only for habitats which occur within their boundaries. The fact that the Lower River Shannon SAC (002165) lies within a different catchment, combined with its distance from the landfill site precludes impacts to the mobile species for which it is designated. As such, no impacts to these sites in terms of their qualifying interests are envisaged in this regard. **Resource requirements** **Potential Effects:** None There will be no resource requirements from any European site as a result of the remediation works to the historic landfill. Therefore, no direct or indirect effects on any European site is envisaged. **Emissions** **Potential Effects:** Possible transport of pollutants, contaminants and/or invasive species reproductive material via river network to the Lower River Suir SAC During Remediation Works As the historic landfill is not located within any European sites, no direct effect via emissions will occur. During remediation emissions in the following categories will be produced: • Sediment will be produced during: - Reprofiling and capping of the site. - The installation of the barrier system which will require vertical cut-offs on all boundaries (outside the area of the interred waste body). - During the installation of landfill gas management elements located on the surface of the cap (will not disturb the interred waste body). • Invasive species material - Six invasive plant species are present within the historic landfill site; Japanese knotweed, winter heliotrope, snowberry, Himalayan honeysuckle, butterfly bush and old man's beard. There is potential for reproductive material

Assessment Criteria	Discussion of Potential Effects
	from Japanese knotweed to be transported downstream via the wetland and associated drainage channel. This could result in establishment of Japanese knotweed downstream resulting in bank destabilisation and associated risk of siltation. • Leachate - At present leachate is likely to escape from the site and enter groundwater and surface waters. During remediation works leachate will continue to be produced. Leachate monitoring results showed multiple parameters exceeded the EPA Interim Guideline Values (IGVs) for Groundwater. Elevated levels of ammonia, iron, manganese and chromium were recorded in the surface water monitoring results. The potential for indirect effects due to the transport of emissions in the form of hydrocarbons, leachate and/or suspended solids along the hydrological corridor identified (via the Spital-Land, Ara, and Aherlow) to the Lower River Suir SAC requires consideration. There is also potential for invasive species to be transported via the river network to Lower River Suir SAC (002137). The in-stream distance between the landfill site and the Lower River Suir SAC (18.2 km) and the slow flow rate and low capacity of the Spital-land watercourse means such effects are unlikely but cannot be ruled out. Moanaour Mountain SAC (002257), Philipston Marsh SAC (001847), Galtee Mountains SAC (000646) and Lower River Shannon SAC (002165) are not linked hydrologically to the proposed development site. The fact that the Lower River Shannon SAC (002165) lies within a different catchment, combined with its distance from the landfill site precludes impacts to the mobile species for which it is designated. As such, no impacts to these sites in terms of their qualifying interests are envisaged, and therefore they do not require further consideration in relation to the proposed historical landfill remediation works. After Remediation Works Following remediation works, leachate will continue to be produced and enter groundwater for a time. However, remediation works will prevent rainwater from infiltrating the interred waste body therefore reducing the potential for leachate to be produced. During the establishment of the grass layer (will take several weeks) on the newly engineered cap, there will runoff containing suspended solids will be produced. However, suspended solids will be far less than that produced during

Assessment Criteria	Discussion of Potential Effects
	remediation works and as such will not have the potential to result in effects on any European site. Occasional mowing of the low-flow drain running around the perimeter road may be required to maintain preferential flow paths. If grass clippings were left in situ nutrient inputs to the adjacent wetland could occur, with localised effects downstream. **Excavation requirements** **Potential Effects:** None There will be no excavation requirements from any European site as a result of the proposed development. Excavation works will be limited to site clearance works (2.26 ha) the installation of the barrier system and access road (outside the body of interred waste), installation of above ground elements of the gas collection system and the installation of the surface water drainage system outfall (placed in the bank of an existing river). There will also be the placement of topsoil and subsoil, which will be used to reprofile the historic landfill site; filling in any localised depressions. Soil runoff/suspended solid production will be low-negligible. See above section on 'Emissions' for more information. **Transportation requirements** **Potential Effects:** None. Site access will not traverse any European site. The site is accessed from the east via the Carrownreddy road which is a cul de sac accessed from the R661. No effects owing to transportation requirements are envisaged. **Duration of Construction and Operation** **Potential Effects:** None. It is anticipated that remediation works will occur over approximately 6 - 8 months. Following remediation works, environmental monitoring will be undertaken annually and will be ongoing for several years. Following remediation works, leachate will no longer be able to escape to the surface of the site or enter surface water and rainwater will no longer be able to reach interred waste and eventually leachate will no longer be created.

Assessment Criteria	Discussion of Potential Effects
	The landfill will be left in situ permanently and as such there is no decommissioning phase. **Cumulative Effects** **Potential Effects:** Potential cumulative effects in combination with silvicultural, agricultural, The following paragraphs summarise and analyse the potential for cumulative effects in conjunction with the plans, projects and activities detailed in 6.3 Potential Cumulative Effects. A planning search carried out on 17th August 2020 indicates that no other projects of a scale or type that could act cumulatively with the proposed remediation works at the historic landfill site were permitted in the townlands overlapping and surrounding the site during the previous 5 years. The proposed residential development in the townland of Brodeen would have potential contribute to cumulative effects due to ingress of suspended solids into the drainage network at construction stage. A number of land uses and activities in the area including forestry, agriculture, other historical landfills, a quarry and a dairy processing plant were identified as having the potential to contribute to cumulative effects on water quality in the lower River Suir SAC.
Describe any likely changes to the site arising as a result of: • Reduction of habitat area; • Disturbance of key species; • Habitat or species fragmentation; • Reduction in species density; • Changes in key indicators of conservation value; • Climate change.	There will be no direct reduction in habitat area or habitat fragmentation within any European site as a result of the project due to limited scale of works, nature of works (remediation works will produce a limited amount of silt and the resulting remediation will stop the continuing release of leachate entering groundwater), distance (closest European site is 8.2 km away). The potential for indirect reduction in habitat area due to siltation of gravel beds within the Lower River Suir SAC (18.2 km downstream) is unlikely to be appreciable but must be considered. There is some potential for invasive plant species to be spread to the terrestrial habitats for which the Lower River Suir SAC is designated via the river network. Disturbance of key species or reduction of key species as a result of the proposed development is unlikely but cannot be ruled out and as such must be considered. There is potential for water quality which is a key indicator of conservation value in the Lower River Suir SAC to be affected by the generation and transport of sediment arising from remediation works. Leachate monitoring

Assessment Criteria	Discussion of Potential Effects
	results showed multiple parameters exceeded the EPA Interim Guideline Values (IGVs) for Groundwater. Elevated levels of ammonia, iron, manganese and chromium were recorded in the surface water monitoring results. The proposed remediation works will ultimately have a positive impact on water quality within the River network downstream because leachate generation will reduce following construction of the engineered cap.
Describe any likely impacts [effects] on the Natura 2000 site as a whole in terms of: • *Interference with the key relationships that define the structure of the site;* • *Interference with key relationships that define the function of the site.*	There is potential for effects of unknown magnitude on the key relationships [between aquatic species and their habitats] that define the structure or function of the Lower River Suir SAC due to the proposed remediation works. These effects relate to the siltation of gravel beds and pollution of aquatic habitats, which could negatively affect the breeding habitat and/or foraging habitat of Qualifying Interest (QI) fish or invertebrate species including Atlantic Salmon and White-clawed Crayfish. This in turn could reduce breeding success and lead to population declines. Such declines would reduce prey abundance for Otter which is also a QI for the Lower River Suir SAC.
Provide indicators of significance as a result of the identification of effects set out above in terms of: • *loss,* • *fragmentation,* • *disruption,* • *disturbance,* • *change to key elements of the site (e.g. water quality etc.).*	Habitat loss or fragmentation is not predicted to occur. The significance of disruption, disturbance and/or changes to key elements of the site is likely to be low but cannot be defined with certainty.
Describe from the above those elements of the project or plan, or combination of elements, where the above impacts [effects] are likely to be significant or where the scale of magnitude of impacts [effects] is not known.	Effects of unknown scale or magnitude, either alone or in-combination with other projects or plans could potentially occur due to excavation, drainage and landscaping works associated with the proposed landfill remediation.

6.6 Stage One Screening Conclusion

The screening for Appropriate Assessment undertaken by the EPA to assess, in view of best scientific knowledge and the conservation objectives of the site, if the activity, individually or in combination with other plans or projects is likely to have a significant effect on any European Site. In this context, particular attention was paid to the European Site Lower River Suir SAC (Site Code 002137).

The EPA determined that the activity is not directly connected with or necessary to the management of any European Site and the EPA considered, for the reasons set out below, that it cannot be excluded, on the basis of objective information, that the activity, individually or in combination with other plans or projects, will have a significant effect on any European Site and accordingly determined that an Appropriate Assessment of the activity was required. The reasons for this determination are as follows:

- The closed landfill site is connected hydrologically to the Lower River Suir SAC (002137).
- Leachate monitoring results showed multiple parameters exceeded the EPA Interim Guideline Values (IGVs) for Groundwater.
- Elevated levels of ammonia, iron, manganese and chromium were recorded in the surface water monitoring results.

The conclusions of this Appropriate Assessment Screening report match the findings of the EPAs screening for Appropriate Assessment. It is concluded beyond reasonable scientific doubt that there are not likely to be significant effects from the proposed development on four of the European sites identified for consideration (or any other European site beyond 15km) either alone or in combination with other plans or projects.

No effects on the European Sites listed below are predicted. Therefore, the following four European sites have been ‘screened out’ within the Stage 1: Appropriate Assessment Screening Report:

1. Philipston Marsh SAC (Site Code 001847)
2. Galtee Mountains SAC (Site Code 000646)
3. Moanour Mountain SAC (Site Code 002257)
4. Lower River Shannon SAC (Site Code 002165)

There is the possibility that there could be negative effects on the Lower River Suir SAC (Site Code 002137) as a result of indirect effects from the proposed landfill remediation. In the absence of mitigation measures (which have not been considered at this screening stage), likely significant effects on the qualifying interests of Lower River Suir SAC cannot be ruled on the basis of objective scientific information. A Stage 2 Appropriate Assessment (Natura Impact Statement) of the potential impact on the Lower River Suir SAC will therefore be required.

A Natura Impact Statement has been completed in respect of:

- Lower River Suir SAC (Site Code 002137) (see section 7.)

See Appendix 7 for Findings of No Significant Effects Report

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7. STAGE TWO – NATURA IMPACT STATEMENT

7.1 Introduction

The EPA prepared a Stage One Appropriate Assessment Screening report for the proposed project which determined that a Stage Two Appropriate Assessment was required for Lower River Suir SAC. This section addresses the potential for a likely significant effect or effects on the Lower River Suir SAC (Site Code 002137).

7.2 Assessment of the Effects of the Project or Plan on the Integrity of the Sites

'*Describe the elements of the project or plan (alone or in combination with other projects or plans) that are likely to give rise to significant effects on the site (from screening assessment)*'

In the scenario of a large release of suspended sediment and / or polluted runoff into the drainage and river networks during construction works, there could be significant indirect effects to the Lower River Suir SAC. The historical landfill site is linked to the aforementioned European site via the surrounding wetland, Spital-land channel and the River Ara. The in-stream distance between the Tipperary Town Historical Landfill and the Lower River Suir SAC is 18.2 km.

Given the hydrological connection between the Lower River Suir SAC and the proposed development, the potential exists for indirect effects, via water quality, on the key species for which this European site has been designated. In the event of siltation or pollution of watercourses resulting from uncontrolled run-off from the proposed remediation works, the river network downstream could be indirectly damaged by changes to water turbidity and water quality. A deterioration in water quality has the potential to negatively affect aquatic species in the Lower River Suir SAC. There is potential for effects on designated aquatic species including, inter alia, freshwater pearl mussel, lamprey, Atlantic salmon, white-clawed crayfish, and otter due to water quality changes which could cause morbidity in individuals or populations. Changes in water quality could reduce the availability of prey for the abovementioned qualifying interest (QI) species in the Lower River Suir SAC and reduce breeding sites for fish and bivalve species. While such effects are unlikely, it is prudent to include mitigation measures to further reduce the potential for significant effects.

It is noted that freshwater pearl mussel as a qualifying interest refers specifically to the population in the Clodiagh catchment.

Intensive agriculture, forestry, development and industrial discharges are threats to water quality in the Suir catchment. There is potential for the proposed remediation works to contribute to a cumulative impact on water quality in local watercourses downstream of the site, through the potential for sediments and other pollutants entering the watercourses due to capping and associated infrastructure works in conjunction with the sources outlined above. Where remedial works and potentially activities damaging activities at other sites occur at the same time there is the potential for significant in-combination or cumulative impacts on local watercourses which in turn may affect the integrity of the Lower River Suir SAC.

All watercourses / water bodies which could be affected directly were considered as part of the Aquatic Ecology appraisal.

A total of 7 sites were selected for detailed assessment (see Aquatic Ecology Report in Appendix 3); these were located along the River Ara between Tipperary town and the Ara/Aherlow confluence (bridge upstream of Tipperary WWTP, Cordangan Bridge, N24 Bridge, Bansha Bridge, Ara Bridge Barnlough, Ara Bridge Ballygorteen and the Ara/Aherlow confluence).

Desktop and aquatic survey results are detailed below for relevant QI species.

7.2.1 Fish Surveys in the Study Area

IFI carried out an electrofishing survey of the entire River Suir between Kilsheelan and north of Cashel in 2018. Twelve fish species were recorded at ten sites surveyed on the River Suir in 2018. Brown trout and salmon were the most abundant species captured. Brown trout were present at all ten sites and salmon were recorded at nine out of ten sites surveyed. European eel was recorded at four sites. Dace and pike were recorded at three sites. Lamprey were captured at site 2 only (upstream of Golden). Two survey sites (1 & 10) were assigned Good fish ecological status. The remaining sites achieved a moderate or poor fish status.

The aquatic ecology survey carried out on 18th and 19th May 2020 by Sweeney Consultancy Ltd. on behalf of Fehily Timoney included habitat quality assessments for salmon and lamprey. The aquatic ecology appraisal noted the poor water quality in the Ara would preclude salmon from this river, but that salmon are known to be present in the Aherlow. No lamprey ammocoetes were found in muddy sediments sampled in the fieldwork for the current survey.

7.2.2 Atlantic salmon

The Atlantic salmon Salmo salar is listed under Annexes II and V of the EU Habitats Directive and Appendix III of the Bern Convention. It an economically important species and salmon recreational and commercial fisheries occur throughout Ireland. Atlantic salmon are an anadromous species, meaning they are spawned in freshwater habitats and then migrate to the sea. Salmon habitats are usually fast flowing riffle and glide habitats with cobble or gravel substrates. The gravels at these sites must be clean and well oxygenated for successful hatching.

Crisp (2000) notes that salmon spawning site selection is governed by a complex of environmental factors including intra-gravel flow, gravel size, water depth as well as stream velocity and cover, which are all essential for successful spawning, egg survival and hatching. One of the most important factors for salmon egg survival is oxygen supply, which is dependent upon dissolved oxygen concentration and inter-gravel flow. High concentrations of suspended solids in the river are undesirable as they are likely to result in infilling of the gravel pores with fine material (Cowx and Fraser, 2003). Juvenile salmon require fast flowing clean water and the cover of instream rocks, plants and banks to thrive. Adult salmon require pool habitat to rest in the interval between entering the river and reaching spawning grounds and the act of spawning. Salmon angling areas are usually located on main river channels or small rivers in deep glides of 1.5m depth or more.

The Overall Status of Atlantic salmon populations in Ireland is currently assessed as Stable (NPWS, 2019). Atlantic Salmon are precluded from the Ara due to poor water quality but are known to occur in the River Aherlow (Pers. Comm. Pascal Sweeney Aquatic Surveyor, 2020)[1].

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[1] Pascal Sweeney [Sweeney Consultancy Ltd], M.Sc, MCIEEM is an experienced aquatic ecologist with prior professional knowledge of the Suir catchment. He has previously carried out work in the area on contract to the EPA and prepared the Aquatic Ecology Report for this project (see Appendix 6).

7.2.3 Lamprey

The brook lamprey Lampetra planeri is the smallest of the three lamprey species native to Ireland and it is the only one of the three species that is non-parasitic and spends all its life in freshwater (Maitland & Campbell, 1992). Brook lamprey is listed in Annex II of the EU Habitats Directive (92:43: EEC) and in Appendix III of the Bern Convention. Brook lamprey are the most common and widespread of the three Irish lamprey species (Kurtz & Costello, 1999). Brook lamprey live for up to five years burrowed into silt deposits in rivers. They metamorphose into adults and spawn in the early spring in fast flowing streams with gravel substrates. Unlike the other two Irish lamprey species they are not parasitic as adults and undertake only localised migrations.

Although still common in Ireland they are under significant threat from drainage and navigation maintenance works and also from water quality deterioration. Brook lamprey are also doing less well across the rest of EU.

The river lamprey Lampetra fluviatilis and sea lamprey Petromyzon marinus are larger in size than the brook lamprey and exhibit an anadromous life cycle. Both species are listed in Annex II and IV of the Habitats Directive (92:43: EEC), and also in Appendix III of the Bern Convention. Lamprey are poor swimmers and cannot jump or climb (Reinhardt et al., 2009), so have significant difficulty getting past barriers such as weirs.

The Overall Status of river lamprey populations in Ireland is currently assessed as Favourable. The Overall Status of sea lamprey is assessed as Bad with a stable trend, unchanged since the last Article 17 assessment (NPWS, 2019).

The aquatic ecology appraisal (Sweeney, 2020) noted that adult sea lampreys are reported to occur in the lower reaches, up to 8km upstream of Clonmel (Kurz and Costello, 1999). This corresponds well with the findings of O'Connor (2007), whose survey showed the main distribution of sea lamprey ammocoetes to be in the main channel of the Suir, between Caher and Clonmel. O'Connor (2007) found juvenile brook/river lamprey at a site in the lower part of the Ara River, but none at a site near Tipperary Town. No lamprey ammocoetes were found in muddy sediments sampled in the fieldwork for the current survey.

7.2.4 Freshwater Pearl Mussel

The freshwater pearl mussel Margaritifera is a large bivalve species found in oligotrophic, soft to neutral waters of rivers and, occasionally, in lakes. In Ireland, the species is concentrated along the western sea-board, but also occurs in the south and east where geology allows. The biology and ecology of the species are particularly notable in that individuals can grow to very large sizes relative to other freshwater molluscs, building up thick calcareous valves in rivers with relatively soft water and low levels of calcium. Their shell building is consequently very slow, and individuals in natural conditions live to over a hundred years of age.

A single live freshwater pearl mussel and several empty joined shells were found c. 130m downstream of the Ara/Aherlow confluence during current surveys.

The Overall Status of Freshwater pearl mussel in Ireland is Bad and deteriorating, unchanged since the 2013 Article 17 assessment (NPWS, 2019). The Article 17 assessment outlines the status of EU protected habitats and species in Ireland.

As previously noted, freshwater pearl mussel as a qualifying interest refers specifically to the population in the Clodiagh catchment. The Clodiagh located on a sub separate catchment from the historical landfill, joins the Suir downstream of Carrick-on-suir, over 92 km downstream of Tipperary Town historical landfill site.

The Clodiagh freshwater pearl mussel catchment falls within the category 'Catchments of SAC populations listed in S.I. 296 of 2009'. The Suir catchments falls within the category 'Catchments with previous records of Margaritifera but current status unknown.'

7.2.5 White-clawed crayfish

The white-clawed crayfish Austropotamobius pallipes is the only freshwater crayfish recorded in Ireland. Populations of the species in the rest of Europe have declined dramatically and Ireland is seen as a unique stronghold for this species in a European context (Reynolds, 1998).

The white-clawed crayfish is protected both under European and Irish legislation. It is protected by the Wildlife Act, 1976 and has been classified as endangered in the IUCN Red List. It is also listed under Appendix III of the Bern Convention and Annexes II and V of the EU Habitats Directive (1992). The white-clawed crayfish is Ireland's only crayfish species. Ireland is understood to hold some of the best European stocks of this species, under least threat from external factors. Irish stocks are therefore of substantial conservation importance (Reynolds, 1998).

Throughout its natural range across Western Europe, the distribution and abundance of white-clawed crayfish has been dramatically reduced in the last 150 years due to human disturbances such as overfishing, habitat destruction, pollution and the introduction of foreign crayfish species (Reynolds, 1998). In Britain, the North American signal crayfish (Pacifastacus leniusculus) was introduced for aquaculture and subsequently escaped into the wild, where it has had a devastating effect on white-clawed crayfish populations. While this species has not been recorded in Ireland, there is a real threat that this alien crayfish species will reach this country. The crayfish plague, which was transmitted by introduced crayfish species and is caused by the fungus Aphanomyces astaci, has been found in Ireland since the late 1980s.

White-clawed crayfish are widespread in areas which are underlain by Carboniferous limestone, or its derivative - glacial drift (Reynolds, 1998). Demers et al., (2005) reported that white-clawed crayfish are still widespread in the rivers of the Irish midlands, where the geology is predominantly limestone. However, these authors also report that the distribution of white-clawed crayfish in rivers has been restricted since the mid-1980s. This was attributed in part to an outbreak of the crayfish plague. Recent data from the EPA suggests a decline in crayfish populations in the north midlands (Reynolds, 2006).

The Overall Status of the species in Ireland is Bad with a deteriorating trend. This represents a decline since the last Article 17 reporting period and is mainly due to bad Future prospects for the species due to the presence of crayfish Plague across six catchments (NPWS, 2019).

No crayfish were found at any of the sites surveyed in the River Ara or in the Aherlow River. In a 2017 licensed survey of crayfish at EPA river monitoring sites, reported to NPWS, Sweeney Consultancy recorded no crayfish at any of the four sites surveyed on the Ara River, but a high density of crayfish in the Aherlow River downstream of the Ara confluence. However, in 2017, crayfish plague spread through the lower parts of the River Suir main channel and some of the lower tributaries. This spread continued upstream, killing crayfish throughout the main channel and tributaries. (Sean Breen, NPWS pers. comm. from Aquatic Ecology Report). It therefore appears that this infection has now wiped out all crayfish downstream of the subject site.

7.2.6 Otter

Ireland represents a stronghold for the European otter Lutra. Four national surveys were conducted between 1980/81 and 2010. The 1980/81 survey found otter signs at 88% of sites surveyed.

Declines were indicated in 1990/91 and 2004/05 however the most recent survey in 2010 pointed to a recovery to levels recorded in 1980.

Aquatic prey and safe refuges to rest and breed are the two primary requirements of otter. In Ireland, populations of otter are found along rivers lakes and coasts where aquatic prey are abundant and adequate bankside cover is available. Otters are opportunistic predators with a broad and varied diet which includes fish in freshwater and coastal habitats, crabs and molluscs in coastal areas and crayfish and frogs inland.

The main threats to otter include pollution (organic pollution resulting in fish kills is a particular concern) and accidental death caused by road traffic collisions and fishing gear. A total of 44 SACs which include extensive stretches of river channels and coastline (mainland and offshore islands) have been designated for otter (NPWS, 2019).

The Overall Status of the species in Ireland is Favourable and improving. This trend is unchanged since the last Article 17 reporting period (NPWS, 2019).

No evidence of otter presence was found from the subject site to 1km downstream of the point where the drain enters the River Ara. No otters were recorded on the camera trap placed overnight on the bridge beside Tipperary WWTP entrance. The National Biodiversity Data Centre (NBDC) website does not show any record of otters close to Tipperary Town. This absence of otters here is to be expected, where prey is scarce and human disturbance relatively high. An otter spraint was found on a rock just downstream of Cordangan Bridge (c. 4 km downstream of the historic landfill). Otters are plentiful in the Aherlow River (Pers. Comm. Pascal Sweeney Aquatic Surveyor, 2020).

7.2.7 Biological Water Quality

Macroinvertebrate sampling was carried out at one location downstream of the historical landfill site. The sampling location was located at the bridge upstream of Tipperary WWTP outfall.

At this location (EPA Station 16A03 0300), the river was found to be at Q3, indicating poor ecological quality. Pollution sensitive species from Groups A and B are absent. Chironomidae (non-biting midge larvae) from Group C dominate the fauna, indicating that the fauna was impacted by a pollution incident in recent months. This is possibly related to a dairy discharge which turned the river white and which was reported to Inland Fisheries Ireland (Sean Breen, NPWS, pers. comm.). Other Group C species common in occurrence are the freshwater shrimp, Gammarus duebeni, freshwater mites (Hydrachnidae) and flatworms (Tricladida). A relatively high representation of Group D species, mainly the water slater, Asellus aquaticus, and the orb mussel, Sphaerium corneum, brings the Q-value down to the lower end of the Q3 range, close to Q2-3.

EPA Q-values recorded in the River Ara for the Rivers Monitoring Programme are presented in Appendix 7 of the aquatic ecology appraisal (contained in Appendix 3 of this report). The 2014 and 2017 assessments were carried out by Sweeney Consultancy (author of current aquatic appraisal), on contract to the EPA. The biological water quality at Station 16A03 0300 has been unsatisfactory on every one of the 17 assessment occasions since 1971. In 2017, the Q-value here had declined to Q2-3 from the Q3 recorded from 2003 to 2014.

Also in 2017, the two stations assessed further downstream on the Ara while less severely polluted, were still in unsatisfactory ecological condition (Q3-4). Overall, the River Ara has been one of the worst polluted rivers in the Suir catchment since recording of biological water quality began.

7.3 The Conservation Objectives of the European (Natura 2000) Sites

'Set out the conservation objectives of the site'.

The conservation objectives for the Lower River Suir SAC is to either maintain or restore the favourable conservation status of the key species and habitats for which the sites have been designated. The conservation objectives for each qualifying interest / special conservation interest in the Lower River Suir SAC are detailed in Table 7-1 along with an evaluation as to whether there is potential for the conservation objectives to be affected by the proposed development.

Table 7-1: Conservation Objectives, Attributes and Targets– Lower River Suir SAC

Qualifying Interest / Special Conservation Interest	Conservation Objective	Attribute	Target	Potential to be affected
Atlantic salt meadows	Restore favourable conservation condition	Details not required	Details not required	No potential to be affected due to distance from proposed remediation works (Located in estuarine reaches east of Waterford city).
Mediterranean salt meadows	Restore favourable conservation condition	Details not required	Details not required	No potential to be affected due to distance from proposed remediation works (Located in estuarine reaches east of Waterford city).
Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	Maintain favourable conservation condition	Details not required	Details not required	This habitat occurs below the Aherlow/Suir confluence (c. 23 km downstream) and is unlikely to be vulnerable to effects arising from the proposed remediation works.
Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	Maintain favourable conservation condition	Details not required	Details not required	No potential to be affected. This habitat is not vulnerable to siltation and is unlikely to be affected by potential pollutant inputs at the low levels predicted for the proposed remediation works. None of the invasive species present at the historical landfill would be likely to establish in this habitat due to unsuitable (waterlogged) ground conditions.

Qualifying Interest / Special Conservation Interest	Conservation Objective	Attribute	Target	Potential to be affected
Old sessile oak woods with *Ilex and Blechnum* in the British Isles	Restore favourable conservation condition	Details not required	Details not required	No potential to be affected. This terrestrial habitat is not vulnerable to siltation or aquatic pollution. It's limited extent and locations within the Lower River Suir SAC (confirmed locations are near Cappawhite upstream of the landfill site and Poulavanogue Stream near Clonmel and Curraghmore Estate near Portlaw upstream of the Suir) mean the introduction of invasive species via the river network is unlikely to occur.
Alluvial forests with *Alnus glutinosa and Fraxinus excelsior*	Restore favourable conservation condition	Details not required	Details not required	No potential to be affected. This habitat is not vulnerable to siltation and is unlikely to be affected by potential pollutant inputs at the low levels predicted for the proposed remediation works. None of the invasive species present at the historical landfill would be likely to establish in this habitat due to waterlogged ground conditions.
***Taxus baccata* woods of the British Isles**	Restore favourable conservation condition	Details not required	Details not required	No potential to be affected. This terrestrial habitat is not vulnerable to siltation or aquatic pollution. It's limited extent and locations within the Lower River Suir SAC (only one confirmed location at Cahir Park upstream of the proposed remediation works) mean the introduction of invasive species via the river network is unlikely to occur.
Freshwater Pearl Mussel	Restore favourable conservation condition	Details not required	Details not required	The conservation objective applies to the Clodiagh freshwater pearl mussel population, which is listed on The European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009. (S.I. 296 of 2009). Considering the Clodiagh catchment is upstream of the main channel of the River Suir and the Clodiagh/Suir confluence is over 92 km downstream of the proposed remediation works, effects on the Clodiagh freshwater pearl mussel population are unlikely.

Qualifying Interest / Special Conservation Interest	Conservation Objective	Attribute	Target	Potential to be affected
White-clawed crayfish	Maintain favourable conservation condition	Distribution	No reduction from baseline	White-clawed crayfish were not recorded during current surveys. Current indications are that crayfish plague has wiped out all crayfish downstream of the subject site. As such there is no potential for the proposed remediation works to affect the distribution of white-clawed crayfish in the Lower River Suir SAC.
		Population structure: recruitment	Juveniles and/or females with eggs in at least 50% of positive samples	Due to the absence of crayfish downstream (resulting from crayfish plague) there is no potential for the proposed remediation works to affect the population structure of white-clawed crayfish in the Lower River Suir SAC.
		Negative indicator species	No alien crayfish species	N/A. This target is not relevant to proposed remediation works.
		Water quality	At least Q3-4 at all sites sampled by the EPA	While unlikely due to the predicted brevity of any water quality declines arising from proposed works and distance from the historical landfill site, reductions in water quality affecting this target cannot be ruled out. However, since white-clawed crayfish are currently absent from the catchment downstream this target would be of concern in the longer-term pending re-introduction of the species.
		Habitat quality: heterogeneity	No decline in heterogeneity or habitat quality	While unlikely, there is potential for sediment arising from proposed remediation works to be transported via the river network to be deposited in the riverbed resulting in a reduction in habitat heterogeneity. However, since white-clawed crayfish are currently absent from the catchment downstream this target would be of concern in the longer-term pending re-introduction / re-colonisation of the species.

Qualifying Interest / Special Conservation Interest	Conservation Objective	Attribute	Target	Potential to be affected
Sea Lamprey	Restore favourable conservation condition	Distribution: extent of anadromy	Greater than 75% of main stem length of rivers accessible from estuary	N/A. This target does not have the potential to be influenced by proposed remedial works.
		Population structure of juveniles	At least three age/size groups present	This target is unlikely to be affected by proposed remedial works.
		Juvenile density in fine sediment	Juvenile density at least 1/m²	This target is unlikely to be affected by proposed remedial works.
		Extent and distribution of spawning habitat	No decline in extent and distribution of spawning beds	It is unlikely that sediment or pollutant emissions arising from proposed remediation works would result in effects on spawning habitat (in-stream distance between proposed remediation works and known populations is c. 28 km). While unlikely, if Japanese knotweed was transported downstream and become established on riverbanks this could cause bank collapse resulting in sediment inputs which could negatively affect spawning beds.
		Availability of juvenile habitat	More than 50% of sample sites positive	This target is unlikely to be affected by proposed remedial works.
Brook Lamprey	Restore favourable conservation condition	Distribution: extent of anadromy	Access to all water courses down to first order streams	N/A. This target does not have the potential to be influenced by proposed remedial works.
		Population structure of juveniles	At least three age/size groups of brook/river lamprey present	This target is unlikely to be affected by proposed remedial works.

Qualifying Interest / Special Conservation Interest	Conservation Objective	Attribute	Target	Potential to be affected
		Juvenile density in fine sediment	Mean catchment juvenile density of brook/river lamprey at least 2/m²	This target is unlikely to be affected by proposed remedial works.
		Extent and distribution of spawning habitat	No decline in extent and distribution of spawning beds	Although unlikely, sediment or pollutant emissions arising from proposed remediation works could potentially result in effects on spawning habitat (spawning habitat could potentially be present in the Aherlow). While unlikely, if Japanese knotweed was transported downstream and become established on riverbanks this could cause bank collapse resulting in sediment inputs which could negatively affect spawning beds.
		Availability of juvenile habitat	More than 50% of sample sites positive	This target is unlikely to be affected by proposed remedial works.
River Lamprey	Restore favourable conservation condition	Distribution	Access to all water courses down to first order streams	N/A. This target does not have the potential to be influenced by proposed remedial works.
		Population structure of juveniles	At least three age/size groups of river/brook lamprey present	This target is unlikely to be affected by proposed remedial works.
		Juvenile density in fine sediment	Mean catchment juvenile density of brook/river lamprey at least 2/m²	This target is unlikely to be affected by proposed remedial works.

Qualifying Interest / Special Conservation Interest	Conservation Objective	Attribute	Target	Potential to be affected
		Extent and distribution of spawning habitat	No decline in extent and distribution of spawning beds	Although unlikely, sediment or hydrocarbon emissions arising from proposed remediation works could potentially result in effects on spawning habitat (spawning habitat could potentially be present in the Aherlow). While unlikely, if Japanese knotweed was transported downstream and became established on riverbanks this could cause bank collapse resulting in sediment inputs which could negatively affect spawning beds.
		Availability of juvenile habitat	More than 50% of sample sites positive	This target is unlikely to be affected by proposed remedial works.
Twaite Shad	Restore favourable conservation condition	Details not required	Details not required	Twaite shad do not occur upstream of the weir at Clonmel (c. 58 km downstream of proposed remediation works) (see Aquatic Ecology Appraisal in Appendix 3). As such this species is unlikely to be affected by the proposed remediation works.
Atlantic Salmon	Restore favourable conservation condition	Distribution: extent of anadromy	100% of river channels down to second order accessible from estuary	N/A. This target does not have the potential to be influenced by proposed remedial works.
		Adult spawning fish	Conservation limit (CL) for each system consistently exceeded	Since Salmon are known to occur in the River Aherlow, there is potential for these targets to be affected by sediment or pollutant inputs arising from proposed remediation works. Effects in this category would be most likely to impact spawning habitat and juvenile salmonids. Similarly, if Japanese knotweed was transported downstream and become established on riverbanks this could cause bank collapse resulting in sediment inputs which could negatively affect spawning beds.
		Salmon fry abundance	Maintain or exceed 0+ fry mean catchment-wide abundance threshold value. Currently set	

Qualifying Interest / Special Conservation Interest	Conservation Objective	Attribute	Target	Potential to be affected
			at 17 salmon fry/5 minutes sampling	
		Out-migrating smolt abundance	No significant decline	
		Number and distribution of redds	Number and occurrence	
		Water quality	At least Q4 at all sites sampled by EPA	
Otter	Maintain favourable conservation condition	Distribution	No significant decline	N/A. This target does not have the potential to be influenced by proposed remedial works.
		Extent of terrestrial habitat	No significant decline. Area mapped and calculated as 116.17ha above high water mark (HWM) and 726.61ha along river banks	N/A. This target does not have the potential to be influenced by proposed remedial works.
		Extent of marine habitat	No significant decline. Area mapped and calculated as 712.27ha	N/A. This target does not have the potential to be influenced by proposed remedial works.
		Extent of freshwater (river) habitat	No significant decline. Length mapped and	N/A. This target does not have the potential to be influenced by proposed remedial works.

Qualifying Interest / Special Conservation Interest	Conservation Objective	Attribute	Target	Potential to be affected
			calculated as 382.31km	
		Couching sites and holts	No significant decline	N/A. This target does not have the potential to be influenced by proposed remedial works.
		Fish biomass available	No significant decline	Sediment, pollutant or invasive species material emissions arising from proposed remediation works could potentially result in negative effects on fish spawning habitat, thereby reducing fish biomass in otter foraging territories.
		Barriers to connectivity	No significant decline	N/A. This target does not have the potential to be influenced by proposed remedial works.

7.4 Potential Effects on Key Species and Key Habitats

'Describe how the project or plan will affect key species and key habitats. Acknowledge uncertainties and any gaps in information'

No direct effects are predicted on any European site as a result of the proposed development. In the hypothetical scenario of a large release of contaminated runoff, leachate or silt into the surrounding wetland and Spital-land channel during construction works, there could be significant indirect effects on the Lower River Suir SAC.

Indirect effects may occur, via water quality, on key species for which this European site has been designated. In the event of siltation or pollution of watercourses resulting from uncontrolled run-off from the proposed remediation works, the river network downstream of the site which is connected to and partly encompassed by the Lower River Suir SAC could be indirectly damaged by changes to water turbidity and water quality.

Atlantic salmon are known to occur within the River Aherlow. River and brook lamprey could also potentially occur in the Aherlow, which is encompassed by the Lower River Suir SAC. The River Ara downstream of the historical landfill is not suitable for salmonids or lamprey habitat. Juvenile brook/river lamprey have previously been recorded in the lower reaches of the Ara, but not near Tipperary town. No lamprey ammocoetes were found in muddy sediments sampled in the fieldwork for the current survey.

While the lack of localised populations of these species downstream of the landfill would reduce the likelihood for significant effects it is prudent to include mitigation measure to further reduce potential effects. These species could be indirectly affected further downstream by sediment inputs, polluted runoff or bank destabilisation arising from the spread of Japanese knotweed along watercourses caused by proposed remediation works.

Sea lamprey occur in the main channel of the Suir between Caher and Clonmel. As such they are unlikely to be affected by sediment or polluted runoff arising from proposed remediation works. However, this species could potentially be effected if Japanese knotweed was spread downstream and caused bank destabilisation resulting in sediment ingress impacting spawning beds.

A single live freshwater pearl mussel and several joined empty shells were present at the Ara/Aherlow confluence during current surveys.

While potential effects to freshwater pearl mussels at this location could occur, the conservation objective applies to the Clodiagh freshwater pearl mussel population, which is listed on The European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009. (S.I. 296 of 2009). As such there is no potential for appreciable effects on this conservation objective.

Although previously present at high densities in the Aherlow River downstream of the Ara confluence, white-clawed crayfish were not recorded during current surveys, and current indications are that crayfish plague has wiped out all white-clawed crayfish downstream of the subject site. As such there is currently no potential for proposed remediation works to affect this species.

An otter spraint was found on a rock just downstream of Cordangan Bridge (c. 4 km downstream of the historic landfill). Otters are common in the Aherlow River (personal observation of aquatic surveyor).

Sediment, pollutant or invasive species material emissions arising from proposed remediation works could potentially result in negative effects on fish spawning habitat, thereby reducing fish biomass in otter foraging territories.

In the unlikely event of the spread of Japanese knotweed downstream there could be an indirect effect on fish species via reduction in breeding habitat and available habitat for juvenile fish species. Due to a potential change in river habitat, there could also be effects on aquatic species and otter due to prey availability.

In the absence of mitigation measures the potential exists for effects to some of the key species of the Lower River Suir SAC downstream of the site.

7.5 Potential Effects on the Integrity of the Sites

‘*Describe how the integrity of the site (determined by structure and function and conservation objectives) is likely to be affected by the project and plan (e.g., loss of habitat, disturbance, disruption, chemical changes, hydrological changes and geological changes etc.). Acknowledge uncertainties and any gaps in information’*

The potential indirect effects on the conservation objectives of the qualifying interests of the Lower River Suir SAC have been detailed in Table 7-1. In summary, the integrity of the site could be indirectly affected by the proposed remediation works through a reduction in water quality affecting aquatic QI species such as lamprey, salmon, and otter. This in turn could lead to reduced numbers of different age classes or reduced breeding success. Adequate information on the existing environment was available for all required appraisals.

The magnitude of potential effects arising from reductions in water quality cannot be predicted with certainty. As such, mitigation measures are designed to be as robust as possible in accordance with the precautionary principle.

7.6 Proposed Mitigation Measures

'*Describe what mitigation measures are to be introduced to avoid or reduce the adverse effects on the integrity of the site. Acknowledge uncertainties and any gaps in information'*

- List measures to be introduced;
- Explain how the measures will avoid the adverse effects on the integrity of the site;
- Explain how the measures will reduce the adverse effects on the integrity of the site;
- Provide evidence of how they will be implemented and by whom.

The requirements for the remediation and monitoring of the site are set out in condition 3 of the certification of authorisation (see Appendix 1).

The proposed mitigation measures are listed in Table 7-2, detailing how the measures will avoid or reduce adverse effects on the Lower River Suir SAC, who will implement the measures and the degree of confidence in their successful implementation.

7.6.1 Mitigation by Avoidance and Design

The following measures have been undertaken at the planning stage of the project to reduce effects on designated sites through avoidance and design:

- Landfill side slopes no steeper than 1:2.5 and swale drainage system to mitigate the risk of erosion,
- Access track construction methodology to reduce suspended solids generation and prevent off-site landfill gas migration,
- Ongoing Invasive Species Management.

Landfill Side Slopes

Landfill side slopes are to be re-profiled such that they will not be steeper than 1:2.5. This is to facilitate access for maintenance and to mitigate the risk of rotational slope instabilities and erosion.

To mitigate the risk of translational instability (cap subsoil materials sliding off the barrier LLDPE membrane):

- An access track in the wetland, see below, will be provided to provide a foundation upon which the cap toe can be founded, and
- Geogrids were selected to provide support to facilitate placement of soils overlying synthetic materials on steep side slopes. Geogrids were selected to avoid the need to excavate large volumes of waste materials to provide stable slopes upon which an engineered cap cold be placed.

To mitigate the risk of erosion on steep side slopes:

- Shallow surface water swales will be constructed at flat longitudinal slopes to reduce the risk of rill and gully erosion that might increase suspended solids and or compromise cap integrity during the aftercare period.

Access Track Installation

A perimeter access track in the wetland is required to facilitate import of material and to provide a foundation upon which the cap can be constructed. The perimeter track was also designed to encourage water to enter the perimeter boundary cut-off gas venting trench. Water provides a barrier to landfill gas migration.

The perimeter access track will be constructed using a methodology designed to minimise the need for excavation thereby reducing the generation of suspended solids. Granular fill will be placed above the existing wetland substrate on a separation membrane and geogrid. This methodology has been selected to negate the need for further excavation into the wetland for perimeter access track construction in order to minimise disturbance and formation of suspended solids.

In addition, access track construction shall use granular blocky aggregate with minimal fines. This will minimise the potential for the access track to generate suspended solids.

Invasive Species Management

Invasive species control and eradication measures are currently being implemented on site, in accordance with the invasive species management plan. Monitoring of invasive species stands is undertaken on a bi-annual basis to assess the progress of these measures. The invasive species management plan and progress reports are included in Appendix 4.

General Mitigation Measures

Table 7-2 below details mitigations measures that will be implemented prior to and/or during construction.

Table 7-2: Details of Mitigation Measures for Proposed Development

No.	Mitigation Measure	How Measure Will Avoid/Reduce Adverse Effects	Implementation of Mitigation Measure and Likely Success	Monitoring scheme to prevent mitigation failure
Mitigation Measures to be Implemented Prior to and During the Construction Phase				
	Soil stockpiles will not be stored on the slopes or the toe of the mound	Minimise ingress of suspended solids into adjacent waterbodies	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
	Compact surface of stored soils during reprofiling and capping works	Minimise generation of suspended solids	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
	Weather forecasts will be reviewed on a daily basis and earthworks will not be undertaken during periods of heavy rainfall. Compact surface of soils during reprofiling and capping works as soon as practicably possible	Minimise generation of suspended solids	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
	Silt fencing shall be located adjacent to all water courses and at the toe of the landfill side slopes.	Minimise ingress of suspended solids into adjacent waterbodies	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.

No.	Mitigation Measure	How Measure Will Avoid/Reduce Adverse Effects	Implementation of Mitigation Measure and Likely Success	Monitoring scheme to prevent mitigation failure
	A series of silt fences shall be securely placed within the outflow channel draining the wetland to the east of the landfill. These shall be installed prior to any works. Straw bales will be incorporated into silt barrier closest to landfill if this does not cause excessive water retention.	Minimise transport of suspended solids downstream	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
	Temporary on-site silt ponds will be provided round the perimeter of the landfill side slopes to allow settlement of suspended solids prior to runoff exiting the works area. These are to be constructed prior to commencement of remediation works.	Minimise ingress of suspended solids into adjacent waterbodies	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
	Dewatering flows from excavations will be managed to prevent elevated suspended solids entering the watercourse by use of temporary dedicated settlement ponds. Discharges into the onsite drainage network will only take place after silt fencing has been installed.	Minimise ingress of suspended solids into adjacent waterbodies	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
	If excavations contain leachate, dewatering discharges will be directed to a holding area and retained within the waste body or	Prevent leachate discharges to adjacent waterbodies	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with	A suitably qualified person will be appointed to ensure the effective operation and maintenance of

No.	Mitigation Measure	How Measure Will Avoid/Reduce Adverse Effects	Implementation of Mitigation Measure and Likely Success	Monitoring scheme to prevent mitigation failure
	removed offsite and disposed of at a licensed facility.		competent supervisory staff overseeing the works. High probability of success.	mitigation measures during the construction process.
	To construct the perimeter access track, granular fill will be placed above the existing wetland substrate on a separation membrane and geogrid. This methodology has been selected to negate the need for excavating into the wetland in order to minimise disturbance and formation of suspended solids.	Minimise generation of suspended solids	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
	A silt screen shall be constructed at the toe of the reprofiled slopes to prevent silt entering adjacent watercourses.	Minimise ingress of suspended solids into adjacent waterbodies	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
	Any other diesel, fuel or hydraulic oils stored on site will be stored in bunded storage tanks – the bund area will have a volume of at least 110 % of the volume of such materials stored.	Reduce the risk of hydrocarbons reaching the waterways within the catchment of the proposed remediation works.	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
	Refueling of plant during construction will only be carried out at a designated bunded refueling station located near the site entrance	Reduce the risk of hydrocarbons reaching the waterways within the catchment of the proposed remediation works.	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.

No.	Mitigation Measure	How Measure Will Avoid/Reduce Adverse Effects	Implementation of Mitigation Measure and Likely Success	Monitoring scheme to prevent mitigation failure
			competent supervisory staff overseeing the works. High probability of success.	
	Appropriate spill control equipment, such as oil soakage pads, will be kept within the construction area and in each item of plant to deal with any accidental spillage.	Reduce the risk of hydrocarbons reaching the waterways within the catchment of the proposed remediation works.	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
	Portaloos and / or containerised toilets and welfare units will be used to provide toilet facilities for site personnel. Sanitary waste will be removed from site by a licensed waste disposal contractor.	Ensure that no sanitary waste enters the waterways within the catchment of the proposed remediation works.	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
	Existing invasive species management undertaken in line with the invasive species management plan shall continue during remediation works as required.	Prevent the accidental spread of invasive plant species	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
	A 7 m exclusion zone* around Japanese knotweed growths will be cordoned off prior to construction. **[conditional on treatment]* *If current treatment is successful in eradicating Japanese knotweed and 2 consecutive years with no growth of this species is recorded*	Prevent the accidental spread of Japanese knotweed	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.

No.	Mitigation Measure	How Measure Will Avoid/Reduce Adverse Effects	Implementation of Mitigation Measure and Likely Success	Monitoring scheme to prevent mitigation failure
	onsite prior to construction the 7m buffer can be discarded.			
	Soil infested with Japanese knotweed including an area of 7m* surrounding growths shall be excavated to a depth of 1-3m as required. Excavated material shall be encapsulated in a 0.7 mm thick plastic membrane and a minimum cover of 2.0 m of soil above which the cap shall be constructed will be provided.	Prevent the accidental spread of Japanese knotweed	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
	As such all Japanese knotweed material will remain onsite. *[*conditional on treatment*] *If current treatment is successful in eradicating Japanese knotweed and 2 consecutive years with no growth of this species is recorded onsite prior to construction the 7m buffer can be discarded.*			
	Any stockpiled Japanese knotweed material awaiting burial will be stored securely and covered within designated cordoned areas.	Prevent the accidental spread of Japanese knotweed	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
	All machinery used to carry out Japanese knotweed eradication	Prevent the accidental spread of Japanese knotweed	Mitigation measures will be implemented by the Client through the Contractor	A suitably qualified person will be appointed to ensure the effective

No.	Mitigation Measure	How Measure Will Avoid/Reduce Adverse Effects	Implementation of Mitigation Measure and Likely Success	Monitoring scheme to prevent mitigation failure
	measures will be visually checked and washed down thoroughly. Potentially contaminated runoff will be collected, treated and any potentially contaminated residual material will be interred with the main body of contaminated material (residual material should also be encapsulated).		awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	operation and maintenance of mitigation measures during the construction process.
	Silt fences downstream of the landfill will be checked for Japanese knotweed material during and after eradication measures.	Prevent the accidental spread of Japanese knotweed	Mitigation measures will be implemented by the Client through the Contractor awarded the contract to carry out remedial works in combination with competent supervisory staff overseeing the works. High probability of success.	A suitably qualified person will be appointed to ensure the effective operation and maintenance of mitigation measures during the construction process.
Mitigation Measures to be Implemented During the Operational / Post Construction Phase				
	Current invasive species monitoring (and treatment where required) will continue during the Operational / Post Construction Phase until two consecutive years where no invasive species are recorded onsite or immediately adjacent is achieved.	Prevent the landfill acting as a reservoir for the spread of invasive plant species	Mitigation measures will be inspected by a suitably qualified person appointed by the client. High probability of success	Inspection by a suitably qualified person appointed by the client.
	Grassed water ways constructed at slopes to prevent erosion shall discharge surface and sub surface runoff flows to receiving water via the access track. No excavation of these waterways shall be	Minimise generation of suspended solids	Mitigation measures will be inspected by a suitably qualified person appointed by the client. High probability of success	Inspection by a suitably qualified person appointed by the client.

No.	Mitigation Measure	How Measure Will Avoid/Reduce Adverse Effects	Implementation of Mitigation Measure and Likely Success	Monitoring scheme to prevent mitigation failure
	undertaken and maintenance works will be limited to mowing only.			
	There may be a requirement to locally mow the low flow drainage channel adjacent to the perimeter road to provide a preferential drainage path. If mowing is carried out grass clippings should be removed immediately to prevent nutrient inputs to the downstream catchment.	Prevent incidental generation of nutrient inputs	Mitigation measures will be inspected by a suitably qualified person appointed by the client. High probability of success	Inspection by a suitably qualified person appointed by the client.
	The capped surface will be vegetated post-construction to prevent the generation of silted runoff.	Minimise generation of suspended solids	Mitigation measures will be inspected by a suitably qualified person appointed by the client. High probability of success	Inspection by a suitably qualified person appointed by the client.
	Post construction the LLDPE barrier will provide an engineered barrier that will isolate the waste body from rainfall inputs and prevent leachate production that might otherwise contaminate groundwater.	Minimise generation of leachate	Mitigation measures will be inspected by a suitably qualified person appointed by the client. High probability of success	Inspection by a suitably qualified person appointed by the client.

7.6.2 Mitigation for Cumulative Effects

A number of sources of potential cumulative effects in the surrounding region were identified:

Proposed Residential Development

If authorised, the proposed 84 unit residential development in the townland of Brodeen would have the potential contribute to cumulative effects due to ingress of suspended solids into the drainage network at construction stage.

Other Historic Landfills

As previously noted, 11 additional historical landfill sites are present within the Suir catchment in Co. Tipperary.

In the absence of risk assessments for the other 11 historical landfill sites identified within the Suir catchment (Brittas Road and Moneanearla, Thurles; Convent Cross, Dundrum; Coole, Clonmel; Connawarries, Carrick on Suir; Caherabbey and Killeigh, Cahir; Deansgrove, Cashel; Kilsheelan; Kiltillane, Templemore and Templeree, Templetuohy) and assuming a worst-case scenario where sediment was generated during remedial works at these sites and entered the river network, some potential for cumulative effects could exist. This could occur even if works were separated by a long period since the build-up of silt in gravel beds is a persistent problem. It is noted the same areas of the Lower River Suir SAC would not be affected due to the distance between the sites, but that effects on the SAC as a whole could occur.

Other Land Uses

There are mature forestry plantations on the Galtees and Moanour mountain with connectivity to the Lower River Suir SAC (streams draining these slopes feed into the Aherlow River which is within the SAC). These are upstream of the Ara/Aherlow confluence and harvesting activities could potentially generate sediment inputs which could contribute to cumulative effects.

Agricultural activities within the catchment have the potential to contribute to cumulative effects.

There is potential for the quarry upstream of the historic landfill to generate sediment which could act cumulatively with sediment generated by the proposed remediation works.

Dairy Industry

Although the activities of Tipperary Co-Operative Creamery are governed by an IPC licence (P0801-01), evidence of ineffective compliance with licence conditions has been recorded. As such it is not possible to rule out potential cumulative impacts in conjunction with this operation.

Mitigation measures for the proposed development are detailed in Table 7-2. With the implementation of these mitigation measures, it is concluded beyond reasonable scientific doubt that the cumulative effect of the proposed development will **not be significant.**

7.7 Efficacy of the Proposed Mitigation Measures

Mitigation measures were devised in consideration of the following consultation responses, legislation, guidelines and the Certification of Authorisation (H0004-01):

- S.I. No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations, 1988;
- Water Framework Directive (2000/60/EC);
- CIRIA Environmental Good Practice on Site;
- Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora;
- Directive 2009 / 147 / EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds;
- Best Practice Guide BPGCS005, Oil Storage Guidelines;
- CIRIA Control of Water Pollution from Construction Sites. Guidance for Consultants and contractors (C532);
- UK Pollution Prevention Guidelines (PPG):
    I. PPG1: Good Environmental Practices (2013)
    II. PPG2: Above ground oil storage tanks (2011)
    III. PPG3: Use and design of oil separators in surface water drainage systems (2006)
    IV. PPG4: The disposal of sewage where no foul sewer is available (2006)
    V. PPG5: Works and maintenance in or near water (2007)
    VI. PPG6: Working at construction and demolition sites (2012)
    VII. PPG7: The safe operation of refuelling facilities (2011)
    VIII. PPG8: Safe storage and disposal of used oil (2004)
    IX. PPG21: Incident response planning (2009)
    X. PPG22: Dealing with Spills (2011)
    XI. PPG26: Drums and Intermediate Bulk Containers (2011)

- Relevant guidance published by the National Roads Authority (NRA) such as '*Guidelines for Assessment of Ecological Impacts of National Road Schemes*', '*Guidelines for Assessment of Ecological Impacts of National Road Schemes, Revision 1*', '*Environmental Impact Assessment of National Road Schemes – A practical guide*' and '*Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes*', '*Guidelines for the Treatment of Otters Prior to the Construction of National Road Schemes*' have also been followed.

Without the implementation of mitigation measures, the proposed remediation works have the potential to affect the integrity of the Lower River Suir SAC predominately through changes in water quality due to a hydrological link between the European site and Tipperary town historical landfill. Negative effects to water quality can be caused by the uncontrolled release of silt from excavations and earthworks, fuel spills, sanitary waste inputs and the instream spread of Japanese knotweed material. Due to the hydrological link between the historical landfill site and the European site, potential effects could occur to water quality dependent qualifying interests such as salmon, lamprey and otter. If adverse impacts on water quality are avoided or mitigated, then there will be no significant effects on European sites.

Water quality will be protected in a number of ways. An ecologist/Ecological Clerk of Works will also be appointed to carry out site inspections and to monitor the efficacy of mitigation measures. Mitigation measures include the site drainage system, silt traps, careful placement and management of soils and aggregates, which will limit silt production and uncontrolled runoff. In addition, earthworks activities with significant potential for the release of sediment will not be conducted during high rainfall conditions.

To minimise the risk of pollution incidents, all personnel working on site will be trained in pollution incident control response Mitigation will reduce pollutants entering streams and drainage ditches. To prevent the introduction of invasive species/biohazards, all machinery, PPE and tools used will require sanitisation prior to works.

With the implementation of mitigation measures to protect water quality in the area of the proposed remediation works there will be no significant effects and no negative effects on the integrity of the Lower River Suir SAC or it's constitutive elements.

As the potential negative effects that the proposed development may have on water quality will be mitigated on site and mitigation efficacy carefully monitored, no cumulative effects are envisaged between the proposed remediation works and any other developments or activities in the surrounding landscape and downstream catchment.

7.8 Avoiding Mitigation Failure

Explain how any mitigation failure will be addressed.

Mitigation measures for the construction and operational phases have been designed with cognisance of best practice and best scientific knowledge (see Section 7.7 for more information). The main element of the proposed development that requires mitigation is during construction, with the management of works and control of potential pollutants which could enter site waterbodies and make their way downstream to the Lower River Suir SAC.

Mitigation measures will be implemented by the client and their main contractor and monitored by a suitably qualified person. An ecologist/Ecological Clerk of Works will be appointed to monitor and report on the effectiveness of the mitigation measures.

7.9 Conclusion

The Appropriate Assessment Screening presented in Section 6. above concluded that at screening stage, in the hypothetical scenario of a large release of suspended solids, silt or leachate adjacent waterbodies during construction, it was not possible to exclude the possibility that the proposed remediation works would have significant indirect effects on the Lower River Suir SAC. Leachate monitoring results showed multiple parameters exceeded the EPA Interim Guideline Values (IGVs) for Groundwater. Elevated levels of ammonia, iron, manganese and chromium were recorded in the surface water monitoring results. Similarly, the potential for effects on water quality arising from fuel or oil spillages and riverbank destabilisation resulting from instream spread of Japanese knotweed could not be excluded. These indirect effects, via water quality, could occur on the key species for which the European site has been designated.

In the event of these occurrences, the river network downstream including the Lower River Suir SAC could be indirectly damaged by changes in turbidity and water quality. There is also potential for indirect effects to designated fish and aquatic species including, inter alia, lamprey and salmon, due to water quality changes which could cause a fish kill. Changes in water quality could in turn reduce prey availability of breeding otter in the Lower River Suir SAC and reduce breeding sites for aquatic species.

Whilst it has been acknowledged that there could be potential for the proposed historical landfill remediation to have significant effects on Lower River Suir SAC, with the implementation of the detailed mitigation measures identified in this NIS and set out in Condition 3 of the certification of authorisation, it is concluded beyond reasonable scientific doubt that the integrity of Lower River Suir SAC will not be adversely affected. The finding of this NIS are in line with the EPA stage two AA determination to allow the grant of the CoA.

This report has assessed the potential effects on the integrity of the Lower River Suir SAC in light of the site's conservation objectives and mitigation measures have been developed to prevent such potential effects occurring.

On the basis of objective scientific information, the proposed development will not, either alone or in combination with other plans or projects, adversely affect any of the constitutive interests of the Lower River Suir SAC, in light of the site's conservation objectives.

Accordingly, it can be concluded as follows:

(i) all aspects of the proposed development project have been identified which, in the light of the best scientific knowledge in the field, can by themselves or in combination with other plans or projects, affect the European site in the light of its conservation objectives;
(ii) (there are complete, precise and definitive findings and conclusions regarding the identified potential effects on any European site;
(iii) on the basis of those findings and conclusions, the competent authorities are able to determine that no scientific doubt remains as to the absence of the identified potential effects; and
(iv) thus, the competent authorities may determine that the proposed development will not adversely affect the integrity of any European site.

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FEHILY
TIMONEY

CONSULTANTS IN ENGINEERING,
ENVIRONMENTAL SCIENCE
& PLANNING

APPENDIX 1

Certificate of Authorisation

(Licence number: H0004-01

Headquarters
P.O. Box 3000
Johnstown Castle Estate
County Wexford
Ireland

Closed Landfill

Certificate of Authorisation

Certificate of Authorisation Number:	H0004-01
Certification of Authorisation Holder:	Tipperary County Council
Location of Facility:	Carrownreddy Tipperary Town County Tipperary

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

HEADQUARTERS
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WASTE MANAGEMENT (CERTIFICATION OF HISTORIC UNLICENSED WASTE DISPOSAL AND RECOVERY ACTIVITY) REGULATIONS 2008

HISTORIC LANDFILL

CERTIFICATE OF AUTHORISATION

Decision of Agency, under Regulation 7(6) of the Waste Management (Certification of Historic Unlicensed Waste Disposal and Recovery Activity) Regulations 2008

Reference Number: **H0004-01**

In pursuance of the powers conferred on it by the Waste Management (Certification of Historic Unlicensed Waste Disposal and Recovery Activity) Regulations 2008, the Environmental Protection Agency (the Agency) grants, under Regulation 7(6) of the said Regulations, this Certificate of Authorisation to Tipperary County Council, County Hall, Clonmel, County Tipperary, in respect of the closed landfill at Carrownreddy, Tipperary Town, County Tipperary, subject to conditions set out in the Certificate of Authorisation.

A copy of the Decision is attached.

Sealed by the Seal of the Agency on this the 6th day of February, 2019

PRESENT when the seal of the Agency was affixed hereto:

Tara Gillen

Tara Gillen, Authorised Person

TG

Glossary of Terms

All terms in this Certificate of Authorisation should be interpreted in accordance with the definitions in the Waste Management (Certification of Historic Unlicenced Waste Disposal and Recovery Activity) Regulations 2008 (S.I. No. 524 of 2008) unless otherwise defined in the Certificate of Authorisation.

Agency	Environmental Protection Agency.
Agreement	Agreement in writing.
Annually	At approximately twelve-monthly intervals.
Application	The application by the local authority for this Certificate of Authorisation including the risk assessment, any amendments to the risk assessment, additional information received from the local authority and other documents provided by the local authority.
Certificate of Authorisation	Includes this document and the application.
Closed landfill	As defined in the Waste Management (Certification of Historic Unlicenced Waste Disposal and Recovery Activity) Regulations 2008.
Code of Practice	As defined in the Waste Management (Certification of Historic Unlicenced Waste Disposal and Recovery Activity) Regulations 2008.
Biannually	All or part of a period of six consecutive months.
Documentation	Any report, record, results, data, drawing, proposal, interpretation or other document in written or electronic form which is required by this Certificate of Authorisation.
Drawing	Any reference to a drawing or drawing number means a drawing or drawing number contained in the application, unless otherwise specified in this Certificate of Authorisation.
Environmental Pollution	As defined in the Waste Management Act 1996 as amended.
Incident	The following shall constitute an incident for the purposes of this Certificate of Authorisation: (i) an emergency; (ii) any emission which does not comply with the requirements of this Certificate of Authorisation; (iii) any trigger level specified in this Certificate of Authorisation which is attained or exceeded; and (iv) any indication that environmental pollution has, or may have, taken place.

Inert Waste	Waste that does not undergo any significant physical, chemical or biological transformations. Inert waste will not dissolve, burn or otherwise physically or chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm human health. The total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant, and in particular not endanger the quality of surface water and/or groundwater.
Maintain	Keep in a fit state, including such regular inspection, servicing, calibration and repair as may be necessary to perform its function adequately.
Necessary Measures	As defined in the Waste Management (Certification of Historic Unlicenced Waste Disposal and Recovery Activity) Regulations 2008.
Risk Assessment	As defined in the Waste Management (Certification of Historic Unlicenced Waste Disposal and Recovery Activity) Regulations 2008.
Sample	Unless the context of this document indicates to the contrary, the term sample or samples shall include measurements taken by electronic instruments.
The Local Authority	Tipperary County Council, County Hall, Clonmel, County Tipperary.
Trigger Level	A parameter value the achievement or exceedance of which requires certain actions to be taken by the local authority.

TG

Part I Authorisation of a closed landfill

The Environmental Protection Agency (the Agency) grants, under Regulation 7(6) of the Waste Management (Certification of Historic Unlicenced Waste Disposal and Recovery Activity) Regulations 2008 (the Regulations), this Certificate of Authorisation to Tipperary County Council, County Hall, Clonmel, County Tipperary, in respect of the closed landfill at Carrownreddy, Tipperary Town, County Tipperary, subject to conditions set out in Part II and the Reasons for the Decision in Part III.

Part II Conditions

Condition 1. Scope

1.1 For the purposes of this Certificate of Authorisation, the closed landfill authorised by this Certificate of Authorisation is the area of land outlined in red on Drawing No. P0563-INFO-0001 Rev. A, dated 05.11.18, submitted with the application. Any reference in this Certificate of Authorisation to "closed landfill" shall mean the area thus outlined in red. Activities associated with the closed landfill shall be carried on only within the area outlined.

1.2 No waste shall be accepted at the closed landfill.

1.3 No waste shall be burned at the closed landfill.

1.4 The facility shall be controlled, operated and maintained, and emissions shall take place as authorised by this Certificate of Authorisation. No material change that will result in an increase in the actual or potential nature or quantity of any emission shall be carried out or commenced without the agreement of the Agency.

1.5 Nothing in this Certificate of Authorisation shall prohibit authorised beneficial uses of the site of the closed landfill that do not interfere with the integrity of the remediation measures adopted.

Reason: *To clarify the scope of this Certificate of Authorisation.*

Condition 2. Notifications, Records and Reports

2.1 The local authority shall notify the Agency as soon as practicable after the occurrence of any incident. The incident notification shall be provided in a format as may be specified in relevant guidance issued by the Agency.

2.2 The local authority shall keep the following documents available for inspection by the Agency at all reasonable times and to members of the public by request:

2.2.1 Records of all sampling, analyses, measurements, examinations, calibrations and maintenance;

2.2.2 Records of incidents;

2.2.3 Records of all complaints of an environmental nature;

2.2.4 The validation report prepared on completion of the remediation; and

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2.2.5 Other documentation required by this Certificate of Authorisation or as may be otherwise directed by the Agency.

2.3 Environmental Liabilities

The local authority shall put in place and maintain a financial provision for costs of likely events or accidents/incidents related to the closed landfill and associated works.

2.4 The local authority shall annually pay to the Agency €1,100, or such sum as the Agency from time to time determines in accordance with charges policy, for the performance of its functions under the Waste Management (Certification of Historic Unlicensed Waste Disposal and Recovery Activity) Regulations 2008 in relation to the closed landfill regulated by this Certificate of Authorisation.

Reason: *To provide for the collection and reporting of adequate information on the activity. To provide for adequate financing for monitoring and financial provisions for measures to protect the environment.*

Condition 3. Management and Monitoring

3.1 The local authority shall implement the following measures within 12 months of the date of grant of this Certificate of Authorisation, or as otherwise agreed by the Agency.

a) prepare and implement a programme of 24-hour pumping trials for seven days, at least 3 gas yielding monitoring locations (12% v/v or above) to determine the quantity and characteristics of the landfill gas. This programme shall be submitted to the Agency and approval obtained in advance of implementation. The monitoring programme shall be completed within 4 months of the date of this certificate of authorisation.

b) in the event that methane values consistently exceed 12% v/v, install measures for extracting and treating landfill gas by flaring or another suitable technique that is satisfactory to the Agency.

c) install a low permeability landfill cap, minimum 500mm.

d) install gas protection measures including the installation of a landfill gas cut-off trench along the southern boundary of the capped landfill area.

e) unless otherwise agreed by the Agency, install gas vents in the landfill body at appropriate locations such that the increased back-pressure caused by the cap does not result in increased lateral movement of gas.

f) minimise the disturbance of deposited waste to the extent possible.

3.2 The local authority shall manage the closed landfill to ensure that discharges and emissions from the closed landfill do not cause environmental pollution or deterioration in the status of the receiving surface water body or groundwater body.

3.3 The local authority shall compile a validation report in accordance with the requirements of the Code of Practice. Unless otherwise agreed, the validation report shall be submitted to the Agency within 30 months of the date of grant of this Certificate of Authorisation.

3.4 The local authority shall assess the results of all monitoring carried out to confirm whether the closed landfill continues to achieve the objectives set for it in the risk assessment or this Certificate of Authorisation.

3.5 The local authority shall annually conduct and record:

a) a visual inspection of the landfill to ensure that the condition of the site has not deteriorated;

b) monitoring for leachate (sample, analyse, characterise, and measure the level of leachate) in all leachate monitoring boreholes;

c) monitoring to detect the presence and concentration of landfill gas in all monitoring boreholes;

d) monitoring (sample, analyse and characterise) of relevant surface waters both upstream and downstream of the closed landfill;

e) monitoring (sample, analyse and characterise) of groundwater from at least three available groundwater monitoring boreholes, two of which shall be downgradient of the closed landfill; and

f) the assessment of monitoring results against trigger levels and/or standard reference values for relevant pollutants including environmental quality standards in the European Communities Environmental Objectives (Surface Waters) Regulations 2009 and European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended.

3.6 The following are the trigger levels for landfill gas emissions from the facility measured in any service duct or manhole on, at or immediately adjacent to the facility and/or at any other point located outside the body of the waste:-

a) Methane, greater than or equal to 1.0% v/v; or

b) Carbon dioxide, greater than or equal to 1.5% v/v.

3.7 In relation to surface emissions measured over the waste body and identified features, the following shall constitute a trigger level:-

a) VOC greater than or equal to 50ppmv as methane average over capped area; or

b) VOC greater than or equal to 100ppmv as methane instantaneous reading on open surfaces within the landfill footprint; or

c) VOC greater than or equal to 500ppmv as methane around all identified features.

3.8 The location, frequency, methods and scope of monitoring, sampling and analyses, as set out in this Certificate of Authorisation, may be amended with the agreement of the Agency.

3.9 Soil and stone imported for use in remedial, corrective or other engineering works at the closed landfill shall be greenfield soil and stone or soil and stone of equivalent nature and character in terms of chemical and physical contamination.

Documented acceptance, storage/stockpiling and utilisation procedures shall be operational in advance of receipt of such materials. Records shall be maintained showing the site of origin of the soil and stone and its nature.

3.10 No emissions, including odours and noise, from works carried on at the site shall result in an impairment of, or an interference with amenities or the environment beyond the facility boundary or any other legitimate uses of the environment beyond the facility boundary.

3.11 The local authority shall ensure that the closed landfill does not result in an impairment of, or an interference with, amenities or the environment at the facility or beyond the facility boundary (including those arising from emissions (including odours, noise, dust, litter and mud), vermin and birds).

3.12 Wells and boreholes

3.12.1 Groundwater monitoring wells shall be constructed having regard to the guidance given in the Agency's landfill manual "Landfill Monitoring".

3.12.2 All wellheads shall be adequately protected to prevent contamination or physical damage.

3.12.3 All wells & boreholes shall be adequately sealed to prevent surface contamination and, as may be appropriate, decommissioned in accordance with the UK Environment Agency guidelines "Decommissioning Redundant Boreholes and Wells", unless otherwise agreed by the Agency.

3.13 The local authority shall clearly label and provide safe and permanent access to all on-site sampling and monitoring points and to off-site points as required by the risk assessment or this Certificate of Authorisation. The requirement with regard to off-site points is subject to the prior agreement of the landowners concerned.

3.14 Incidents

In the event of an incident the local authority shall immediately:

(i) if necessary, contact the emergency services;

(ii) carry out an investigation to identify the nature, source and cause of the incident and any emission arising therefrom;

(iii) isolate the source of any such emission;

(iv) evaluate the environmental pollution, if any, caused by the incident;

(v) identify and execute measures to minimise the emissions/malfunction and the effects thereof;

(vi) identify the date, time and place of the incident; and

(vii) notify the Agency (in accordance with Condition 2.1) and all other relevant authorities including, where relevant, the Water Services Authority and Inland Fisheries Ireland.

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3.15 Communications

a) The local authority shall establish, maintain and implement a communications programme to inform the occupiers and owners of land and buildings adjacent to the closed landfill of the risks posed by landfill gas and its migration.

b) The local authority shall, as part of the communications programme, publish gas monitoring data quarterly in a manner accessible by the public.

Reason: *To make provision for the proper closure of the activity ensuring protection of the environment.*

TG

Part III: Schedules

Schedule 1: Reasons for the Decision

In granting this certificate of authorisation, the Agency determines that the risk assessment submitted by the local authority as part of the application for a certificate of authorisation is adequate. To ensure appropriate protection for human health and the environment and to ensure conformity with the provisions of Council Directive 2006/12/EC and Council Directive 80/68/EC, the conditions set out in Part II of this certificate of authorisation are specified as further necessary measures in addition to those identified by the risk assessment.

A screening for Appropriate Assessment was undertaken to assess, in view of best scientific knowledge and the conservation objectives of the site, if the activity, individually or in combination with other plans or projects is likely to have a significant effect on any European Site. In this context, particular attention was paid to the European Sites at the Lower River Suir SAC (Site Code 002137).

The activity is not directly connected with or necessary to the management of any European Site and the Agency considered, for the reasons set out below, that it cannot be excluded, on the basis of objective information, that the activity, individually or in combination with other plans or projects, will have a significant effect on any European Site and accordingly determined that an Appropriate Assessment of the activity was required. The reasons for this determination are as follows:

- The closed landfill site is connected hydrologically to the Lower River Suir SAC (002137).
- Leachate monitoring results showed multiple parameters exceeded the EPA Interim Guideline Values (IGVs) for Groundwater.
- Elevated levels of ammonia, iron, manganese and chromium were recorded in the surface water monitoring results.

The Agency has completed the Appropriate Assessment of potential impacts on these sites and has made certain, based on best scientific knowledge in the field and in accordance with the European Communities (Birds and Natural Habitats) Regulations 2011 as amended, pursuant to Article 6(3) of the Habitats Directive, that the activity, individually or in combination with other plans or projects, will not adversely affect the integrity of any European Site, in particular the Lower River Suir SAC (002137), having regard to their conservation objectives and will not affect the preservation of these sites at favourable conservation status if carried out in accordance with the application and risk assessment, this certificate of authorisation and the conditions attached hereto for the following reasons:

- The Lower River Suir SAC (Site Code 002137) is located approximately 6.5km northeast, east & south of the historical landfill site. Given the distance and water monitoring results from site investigations, it is unlikely that the Carrownreddy closed landfill site and the proposed construction works present any significant risk to the Lower River Suir SAC (Site Code 002137).

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- Specifically, the construction works will be undertaken to avoid the potential for water pollution and will ensure that there will be no significant impact on Lower River Suir SAC (002137).
- the project, alone or in-combination with other projects, will not adversely affect the integrity, and conservation status of any of the qualifying interests of the Lower River Suir SAC (002137).
- Condition 3.5 requires ongoing environmental assessment and monitoring.

The Agency is satisfied that no reasonable scientific doubt remains as to the absence of adverse effects on the integrity of the European Sites: Lower River Suir SAC (002137).

Part IV: SIGNATURE

Sealed by the Seal of the Agency on this the 6th day of February 2019

PRESENT when the Seal of the Agency was affixed hereto:

Tara Gillen.

Tara Gillen, Authorised Person

TG

FEHILY
TIMONEY

CONSULTANTS IN ENGINEERING,
ENVIRONMENTAL SCIENCE
& PLANNING

APPENDIX 2

Environmental Risk Assessments in support of CoA Application to the EPA

The following Environmental Risk Assessments were developed to support the application to the EPA for the Certificate of Authorization (Licence number: H0004-01):

- Tier 1 Environmental Risk Assessment
- Tier 2 Environmental Risk Assessment (Exploratory SI)
- Tier 2 Environmental Risk Assessment (Detailed SI)
- Tier 3 Environmental Risk Assessment
- Addendum to Tier 3 Environmental Risk Assessment

These documents have been reproduced hereunder.

SOUTH TIPPERARY COUNTY COUNCIL

ENVIRONMENTAL RISK ASSESSMENT FOR UNREGULATED WASTE DISPOSAL SITES

Tier 1 Risk Assessment on the closed landfill at Carronreddy, Tipperary Town

01/10/2009

Tipperary Town Closed Landfill

The closed landfill is located in the Townland of Carrownreddy and is accessed from the Lake Road, off the R610 Tipperary to Dundrum Road. It is within the Tipperary environs area and is currently used as a depot by Tipperary Town Council. The information available on this site is limited; the extent of the area landfill is not accurately known but the area shown in Figure 6 is raised above the surrounding field and is considered to be the landfilled area.

The closed landfill in Tipperary Town operated as the town dump from circa 1940 until it closed as a landfill in 1990. The site is approximately 1.8 hectares, within this area is a fenced off area of 0.2 hectares which was apparently used exclusively for wastewater sludge. The waste body is reported to be 9–12m deep. The other wastes accepted at the site are most likely to have been municipal and commercial waste. Since the landfill at Donohill was developed this site has been operated as a Depot for storage of road works materials, machinery etc by Tipperary Town Council.

The lands adjoining the landfill appear to be used primarily for low intensity agriculture, grazing horses etc and at present there are no residences within 250m of the site, however given the zoning this may change over the next 5 years. Immediately to the north is a marshy area (once known as the Lake), the lands east of the site are identified in a Master Plan[1] by the developer as intended for light industrial warehousing etc, beyond this site (approx 200m north east of the closed landfill) the residential aspect of the development (~250 houses) is under construction. South of the site is currently grazed by horses but these lands will be developed for social housing (SW) and light industrial (SE). There are currently no proposals to develop the lands to the west. There are also plans to extend the Lake Road west to link up with the R497, the Donohill Road. Tipperary Town Council intend to move the Depot to an alternative location to enable the investigation and remedation of the site. Eventually the Environment Section intend to develop a Civic Amenity Site at this location.

The closed landfill is within a zone of archaeological potential and an archaeological assessment[2] was carried out at the site in May 2005. The resulting report stated that due to the landfilling activities of the past "the testing results suggest that the possible enclosure is no longer extant (if indeed one existed on this site)". This report also outlines the history to the site; the First Edition of the Ordnance Survey c. 1840 indicates a lake, Carrownreddy Lough, immediately to the north of the site, in the 1901 version the Lough has substantially reduced in size and today this area is marsh.

Walk-over Inspection

As stated previously the site is currently used as a Depot by Tipperary Town Council. The southern, and part of the eastern and western perimeters of the site are fenced. There is no visible boundary, other than the raised landfilled area, marking the northern boundary of the site. The southern part of the site has a hardcore surface and is used for storing road-works

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[1] Planning Ref 03/375

[2] Archaeological Test Trenching and Impact Assessment at Carrownreddy, Co. Tipperary
Aegis Archaeology Limited May 2005

materials and machinery, chippings etc. There is also a shed on-site used for storage. At the time of my inspection there was a portacabin on-site with toilet facilities for staff. The remainder of the site, north of the shed has a considerable volume of discarded waste materials comprising of large mounds of construction & demolition waste, waste tyres (partially burned), household waste, white goods (fridges, washing machines etc), green waste etc.

3.3 Tipperary Town - Risk Screening

The risk assessment methodology outlined in the Code of Practice Manual is based on the principle of linkages between the Source, Pathway, and Receptor.

Refer to Chapter 4 of the Manual for the Risk Score Tables.

Table 6

Ref	**Source**	*Score*	*Rational*
1a	Leachate	7	▪ <5 hectares ▪ Waste likely to be both municipal & industrial
1b	Gas	7	▪ <5 hectares ▪ Highest rating given as proportion of municipal: industrial wastes is not known.

Table 7

Ref	**Pathways**	*Score*	*Rational*
2a	Groundwater vulnerability	2	▪ GSI data states that the site is rated as having high vulnerability.
2b	Groundwater flow regime	5	▪ Bedrock described as karst
2c	Surface water drainage	2	▪ Landfill is reportedly connected to town surface water drainage system
2d	Landfill gas lateral migration	3	▪ Residences not currently within 250m of site, but will be within 5 years ▪ Karst bedrock
2e	Landfill gas vertical migration	5	▪ Building on site, to be retained and further buildings to be constructed in proposed redevelopment

Table 8

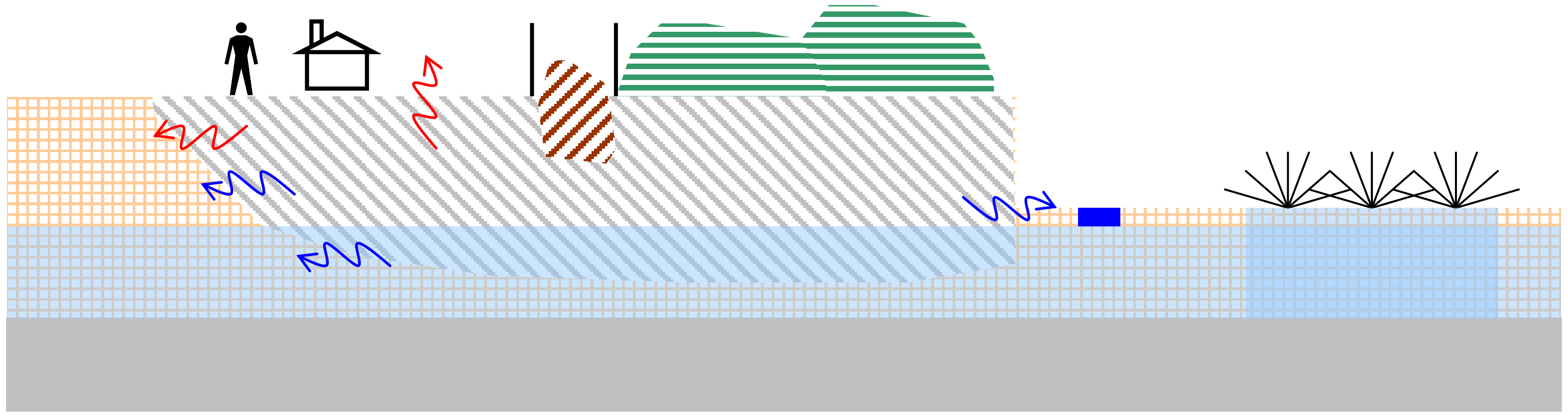
Ref	**Receptors**	*Score*	*Rational*
3a	Human presence (leachate)	2	▪ Currently no houses within 250m, there will be within 5 years ▪ Note: All houses will be served by public water
3b	Protected areas	1	▪ No protected areas within 1 km of site ▪ The marsh area has been considered as an undesignated GWDTE, precautionary approach. ▪ No consultation with the NPWS has taken place.
3c	Aquifer category	5	▪ Regionally important aquifer underlies part of landfill
3d	Public water supply	3	▪ Public water supply is greater than 1km away (Cordangan) ▪ Karst bedrock – but different geological formation ▪ Precautionary approach assumed
3e	Surface water	3	▪ Surface water drain within 50m of site boundary

	bodies		
3f	Human presence (gas)	5	▪ Building on site

3.4 Tipperary – Risk Classification

Table 9

S-P-R Linkage Score		**Max Score**	**Actual Score**	**Normalised Score**	**Risk Classification**
SPR 1	Leachate migration to surface waters through combined groundwater and surface water pathways	300	1a x (2a + 2b + 2c) x 3e = 189	63%	Class B – Moderate risk
SPR 2	Leachate migration to protected areas through combined groundwater and surface water pathways	300	1a x (2a + 2b + 2c) x 3b = 63	21%	Class C – Lowest risk
SPR 3	Leachate migration to human receptors via groundwater	240	1a x (2a + 2b) x 3a = 98	41%	Class B – Moderate risk
SPR 4	Leachate migration to protected areas via groundwater	240	1a x (2a + 2b) x 3b = 49	20%	Class C – Lowest risk
SPR 5	Leachate migration to bedrock via groundwater	400	1a x (2a + 2b) x 3c = 245	61%	Class B – Moderate risk
SPR 6	Leachate migration to public water sources via groundwater	560	1a x (2a + 2b) x 3d = 147	26%	Class C – Lowest risk
SPR 7	Leachate migration to surface water via groundwater	240	1a x (2a + 2b) x 3e = 147	61%	Class B – Moderate risk
SPR 8	Leachate migration to surface water via surface water	60	1a x 2c x 3e = 42	70%	Class A – Highest risk
SPR 9	Leachate migration to protected area via surface water	60	1a x 2c x 3b = 14	23%	Class C – Lowest risk
SPR 10	Gas migration to human receptors via subsoil – lateral	150	1b x 2d x 3f = 105	70%	Class A – Highest risk
SPR 11	Gas migration to human receptors via subsoil – vertical	250	1b x 2e x 3f = 175	70%	Class A – Highest risk
Overall Site Classification: Class A – Highest Risk					



Source		Receptors		Pathways		Geology	
▨	Main waste body (depth 9-12m)	🟦	Surface water drain	↝	Gas migration – vertical & lateral	▦	Subsoil – parent material limestone glacial till Vulnerability Rating: High
▨	Wastewater treatment plant sludge area (depth not known)	■	Groundwater (GW depth not known)	↝	Leachate migration – saturated and unsaturated zone	■	Bedrock – Regionally important karst bedrock
☰	Material deposited since landfill closed	✱	Marshy area (undesignated GWDTE)				
		🚶	Human beings				
		⌂	Buildings on-site				

Figure 5 Conceptual Site Model
Tipperary Town Closed landfill

Not to scale

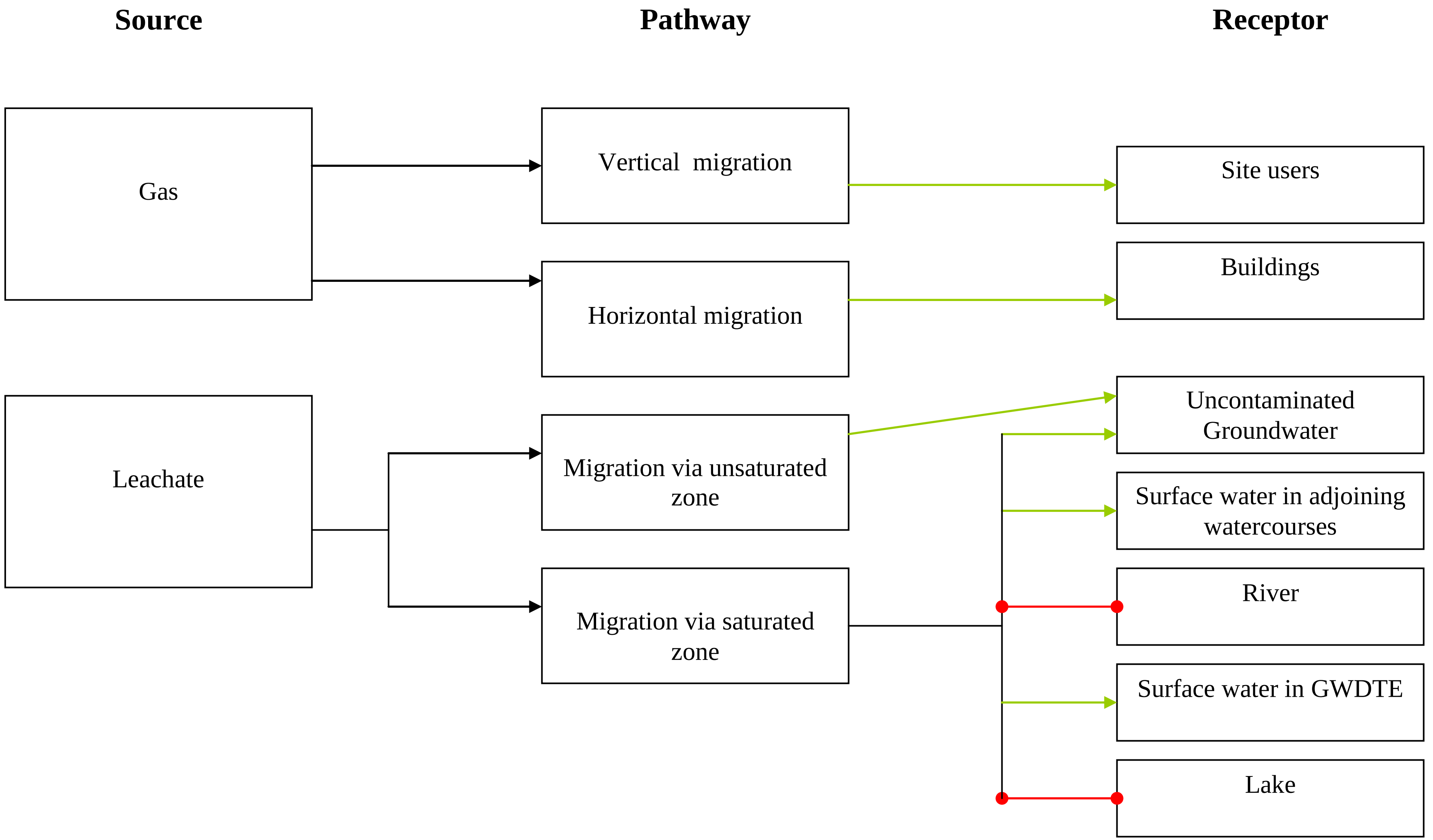


Figure 8 **Tipperary Town Closed landfill**

Conceptual Model – Network Diagram illustrating SPR linkages

Conclusions - Tipperary Town

The highest risks associated with the closed landfill in Tipperary Town are associated with leachate migration to surface water drains and also the risks presented by landfill gas to the users of the site. The risk from leachate migration to other receptors is considered moderate to low due to the size of the landfill (<5 hectares) and the lack of protected areas in the vicinity of the landfill.

5.0 References

1. Archaeological Test Trenching & Assessment Report at Carrownreddy, Co. Tipperary, Aegis Archaeology Limited, May 2005

2. Code of Practice: Environmental Risk Assessment for Unregulated Waste Disposal Sites, Environmental Protection Agency, 2007

3. A Review of the Environmental Risk Associated with the Municipal Waste Landfills in South Tipperary; Fehily, Timoney & Company, December 2007

4. Hydrogeological Assessment of the Carrick on Suir Landfill, Fehily Timoney & Company, March 2001

5. Tipperary Town and Environs Development Plan 2007

Tipperary Walkover Survey Checklist & Photographic Survey 21/08/2007

Checklist Questions	**Checked**	**Comment (include distances from site boundary)**
1. What is the current land use?	√	Tipperary Area Depot – storage of materials, equipment etc and unauthorised deposition of waste materials
2. What are the neighbouring land uses?	√	North – marsh area West – Agriculture; horses grazing. South – Agriculture; horses grazing & local access road East – Agriculture; horses grazing (zoned for light industrial development up to site boundary, residential development 200m NE)
3. what is the site size?	√	Unlined - ~1.8 hectares
4. What is the topography?	√	Closed landfill is elevated above surrounding fields ~2-3m
5. Are there any potential receptors?	√	Yes
Houses		200m north east of site under construction
Surface water features		Land drain north of site
Any wetland or protected area		Marsh area north of site
Public water supplies		Public water supply at Cordangan >1 km
Private wells		None known
Services		None
Other buildings		Yes, Area depot storage building & portacabin
Other		None
6. Are there any sources of potential contamination?	√	Yes
Surface waste		Yes – C&D, waste tyres, household waste, WEEE etc
Surface ponding of leachate		None observed – could not access fenced off area
Leachate seepage		None observed
Landfill gas odours		None observed
7. Are there any outfalls to surface water?	√	Land drains through marshy area
8. Are there any signs of impact on the environment?	√	Not possible to determine whether any impacts on the environment are from the current use of the site or the past use.
Vegetation die-off		Not possible to determine due to deposited waste
Leachate seepages		None observed
Odours		None observed
Litter		Yes
Gas bubbling through water		None observed
Signs of settlement, subsidence, water logged areas		Not possible to determine due to deposited waste
Drainage or hydraulic issues		None observed
Downstream water quality appears poorer than upstream water quality		Not noted.
9. Are there any indications of remedial measures?	√	
Capping		Part of the area used by the has a concrete base
Landfill gas collection		None

Checklist Questions	**Checked**	**Comment (include distances from site boundary)**
Leachate collection		None
10. Describe fences and security features (if any).	√	Partially fenced; southern boundary & part of eastern & western boundaries

Tipperary Town – Closed landfill

 Entrance	 Waste materials at site, storage building & portacabin in background
 Fenced off area where sewage sludge was deposited (in background)	 Waste materials at site
 Waste materials at site	 Waste materials at site

 Marsh area to north of landfill	 View of landfill from adjacent land
 View of landfill from adjacent land	

Tier 2 Exploratory Site Investigation Former Landfill at Tipperary Town

Prepared For:

South Tipperary County Council

Prepared By: -

O' Callaghan Moran & Associates,
Granary House,
Rutland Street,
Cork.

November 2009

TABLE OF CONTENTS

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1. INTRODUCTION

O'Callaghan Moran & Associates (OCM) was appointed by Tipperary South Riding County Council (the Council) to complete a Tier 2 environmental risk assessment of the closed Tipperary Town Landfill.

1.1 Background

The Council completed a Tier 1 Assessment of the landfill in accordance with the "Code of Practice Environmental risk Assessment for Unregulated Waste Disposal Sites (CoP)" published by the Environmental Protection Agency (EPA). The Assessment concluded that the site was a Class A – High Risk site, due to the risk to humans from landfill gas and the potential for leachate migration to surface water.

In September 2009, the EPA prepared guidance on the completion of Tier 2 Site investigations in which it was recommended that the investigations be completed in two phases. Phase 1 should consist of Exploratory Works, following which the initial Tier 1 assessment should be revised and the need for and/or extent of a Phase 2 Detailed Site Investigation. This Report documents the findings of the Exploratory Phase..

1.2 Work Scope

The EPA guidance states that trial and trench site investigations and an assessment of the nature of the waste is a mandatory in the Exploratory Phase. Testing of the surrounding soil, waste and where possible leachate, surface and groundwater is recommended as is a topographic and GPS survey.

Following a review of the Tier 1 Assessment, a site inspection and experience of the implementation of Tier 2 Assessments, OCM concluded that the Exploratory Phaes should include;

- Geophysical Survey,
- Waste and Soil Characterisation,
- Waste Testing
- Surface Water Monitoring.

As there were no landfill gas, leachate or groundwater monitoring wells installed at the site, monitoring for these elements was not completed.

OCM concluded that given the high risk ranking, that a geophysical site survey be included in the Exploratory Phase, although this is not recommended in the EPA guidance. Completing the survey at this stage would ;

- A more comprehensive delineation of the lateral and vertical extent of the waste
- Identify possible leachate plumes migrating to surface and or groundwater
- Identify potential anomalous zones in the waste such as buried drums or areas where drilling might prove difficult,
- Establish total thickness of waste,
- Establish thickness of subsoil beneath the waste and depth to bedrock.

This information would then be used to amend the Conceptual Site Model and develop the scope of the Detailed Site Investigation. For example, if the groundwater pathway is not significant there may not be need to install bedrock groundwater monitoring wells. Alternatively if the subsoil thickness beneath the waste is thin or absent it would provide justification for installing deeper bedrock groundwater monitoring wells. This is particularly important in Karst Limestone aquifers where flow paths can be several kilometres in length.

OCM did not include a topographic survey at this stage as experience has shown that this survey should be completed at the end of Phase 2 so that all landfill gas and groundwater monitoring points, trial pits and surface water monitoring locations can be surveyed in at one time, thereby avoiding remobilising a survey crew.

2. SUMMARY OF TIER 1 ASSESSMENT

The site is in the Townland of Carrownreddy and is accessed by the Lake Road off the R610 Tipperary to Dundrum Road and is within the Tipperary Environs area Figure 2.1). It served as the landfill for Tipperary Town from circa 1940, until it closed l in 1990. The site is currently used by Tipperary Town Council as a Depot for road maintenance materials and machinery.

The site is approximately 1.8 hectares and within this area is a fenced off area of 0.2 hectares, which was apparently used exclusively for wastewater sludge. The southern, and part of the eastern and western site perimeter is fenced, but there is no visible boundary, other than the raised landfilled area, marking the northern boundary. The waste body is understood to be between 9-12meters thick. In addition to the sludges, the other wastes accepted are most likely to have been commercial and domestic.

The southern part of the site has a hardcore surface and is used for storing road maintenance materials and machinery. There is also a storage shed site, and a portacabin with toilet facilities for staff. The remainder of the site, north of the shed is covered with a considerable volume of miscellaneous wastes, including large mounds of construction & demolition waste, waste tyres (partially burned), household waste, white goods (fridges, washing machines etc) and green waste.

The underlying aquifer beneath is classified as being Regionally Important and the vulnerability rating is High. There are no groundwater, leachate or landfill gas monitoring wells and it is understood that surface water run-off from the site discharges to the Town's drainage system.

2.1 Surrounding Land Use

The adjoining lands are currently used primarily for low intensity agriculture, (grazing horses). Immediately to the north is a marshy area (once known as the Lake). There are residences within 250m of the site. A residential development (~250 houses) is under construction approximately 200m to the northeast of the site and it is the intention to develop the land between landfill and the residential estate for light industrial warehousing.

The lands to the south are currently used for grazing, but it is intended to develop these lands for social housing and light industrial use. There are currently no proposals to develop the lands to the west, but there are plans to extend the Lake Road west to link up with the R497, the Donohill Road.

Tipperary Town Council intend to move the Depot to an alternative location to enable the investigation and remediation of the site. In the longer term, the Council intends to develop a Civic Amenity Site at the site.

3. EXPLORATROY PHASE SITE INVESTIGATION

3.1 Site Inspection

OCM completed a site inspection on October 27th 2009 accompanied by the Council's Ms Ruth Hennessy and Mr John O'Sullivan. Ms. Hennessy had completed the Tier 1 assessment and Mr.O'Sullivan (Ruth to confirm name?) is the local area Engineer who had a detailed knowledge of the site history and surrounding land use. The objective of the visit was confirm the location of sensitive receptors, the surrounding land use and surface water drainage.

3.2 Trial Pitting and Trench Investigations

The investigations were undertaken on November 2nd and 3rd 2009 in accordance with BS10175, 2001, Investigation of Potentially Contaminated Sites - Code of Practice and were supervised by OCM personnel experienced in the investigation of landfills and contaminated lands.

A tracked excavator, capable of travelling on variable terrain, with a reach of 6 metres below ground level was used to excavate the trial pits. The excavations were logged in accordance with BS5930. The trial pit locations are shown on Figure 3.1 and a complete set of photographs and trial pit logs will be included in the Detailed Site Investigation Report. A selection of photographs are included below for reference purposes.

3.2.1 Lateral Extent of the Waste

The lateral extent of the waste is clearly defined by the difference in level between the fill area and the surrounding natural ground. The lands on the eastern, western and northern boundaries are at least 6m, 5m and 3m (respectively) higher than the surrounding lands. The northern boundary is defined by a wetland area. .

Excavations were carried out at the northern, western and eastern boundaries to confirm that the toe of the slope marked the lateral extent of the waste. Excavations along the southern boundary indicated that the waste extended to the road way that runs along the southern site boundary.

The natural ground surrounding the landfill comprises saturated lacustrine sediments overlying gravely clay till, which appears to be of moderate to low permeability and was moist to dry in the top 2-3 metres.

3.2.2 Vertical Extent of Waste

The full thickness of the waste was defined along the margins, but it was not possible to establish the full depth in the central portion of the site, because the waste extended beyond the reach of the excavator. The average depth of the excavations was six metres.

Based on the difference in levels between the fill area and the surrounding lands, it is estimated that in the central area the waste is on average 12m deep. The geophysical survey indicates the waste ranges from 6-7m up to 17m in the northern section of the landfill. The geophysical survey is discussed in more detail below in Section 3.4

3.2.3 Waste Characterisation

There is a variation in the waste types across the site. The wastes in the northern, western and eastern edges of the site consist of mainly Construction and Demolition (C&D) waste comprising soils and stone, with minor amounts of rubble. The central section contains more domestic and commercial types

The municipal waste comprises a mix of plastic and glass bottles, occasional empty flattened steel drums, empty plastic drums, concrete pipes, steel, papers, tyres, tyre tubes, timber and trees, all of which were supported by a sandy gravelly clay matrix. It ranged from damp to dry with some minor seeps of water in the upper 2m.

It is assumed that the sandy clay was used as cover material when the site was operational, but no discrete layers were noted. No datable materials (newspapers, stationary) which could be used to establish the age of the waste found. There was no evidence of any significant amounts of hazardous waste (e.g. oils, solvents), staining or odours. Strong putrescible odours were only detected in two trial pits TP-9 and TP-10, which are in the western section of the site.

The area north of the on site building and road maintenance materials is covered in soils and stone mixed with minor amounts of what appears to be C&D waste. This material is on average 1.5m to 2.5m thick. This material appears to have been brought onto site after the facility officially closed and has not been graded

Photo 1 Waste in TP-1.

Photo 2 Waste in TP-3.

Photo 8 Waste in TP-11

Photo 3 Waste in TP-10

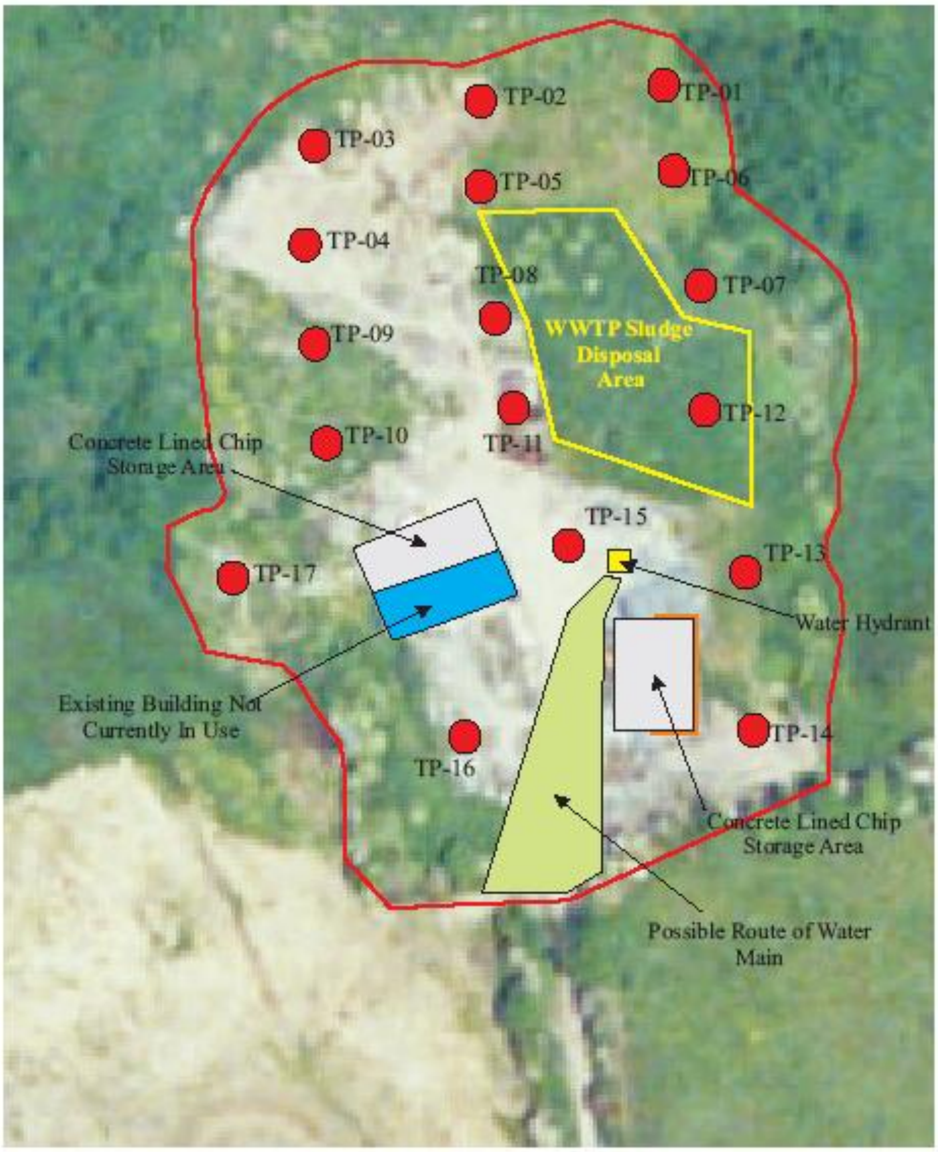
Photo 4 Waste in TP-13

Photo 5 Waste in TP-15

Photo 6 Waste in TP-17

3.2.4 Waste Sampling Programme

Composite samples of the waste were collected in accordance with OCM's sampling protocol. The samples were field screened for the presence of volatile organic compounds (VOC) using a photo ionisation detector (PID). The PID readings are included in the trial pit logs. PID readings ranged from non detect to 10 ppm and were not considered to be indicative of the presence of significant levels of VOCs. The samples were placed in laboratory prepared containers and stored in coolers prior to shipment to Jones Environmental Forensics in the UK.



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CLIENT
South Tipperary County Council

TITLE
Trial Pit Locations

● TP-14 Trial Pit Location
— Site Boundary

Figure 3.1

Scale	Rev.
NTS	A

3.3 Surface Water

A surface water drain flows from the site to the east for 150m. The drain then turns south towards the access road. From the access road, it is piped through the Town and eventually discharges to the River Ara. A surface water sample was collected from the drain approximately 50m from the landfill on the 3rd November 2009.

3.3.1 Laboratory Analysis

Two samples were selected to be analysed for the parameters set out in the EU Council Decision establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC (Council Decision).

The Council Decision sets threshold limits for a range of inorganic and organic parameters, which define whether a waste is suitable for disposal to an inert, non-hazardous or hazardous waste landfill. Based on field observations it was considered the parameters specified in the Council Decision were appropriate for assessment purposes. However, depending on the test results, additional analyses may be carried out.

The solid samples were tested for Total Organic Carbon (TOC), BTEX (benzene, toluene, ethylbenzene and xylene) Polychlorinated biphenyls (PCB), Mineral Oil and Polycyclic Aromatic Hydrocarbons (PAH). Leachate generated from the waste samples were tested for metals (arsenic, barium, cadmium, chromium, copper, mercury, molybdenum, nickel, lead, antimony, selenium and zinc), chloride, fluoride, soluble sulphate, phenols, dissolved organic carbon (DOC) and total dissolved solids (TDS). The laboratory methodologies were all ISO approved or equivalent and the method detection limits (MDL) were all below the relevant guidance limit.

The results of the laboratory analysis were not be available at the time of the preparation of this report. However, based on OCM experience, the waste is considered to be typical of that found in small scale municipal landfills. No significant zones of potentially contaminated or hazardous waste were identified.

The surface water samples were collected in accordance with OCM sampling protocols and were placed in laboratory prepared containers and stored in a cooler. Field measurement and observations recorded at the time of sampling are presented in Table 3.5. The samples were sent for analyses to Jones Environmental Laboratory in the UK. The Chain of Custody documentation will be included in the detailed site investigation report.

3.4 Geophysical Site Investigation

The geophysical survey was completed by Apex Geoservices Ltd on the 29th and 30th October 2009. The full Apex report is presented in Appendix 1 and summarised below.

The objectives of the survey was to:

1. Determine the sub-surface conditions including thickness and extent of the buried waste, nature of subsurface material and depth to bedrock.

2. Identify leachate plumes into surface drains or underlying karstic limestone.

3. Locate any local anomalies (buried drums, etc) within the waste material.

The geophysical methods employed were:

1. EM31 Conductivity mapping to provide information on variations in the bulk conductivity value which reflects variation in the composition of the material in the top 6m of the subsurface.

2. 2-D Resistivity Profiles to provide information on the nature and thickness of the deposit, the extent of capping material and the nature of the underlying soils and rock.

The survey findings are shown on the APEX Drawing in Appendix 1. The survey concluded that:

- The lateral extent of the landfill is defined by the steep slopes of its boundary.

- The fill comprises organic waste and C&D waste, which typically includes a cap of C&D material and mixed C&D and organic waste material up to 6m thick underlain by organic waste material over lacustrine sediments and sandy gravelly silt/clay.

- The combined thickness of the landfill material ranges from 6.7m on Profile R2 to possibly up to 17m on R4.

- Localized increases in resistivity values across the site indicate an increase in the C&D content and a decrease in the organic waste content of the fill.

- In the fill area, the resistivity contrast between leachate saturated lacustrine sediments and the waste is poor. This indicates that leachate from the waste has most likely migrated into the underlying lacustrine sediments

- Beneath the lacustrine sediments is a layer of sandy gravelly silty clay of medium to low permeability (Bounder Clay). The thickness of this layer could not be established in the centre of the site because of the thickness of the waste mass. However the depth to bedrock and hence thickness of the boulder clay above the bedrock was established at the edges of the fill. This indicates that the waste mass is not in direct contact with the bedrock and that there may be 3-4m of subsoil above the bedrock.

- The resistivity values of the rock are relatively low (<400 Ohm-m) indicating that it is likely to be argillaceous/shaly and therefore is unlikely to be prone to extensive karstification. This indicates that the boundary between the Regionally Important Karstified Limestone (RKd) aquifer and the Locally Important Ll a Shaly limestone is either further north or south, but not underneath the site.

- The resistivity data also indicate a possible leachate zone, where the fill and outlet stream meet. This indicates a possible preferential flow path toward the surface water system for leachate collecting in the landfill.

- Areas of possible buried metal have been identified

3.5 Landfill Gas Risk

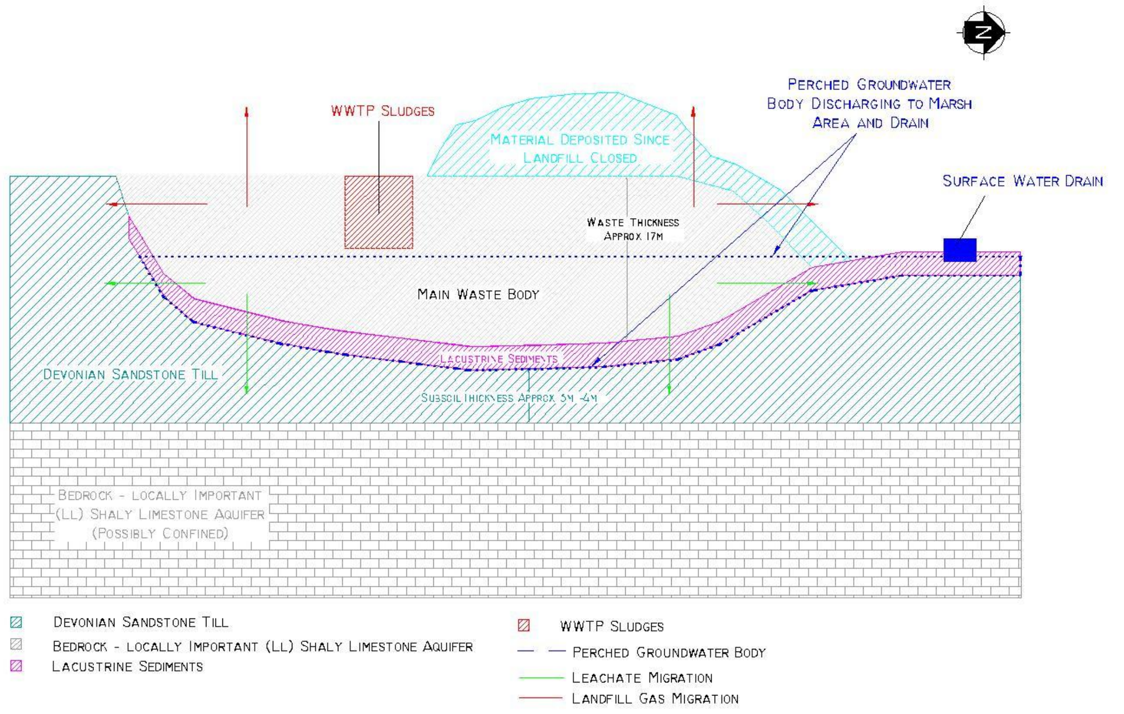
There are no landfill gas monitoring wells on the site. During the initial site inspection OCM were informed that the on-site building is no longer used and it is planned to demolish the structure in the near future. It is reasonable therefore to assume that the risk to users of the building in the medium to long term will be eliminated and the landfill risk assessment should therefore be reassessed.

OCM observed that lands beyond the marsh area to the north and northwest approximately 200 - 300m away have been reclaimed with construction demolition waste as part of the planned future development of these lands for residential and or commercial purposes. It is also possible that the lands immediately to the east and west of the site could be developed for residential and/or commercial purposes. The risk therefore to potential off-site receptors remains significant and needs to be assessed in the Detailed Site Investigations.

4. REVISION OF TIER I RISK ASSESSMENT & CONCEPTUAL SITE MODEL

4.1 Revised Conceptual Site Model

A revised conceptual Site Model is presented on Figure 4.1 below. This model illustrates the presence of low –to moderate permeability boulder clay and Ll aquifer beneath the site. The Leachate beneath the landfill is likely to perched above the boulder clay with preferential discharge to the surface water system.



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CLIENT
SOUTH TIPPERARY COUNTY COUNCIL

TITLE
CONCEPTUAL SITE MODEL

FIGURE No. 4.1

SCALE NTS

REV. A

4.2 Risk Assessment

OCM has modified the original risk assessment on the basis of the findings of the Exploratory Phase and the changes are highlighted in blue.

Table 6

Ref	**Source**	*Score*	*Rational*
1a	Leachate	7	▪ <5 hectares ▪ Waste likely to be both municipal & industrial
1b	Gas	7	▪ <5 hectares ▪ Highest rating given as proportion of municipal: industrial wastes is not known.

Table 7

Ref	**Pathways**	*Score*	*Rational*
2a	Groundwater vulnerability	2	▪ GSI data states that the site is rated as having high vulnerability.
2b	Groundwater flow regime	1	▪ Bedrock was originally considered to be karst. The geophysical survey indicates that bedrock is not karst and is likely to be Shaley Limestone i.e Ll Aquifer. Score reduces from 5 to 1.
2c	Surface water drainage	2	▪ Landfill is reportedly connected to town surface water drainage system
2d	Landfill gas lateral migration	3	▪ Residences not currently within 250m of site, but will be within 5 years ▪ Karst bedrock
2e	Landfill gas vertical migration	0	▪ Building on site not occupied and will be removed risk score reduces from 5 - 0

Table 8

Ref	**Receptors**	*Score*	*Rational*
3a	Human presence (leachate)	2	▪ Currently no houses within 250m, there will be within 5 years ▪ Note: All houses will be served by public water
3b	Protected areas	1	▪ No protected areas within 1 km of site ▪ The marsh area has been considered as an undesignated GWDTE, precautionary approach. ▪ No consultation with the NPWS has taken place.
3c	Aquifer category	5	▪ Locally Important Ll aquifer underlies the site, score reduces from 5 to 3
3d	Public water supply	3	▪ Public water supply is greater than 1km away (Cordangan) ▪ Karst bedrock – but different geological formation ▪ Precautionary approach assumed
3e	Surface water bodies	3	▪ Surface water drain within 50m of site boundary
3f	Human presence (gas)	0	▪ Building on site unoccupied and to be removed

			score reduces from 5 to 0

The revised risk assessment indicates that the site remains High Risk. However, the High Risk categories no longer include a landfill gas risk to site occupants or nearby residents. The risk posed by landfill gas to nearby residences is now considered to be Moderate Risk.

The risk posed by leachate migration to the surface water system is the primary High Risk Driver. The fill area is underlain by lacustrine sediments and moderate to low permeability glacial till, which is estimated to be 3-4m thick.

While leachate may have saturated the lake sediments, the tills are likely to limit the vertical migration toward the bedrock aquifer. The aquifer appears to be a shaley limestone (Ll) aquifer. Such aquifers tend to have short flow paths with discharge to the local surface water system. It is highly likely, based on the findings of the Geophysical Survey, that there is preferentially flow laterally toward the surface water system.

Note: The table below represents the Tier 1 Risk rating for this site. SPR1 to 9 represent the leachate risk scores. SPR10 & 11 represent Landfill Gas Risk. The migration pathways are colour coded as follows:

Groundwater & Surface Water	**Groundwater only**	**Surface water only**	**Lateral & Vertical**

Calculator		**SPR Values**	**Maximum Score**	**Normalised Score**
SPR1	1a x (2a + 2b + 2c) x 3e	105	300	35.00%
SPR2	1a x (2a + 2b + 2c) x 3b	35	300	11.67%
SPR3	1a x (2a + 2b) x 3a	42	240	17.50%
SPR4	1a x (2a + 2b) x 3b	21	240	8.75%
SPR5	1a x (2a + 2b) x 3c	63	400	15.75%
SPR6	1a x (2a + 2b) x 3d	63	560	11.25%
SPR7	1a x (2a + 2b) x 3e	63	240	26.25%
SPR8	1a x 2c x 3e	42	60	70.00%
SPR9	1a x 2c x 3b	14	60	23.33%
SPR10	1b x 2d x 3f	63	150	42.00%
SPR11	1b x 2e x 3f	This linkage is not present due to no receptor above the source		
Overall Risk Score		105		**70.00%**
				A

Risk Classification	**Range of Risk Scores**
Highest Risk (Class A)	**Greater than 70 for any individual SPR linkage**
Moderate Risk (Class B)	**40-70 for any individual SPR linkage**
Lowest Risk (Class C)	**Less than 40 for any individual SPR linkage**

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The Exploratory Phase has confirmed that the site is a Class A High Risk Site. However the highest risk is posed only by leachate migration to the surface water system. The risk posed by landfill gas to site users has been eliminated as the onsite buildings will be demolished. The risk posed to nearby residences has reduced from High to Moderate Risk based on strong evidence for the presence of an Ll aquifer beneath the site.

It is likely that leachate migration is occurring from the site toward the marsh wetland area and into the drain, which ultimately discharges to the River Ara several kilometres downstream of the site. The surface water sampling results will assist in determining if leachate is impacting on water quality in the drain.

5.2 Recommendations

OCM recommend that a Detailed Risk Assessment of the site be undertaken to assess the risk posed by leachate and landfill gas migration from the site.

5.2.1 Leachate Risk

5.2.1.1 Surface Water

OCM recommend that the results of the surface water sampling form the basis for the assessment of the risk to surface water. If an impact is confirmed there may be a need for further assessment of the surface water system as part of the detailed site assessment.

5.2.1.2 Groundwater

OCM recommend that three groundwater monitoring wells be installed around the perimeter of the site in the subsoil formation above the bedrock to establish if leachate migration is reaching an/or migrating through this layer.

One well will if possible be installed up hydraulic gradient of the landfill site to the north or northeast depending on site conditions. Currently this area is under water as it is part of the old marsh. Two wells will be installed down hydraulic gradient of the site. One to the east of the landfill, between the landfill and the surface water drain through which all surface water appears to discharge form the landfill catchment. One well to the west of the site to establish if leachate is migrating away from the site in that direction.

5.2.1.3 Leachate

OCM recommend that three internal leachate wells be installed at locations identified in the geophysical site investigation. These wells will also be used to monitoring landfill gas. . The wells will extend to the base of the waste.

5.2.2 Landfill Gas

OCM recommend that six (6 no.) landfill gas wells be installed around the perimeter of the landfill site. Three of the (3) the landfill gas wells located outside the fill area will be used to monitor groundwater quality in the shallow subsurface, where flow may contribute to the local surface water drainage system.

The wells will be located adjacent to the closest sensitive receptors (the halting site to the west and the residential development site to the northeast. Gas monitoring wells will also be located adjacent to the site entrance to the south and to the east and west because these lands are zoned for residential development in the future.

The landfill gas levels in the wells should be monitored weekly intervals over the following three weeks. The monitoring will include methane, carbon dioxide and hydrogen sulphide pressure and flow rates.

Tier 2 Detailed Site Investigation Former Landfill at Tipperary Town

Prepared For:

South Tipperary County Council

Prepared By: -

O' Callaghan Moran & Associates,
Granary House,
Rutland Street,
Cork.

21st December 2009

TABLE OF CONTENTS

1. INTRODUCTION

South Tipperary County Council (the Council) completed a Tier 1 Assessment of the closed Tipperary Town Landfill in accordance with the "Code of Practice Environmental risk Assessment for Unregulated Waste Disposal Sites (CoP)" published by the Environmental Protection Agency (EPA).

The Assessment concluded that the site was a Class A – High Risk site, due the potential for leachate migration to surface water and the risk to humans from landfill gas linked to the nature of the bedrock beneath the site.

In September 2009, the EPA prepared guidance on the completion of the Tier 2 Assessment, which recommended that it be completed in two phases. Phase 1 should consist of Exploratory Site Investigation Works, following which the findings of the Tier 1 Assessment should be revised and the need for and/or extent of a Phase 2 Detailed Site Investigation should be determined.

The Department of Environment Heritage and Local Government (DEHLG) advised all local authorities that the Tier 2 Assessment would require an input from consultants with experience in the investigation of waste disposal sites, and in particular risk assessment. The Council appointed O'Callaghan Moran & Associates (OCM) to complete the Tier 2 Assessment.

OCM completed the Exploratory Site Investigation in November 2009. Given the high risk ranking, OCM considered that a geophysical survey should be completed, although this is not recommended for the Exploratory Phase in the EPA guidance. The survey provided valuable information on the site and in particular

- Allowed a more comprehensive delineation of the lateral and vertical extent of the waste;
- Confirmed the presence of a leachate plume migrating toward the surface water drain to the east of the site;
- Identified pockets of metal buried in the waste, which could present difficulties in subsequent drilling;
- Confirmed the composition of waste types and distribution and established total thickness of waste ;
- Allowed estimates of the thickness of subsoil beneath the waste and depth to bedrock;
- Indicated that the bedrock was most likely a shaley limestone, which was not a Regionally Important Aquifer.

The investigations confirmed the Class A High Risk Site category. However, the highest risk was linked to leachate migration to the surface water system. The risk presented by landfill gas to site users was eliminated, as it was proposed to demolish the onsite buildings. The level of risk posed to nearby residences reduced from High to Moderate, based on the information on the nature of the underlying bedrock obtained from the geophysical survey.

OCM concluded it was likely that leachate was migrating from the site toward a wetland area and into a drain, which ultimately discharges to the River Ara, several kilometres downstream of the site. OCM also concluded that a Detailed Site Investigation was required to assess the risk posed by leachate migration to the shallow groundwater system and the surface water system and the risk of off-site migration of landfill gas.

The Council submitted the OCM Exploratory Works report to the EPA for comment. The EPA accepted OCM's conclusions and recommended that the Detailed Site Investigation should include works to confirm the nature of the bedrock beneath the site.

1.1 Work Scope

OCM scoped out the Detailed Site Investigation based on the results of the Exploratory Works and EPA's comments. A network of deep bedrock groundwater monitoring wells was not considered necessary, but one borehole should be installed to confirm the nature of the bedrock. Monitoring wells were required to monitor the shallow groundwater in subsoil zone, where potential leachate migration had been detected during the geophysical survey. The proposed works included:

- Review of surface water quality in the drain leaving the site (results not available for exploratory phase assessment).
- Installation of three groundwater monitoring wells in the subsoils.
- Installation of one borehole to the bedrock.
- Installation of three combined leachate/landfill gas monitoring wells in the waste body.
- Installation of five gas monitoring wells outside the waste body, three of which would also be suitable for groundwater monitoring.
- Topographical Survey

In response to EPA's comments, the findings of the geophysical survey were re-evaluated to determine the validity of the conclusion on the nature of the bedrock aquifer.

2. SITE DESCRIPTION

The site is in the Townland of Carrownreddy and is within the Tipperary Environs area Figure 2.1). It served as the landfill for Tipperary Town from circa 1940, until it closed l in 1990. It is currently used by Tipperary Town Council as a Depot for road maintenance materials and machinery.

The site is approximately 1.8 hectares and contains a fenced off area of 0.2 hectares, which was apparently used exclusively for the disposal of wastewater sludge. The southern, and part of the eastern and western boundary is fenced, but there is no visible boundary, other than the raised landfilled area, on the northern side. In addition to the sludges, the other wastes accepted were most likely to have been commercial and domestic.

The southern part of the site has a hardcore surface and is used for storing road maintenance materials and machinery. The remainder of the site, north of the shed is covered with miscellaneous wastes, including large mounds of construction & demolition waste, waste tyres, household waste, white goods (fridges, washing machines etc) and green waste.

2.1 Surrounding Land Use

The adjoining lands are currently used primarily for low intensity agriculture, (grazing horses). Immediately to the north is a marshy area. There are at least 20 residences within 250m of the north west and western site boundaries. There is also a newly developed housing estate located approximately 250m to the south eats of the site. A residential development (~250 houses) is under construction approximately 200m to the northeast of the site and it is the intention to develop the land between landfill and the residential estate for light industrial warehousing.

The lands to the south are currently used for grazing, but it is intended to develop these lands for social housing and light industrial use. There are currently no proposals to develop the lands to the west, but there are plans to extend the Lake Road west to link up with the R497, the Donohill Road.

Tipperary Town Council intends to move the Depot to an alternative location to enable the investigation and remediation of the site. In the longer term, the Council intends to leave the site as a closed landfill.

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environmental management for business

CLIENT

South Tipperary County Council

TITLE

Site Location

Legend

FIGURE No.

2.1

SCALE

3. DETAILED SITE INVESTIGATION

The intrusive site investigation works, which included the installation of the groundwater water and landfill gas monitoring wells and the collection of surface water and groundwater samples for laboratory testing, were carried out between 16th and 20th November 2009.

The investigations were undertaken in accordance with BS10175, 2001, Investigation of Potentially Contaminated Sites - Code of Practice and were supervised by OCM personnel experienced in the investigation of landfills and contaminated lands. Ms Ruth Hennessy of the Council attended on site during the works.

3.1 Well Installation

OCM provide specifications for the monitoring wells to the drilling contractor, who was experienced in the investigation of waste disposal sites. A track mounted air rotary drill rig, capable of travelling on variable terrain, was used to install the wells. The boreholes were logged in accordance with BS5930. The borehole locations are shown on Figure 3.1 and borehole logs are included in Appendix 1.

3.1.1 Leachate/Landfill Gas Wells

Three combined leachate/landfill gas wells (MW-1, MW-2 and MW-3) were installed in the waste body. The boreholes were advanced to the base of the waste and drilling stopped once the underlying natural ground was encountered. The depth to the base of the waste ranged from 10.4m to 13.5m below ground level (bgl). Leachate was encountered in the boreholes at depths ranging from 5.85m to 6.4m bgl.

3.1.2 Groundwater/Landfill Gas Wells

Five groundwater/landfill gas wells (MW-4, MW-5, MW-6, MW-7 and MW-8) were installed outside the waste body to monitor groundwater quality and landfill gas. MW- 4, 5, 6, 7 and 8 were installed down hydraulic gradient of the landfill. MW -4 and MW-8 are to the east of the waste, MW-5 and MW-7 are to the south, MW-6 to the south west

The locations of MW-4 and 8 were based on the evidence of leachate migration identified in the geophysical survey. In particular, MW-4 was installed to see if leachate was reaching the surface water drain to the east of the site.

It was not possible to install boreholes in the lands to the north, northwest and northeast of the site because the marsh area was flooded and the soft ground conditions prevented safe access.

MW-4, 5, 6 and 8 were advanced to an average depth of 10m below ground level. MW-7 was advanced to a depth of 20m below ground level. This borehole was installed to try to prove the depth and nature of the bedrock.

The drilling proved 0.65m of soft brown clay underlain by up to eight metres of very stiff brown clay with occasional boulders, which are dry. In MW-7 the clay is underlain by a layer of clay with gravel that extends to a depth of 13.5m and are water bearing. These clayey gravels are underlain by sand and gravel to 14.1m. A layer of dry very stiff clay underlies this from 14.1m to 15.75m. Beneath this is a water bearing layer of gravels from 15.75 to 20m (Ref Table 3.1).

.

It was not possible to drill beyond 20m because the gravels prevented the casing from advancing by jamming the drill stem against the casing.

To prevent MW-7 from becoming a conduit for vertical migration of water from the upper to the lower gravel zone the borehole was back filled with a concrete/bentonite slurry using a tremie pipe to plug the borehole from the base to a level above the clay layer. A summary of the subsoil profile is presented in Table 3.1.

Table 3.1 Subsoil Profile Summary

Depth (m)	**Description**
0 – 0.65	Soft brown Clay.
0.65 – 7.35	Brown very stiff sandy gravelly CLAY. Gravels are subangular dark grey limestone.
7.35 – 13.35	CLAY and GRAVEL. Gravels are subangular to subrounded. Groundwater strike at 8.85m.
13.35 – 14.1	Dark grey limestone SAND and GRAVEL.
14.1 – 15.75	Brown very stiff sandy gravelly CLAY. Gravels are subangular dark grey limestone.
15.75 – 20	Clay rich dark grey limestone GRAVELS. Gravels are subangular to subrounded. Groundwater strike at 15.75m.

* Subsoil profile based on the borehole log for MW-7

3.1.2.1 Well Construction

The leachate and landfill gas monitoring wells were constructed using high density polyethylene (HDPE) 50 mm diameter standpipes, which were slotted from the base of the hole (the base of the waste material) to approximately 1m below ground level.

A gravel filter pack was inserted in the annular space between the boring and the standpipe to a level of 0.5 m above the slotted section of the standpipe. Above the gravel filter the annular space was filled with a bentonite seal. The solid section of the well pipe was brought above the ground level and was fitted with a landfill gas cap and valve to allow landfill gas monitoring. A steel protective well casing, set in a concrete base, was placed around each standpipe.

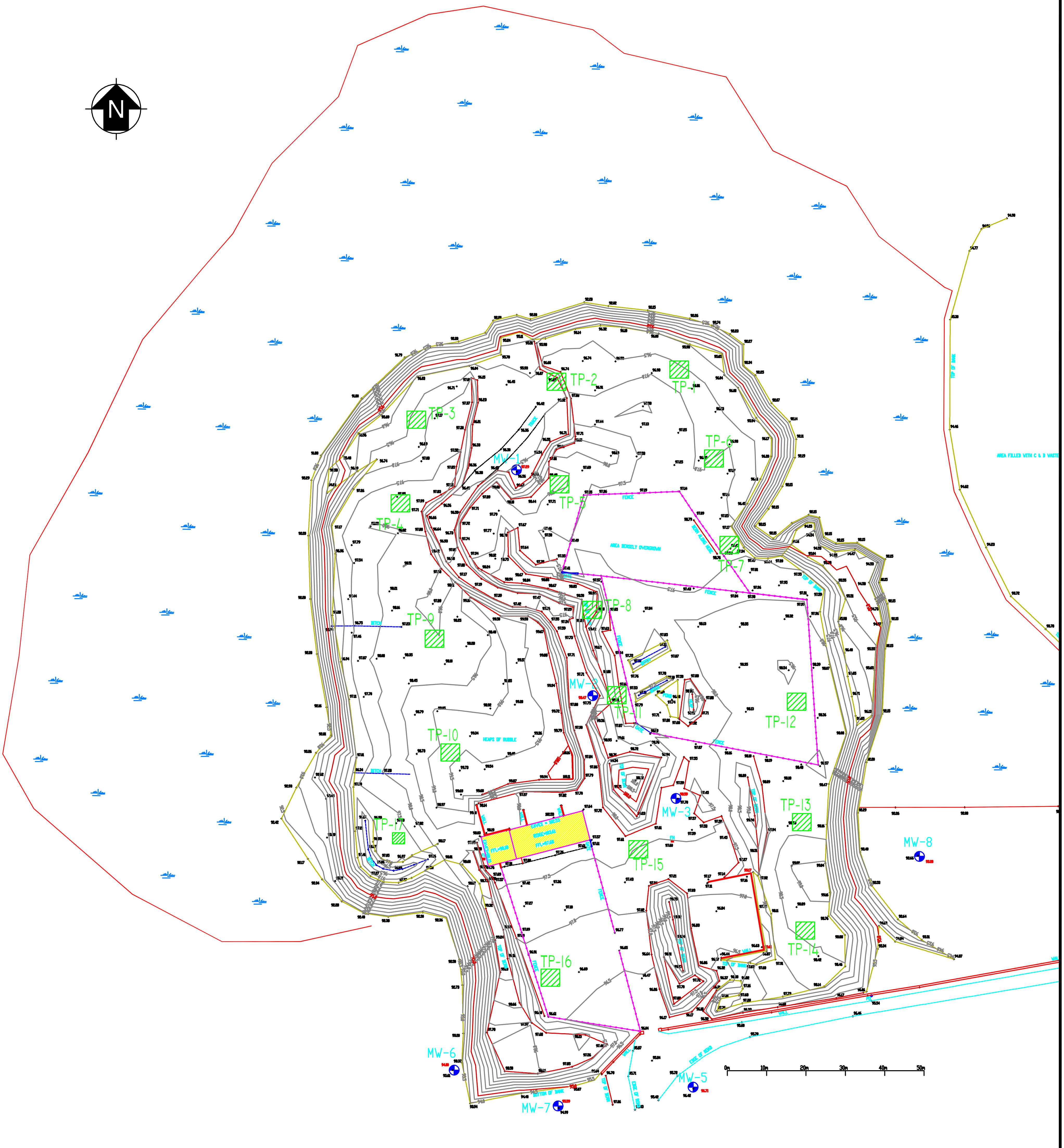
The groundwater wells were constructed using HDPE 50 mm diameter standpipes which were slotted from the base of the hole to approximately 2m below ground level.

A gravel filter pack was inserted in the annular space between the boring and the standpipe to a level of 0.5 m above the slotted section of the standpipe. Above the gravel filter the annular space was filled with a bentonite seal. The solid section of the well pipe was brought above the ground level and was fitted with a landfill gas cap and valve to allow landfill gas monitoring. A steel protective well casing, set in a concrete base, was placed around each standpipe.

3.2 Groundwater Monitoring

3.2.1 Sampling Methodology

Groundwater samples were taken from wells MW-4 to MW-8 on the 23rd November 2009. The samples were collected in accordance with the OCM groundwater sampling protocol, which is included in Appendix 2.



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CLIENT	SOUTH TIPPERARY COUNTY COUNCIL
TITLE	TRIAL PIT AND BOREHOLE LOCATIONS
DETAILS	
Figure No.	3.1
SCALE	1:1,000

After completion of groundwater level measurements, each well was purged to remove the stagnant water in the well and surrounding gravel pack using a 12 volt submersible pump and dedicated polypropylene tubing in each well to prevent cross contamination. pH, electrical conductivity and temperature were measured and the results along with visual observations are presented in Table 3.2.

The samples were placed in laboratory prepared containers, stored in a cooler, and sent for analyses to Jones Environmental Forensics Ltd laboratory. The Chain of Custody (COC) documentation is included in Appendix 3.

Table 3.2 Groundwater Field Measurements

Borehole Number	**MW-4**	**MW-5**	**MW-6**	**MW-7**	**MW-8**
Water Level (mBTOC)	0.3	1.85	0.7	6.35	3.94
Top of Casing (mOD)	93.26	96.71	94	95.59	93.2
Water Level (mOD)	92.96	94.86	93.3	89.24	89.26
pH	7.98	8.22	8.16	7.99	7.65
EC (µS/cm)	1,365	1,126	1,320	1,102	1,398
Temperature	10.1	10.2	10.2	10.3	10.6
Colour	Cloudy	Cloudy	Cloudy	Clear	Clear
Odour	None	None	None	None	None
Recovery	Good	Good	Good	Good	Good

3.2.2 Laboratory Analysis

The samples were analysed for a range of organic and inorganic parameters that included, pH and electrical conductivity, dissolved oxygen, ammonia, nitrite, nitrate, orthophosphate, potassium, sodium, chloride, sulphate, metals, cyanide, total organic carbon (TOC), polyaromatic hydrocarbons (PAH), volatile organic compounds (VOC), semi-volatile organic compounds (sVOC) and pesticides.

The laboratory methodologies were all ISO/CEN approved or equivalent and the method detection limits (MDL) were all below the relevant guidance limit.

3.2.3 Laboratory Results

The full laboratory test report is in Appendix 3 and the results are summarised in Table 3.3, 3.4 and 3.5. The table includes Interim Guideline Values (IGV) published by the EPA. The IGVs are not statutory, but were developed to assist in the assessment of impacts on groundwater quality in the context of the implementation of the EU Water Framework Directive. The guidelines are based on, but are more conservative than the Dinking Water quality standards.

Table 3.3 Groundwater Results – Inorganics and Total Organic Carbon

Sample I.D.	**Units**	**MW-4**	**MW-6**	**MW-8**	**IGV**
Sample Date					
Arsenic	µg/l	6	6.6	6.6	10
Boron	µg/l	25	258	20	1,000
Cadmium	µg/l	<0.5	<0.5	<0.5	5
Copper	µg/l	<7	<7	12	30
Mercury	µg/l	<1	<1	<1	1
Nickel	µg/l	<2	2	4	20
Lead	µg/l	5	7	8	10
Zinc	µg/l	<3	<3	10	100
Iron	µg/l	<20	<20	<20	200
Manganese	µg/l	116	342	538	50
Calcium	mg/l	119.10	144.4	147.7	200
Magnesium	mg/l	9.30	14.82	19.03	50
Sulphate	mg/l	14.78	104.22	11.22	200
Chloride	mg/l	57.9	135.9	276.2	30
Fluoride	mg/l	<0.3	<0.3	<0.3	1
Total Alkalinity as CaCO3	mg/l	308	388	368	No Abnormal Change
Total Cyanide	µg/l	<40	<40	<40	10
Chromium - total	µg/l	<1.5	<1.5	<1.5	30
Phosphorous	µg/l	10	12	11	30
Potassium	mg/l	1.58	5.64	1.21	5
Sodium	mg/l	40.11	101.30	81.15	150
pH	pH units	7.82	8.02	8.30	6.5-9.5
Electrical Conductivity	µS/cm	1232	1389	1490	1,000
Total Oxidised Nitrogen	mg/l	1.22	42.27	<0.05	No Abnormal Change
Ammonia	mg/l	0.7	0.8	0.2	0.15
Total Dissolved Solids	mg/l	472	947	919	-
TOC	mg/l	5	10	6	-

Table 3.4 Groundwater Results PAH

Parameter	Units	MW-4	MW-6	MW-8	IGV
Naphthalene	µg/l	<0.1	<0.1	<0.1	**1**
Acenaphthylene	µg/l	<0.08	<0.08	<0.08	**-**
Acenaphthene	µg/l	<0.1	<0.1	<0.1	**-**
Fluorene	µg/l	<0.07	<0.07	<0.07	**-**
Phenanthrene	µg/l	<0.07	<0.07	<0.07	**-**
Anthracene	µg/l	<0.08	<0.08	<0.08	**10000**
Fluoranthene	µg/l	<0.09	<0.09	<0.09	**1**
Pyrene	µg/l	<0.12	<0.12	<0.12	**-**
Benz(a)anthracene	µg/l	<0.09	<0.09	<0.09	**-**
Chrysene	µg/l	<0.1	<0.1	<0.1	**-**
Benzo(bk)fluoranthene	µg/l	<0.26	<0.26	<0.26	**0.50**
Benzo(a)pyrene	µg/l	<0.12	<0.12	<0.12	**0.01**
Indeno(123cd)pyrene	µg/l	<0.1	<0.1	<0.1	**0.05**
Dibenzo(ah)anthracene	µg/l	<0.1	<0.1	<0.1	**-**
Benzo(ghi)perylene	µg/l	<0.12	<0.12	<0.12	**-**
2-Methylnaphthalene	µg/l	<10	<10	<10	**-**
Total PAHS	µg/l	<1.60	<1.60	<1.60	

Table 3.5 Groundwater Results VOC, sVOC and Pesticides -

Parameter	Units	MW-4	MW-6	MW-8	IGV
VOCs					
Ethylbenzene	µg/l	<3	<3	<3	10
p/m-Xylene	µg/l	<5	<5	<5	10
o-Xylene	µg/l	<3	<3	<3	10
1,2,4-Trimethylbenzene	µg/l	<3	<3	<3	-
4-Isopropyltoluene	µg/l	<3	<3	<3	-
Naphthalene	µg/l	<2	<2	<2	1
DRO	mg/l	<0.01	<0.01	<0.01	0.01
Mineral Oil	mg/l	<0.01	<0.01	<0.01	0.01
sVOC	µg/l	ND	ND	ND	-
Pesticides	µg/l	ND	ND	ND	

Elevated levels of ammonia manganese, chloride and electrical conductivity, which are indicative of leachate contamination were detected in the shallow gravel/clay zone The levels decrease in concentration moving from MW-8 located east of the waste body to MW-4, approximately 150m east of the landfill approximately 10 west of the drain.

3.3 Leachate Monitoring

3.3.1 Sampling Methodology

Leachate samples were collected from MW-1 to MW-3 on the 23rd November 2009. The samples were collected in accordance with the OCM sampling protocol, which is included in Appendix 2.

After completion of leachate level measurements, each well was purged using dedicated PVC bailers. The field measurements recorded are presented in Table 3.6. A strong hydrocarbon odour was noted from the sample collected from MW-1 and a black oily residue noted on the bailer. The samples were placed in laboratory prepared containers, stored in a cooler, and sent for analyses to Jones Environmental Forensics. The COC documentation is included in Appendix 3.

Table 3.6 Leachate Field Measurements

Borehole Number	**MW-1**	**MW-2**	**MW-3**
Water Level (mBTOC)	4.34	5.8	6.91
Top of Casing (mOD)	97.29	98.47	98.59
Water Level (mOD)	92.95	92.67	91.68
pH	8.26	8.69	8.01
EC	>3999	>3999	>3999
Temperature	10.9	10.8	10.8
Colour	Black	Black	Black
Odour	Hydrocarbon	Putrescible	Putrescible
Recovery	Good	Good	Good

3.3.2 Laboratory Analysis

The samples were analysed for a range of organic and inorganic parameters that included pH and electrical conductivity, total oxidised nitrogen (TON), ammonia, biological oxygen demand (BOD), chemical oxygen demand (COD), sulphate, chloride, fluoride, total alkalinity, metals, total cyanide, phosphorus, mineral oil, VOC, sVOC, PAH, diesel range organics (DRO) and pesticides. The laboratory methodologies were all ISO/CEN approved or equivalent and the method detection limits (MDL) were all below the relevant guidance limit.

3.3.3 Laboratory Results

The full laboratory test report is in Appendix 3 and the results are summarised in Tables 3.7, 3.8 and 3.9. Included in the Table for comparative purposes are the groundwater IGVs

Table 3.7 Leachate Results – Inorganics, TON and BOD

Sample I.D. **Sample Date**	**Units**	**MW-1**	**MW-2**	**MW-3**	**IGV**
Arsenic	µg/l	19.2	17.1	10.3	10
Boron	µg/l	945	1917	733	1,000
Cadmium	µg/l	<0.5	<0.5	<0.5	5
Copper	µg/l	<7	<7	<7	30
Mercury	µg/l	<1	<1	<1	1
Nickel	µg/l	4	15	<2	20
Lead	µg/l	16	5	11	10
Zinc	µg/l	4	11	4	100
Iron	µg/l	81	52	<20	200
Manganese	µg/l	903	385	706	50
Calcium	mg/l	122.30	47.91	166.40	200
Magnesium	mg/l	42.28	28.96	58.08	50
Sulphate	mg/l	6.79	100.53	3.15	200
Chloride	mg/l	235.2	948.6	1703.7	30
Fluoride	mg/l	<0.3	0.3	0.5	1
Total Cyanide	µg/l	<40	<40	<40	10
Chromium - total	µg/l	19.1	2.5	16.6	30
Phosphorous	µg/l	56	336	21	30
Potassium	mg/l	74.02	127.00	65.60	5
Sodium	mg/l	100.30	352.50	586.30	150
pH	pH units	8.01	8.50	7.88	6.5-9.5
Electrical Conductivity	µS/cm	3710	4370	6370	1,000
TON	mg/l	<0.05	<0.05	<0.05	No Abnormal Change
Ammonia	mg/l	70.5	43.5	18.1	0.15
BOD settled	mg/l	20	26	9	-
COD	mg/l	114	183	52	-

Table 3.8 Leachate PAH Results - 23/11/2009

Parameter	Units	MW-1	MW-2	MW-3	IGV
Naphthalene	µg/l	**42.5**	<0.1	<0.1	**1**
Acenaphthylene	µg/l	<0.08	<0.08	<0.08	**-**
Acenaphthene	µg/l	**1.4**	<0.1	<0.1	**-**
Fluorene	µg/l	**0.90**	<0.07	<0.07	**-**
Phenanthrene	µg/l	**0.80**	<0.07	<0.07	**-**
Anthracene	µg/l	<0.08	<0.08	<0.08	**10000**
Fluoranthene	µg/l	<0.09	<0.09	<0.09	**1**
Pyrene	µg/l	<0.12	<0.12	<0.12	**-**
Benz(a)anthracene	µg/l	<0.09	<0.09	<0.09	**-**
Chrysene	µg/l	<0.1	<0.1	<0.1	**-**
Benzo(bk)fluoranthene	µg/l	<0.26	<0.26	<0.26	**0.50**
Benzo(a)pyrene	µg/l	<0.12	<0.12	<0.12	**0.01**
Indeno(123cd)pyrene	µg/l	<0.1	<0.1	<0.1	**0.05**
Dibenzo(ah)anthracene	µg/l	<0.1	<0.1	<0.1	**-**
Benzo(ghi)perylene	µg/l	<0.12	<0.12	<0.12	**-**
2-Methylnaphthalene	µg/l	19	<10	<10	**-**
Total PAHS	µg/l	**64.60**	<1.60	<1.60	

Table 3.9 Leachate VOC, sVOC and Pesticides Results

Parameter	Units	MW-1	MW-2	MW-3	IGV
VOCs					
Ethylbenzene	µg/l	4	<3	<3	10
p/m-Xylene	µg/l	9	<5	<5	10
o-Xylene	µg/l	5	<3	<3	10
1,2,4-Trimethylbenzene	µg/l	8	<3	<3	-
4-Isopropyltoluene	µg/l	10	<3	<3	-
Naphthalene	µg/l	68	<2	<2	1
DRO	mg/l	0.351	0.092	<0.01	0.01
Mineral Oil	mg/l	<0.01	<0.01	<0.01	0.01
sVOC	µg/l	ND	ND	ND	-
Pesticides	µg/l	ND	ND	ND	

The results confirm the presence of an aged leachate in the waste mass. The leachate levels range from 91.68 – 92.95mOD and indicate variable levels associated with localized perching within the waste body. The water levels in the wells immediately outside the landfill ranges from 89.24 – 94.86mOD.

The variations in level again probably relate to local variations in the natural subsoil permeability. The variations in level between the leachate and the surrounding wells do not indicate a direct hydraulic connection between the leachate and the groundwater in the gravels. However, the levels of manganese, chloride and ammonia detected in the wells outside the landfill footprint do indicate that leachate has migrated, albeit at dilute concentrations, into this gravel zone.

3.4 Surface Water Monitoring

A surface water drain flows from the site to the east for 150m and then turns south towards and passes beneath the access road towards a housing development. Where the drain reaches this development it is piped through Tipperary Town and eventually discharges to the River Ara. A surface water sample was collected from the drain approximately 50m downstream of the waste body during the Exploratory Works, but the results were not available for inclusion in the Exploratory Phase Report.

3.4.1 Sampling Methodology

The sampling was carried out by full submergence of the laboratory supplied sample containers into the surface water body where possible. During submergence every effort was made to keep the container steady so as to prevent sediment disturbance. Field measurements of temperature, pH, electrical conductivity and dissolved oxygen were recorded.

The samples were stored in cooler boxes to maintain sample temperature at approximately 4°C. All the samples were submitted to Jones Environmental Forensics in the UK within 24 hours of sampling. The COC is included in Appendix 3.

3.4.2 Laboratory Analysis

The samples were analysed for a range of organic and inorganic parameters that included indicators of general water quality and leachate contamination. The laboratory methodologies were all ISO/CEN approved or equivalent and, with the exception of ammonia, the method detection limits were all below the relevant guidance limit.

3.4.3 Laboratory Results

The laboratory test report is contained in Appendix 3 and the results are summarised in Table 3.10. The table includes for comparative purposes Environmental Quality Standards (EQS) published by the EPA. The EQS limits are proposed water quality standards and are derived from the EU Directive on Drinking Water Quality 80/778/EEC and the Directive on the Protection of Groundwater against pollution caused by certain dangerous substances 80/66/EEC.

Table 3.10 Surface Water Results

Sample I.D.	Units	SW-1	EQS
pH	pH Units	7.290	4.5-9
Electrical Conductivity	uS/cm	707.000	-
Arsenic	mg/l	0.004	0.025
Boron	mg/l	0.034	-
Cadmium	mg/l	<0.005	0.0015
Copper	mg/l	<0.007	0.03
Lead	mg/l	<0.005	0.0072
Manganese	mg/l	<0.002	-
Magnesium	mg/l	9.420	-
Mercury	mg/l	<0.001	0.00007
Nickel	mg/l	<0.002	0.02
Iron	mg/l	0.182	1
Total Cyanide	mg/l	<0.04	0.01
Total Chromium	mg/l	<0.0015	0.0047
Zinc	mg/l	<0.003	0.1
Sulphate	mg/l	26.99	200
Chloride	mg/l	28.16	250
Calcium	mg/l	103.40	-
Fluoride	mg/l	<0.3	5
Phosphorus	mg/l	0.07	-
Total Oxidised Nitrogen	mg/l	0.50	No Abnormal change
Total Suspended Solids	mg/l	6.00	-
Total Alkalinity as CaCO3	mg/l	240.00	-
BOD	mg/l	3.00	5
COD	mg/l	23.00	-
Potassium	mg/l	5.44	-
Sodium	mg/l	17.54	-
Ammonia*	mg/l	1.32	0.02
PAH	mg/l	ND	-
VOC	mg/l	ND	-
sVOC	mg/l	ND	-
Pesticides	mg/l	ND	-
DRO	mg/l	<0.01	-
Mineral Oil	mg/l	<0.01	-

ND - denotes not detected

With the exception of ammonia (1.7mg/l), all of the parameters were less than the relevant EQS and there is no evidence of leachate contamination. It should be noted however that the sampling took place after a period of very wet weather, when dilution was significant.

3.5 Landfill Gas Monitoring

Landfill gas monitoring was conducted in all eight monitoring wells (MW-1 to MW-8) on the 23rd November, 2nd December and on the 10th December 2009. The monitoring included the measurement of methane, carbon dioxide, oxygen and atmospheric pressure using a Gas Data LSMx gas analyser. The meter was calibrated before use. The detection limit is 0.1% for methane, carbon dioxide and oxygen.

The results are presented in Table 3.11. The table includes guideline limits taken from the Department of the Environment (DOE) publication on the 'Protection of New Buildings and Occupants from Landfill Gas' (1994).

3.5.1 Wells Inside the Waste Body

MW-1, MW-2 and MW-3 are all located within the waste body. Carbon dioxide and methane were detected in all three wells ranging from 31.5% to 56% for methane, and 1.5% to 16% for carbon dioxide. Oxygen levels ranged from 0.8% to 1.4% for oxygen.

The guidelines stipulate that, where carbon dioxide or methane are present in a landfill at 0.5% v/v and 1% v/v respectively, then housing should not be erected within 50 m of the landfill and private gardens should not be allowed within 10 m. There is one building on site, which was previously used of materials including pipes. This building is no longer in use, has been sealed and will shortly be demolished. There is a halting site located approximately 150m to the south of the site.

3.5.2 Wells Outside the Waste Body

MW-4, MW-5, MW-6, MW-7 and MW-8 are all located outside the waste body. Methane was only detected in one of the wells, MW-8 along the eastern site boundary where the concentrations ranged from 0.8% to 1.3%. Carbon dioxide was detected in all of the wells, with the concentrations ranging from 0% to 5%. The oxygen levels ranged from 2.9% to 22.6%, with the lowest level detected in MW-8.

Table 3.11 Landfill Gas Monitoring Data: November and December 2009

Monitoring Well	Methane			Carbon Dioxide			Oxygen			Barometric Pressure		
	23/11/2009	02/12/2009	08/12/2009	23/11/2009	02/12/2009	08/12/2009	23/11/2009	02/12/2009	08/12/2009	23/11/2009	02/12/2009	08/12/2009
MW-1	31.5	53	52	12	15	16	1.4	1.1	1	1002	1001	1002
MW-2	55	55	56	3.6	3.9	4.1	1.3	1.1	1.1	1002	1001	1002
MW-3	35	37.5	38	1.5	3.6	3.7	1.1	0.8	0.9	1002	1001	1002
MW-4	0	0	0	1.9	2.1	2.5	22.3	19.9	18.4	1002	1001	1002
MW-5	0	0	0	1.6	0.9	1	18.1	21.8	21.6	1002	1001	1002
MW-6	0	0	0	1.8	4	3.6	21	20.1	20.1	1002	1001	1002
MW-7	0	0	0	0	0.9	1	22.6	3.7	19.1	1002	1001	1002
MW-8	0.8	1.1	1.3	5	4.5	4.6	2.9	3.6	3.6	1002	1001	1002
DOE Limit (%)	**0.5%**			**1%**			**-**			**-**		

DOE limit not established

3.6 Waste Characterisation

Waste Characterisation had been undertaken during the Exploratory Phase Site Investigations which were detailed in a separate Exploratory Phase Site Investigation report. As part of the assessment two waste samples were selected to be analysed but results had not been received in time for the completion of that report. The results are incorporated below to complete the characerisation process. The samples were analysed for the parameters set out in the EU Council Decision establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC (Council Decision).

The Council Decision sets threshold limits for a range of inorganic and organic parameters, which define whether a waste is suitable for disposal to an inert, non-hazardous or hazardous waste landfill. Based on field observations it was considered the parameters specified in the Council Decision were appropriate for assessment purposes. However, depending on the test results, additional analyses may be carried out.

The solid samples were tested for Total Organic Carbon (TOC), BTEX (benzene, toluene, ethylbenzene and xylene) Polychlorinated biphenyls (PCB), Mineral Oil and Polycyclic Aromatic Hydrocarbons (PAH). Leachate generated from the waste samples were tested for metals (arsenic, barium, cadmium, chromium, copper, mercury, molybdenum, nickel, lead, antimony, selenium and zinc), chloride, fluoride, soluble sulphate, phenols, dissolved organic carbon (DOC) and total dissolved solids (TDS). The laboratory methodologies were all ISO approved or equivalent and the method detection limits (MDL) were all below the relevant guidance limit.

The full laboratory test report is in Appendix 3 and the results are summarised in Table 3.1. Included in the Table are the WAC for Inert and Non-Hazardous Waste.

Table 3.12 Waste Characterisation

Parameter	Unit	TP-4	TP-15	Inert Landfill	Non-Hazardous Landfill
Antimony	**mg/kg**	0.03	0.24	0.06	0.7
Arsenic	**mg/kg**	0.08	0.115	0.5	2
Cadmium	**mg/kg**	<0.01	<0.01	0.04	1
Copper	**mg/kg**	<0.12	<0.12	2	50
Chromium	**mg/kg**	<0.02	<0.02	0.5	10
Lead	**mg/kg**	<0.1	<0.1	0.5	10
Nickel	**mg/kg**	<0.06	0.05	0.4	10
Molybdenum	**mg/kg**	0.13	0.95	0.5	10
Selenium	**mg/kg**	<0.03	<0.03	0.1	0.5
Zinc	**mg/kg**	0.05	0.09	4	50
Mercury	**mg/kg**	<0.001	<0.001	0.01	0.2
Barium	**mg/kg**	0.48	1.92	20	100
Chloride	**mg/kg**	70	1847	800	15,000
Fluoride	**mg/kg**	<1	<1	10	150
Sulphate*	**mg/kg**	503	934	1000*	20,000
Dissolved Organic Carbon	**mg/kg**	120	190	500	800
Total Dissolved Solids	**mg/kg**	2,340	5,860	4,000	60,000
Phenols	**mg/kg**	<1	<1	1	NE
Total Organic Carbon	**mg/kg**	2,100	12,300	30,000**	NE
Benzene	**mg/kg**	<0.002	<0.002	6	NE
Toluene	**mg/kg**	<0.002	<0.002	6	NE
Ethylbenzene	**mg/kg**	<0.002	<0.002	6	NE
Total Xylene	**mg/kg**	<0.006	<0.006	6	NE
PCB Total of 7	**mg/kg**	<0.035	<0.035	1	NE
Naphthalene	**mg/kg**	<0.03	<0.03	NE	NE
Acenaphthylene	**mg/kg**	<0.02	0.09	NE	NE
Acenaphthene	**mg/kg**	<0.02	0.06	NE	NE
Fluorene	**mg/kg**	<0.02	0.09	NE	NE
Phenanthrene	**mg/kg**	0.29	0.76	NE	NE
Anthracene	**mg/kg**	0.10	0.31	NE	NE
Fluoranthene	**mg/kg**	0.59	1.96	NE	NE
Pyrene	**mg/kg**	0.49	1.60	NE	NE
Benzo(a)anthracene	**mg/kg**	0.40	1.15	NE	NE
Chrysene	**mg/kg**	0.40	1.18	NE	NE
Benzo(b)+Benzo(k)fluoranthene	**mg/kg**	1.09	2.21	NE	NE
Benzo(a)pyrene	**mg/kg**	0.58	1.57	NE	NE
Indeno(123cd)pyrene	**mg/kg**	0.46	1.06	NE	NE
Dibenzo(ah)anthracene	**mg/kg**	0.40	0.61	NE	NE
Benzo(ghi)perylene	**mg/kg**	0.55	1.09	NE	NE
Coronene	**mg/kg**	0.19	0.3	NE	NE
Total 17 PAH's	**mg/kg**	5.54	14	NE	NE
Mineral Oil	**mg/kg**	<30	<30	500	NE

NE - Not Established

* - sulphate level exceeding inert waste limit may be considered as complying if the TDS value does not exceed 6,000mg/kg at L/S = 10l/kg.

**-a higher limit may be accepted provided the DOC values of 500mg/kg is achieved

The majority of the parameters were below the Inert Limits; however the levels of antimony, molybdenum, chloride and TDS exceeded the WAC Inert Limit in the samples from TP-15. No significant zones of potentially contaminated or hazardous waste were identified during the site investigations. Based on the site observations during the investigation and the sampling results, the waste is considered to be Non-Hazardous and typical of that found in small scale municipal landfills.

3.7 Re-evaluation of the Geophysical Site Investigation

The Agency review of the Geophysical Site Investigation noted *"that a reclassification of the aquifer vulnerability was being considered due to the results of the geophysical survey. Caution should be observed when reclassifying bedrock on resistivity surveys only – it is best practice to also use seismic geophysics for that interpretation"*

OCM requested APEX Geoservices, who conducted the survey, to review the findings in response of the EPA's comments. APEX comments are as follows:

The Tier 1 Desk Study Assessment indicated the presence of possible high vulnerability and karstic bedrock aquifer beneath the site. The expected resistivity response on R5 & R6 (resistivity lines run outside the landfill footprint) for high vulnerability and Waulsortian karst limestone would be **high resistivity (1000-5000 ohm-m)** at relatively shallow depth (5-10m). This was not the case and **low resistivity (50-250 ohm-m)** was observed to c. 22m bgl on both profiles. This resistivity range is typical of South Midlands gravelly clays with occasional gravel pockets.

At c. 22m, there was a distinct transition on both R5 and R6 to slightly higher resistivity material **(250-400 ohm-m),** which was interpreted as shaley or argillaceous bedrock (probable Athassel dark shaley cherty limestone) rather than the expected cleaner Knockordan or Waulsortian-equivalent limestone. Such variations from the published geological maps would not be unusual in drift covered areas.

Given the strongly contrasting resistivity readings (250 – 400 ohm-m found versus 1000 – 5000 ohm-m typical of the Rkd Aquifer mapped for the area beneath the site) OCM concurs with the Apex Geoservices comments

A deep borehole (MW-7) was installed away from the landfill footprint to try to establish the nature of the bedrock. Dark grey shaley limestone gravels were encountered from approximately 15.5 -20m when the drilling terminated due to the nature of the gravels.

While top of bedrock was not confirmed, the nature of the gravels and difficulty in advancing the drill stem in this hole suggests that the top of bedrock was close. This is supported by the depth to bedrock estimated in the geophysical survey. OCM considers that, based on the nature of the gravels at depth (shaley limestone), and the geophysical interpretation provided by Apex, that the bedrock beneath the site is a shaley limestone and not the Waulsortian karst aquifer.

3.8 Assessment of Surface and Groundwater Pathways for Leachate Migration

3.8.1 Surface Water

Leachate levels recorded in the waste (MW-1 – MW-3) range from 91.68 – 92.95mOD. These levels are all typically more than 0.5m above the natural ground level surrounding the landfill and indicate that the leachate can potentially migrate through the landfill into the Marsh and ultimately into the drain to the east. It is possible therefore that leachate reaches the drain through the ponded marsh area seeping out along the base of the waste. However, based on the existing data the level of impact at such times is very low due to dilution by run-off from the surrounding lands.

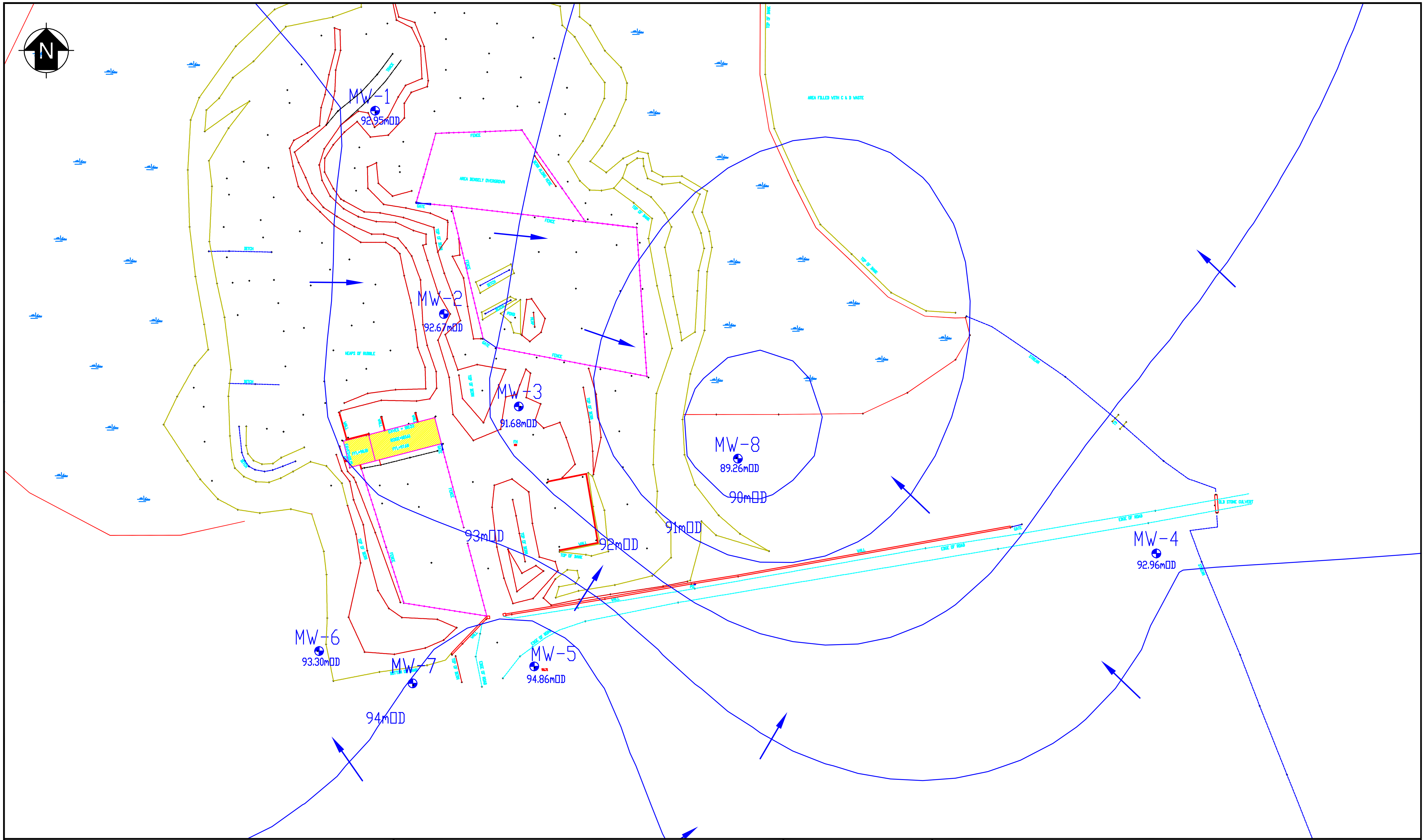
No leachate break outs were observed around the margins of the landfill and the marsh area did not look to be significantly impacted as a result of leachate discharge from the waste. Long term monitoring of the marsh and surface water drain is required to determine if surface water is impacted by leachate discharges from the site, particularly during low flow conditions. Monitoring of water quality in the marsh area may also be required though it is likely that the water in this area will be stagnant with low oxygen levels given its topographically low setting.

A groundwater flow direction has been compiled for the site (Figure 3.2). The groundwater table appears to reflect the topography of the natural ground with a low point in the vicinity of MW-8 to the east of the landfill and flow toward this area from all other areas.

The log for MW-4 located 10m from the surface water drain to the east of the landfill well indicates that the subsoil here comprise 7-8m of clay between the gravel/clay zone at depth and the base of the drain where the drain flows from north to south to the east of the landfill. There does not appear to be any direct connection therefore between this clayey gravel zone at depth and the drain. It appears that the marsh area is the outlet for groundwater /leachate within the catchment and that as the marsh area fills up it over flows to the surface water drain. Leachate migration from the waste is occurring from the waste body toward the natural low point in the marsh along the interface between the base of the waste and compacted natural ground where the landfill merges with the marsh area.

It is unclear if the upper gravelly clay zone is just a lense of gravel in the local area but it has been intersected in all the shallow wells. Groundwater level data indicates that currently leachate migration is not occurring through this zone down hydraulic gradient to the east and south toward the River Ara

The presence of a hard dry 1.75m thick clay layer beneath the uppermost gravel zone would most likely prevent leachate migration to the bedrock aquifer. As the available site investigation data indicates that the aquifer is likely to be Ll, the risk posed is less significant than if the aquifer were a regionally important karst bedrock aquifer.



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CLIENT	SOUTH TIPPERARY COUNTY COUNCIL
TITLE	GROUNDWATER FLOW DIRECTION MAP

DRAWING No.		
3.2		
SCALE	REV.	

NOTES

The public supply well (Tipperary CoOp) is located 1.5 km to the south of the site are uncontaminated, which indicates that leachate contamination in the gravels is not impacting on water quality in the bedrock aquifer.

Comparing the concentrations of (ammonia, chloride and manganese) detected in the groundwater wells with the concentrations in the leachate in the waste indicates that substantial dilution and attenuation is occurring within 5-10m of the landfill mass. It is considered likely there that further dilution and possible natural attenuation is occurring in the marsh area prior to discharge out of the catchment in the drain.

3.9 Assessment of Landfill Gas Pathway

The monitoring in the waste body (MW-1, 2 and 3) indicates that methane and carbon dioxide are still being generated at significant levels. The monitoring in the perimeter wells identified carbon dioxide levels ranging from 2.5 to 4.6%, however methane was only detected at one location, MW-8 located 10m to the east of the of the waste.

While the levels of CO_2 are above the DOE limits they are not very elevated and could at a distance from the site (MW-4) in part be naturally occurring. Methane is most likely associated with the presence of landfill gas emanating from the waste body. Because of the presence of the marsh and ponding water it was not possible to install monitoring wells to the north of the landfill. It is possible that some landfill gas migration may also be occurring into the marsh area. However the marsh land probably acts as a buffer between the landfill and the reclaimed lands to the north of the site, allowing ventilation to atmosphere or dissolution into the ponded water during the winter months.

The on-site building is no longer used and it is planned to demolish the structure in the near future. The risk to on-site users has therefore been eliminated.

The lands north and northwest, approximately 200 - 300m away, have been reclaimed with construction demolition waste as part of the planned future development for residential and commercial purposes. Currently there is a halting site located 150m to the south of the site. There are no other residential dwellings within 250m of the site. It is also possible that in the future the lands surrounding the site could be developed for residential and/or commercial purposes. Long term monitoring for landfill gas will be required around the landfill to ensure that any risk posed to areas proposed for development in the future can be mitigated in advance.

4. REVISION OF TIER 2 RISK ASSESSMENT & CONCEPTUAL SITE MODEL

4.1 Revised Conceptual Site Model

A revised conceptual Site Model is presented on Figure 4.1 below. This model illustrates the presence of low –to moderate permeability boulder clay and gravel which are in turn underlain by layer of low permeability hard clays. Beneath the clay layer is a layer of gravels which in turn appears to overly the shaley limestone Ll aquifer beneath the site. The landfill appears to be located at the low point in a local catchment where both groundwater and surfacewater discharge via a Marsh to the drain to the east of the site.

The leachate, while present in the shallow ground water is likely to be contained above the deeper clay layer. Direct discharge to drain via the groundwater pathway is not considered to occur. This appears to occur via the Marsh which in turn discharges slowly to the drain as water levels rise in the winter period. The marsh conditions more than likely result in some natural attenuation of the leachate prior to discharge of water from the marsh to the stream.

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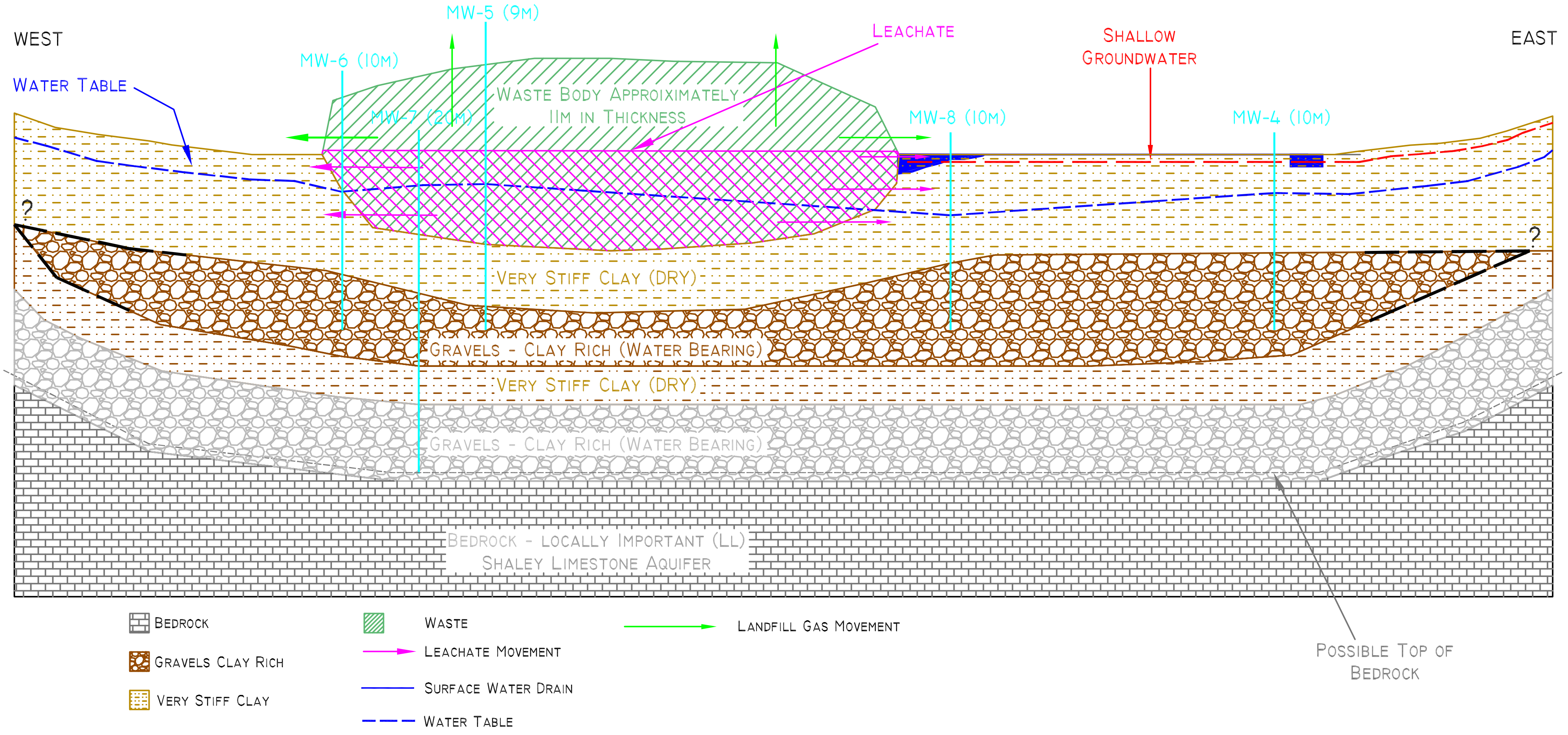

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CLIENT
SOUTH TIPPERARY COUNTY COUNCIL

TITLE
CONCEPTUAL SITE MODEL

details

FIGURE No.
4.1

SCALE

REV.

4.2 Revised Risk Assessment

OCM has modified the original risk assessment on the basis of the findings of the Exploratory Phase and the changes are highlighted in blue.

Table 6

Ref	**Source**	*Score*	*Rational*
1a	Leachate	7	▪ <5 hectares ▪ Waste likely to be both municipal & industrial
1b	Gas	7	▪ <5 hectares ▪ Highest rating given as proportion of municipal: industrial waste is not known.

Table 7

Ref	**Pathways**	*Score*	*Rational*
2a	Groundwater vulnerability	2	▪ GSI data states that the site is rated as having high vulnerability.
2b	Groundwater flow regime	1	▪ Bedrock was originally considered to be karst. The drilling data and geophysical survey indicates that bedrock is not karst and is likely to be Shaley Limestone i.e Ll Aquifer. Score reduces from 5 to 1.
2c	Surface water drainage	2	▪ Landfill is reportedly connected to town surface water drainage system
2d	Landfill gas lateral migration	3	▪ Residences not currently within 250m of site, but will be within 5 years ▪ Karst bedrock
2e	Landfill gas vertical migration	0	▪ Building on site not occupied and will be removed risk score reduces from 5 – 0

Table 8

Ref	**Receptors**	*Score*	*Rational*
3a	Human presence (leachate)	2	▪ Currently no houses within 250m, there will be within 5 years ▪ Note: All houses will be served by public water
3b	Protected areas	1	▪ No protected areas within 1 km of site ▪ The marsh area has been considered as an undesignated GWDTE, precautionary approach. ▪ No consultation with the NPWS has taken place.
3c	Aquifer category	5	▪ Locally Important Ll aquifer underlies the site, score reduces from 5 to 3
3d	Public water supply	3	▪ Public water supply is greater than 1km away (Cordangan) ▪ Karst bedrock – but different geological formation ▪ Precautionary approach assumed
3e	Surface water bodies	3	▪ Surface water drain within 50m of site boundary
3f	Human presence (gas)	0	▪ Building on site unoccupied and to be removed score reduces from 5 to 0

The risk assessment revised after the Detailed Site Investigations indicates that the site remains High risk for leachate because the pathway from the marsh to the drain appears viable. Further monitoring is required to establish if impacts on surface water quality is occurring during low flow conditions.

Landfill Gas Risk remains Moderate because of detection of carbon dioxide in the perimeter wells and methane in one well. The risk posed to receptors cannot be eliminated and needs to be assessed as part of a longer term monitoring programme.

Note: The table below represents the Tier 1 Risk rating for this site. SPR1 to 9 represent the leachate risk scores. SPR10 & 11 represent Landfill Gas Risk. The migration pathways are colour coded as follows:

Groundwater & Surface Water	**Groundwater only**	**Surface water only**	**Lateral & Vertical**

Calculator		SPR Values	Maximum Score	Normalised Score
SPR1	1a x (2a + 2b + 2c) x 3e	105	300	35.00%
SPR2	1a x (2a + 2b + 2c) x 3b	0	300	0.00%
SPR3	1a x (2a + 2b) x 3a	42	240	17.50%
SPR4	1a x (2a + 2b) x 3b	0	240	0.00%
SPR5	1a x (2a + 2b) x 3c	63	400	15.75%
SPR6	1a x (2a + 2b) x 3d	0	560	0.00%
SPR7	1a x (2a + 2b) x 3e	63	240	26.25%
SPR8	1a x 2c x 3e	42	60	70.00%
SPR9	1a x 2c x 3b	0	60	0.00%
SPR10	1b x 2d x 3f	21	150	14.00%
SPR11	1b x 2e x 3f	This linkage is not present due to no receptor above the source		
Overall Risk Score		105		**70.00%**
				A

Risk Classification	Range of Risk Scores
Highest Risk (Class A)	**Greater than 70 for any individual SPR linkage**
Moderate Risk (Class B)	**40-70 for any individual SPR linkage**
Lowest Risk (Class C)	**Less than 40 for any individual SPR linkage**

Risk Classification	**HIGHEST**

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The Detailed Site investigation indicates that the site currently a Class A High Risk Site based on the risk posed to the surface water system.

However, impact on the surface water quality in the drain is currently low with only ammonia exceeding EQS limits. This may in part be due to natural attenuation within the marsh and very high rainfall levels which are attenuating the impact on the surface water system.

It is possible that some leachate migration is occurring from the site toward the marsh wetland area and into the drain, which ultimately discharges to the River Ara several kilometres downstream of the site.

Based on the groundwater flow direction data the groundwater in the catchment is moving to a low point in the vicinity of the marsh. It is likely that the marsh is therefore the local discharge for groundwater.

Significant dilution of leachate appears to be occurring between the landfill and the groundwater based observation of the substantial reduction in Manganese, Chloride and Ammonia levels seen between the leachate in the waste and the external monitoring wells located within 5-10m of the landfill.

Water quality in the public groundwater abstraction well located 1.4km down hydraulic gradient of the site is of good quality which supports the assumption that the clay layer beneath the gravels and above the bedrock inhibits the vertical migration of groundwater.

Some remedial measures may be required to minimize the risk posed by leachate and landfill gas to off-site receptors but further monitoring of landfill gas, surface water quality and groundwater quality over a longer time period will be required to establish the extent of remediation required.

5.2 Recommendations

5.2.1 Leachate Risk

OCM recommend that the more recently deposited waste material deposited at the landfill be capped with low permeability soils/subsoils to minimise the infiltration of rainfall to the waste.

5.2.1.1 Surface Water

OCM recommend that monitoring of the surface water in the marsh area and in the drain be undertaken during lower flow conditions to establish if leachate is migrating into the marsh area and/or into the stream. Monitoring should be undertaken for an initial period of 6 months from April to September on a bimonthly basis (once every two months).

5.2.1.2 Groundwater

Following capping of the site OCM recommend that monitoring of the groundwater be undertaken to establish the effectiveness of the capping programme in reducing the generation of leachate beneath the site. Monitoring should be undertaken at least bi-annually for this purpose.

5.2.2 Landfill Gas

OCM recommend that when the water levels receed that landfill gas monitoring wells be installed to the north, north east and northwest of the marsh area.

OCM recommend that landfill gas monitoring be undertaken particularly in the southern section of the site (MW5, 6 and 7) at monthly intervals to assess the risk of off-site migration toward the halting site, the residential area within 250m of the site.

OCM recommend that all wells be monitored at least annually to assess landfill gas levels. In the event that development occurs within 250m of the site boundary the more frequent monitoring would be required.

If monitoring shows that landfill gas levels increase as a result of capping OCM recommend that mitigation measures be developed to reduce the landfill gas levels. Such measures may include the installation of additional landfill gas wells within the site to ventilate the site.

APPENDIX 1

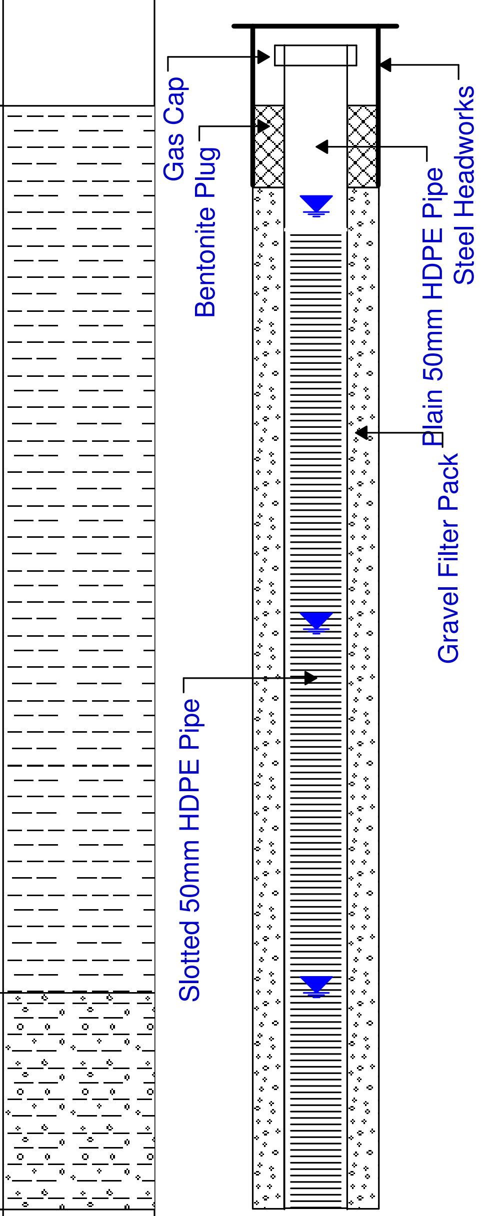
Borehole Logs

O'Callaghan Moran & Associates
Phone: 021-4321521 Fax: 021-4321522

Borehole I.D. MW-01

Project: 09-188-01	Borehole Depth: MW-01
Client: South Tipperary Co. Co.	SWL (m): 4.34m
Location: Tipperary Town Landfill	Borehole Type: MW-01

Depth (m)	Lithology Description	Lithology	Well Construction Details
-1			
0	Ground Surface		
0–11	***Fill/Waste*** Fill comprised of black sandy gravelly Clay with plactics, timber, glass and papers. Water strikes at 1.3m, 6.4m, 10.85m.		
11–14	***Clay*** Very stiff brown sandy gravelly Clay.		



Drilling Contractor:

Hole Size:

Drill Method: Air Rotary

Geologist: B. Sexton

Drill Date: 16/11/2009

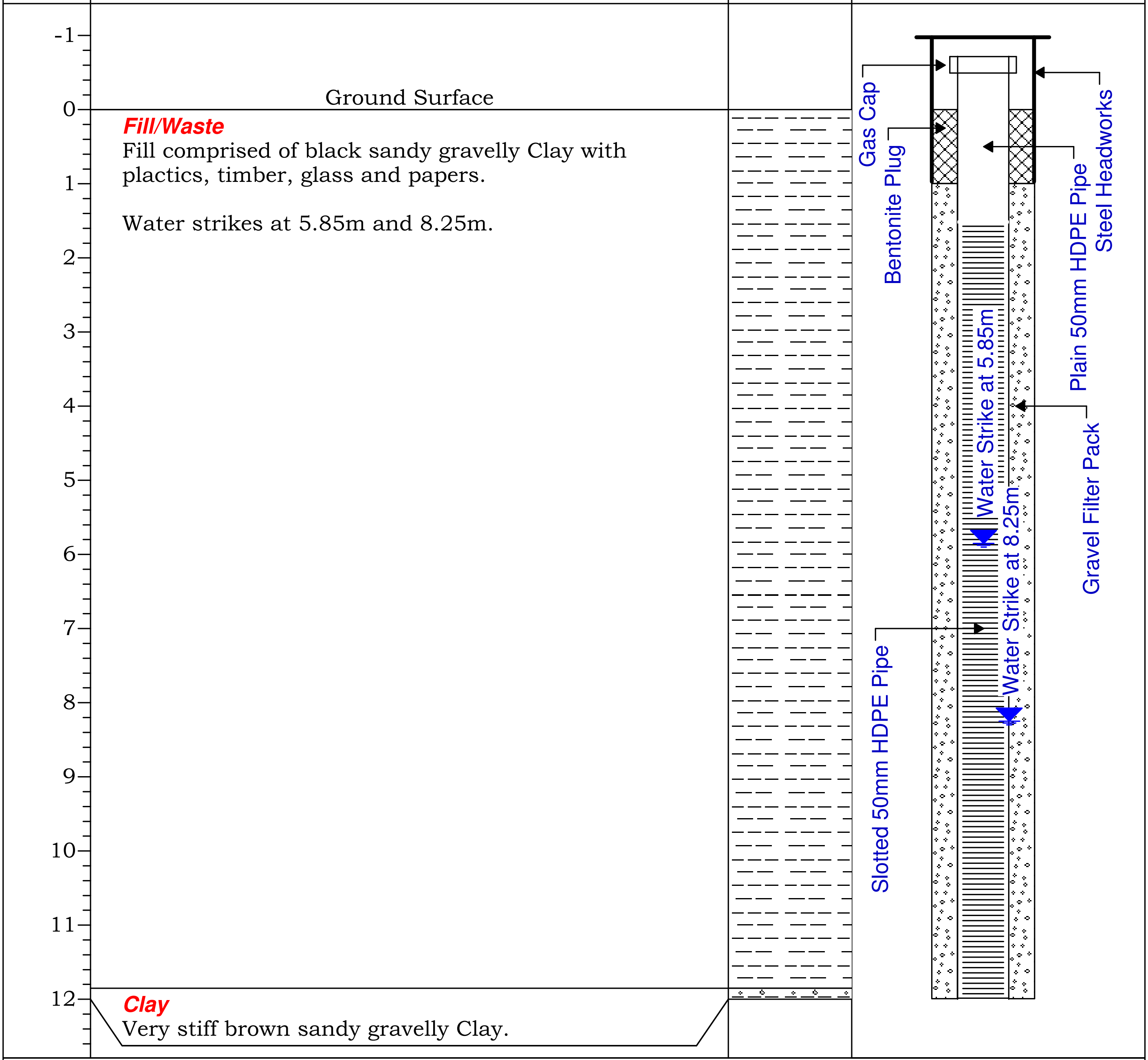
Sheet: 1 of 1

O'Callaghan Moran & Associates
Phone: 021-4321521 Fax: 021-4321522

Borehole I.D. MW-02

Project: 09-188-01
Borehole Depth: MW-02
Client: South Tipperary Co. Co.
SWL (m): 5.8m
Location: Tipperary Town Landfill
Borehole Type: MW-02

Depth (m)	Lithology Description
-1	
0	Ground Surface
0	***Fill/Waste*** Fill comprised of black sandy gravelly Clay with plactics, timber, glass and papers. Water strikes at 5.85m and 8.25m.
12	***Clay*** Very stiff brown sandy gravelly Clay.

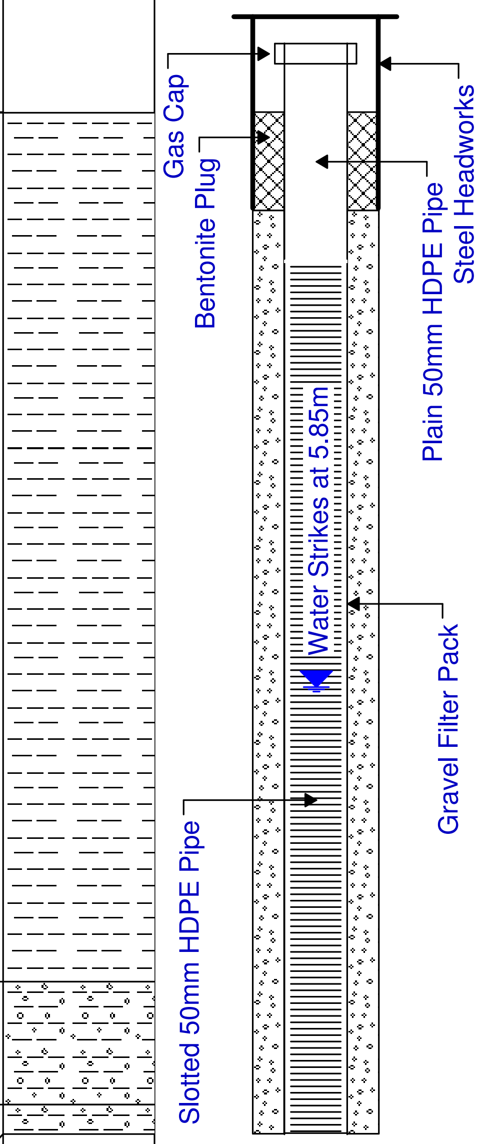


Drilling Contractor:
Hole Size:
Drill Method: Air Rotary
Geologist: B. Sexton
Drill Date: 17/11/2009
Sheet: 1 of 1

O'Callaghan Moran & Associates
Phone: 021-4321521 Fax: 021-4321522

Borehole I.D. MW-03

Project: 09-188-01	Borehole Depth: MW-03
Client: South Tipperary Co. Co.	SWL (m): 6.91m
Location: Tipperary Town Landfill	Borehole Type: MW-03



Depth (m)	Lithology Description	Lithology	Well Construction Details
-1			
0	Ground Surface **Fill/Waste** Fill comprised of black sandy gravelly Clay with plactics, timber, glass and papers. Water strike at 5.85m.		
1			
2			
3			
4			
5			
6			
7			
8			
9	**Gravelly Clay** Gravelly Clay.		
10	**Clay** Very stiff brown sandy gravelly Clay.		
11			

Drilling Contractor:	Hole Size:
Drill Method: Air Rotary	Geologist: B. Sexton
Drill Date: 17/11/2009	Sheet: 1 of 1

O'Callaghan Moran & Associates
Phone: 021-4321521 Fax: 021-4321522

Borehole I.D. MW-04

Project: 09-188-01
Borehole Depth: MW-04

Client: South Tipperary Co. Co.
SWL (m): 0.2m

Location: Tipperary Town Landfill
Borehole Type: MW-04

Depth (m)	Lithology Description	Lithology	Well Construction Details

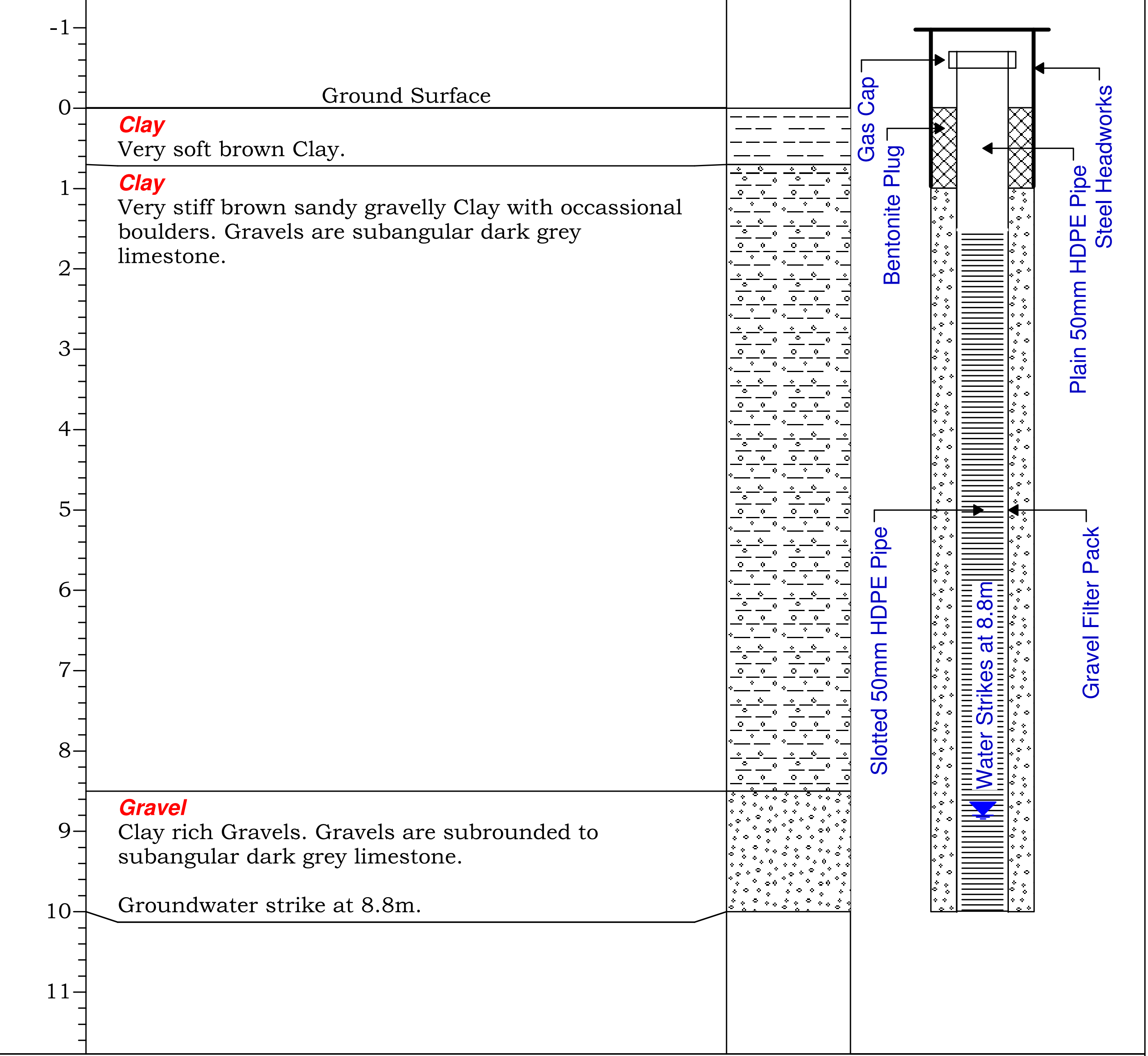
Ground Surface

Clay
Very soft brown Clay.

Clay
Very stiff brown sandy gravelly Clay with occassional boulders. Gravels are subangular dark grey limestone.

Gravel
Clay rich Gravels. Gravels are subrounded to subangular dark grey limestone.

Groundwater strike at 8.8m.



Drilling Contractor:
Hole Size:

Drill Method: Air Rotary
Geologist: B. Sexton

Drill Date: 18/11/2009
Sheet: 1 of 1

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Phone: 021-4321521 Fax: 021-4321522

Borehole I.D. MW-05

Project: 09-188-01
Borehole Depth: MW-05
Client: South Tipperary Co. Co.
SWL (m): 1.85m
Location: Tipperary Town Landfill
Borehole Type: MW-05

Depth (m)

Lithology Description

Lithology

Well Construction Details

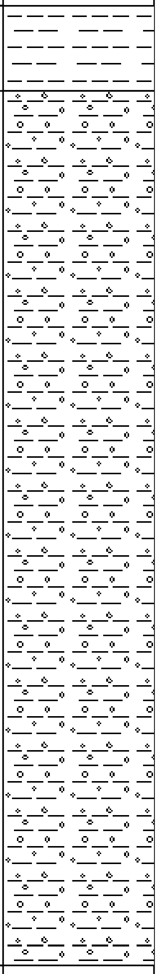
-1
0
1
2
3
4
5
6
7
8
9
10

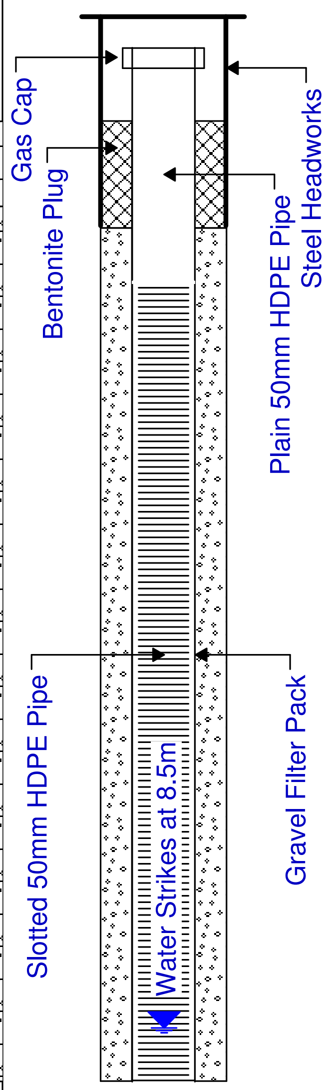
Ground Surface

Clay
Very soft brown Clay.

Clay
Very stiff brown sandy gravelly Clay with occassional boulders. Gravels are subangular dark grey limestone.

Groundwater strike at 8.5m.





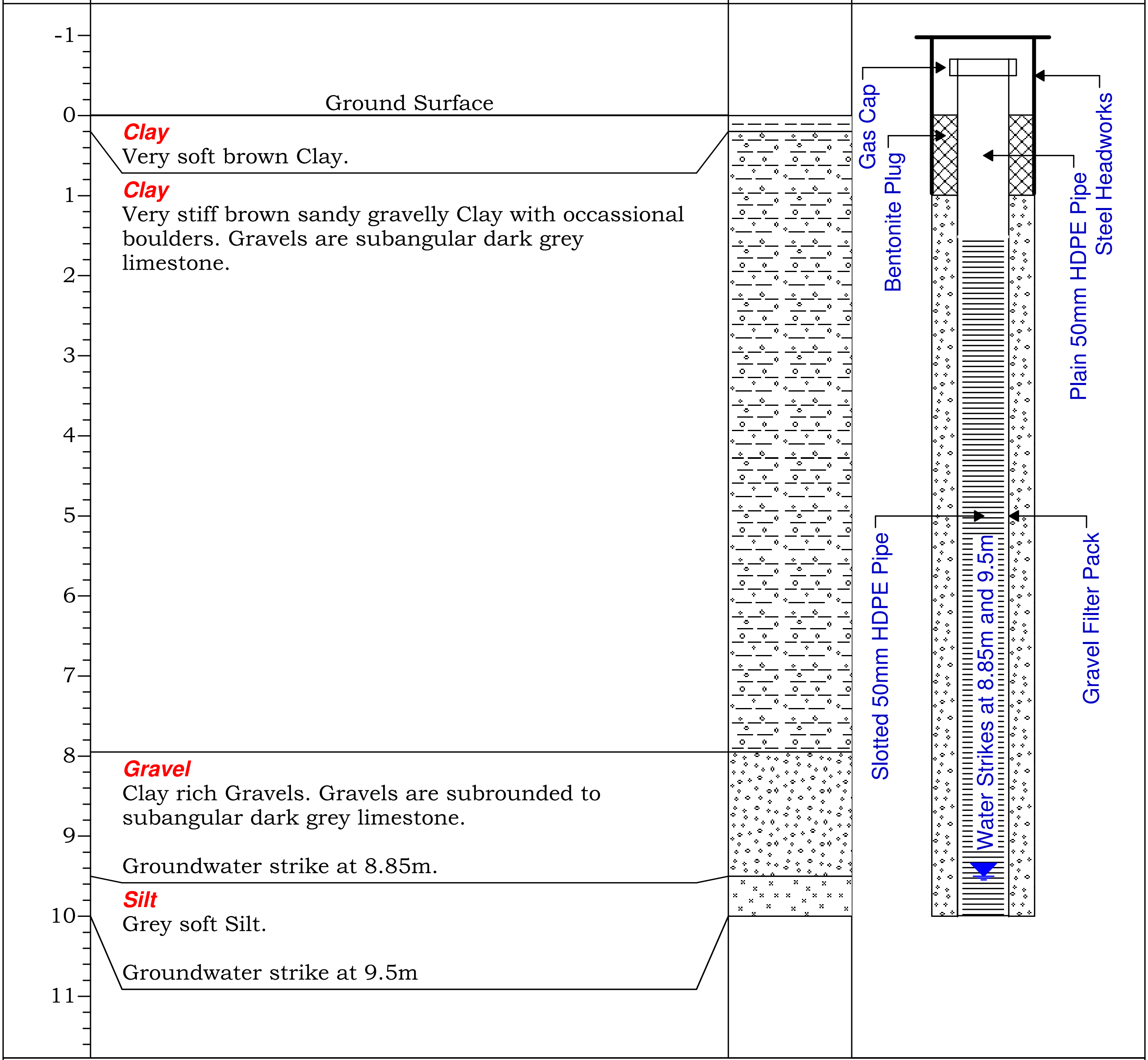
Drilling Contractor:
Hole Size:
Drill Method: Air Rotary
Geologist: B. Sexton
Drill Date: 18/11/2009
Sheet: 1 of 1

O'Callaghan Moran & Associates
Phone: 021-4321521 Fax: 021-4321522

Borehole I.D. MW-06

Project: 09-188-01
Borehole Depth: MW-06
Client: South Tipperary Co. Co.
SWL (m): 0.7m
Location: Tipperary Town Landfill
Borehole Type: MW-06

Depth (m)	Lithology Description	Lithology	Well Construction Details



Ground Surface

Clay
Very soft brown Clay.

Clay
Very stiff brown sandy gravelly Clay with occassional boulders. Gravels are subangular dark grey limestone.

Gravel
Clay rich Gravels. Gravels are subrounded to subangular dark grey limestone.

Groundwater strike at 8.85m.

Silt
Grey soft Silt.

Groundwater strike at 9.5m

Drilling Contractor:
Hole Size:
Drill Method: Air Rotary
Geologist: B. Sexton
Drill Date: 19/11/2009
Sheet: 1 of 1

O'Callaghan Moran & Associates
Phone: 021-4321521 Fax: 021-4321522

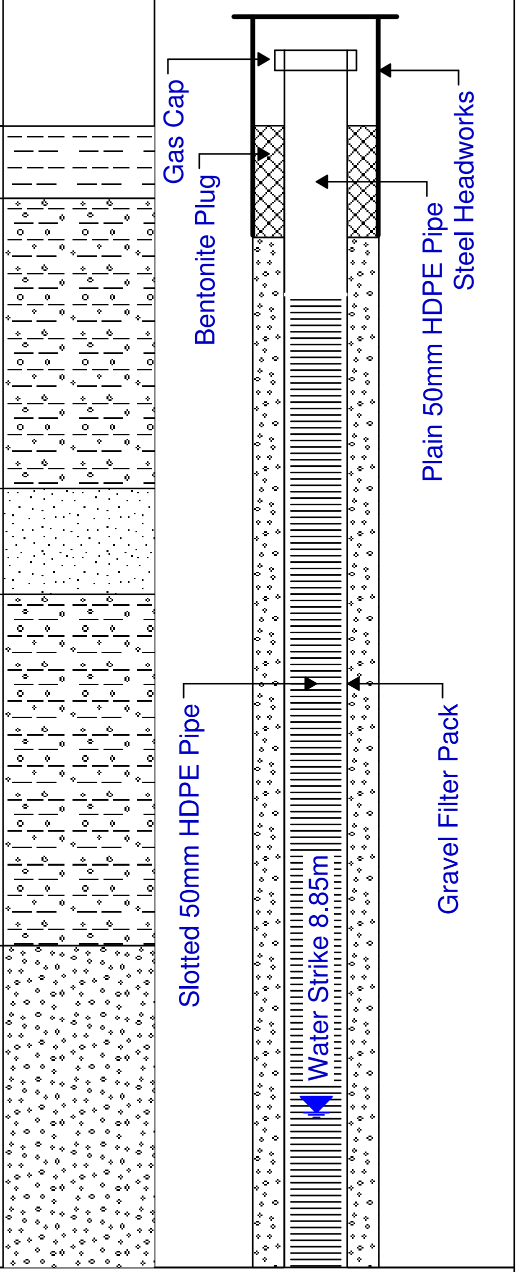
Borehole I.D. MW-07 Revised

Project: 09-188-01
Client: South Tipperary Co. Co.
Location: Tipperary Town Landfill
Borehole Depth: MW-07 Revised
SWL (m): 6.35m
Borehole Type: MW-07 Revised

Depth (m)	Lithology Description
-1	
0	Ground Surface
	Clay Clay with minor amounts of concrete.
1	**Clay** Brown very stiff sandy gravelly Clay. Gravels are subangular dark grey limestone.
2	
3	
	Sand Brown medium sand.
4	
	Gravelly Clay Brown very stiff sandy gravelly Clay. Gravels are subangular dark grey limestone.
5	
6	
7	
	Gravel Clay rich dark grey limestone Gravels. Gravels are subangular to subrounded. Groundwater strike at 8.85m.
8	
9	
10	

Lithology

Well Construction Details

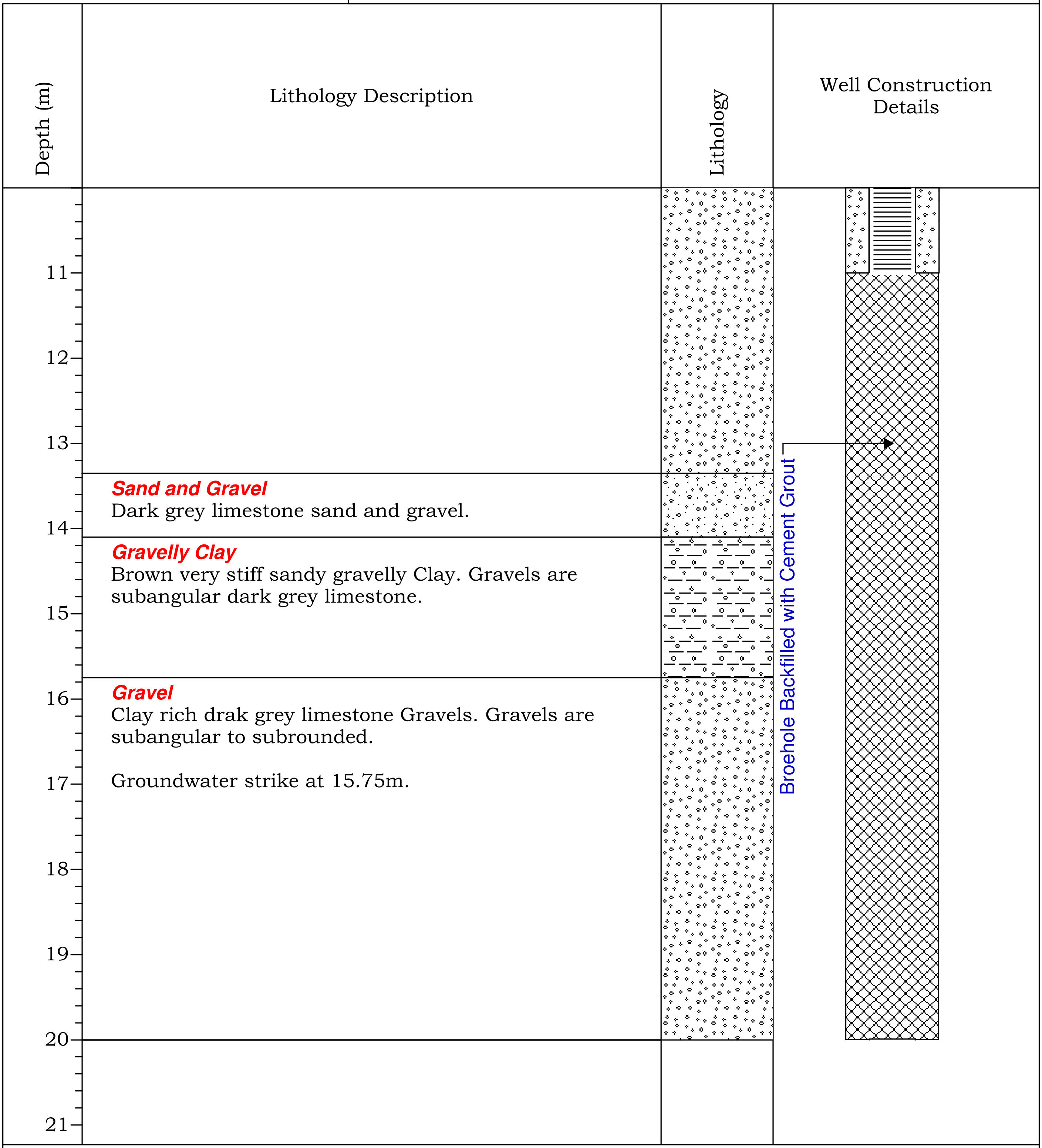


Drilling Contractor:
Drill Method: Air Rotary
Drill Date: 19/11/2009
Hole Size:
Geologist: B. Sexton
Sheet: 1 of 2

O'Callaghan Moran & Associates
Phone: 021-4321521 Fax: 021-4321522

Borehole I.D. MW-07 Revised

Project: 09-188-01
Borehole Depth: MW-07 Revised
Client: South Tipperary Co. Co.
SWL (m): 6.35m
Location: Tipperary Town Landfill
Borehole Type: MW-07 Revised



Sand and Gravel
Dark grey limestone sand and gravel.

Gravelly Clay
Brown very stiff sandy gravelly Clay. Gravels are subangular dark grey limestone.

Gravel
Clay rich drak grey limestone Gravels. Gravels are subangular to subrounded.

Groundwater strike at 15.75m.

Drilling Contractor:
Hole Size:
Drill Method: Air Rotary
Geologist: B. Sexton
Drill Date: 19/11/2009
Sheet: 2 of 2

O'Callaghan Moran & Associates
Phone: 021-4321521 Fax: 021-4321522

Borehole I.D. MW-08

Project: 09-188-01
Borehole Depth: MW-08
Client: South Tipperary Co. Co.
SWL (m): 3.94m
Location: Tipperary Town Landfill
Borehole Type: MW-08

Depth (m)	Lithology Description	Lithology	Well Construction Details

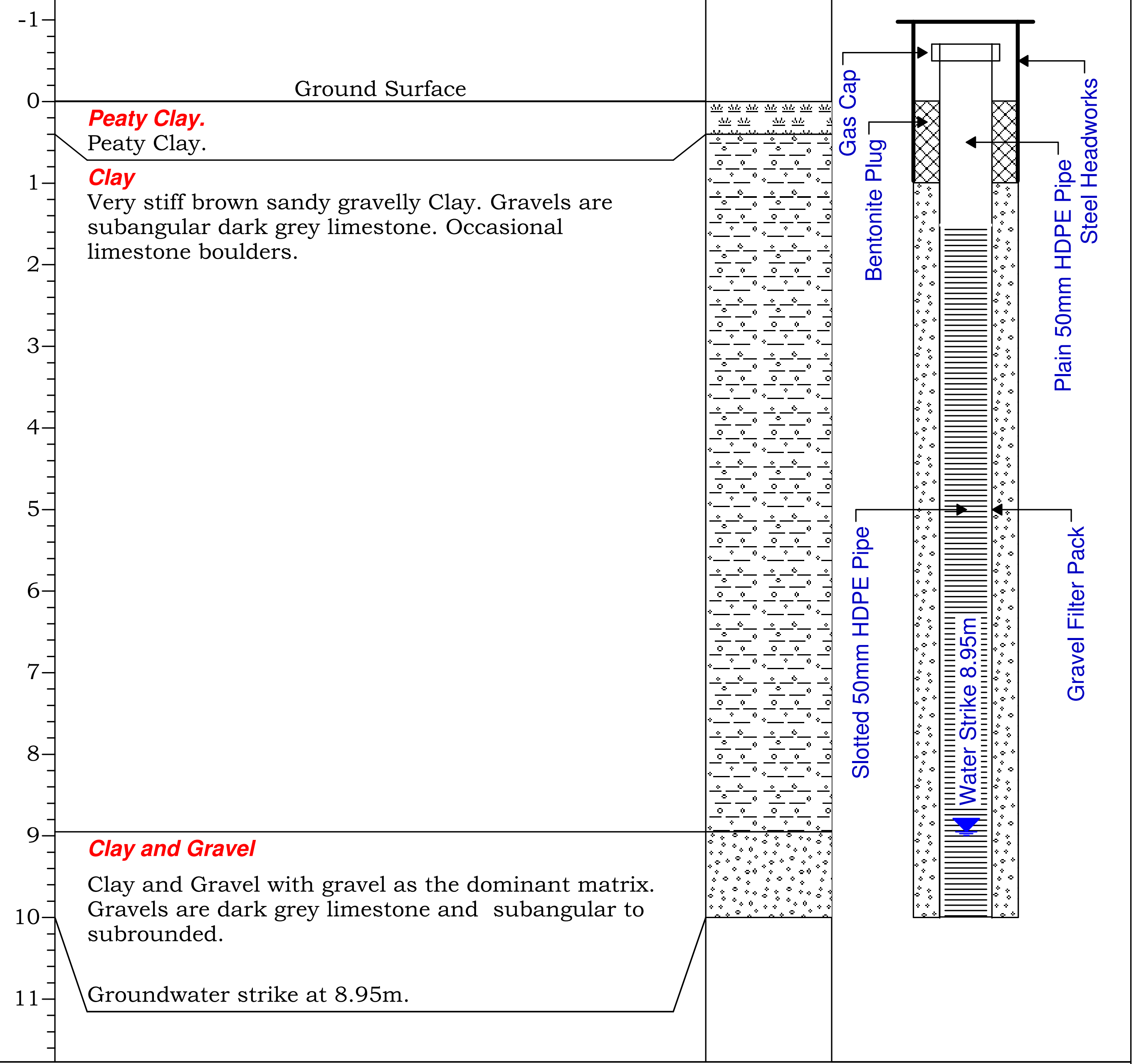
Ground Surface

Peaty Clay.
Peaty Clay.

Clay
Very stiff brown sandy gravelly Clay. Gravels are subangular dark grey limestone. Occasional limestone boulders.

Clay and Gravel
Clay and Gravel with gravel as the dominant matrix. Gravels are dark grey limestone and subangular to subrounded.

Groundwater strike at 8.95m.



Drilling Contractor:
Hole Size:
Drill Method: Air Rotary
Geologist: B. Sexton
Drill Date: 20/11/2009
Sheet: 1 of 1

APPENDIX 2

OCM Sampling Protocol

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STANDARD OPERATING PROCEDURE

SURFACE WATER SAMPLING

The primary objective of surface water sampling is to evaluate the chemical quality of a water body. The purpose of this procedure is to ensure that representative samples of surface water are collected and documented using consistent methods to ensure sample integrity. Surface water grab samples may be collected from rivers, streams, lakes and wetlands. In cases where the depth of the surface water body prevents sampling from the banks of the water body, sampling from, a boat may be required.

1.0 SAMPLING PROCEDURES

1) 1.1 Equipment Needed

- Personal protective clothing and equipment as required in the site-specific risk assessment.
- Decontamination equipment and supplies if known contaminated site.
- Temperature probe EC meter, pH meter, dissolved oxygen meter.
- Appropriate sample containers (some will be pre-preserved), labels and chain of custody documentation.
- Field logbook.
- Hard plastic cooler with ice pack.

1.2 Field Parameter Measurement

Measurements of field parameters of pH, temperature and electrical conductivity are made during sampling. Note visual (colour, turbidity) and odour (e.g hydrocarbon, hydrogen sulphide) characteristics in the field logbook.

1.3 Collection of Water Samples

All samples for chemical analysis will be placed in laboratory prepared bottles. The types of sample containers and preservative required for each type of analysis are described in the workplan. If required, preservatives will be placed in the sample containers prior to collecting the samples.

The following procedure will be used -

1) Slowly submerge unpreserved one-liter amber glass or plastic-capped bottles completely into the water. Open and fill bottle from below the water surface. If wading is required, approach the sample site from downstream and do not enter the actual sample area. Do not disturb bottom sediments. Open-end of the bottle should be pointed at approximately 90° to the upstream direction, in undisturbed gently flowing water. This procedure will be performed to minimize the effects due to high turbulence and aeration, or if surface scum is prevalent.

2) Collect a sufficient volume of water to fill all sample containers.

3) For VOC analysis. Pour the samples slowly into the laboratory prepared 40 ml glass vial. Overfill each vial slightly to eliminate air bubbles, a convex meniscus should be present at the top of the vial. Ensure that the Teflon liner of the septum cap is facing inward and that no bubbles are entrapped. After capping securely, turn bottle upside-down, tap it against your other hand, and observe sample water for bubbles. If bubbles are observed, remove the cap, overfill the vial and reseal. Repeat this step for each vial until the samples with no bubbles are obtained.

4) Obtain the semi-volatile compound/pesticides/PCBs sample(s) by transferring the water to a laboratory prepared 1000 ml amber glass bottle with Teflon-lined cap. Fill the bottle to the bottom of the neck and follow steps 4, 5 and 6 above.

5) Dissolved metals (if necessary) may require filtering the sample water through a .45 micron filter. The water is collected in a 1 litre, unpreserved, plastic or glass bottle with HNO_3 preservative. Filtering must be done within 15 minutes of sample collection.

6) Obtain the total metals sample by directly transferring the water into a laboratory prepared 1000 ml plastic or glass bottle with HNO_3 preservative. Ensure the pH of the metals sampled is less than 2 by pouring off an aliquot in a clean jar and testing for pH using litmus paper.

7) Collect and prepare Field QA/QC samples in accordance with separate SOP.

8) Place a label on the container and enter the following information: -

    Client/Site Name
    Date Collected
    Time Collected
    Analysis

Preservative
Sample Identification Number

9) Place custody seals on the container caps. As soon as possible, place sample containers in a cooler with ice and maintain at 4°C. Surround the bottles with packaging.

10) Record pertinent information in the field logbook and on the Field Data Sheet for Sampling Location. Complete chain-of-custody form, place in cooler and seal and label the cooler.

11) Be sure to record all data required on the Field Data Sheet or Sampling Location and appropriate entries into the field logbook.

12) Decontaminate all sampling equipment according to procedure.

END.

STANDARD OPERATING PROCEDURE

GROUNDWATER SAMPLING

The primary objective of groundwater sampling is to establish groundwater quality and evaluate whether the potential contaminant sources at a site have impacted the groundwater in the underlying aquifer. The additional objective is to measure hydraulic gradient, or slope, of the water table to evaluate the direction of groundwater flow.

The purpose of this procedure is to ensure that representative samples of groundwater are collected and documented using consistent methods to ensure sample integrity.

1.0 SAMPLING PROCEDURES

1.1 Well Operating and Purging Procedures

All groundwater sampling will be conducted after the installed and developed wells have been allowed to equilibrate for at least 2 to 3 days. A Field Data Sheet for Well Sampling will be completed for each well.

Groundwater sampling teams will use to following procedure for approaching, opening, purging and sampling all wells, unless directed otherwise by a site specific workplan.

1) Prior to placing any equipment into the well, decontaminate the sampling equipment according to standard decontamination protocol.

2) Ensure you have a working FID/PID, a well key, and a depth-to-water meter.

3) Unlock and open the well cap just enough to insert the probe of the PID/FID. Take and record a reading. A decision to upgrade PPE may be necessary based on the FID/PID readings in the breathing zone.

4) Where practical, the surface water column will be visually examined for the presence of hydrocarbons, if present or suspected, the thickness of the hydrocarbon layer will be measured using an oil/water interface probe prior to taking the depth-to-water measurement.

5) Insert the water level probe into the well and measure and record the static water level to the nearest 0.01 m with respect to the established survey point on top of the well casing.

6) Decontaminate the water level probe with DDI water (Do not rinse with any solvents unless product was encountered).

7) Calculate and record the minimum volume of water to be purged according to the following conversion factors: -

1 well volume = water column in metres x litres/linear metre

50mm casing = 2.0 LPM
100mm casing = 8.1 LPM
150mm casing = 18.2 LPM
200mm casing = 32.4 LPM

8) Purge the well of at least 3 casing volumes by pumping or bailing with a decontaminated submersible pump or PVC bailer equipped with a bottom filling check valve (if the purge volume is low, generally less than 100 litres, the sampling team might find it more efficient to purge with a bailer than a pump). Use a graduated bucket to track the amount of water removed from the well. Periodically determine the pH, temperature and specific conductance of the purged water. Continue purging until the well has been completely evacuated or until the pH and specific conductance measurements have stabilised for at least one well volume. Wells that become dewatered before producing three casing volumes will be sampled as soon as practical once they recover sufficiently.

9) Dispose of purge water collected in the graduated bucket by pouring onto the ground at a distance of 50 to 60 metres from the vicinity of the well. If the water is known or suspected to be significantly contaminated, it may be necessary to store the purge water in a secure container, such as a drum, pending proper disposal.

10) Be aware and record any unusual occurrence during purging such as cascading (a shallow water entry zone that trickles into the borehole).

1.2 Field Parameter Measurement

Measurements of field parameters of pH, temperature and electrical conductivity are collected and organic vapour screening is conducted while the well is purged. To facilitate the collection of basic field parameters, the field team needs to: -

- Purge three well volumes of water from the well and measure field parameters for each well volume removed.

- Collection of water samples should take place after stabilisation of the following parameters: -

    - Temperature $^{+}$/- 1°C
    - pH (meter or paper) $^{+}$/- 0.2 units
    - Specific conductivity $^{+}$/- 5%

- If the aforementioned parameters do not stabilise within three purge volumes, the well will be purged up to a maximum of six borehole volumes unless two consecutive sets of stabilised parameters are obtained.

- Note any observations in the field logbook.

1.3 Collection of Water Samples

All samples or chemical analysis will be placed in laboratory prepared bottles. The types of sample containers and preservative required for each type of analysis are described in the workplan. If required, preservatives will be placed in the sample containers prior to collecting the samples.

The following procedure will be used to sample a well: -

1) After the well has been purged and allowed to recover, sample the well using a properly decontaminated or dedicated disposable bailer. Gently lower the bailer into the water column. Allow the bailer to sink and fill with a minimum of surface disturbance.

2) Slowly raise the bailer out of the well. Do not allow the bailer line to contact the ground, either by coiling it on a clean plastic sheet or by looping it from arm to arm as the line is extracted from the well.

3) Samples will be collected for VOCs analysis immediately after purging is complete and before other samples are collected. Pour the samples slowly into the laboratory prepared 40 ml glass vial. Overfill each vial slightly to eliminate air bubbles, a convex meniscus should be present at the top of the vial. Ensure that the Teflon liner of the septum cap is facing inward and that no bubbles are entrapped. After capping securely, turn bottle upside-down, tap it against your other hand, and observe sample water for bubbles. If bubbles are observed, remove the cap, overfill the vial and reseal. Repeat this step for each vial until the samples with no bubbles are obtained.

4) Place a label on the container and enter the following information: -

    Client/Site Name
    Date Collected
    Time Collected
    Analysis
    Preservative
    Sample Identification Number

5) Record pertinent information in the field logbook and on the Field Data Sheet for Well Sampling. Complete chain-of-custody form.

6) Place custody seals on the container caps. As soon as possible, place sample containers in a cooler with ice packs and maintain at 4°C until extraction. Surround the bottles with appropriate packaging.

7) Obtain the semi-volatile compound/pesticides/PCBs sample(s) by transferring the water to a laboratory prepared 1000 ml amber glass bottle with Teflon-lined cap. Fill the bottle to the bottom of the neck and follow steps 4, 5 and 6 above.

8) Dissolved metals (if necessary) requires the team to filter the sample water through a .45 micron filter. The water is collected in a 1 litre, unpreserved, plastic or glass bottle with HNO_3 preservative. Filtering must be done within 15 minutes of sample collection.

9) Obtain the total metals sample by directly transferring the water from the bailer into a laboratory prepared 1000 ml plastic or glass bottle with HNO_3 preservative.

10) Be sure the pH of the metals sampled is less than 2 by pouring off an aliquot in a clean jar and testing for pH using litmus paper. Dispose of this water and rinse the jar.

11) Collect and prepare Field QA/QC samples in accordance with separate SOP.

12) Be sure to record all data required on the Field Data Sheet or Well Sampling and appropriate entries into the field logbook.

13) Secure the well cap and replace the locking cover.

14) Decontaminate all sampling equipment according to procedure.

15) Decontaminate submersible pumps as follows: -

Scrub pump and cord in a tub of appropriate detergent and potable water
Pump at least 80 litres of soapy water through pump
Rinse with potable water
Pump at least 80 litres of rinse water through the pump
Rinse with DI water before lowering pump into the next well.

END.

STANDARD OPERATING PROCEDURE

LANDFILL GAS MONITORING

The primary objective of landfill gas monitoring is to assess if gas generation would be likely to give rise to a risk to human health or to the environment. It also helps determine trends in gas generation and migration and evaluates the effectiveness of any in-situ gas control measures. The purpose of this procedure is to ensure that representative measurements of landfill gas are collected using appropriate safety procedures.

1.0 SAMPLING PROCEDURES

All landfill gas monitoring equipment used will be certified intrinsically safe. All landfill gas monitoring equipment shall be regularly calibrated and serviced according to the manufacturer's specification.

The following procedure will be used for monitoring of landfill gas levels in all monitoring boreholes, unless directed otherwise.

1) On arrival at the site, test the equipment in accordance with manufacturer's recommendations and record the ambient gas concentrations, atmospheric pressure and temperature in a field notebook. This ensures the gas analyser chamber is purged prior to monitoring. Record the wind speed and direction and other weather conditions.

2) Unlock the borehole cover. Examine the appearance of the standpipe, cap and gas valve and note any damage or changes since previous recordings. Record any visible (steam), audible or olfactory signs of gas migration. Record the ground conditions (e.g. dry, wet, frozen, compacted, loose etc). If signs of gas migration are noted, measurement of gas concentrations should be made around the standpipe to ensure there are no dangerous accumulations of gas.

3) If the standpipe is fitted with a gas valve, switch on the gas analyser and securely connect the gas analyser inlet port to the gas sample valve via the inlet tube. Open the gas valve and switch on the analyser pump. Run the pump for sufficient time to remove a representative sample from the borehole. Turn the pump off.

4) Record methane (CH_4), carbon dioxide (CO_2) and oxygen (O_2) peaks and steady concentrations.

5) Record atmospheric pressure (mb) and temperature (°C).

6) When measurements are completed, the gas sample valve must be closed and the analyser disconnected.

7) A measurement of the depth to water in the borehole should be undertaken after completion of all gas measurements. Insert the water level probe into the well and measure and record the static water level to the nearest 0.01 m with respect to the established survey point on top of the well casing.

8) Be sure to record all data required in the field log book.

9) Secure the well cap and replace the locking cover.

10) Briefly run the pump on the gas analyser to purge the analyser chamber with ambient air before proceeding to the next monitoring location.

END.

APPENDIX 3

Laboratory Reports and Chain of Custody Documentation

Jones Environmental Laboratory

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O'Callaghan Moran & Associates
Granary House
Rutland Street
Cork

No.4225

Attention :	Barry Sexton
Date :	18th November 2009
Your reference :	09-188-01
Our reference :	Test Report 09/3607
Location :	Tipperary Town Landfill
Date samples received :	05/11/09
Status :	Final Report
Issue :	1

Five soil and one water samples were received for analysis on 5th November 2009 which was completed on 18th November 2009. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced.
All interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

J W Farrell- Jones CChem FRSC
Chartered Chemist

Jones Environmental Laboratory

Client Name: O'Callaghan Moran & Associates **Report :** **Solids**
Reference: 09-188-01
Location: Tipperary Town Landfill **Solids:** V=60g VOC jar, J=250g glass jar, T=plastic tub
Contact: Barry Sexton
JE Job No.: 09/3607

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-2	3-4	5-6	7-8	9-10								
Sample ID	TP-1	TP-4	TP-11	TP-12	TP-15								
Depth	-	-	-	-	-								
COC No / misc													
Containers	J T	J T	J T	J T	J T								
Sample Date	03/11/09	03/11/09	03/11/09	03/11/09	03/11/09								
Sample Type	Soil	Soil	Soil	Soil	Soil								
Batch Number	1	1	1	1	1						**LOD**	**Units**	**Method No.**
Date of Receipt	05//11/09	05//11/09	05//11/09	05//11/09	05//11/09								
DRO/EPH (C8-40)	~	397	~	~	2192						<30	mg/ kg	TM5/PM8
Mineral Oil (interpretation & calculation)	~	<30	~	~	<30						<30	mg/ kg	TM5/PM8
Benzene #	~	<2	~	~	<2						<2	µg/ kg	TM2/PM7
Toluene #	~	<2	~	~	<2						<2	µg/ kg	TM2/PM7
Ethyl benzene #	~	<2	~	~	<2						<2	µg/ kg	TM2/PM7
m/p-Xylene #	~	<4	~	~	<4						<4	µg/ kg	TM2/PM7
o-Xylene #	~	<2	~	~	<2						<2	µg/ kg	TM2/PM7
Total BTEX #	~	<12	~	~	<12						<12	µg/ kg	TM2/PM7
MTBE #	~	<4	~	~	<4						<4	µg/ kg	TM2/PM7
PCB 28#	~	<5	~	~	<5						<5	µg/ kg	TM17/PM8
PCB 52#	~	<5	~	~	<5						<5	µg/ kg	TM17/PM8
PCB 101#	~	<5	~	~	<5						<5	µg/ kg	TM17/PM8
PCB 118#	~	<5	~	~	<5						<5	µg/ kg	TM17/PM8
PCB 138#	~	<5	~	~	<5						<5	µg/ kg	TM17/PM8
PCB 153#	~	<5	~	~	<5						<5	µg/ kg	TM17/PM8
PCB 180#	~	<5	~	~	<5						<5	µg/ kg	TM17/PM8
Total 7 PCBs#	~	<35	~	~	<35						<35	µg/ kg	TM17/PM8
TOC #	~	2.1	~	~	12.3						<0.2	%	TM021
% Dry Matter	~	79.9	~	~	64.3						<0.1	%	PM4

	sample	**ID**	**Depth**	**EPH/DRO Interpretations**
Interpretation	3-4	TP-4	-	Naturally Occurring Compounds
Interpretation	9-10	TP-15	-	Naturally Occurring Compounds

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Jones Environmental Laboratory

Client Name: O'Callaghan Moran & Associates

Report : **Solids**

Reference: 09-188-01

Location: Tipperary Town Landfill

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

Contact: Barry Sexton

JE Job No.: 09/3607

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-2	3-4	5-6	7-8	9-10								
Sample ID	TP-1	TP-4	TP-11	TP-12	TP-15								
Depth	-	-	-	-	-								
COC No / misc													
Containers	J T	J T	J T	J T	J T								
Sample Date	03/11/09	03/11/09	03/11/09	03/11/09	03/11/09								
Sample Type	Soil	Soil	Soil	Soil	Soil								
Batch Number	1	1	1	1	1						**LOD**	**Units**	**Method No.**
Date of Receipt	05//11/09	05//11/09	05//11/09	05//11/09	05//11/09								
PAH 6 Total													
Fluoranthene #	~	0.59	~	~	1.96						<0.02	mg/kg	TM4/PM8
Benzo(bk)fluoranthene #	~	1.09	~	~	2.21						<0.04	mg/kg	TM4/PM8
Benzo(a)pyrene #	~	0.58	~	~	1.57						<0.02	mg/kg	TM4/PM8
Indeno(123cd)pyrene #	~	0.46	~	~	1.06						<0.02	mg/kg	TM4/PM8
Benzo(ghi)perylene #	~	0.55	~	~	1.09						<0.04	mg/kg	TM4/PM8
PAH 6 Total	~	3.27	~	~	7.89						**<0.07**	**mg/kg**	**TM4/PM8**
PAH 16													
Naphthalene #	~	<0.03	~	~	<0.03						<0.03	mg/kg	TM4/PM8
Acenaphthylene	~	<0.02	~	~	0.09						<0.02	mg/kg	TM4/PM8
Acenaphthene #	~	<0.02	~	~	0.06						<0.02	mg/kg	TM4/PM8
Fluorene #	~	<0.02	~	~	0.09						<0.02	mg/kg	TM4/PM8
Phenanthrene #	~	0.29	~	~	0.76						<0.02	mg/kg	TM4/PM8
Anthracene #	~	0.10	~	~	0.31						<0.02	mg/kg	TM4/PM8
Fluoranthene #	~	0.59	~	~	1.96						<0.02	mg/kg	TM4/PM8
Pyrene #	~	0.49	~	~	1.60						<0.03	mg/kg	TM4/PM8
Benz(a)anthracene #	~	0.40	~	~	1.15						<0.02	mg/kg	TM4/PM8
Chrysene #	~	0.40	~	~	1.18						<0.04	mg/kg	TM4/PM8
Benzo(bk)fluoranthene #	~	1.09	~	~	2.21						<0.04	mg/kg	TM4/PM8
Benzo(a)pyrene #	~	0.58	~	~	1.57						<0.02	mg/kg	TM4/PM8
Indeno(123cd)pyrene #	~	0.46	~	~	1.06						<0.02	mg/kg	TM4/PM8
Dibenzo(ah)anthracene #	~	0.40	~	~	0.61						<0.02	mg/kg	TM4/PM8
Benzo(ghi)perylene #	~	0.55	~	~	1.09						<0.04	mg/kg	TM4/PM8
PAH 16 Total	~	5.35	~	~	13.74						**<0.38**	**mg/kg**	**TM4/PM8**
Coronene	~	0.19	~	~	0.30						<0.02	mg/kg	TM4/PM8
PAH 17 Total	~	5.54	~	~	14.00						**<0.40**	**mg/kg**	**TM4/PM8**

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Client Name: O'Callaghan Moran & Associates

Reference: 09-188-01

Location: Tipperary Town Landfill

Contact: Barry Sexton

JE Job No.: 09/3607

Report : **CEN 10:1 Leachates (expressed as mg/kg)**

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-2	3-4	5-6	7-8	9-10								
Sample ID	TP-1	TP-4	TP-11	TP-12	TP-15								
Depth	-	-	-	-	-								
COC No / misc													
Containers	J T	J T	J T	J T	J T								
Sample Date	03/11/09	03/11/09	03/11/09	03/11/09	03/11/09								
Sample Type	Soil	Soil	Soil	Soil	Soil								
Batch Number	1	1	1	1	1						**LOD**	**Units**	**Method No.**
Date of Receipt	05//11/09	05//11/09	05//11/09	05//11/09	05//11/09								
Arsenic	~	0.08	~	~	0.115						<0.01	mg/kg	TM30
Barium	~	0.48	~	~	1.92						<0.03	mg/kg	TM30
Cadmium	~	<0.01	~	~	<0.01						<0.01	mg/kg	TM30
Chromium	~	<0.02	~	~	<0.02						<0.02	mg/kg	TM30
Copper	~	<0.12	~	~	<0.12						<0.12	mg/kg	TM30
Mercury	~	<0.001	~	~	<0.001						<0.001	mg/kg	TM30
Molybdenum	~	0.13	~	~	0.95						<0.05	mg/kg	TM30
Nickel	~	<0.06	~	~	0.05						<0.06	mg/kg	TM30
Lead	~	<0.1	~	~	<0.1						<0.1	mg/kg	TM30
Antimony	~	0.03	~	~	0.24						<0.03	mg/kg	TM30
Selenium	~	<0.03	~	~	<0.03						<0.03	mg/kg	TM30
Zinc	~	0.05	~	~	0.09						<0.04	mg/kg	TM30
Chloride	~	70	~	~	1847						<1	mg/kg	TM38
Fluoride	~	<1	~	~	<1						<1	mg/kg	TM38
Sulphate (Soluble)	~	503	~	~	934						<1	mg/kg	TM38
Phenol	~	<1	~	~	<1						<1	mg/kg	TM26
DOC	~	120	~	~	190						<20	mg/kg	TM060
TDS	~	2340	~	~	5860						<400	mg/kg	TM20

Client Name: O'Callaghan Moran & Associates **Report :** **Liquids**

Reference: 09-188-01

Location: Tipperary Town Landfill

Contact: Barry Sexton

JE Job No.: 09/3607

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	11-16											
Sample ID	SW1											
Depth	-											
COC No / misc												
Containers	V H P G											
Sample Date	03/11/09											
Sample Type	Water											
Batch Number	1										**LOD**	**Units**	**Method No.**
Date of Receipt	05/11/09												
pH#	7.29										<0.01	pH units	TM19/PM11
Electrical Conductivity# @25°	707										<100	µS/cm	TM28/PM11
Total Oxidised Nitrogen as N#	0.50										<0.05	mg/l	TM038W
Ammonia Total as NH3#	1.32										<0.2	mg/l	TM038W
Total Suspended Solids	6										<10	mg/l	TM037W
Dissolved Oxygen	5										<1	mg/l	TM059
BOD settled	3										<1	mg/l	TM058W
COD	23										<7	mg/l	TM057W
Arsenic - dissolved #	3.7										<2.5	µg/l	TM 030W
Boron - dissolved	34										<12	µg/l	TM 030W
Cadmium - dissolved #	<0.5										<0.5	µg/l	TM 030W
Copper - dissolved #	<7										<7	µg/l	TM 030W
Mercury - dissolved #	<1										<1	µg/l	TM 030W
Nickel - dissolved #	<2										<2	µg/l	TM 030W
Lead - dissolved #	<5										<5	µg/l	TM 030W
Zinc - dissolved #	<3										<3	µg/l	TM 030W
Iron - dissolved #	182										<20	µg/l	TM 030W
Manganese - dissolved #	<2										<2	µg/l	TM 030W
Calcium - dissolved	103.4										<0.03	mg/l	TM 030W
Magnesium - dissolved	9.42										<0.02	mg/l	TM 030W
Sulphate#	26.99										<0.05	mg/l	TM038W
Chloride#	28.16										<0.3	mg/l	TM038W
Fluoride	<0.3										<0.3	mg/l	TM027W
Total Alkalinity as CaCO3#	240										<1	mg/l	TM032W
Total Cyanide*	<40										<40	µg/l	subcontracted
Chromium - total	<1.5										<1.5	µg/l	TM 030W
Phosphorous - dissolved #	70										<5	µg/l	TM 030W
Potassium - dissolved	5.44										<0.04	mg/l	TM 030W
Sodium - dissolved	17.54										<0.15	mg/l	TM 030W

Jones Environmental Laboratory

Client Name: O'Callaghan Moran & Associates
Reference: 09-188-01
Location: Tipperary Town Landfill
Contact: Barry Sexton
JE Job No.: 09/3607

Report : **Liquids**

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H_2SO_4, Z=ZnAc, N=NaOH, HN=$HN0_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	11-16												
Sample ID	SW1												
Depth	-												
COC No / misc													
Containers	V H P G												
Sample Date	03/11/09												
Sample Type	Water												
Batch Number	1										**LOD**	**Units**	**Method No.**
Date of Receipt	05/11/09												
VOCs $^{\#}$	See Tab										<1-27	μg/l	TM15/PM10
SVOCs (dissolved)	See Tab										<10	μg/l	TM16/PM9
Combined OP & OC Pesticides	See Tab										<0.01	μg/l	TM042
PAH 16 (Dissolved) MS													
Naphthalene	<0.1										<0.1	μg/l	TM4/PM9
Acenaphthylene	<0.08										<0.08	μg/l	TM4/PM9
Acenaphthene	<0.1										<0.1	μg/l	TM4/PM9
Fluorene	<0.07										<0.07	μg/l	TM4/PM9
Phenanthrene	<0.07										<0.07	μg/l	TM4/PM9
Anthracene	<0.08										<0.08	μg/l	TM4/PM9
Fluoranthene	<0.09										<0.09	μg/l	TM4/PM9
Pyrene	<0.12										<0.12	μg/l	TM4/PM9
Benz(a)anthracene	<0.09										<0.09	μg/l	TM4/PM9
Chrysene	<0.1										<0.1	μg/l	TM4/PM9
Benzo(bk)fluoranthene	<0.26										<0.26	μg/l	TM4/PM9
Benzo(a)pyrene	<0.12										<0.12	μg/l	TM4/PM9
Indeno(123cd)pyrene	<0.1										<0.1	μg/l	TM4/PM9
Dibenzo(ah)anthracene	<0.1										<0.1	μg/l	TM4/PM9
Benzo(ghi)perylene	<0.12										<0.12	μg/l	TM4/PM9
PAH 16 Total	<1.60										<1.60	μg/l	TM4/PM9
EPH (C8-C40) (dissolved) $^{\# SS}$	<10										<10	μg/ l	TM5/PM9
Mineral Oil (interpretation &	<10										<10	μg/ l	TM5/PM9

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Jones Environmental Laboratory

Client Name: O'Callaghan Moran & Associates **SVOC Report :** **LIQUID**

Reference: 09-188-01

Location: Tipperary Town Landfill

Contact: Barry Sexton

JE Job No.: 09/3607

Please see attached notes for all abbreviations and acronyms

J E Sample No.	11-16										**LOD**	**Units**	**Method No.**
Sample ID	SW1												
Depth	-												
COC No / misc													
Containers	V H P G												
Sample Date	03/11/09												
Sample Type	Water												
Batch Number	1												
Date of Receipt	05/11/09												
Phenols													
2-Chlorophenol	<10										<10	µg/ l	TM16/PM9
2-Methylphenol	<10										<10	µg/ l	TM16/PM9
2-Nitrophenol	<10										<10	µg/ l	TM16/PM9
2,4-Dichlorophenol	<10										<10	µg/ l	TM16/PM9
2,4-Dimethylphenol	<10										<10	µg/ l	TM16/PM9
2,4,5-Trichlorophenol	<10										<10	µg/ l	TM16/PM9
2,4,6-Trichlorophenol	<10										<10	µg/ l	TM16/PM9
4-Chloro-3-methylphenol	<10										<10	µg/ l	TM16/PM9
4-Methylphenol	<10										<10	µg/ l	TM16/PM9
4-Nitrophenol	<10										<10	µg/ l	TM16/PM9
Pentachlorophenol	<10										<10	µg/ l	TM16/PM9
Phenol	<10										<10	µg/ l	TM16/PM9
PAHs													
2-Chloronaphthalene	<10										<10	µg/ l	TM16/PM9
2-Methylnaphthalene	<10										<10	µg/ l	TM16/PM9
Naphthalene											<10	µg/ l	TM16/PM9
Acenaphthylene											<10	µg/ l	TM16/PM9
Acenaphthene											<10	µg/ l	TM16/PM9
Fluorene											<10	µg/ l	TM16/PM9
Phenanthrene											<10	µg/ l	TM16/PM9
Anthracene											<10	µg/ l	TM16/PM9
Fluoranthene	SEE										<10	µg/ l	TM16/PM9
Pyrene	PAH										<10	µg/ l	TM16/PM9
Benz(a)anthracene	RESULTS										<10	µg/ l	TM16/PM9
Chrysene											<10	µg/ l	TM16/PM9
Benzo(bk)fluoranthene											<10	µg/ l	TM16/PM9
Benzo(a)pyrene											<10	µg/ l	TM16/PM9
Indeno(123cd)pyrene											<10	µg/ l	TM16/PM9
Dibenzo(ah)anthracene											<10	µg/ l	TM16/PM9
Benzo(ghi)perylene											<10	µg/ l	TM16/PM9
Phthalates													
Bis(2-ethylhexyl) phthalate	<10										<10	µg/ l	TM16/PM9
Butylbenzyl phthalate	<10										<10	µg/ l	TM16/PM9
Di-n-butyl phthalate	<10										<10	µg/ l	TM16/PM9
Di-n-Octyl phthalate	<10										<10	µg/ l	TM16/PM9
Diethyl phthalate	<10										<10	µg/ l	TM16/PM9
Dimethyl phthalate	<10										<10	µg/ l	TM16/PM9
Other SVOCs													
1,2-Dichlorobenzene	<10										<10	µg/ l	TM16/PM9
1,2,4-Trichlorobenzene	<10										<10	µg/ l	TM16/PM9
1,3-Dichlorobenzene	<10										<10	µg/ l	TM16/PM9
1,4-Dichlorobenzene	<10										<10	µg/ l	TM16/PM9
2-Nitroaniline	<10										<10	µg/ l	TM16/PM9
2,4-Dinitrotoluene	<10										<10	µg/ l	TM16/PM9
2,6-Dinitrotoluene	<10										<10	µg/ l	TM16/PM9
3-Nitroaniline	<10										<10	µg/ l	TM16/PM9
4-Bromophenylphenylether	<10										<10	µg/ l	TM16/PM9
4-Chloroaniline	<10										<10	µg/ l	TM16/PM9
4-Chlorophenylphenylether	<10										<10	µg/ l	TM16/PM9
4-Nitroaniline	<10										<10	µg/ l	TM16/PM9
Azobenzene	<10										<10	µg/ l	TM16/PM9
Bis(2-chloroethoxy)methane	<10										<10	µg/ l	TM16/PM9
Bis(2-chloroethyl)ether	<10										<10	µg/ l	TM16/PM9
Carbazole	<10										<10	µg/ l	TM16/PM9
Dibenzofuran	<10										<10	µg/ l	TM16/PM9
Hexachlorobenzene	<10										<10	µg/ l	TM16/PM9
Hexachlorobutadiene	<10										<10	µg/ l	TM16/PM9
Hexachlorocyclopentadiene	<10										<10	µg/ l	TM16/PM9
Hexachloroethane	<10										<10	µg/ l	TM16/PM9
Isophorone	<10										<10	µg/ l	TM16/PM9
N-nitrosodi-n-propylamine	<10										<10	µg/ l	TM16/PM9
Nitrobenzene	<10										<10	µg/ l	TM16/PM9

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Client Name: O'Callaghan Moran & Associates **VOC Report :** **LIQUID**
Reference: 09-188-01
Location: Tipperary Town Landfill
Contact: Barry Sexton
JE Job No.: 09/3607

Please see attached notes for all abbreviations and acronyms

J E Sample No.	11-16												
Sample ID	SW1												
Depth	-												
COC No / misc													
Containers	V H P G												
Sample Date	03/11/09												
Sample Type	Water												
Batch Number	1										**LOD**	**Units**	**Method No.**
Date of Receipt	05/11/09												
Dichlorodifluoromethane	<2										<2	µg/l	TM15/PM10
Methyl Tertiary Butyl Ether	<2										<2	µg/l	TM15/PM10
Chloromethane #	<3										<3	µg/l	TM15/PM10
Vinyl Chloride	<2										<2	µg/l	TM15/PM10
Bromomethane	<1										<1	µg/l	TM15/PM10
Chloroethane #	<3										<3	µg/l	TM15/PM10
Trichlorofluoromethane #	<3										<3	µg/l	TM15/PM10
1,1-Dichloroethene #	<3										<3	µg/l	TM15/PM10
Carbon Disulphide #	NA										<3	µg/l	TM15/PM10
Dichloromethane #	<3										<3	µg/l	TM15/PM10
trans-1-2-Dichloroethene #	<3										<3	µg/l	TM15/PM10
1,1-Dichloroethane #	<3										<3	µg/l	TM15/PM10
cis-1-2-Dichloroethene #	<3										<3	µg/l	TM15/PM10
2,2-Dichloropropane	<1										<1	µg/l	TM15/PM10
Bromochloromethane #	<2										<2	µg/l	TM15/PM10
Chloroform #	<3										<3	µg/l	TM15/PM10
1,1,1-Trichloroethane #	<3										<3	µg/l	TM15/PM10
1,1-Dichloropropene #	<3										<3	µg/l	TM15/PM10
Carbon tetrachloride #	<2										<2	µg/l	TM15/PM10
1,2-Dichloroethane #	<2										<2	µg/l	TM15/PM10
Benzene #	<3										<3	µg/l	TM15/PM10
Trichloroethene	<3										<3	µg/l	TM15/PM10
1,2-Dichloropropane #	<2										<2	µg/l	TM15/PM10
Dibromomethane #	<3										<3	µg/l	TM15/PM10
Bromodichloromethane #	<3										<3	µg/l	TM15/PM10
cis-1-3-Dichloropropene #	<2										<2	µg/l	TM15/PM10
Toluene #	<3										<3	µg/l	TM15/PM10
trans-1-3-Dichloropropene #	<2										<2	µg/l	TM15/PM10
1,1,2-Trichloroethane #	<2										<2	µg/l	TM15/PM10
Tetrachloroethene #	<3										<3	µg/l	TM15/PM10
1,3-Dichloropropane #	<2										<2	µg/l	TM15/PM10
Dibromochloromethane #	<2										<2	µg/l	TM15/PM10
1,2-Dibromoethane #	<2										<2	µg/l	TM15/PM10
Chlorobenzene #	<2										<2	µg/l	TM15/PM10
1,1,1,2-Tetrachloroethane #	<2										<2	µg/l	TM15/PM10
Ethylbenzene #	<3										<3	µg/l	TM15/PM10
p/m-Xylene #	<5										<5	µg/l	TM15/PM10
o-Xylene #	<3										<3	µg/l	TM15/PM10
Styrene #	<2										<2	µg/l	TM15/PM10
Bromoform #	<2										<2	µg/l	TM15/PM10
Isopropylbenzene #	<3										<3	µg/l	TM15/PM10
1,1,2,2-Tetrachloroethane	<4										<4	µg/l	TM15/PM10
Bromobenzene #	<2										<2	µg/l	TM15/PM10
1,2,3-Trichloropropane #	<3										<3	µg/l	TM15/PM10
Propylbenzene #	<3										<3	µg/l	TM15/PM10
2-Chlorotoluene #	<3										<3	µg/l	TM15/PM10
1,3,5-Trimethylbenzene #	<3										<3	µg/l	TM15/PM10
4-Chlorotoluene #	<3										<3	µg/l	TM15/PM10
tert-Butylbenzene #	<3										<3	µg/l	TM15/PM10
1,2,4-Trimethylbenzene #	<3										<3	µg/l	TM15/PM10
sec-Butylbenzene #	<3										<3	µg/l	TM15/PM10
4-Isopropyltoluene #	<3										<3	µg/l	TM15/PM10
1,3-Dichlorobenzene #	<3										<3	µg/l	TM15/PM10
1,4-Dichlorobenzene #	<3										<3	µg/l	TM15/PM10
n-Butylbenzene #	<3										<3	µg/l	TM15/PM10
1,2-Dichlorobenzene #	<3										<3	µg/l	TM15/PM10
1,2-Dibromo-3-chloropropane	<2										<2	µg/l	TM15/PM10
1,2,4-Trichlorobenzene	<3										<3	µg/l	TM15/PM10
Hexachlorobutadiene #	<3										<3	µg/l	TM15/PM10
Naphthalene	<2										<2	µg/l	TM15/PM10
1,2,3-Trichlorobenzene	<3										<3	µg/l	TM15/PM10

Jones Environmental Laboratory

Client Name: O'Callaghan Moran & Associates
Reference: 09-188-01
Location: Tipperary Town Landfill
Contact: Barry Sexton
JE Job No.: 09/3607

J E Sample No.	11-16											
Sample ID	SW1											
Depth	-											
Containers	V H P G											
Sample Date	03/11/09											
Sample Type	Water											
Batch Number	1									**LOD**	**Units**	**Method Number**
Date of Receipt	05/11/09											
Combined Pesticide Suite												
Dichlorvos	<0.01									<0.01	µg/l	TM042
Mevinphos	<0.01									<0.01	µg/l	TM042
Alpha-BHC	<0.01									<0.01	µg/l	TM042
Beta-BHC	<0.01									<0.01	µg/l	TM042
Gamma-BHC	<0.01									<0.01	µg/l	TM042
Diazinon	<0.01									<0.01	µg/l	TM042
Methyl Parathion	<0.01									<0.01	µg/l	TM042
Ethyl Parathion (Parathion)	<0.01									<0.01	µg/l	TM042
Heptachlor	<0.01									<0.01	µg/l	TM042
Fenitrothion	<0.01									<0.01	µg/l	TM042
Aldrin	<0.01									<0.01	µg/l	TM042
Malathion	<0.01									<0.01	µg/l	TM042
Heptachlor Epoxide	<0.01									<0.01	µg/l	TM042
Endosulfan I	<0.01									<0.01	µg/l	TM042
Dieldrin	<0.01									<0.01	µg/l	TM042
4, 4'-DDE	<0.01									<0.01	µg/l	TM042
Endosulfan II	<0.01									<0.01	µg/l	TM042
4,4'-DDD	<0.01									<0.01	µg/l	TM042
Ethion	<0.01									<0.01	µg/l	TM042
Endrin	<0.01									<0.01	µg/l	TM042
Endosulfan Sulphate	<0.01									<0.01	µg/l	TM042
4,4'-DDT	<0.01									<0.01	µg/l	TM042
Methoxychlor	<0.01									<0.01	µg/l	TM042
Azinphos Methyl	<0.01									<0.01	µg/l	TM042
Disulfoton	<0.01									<0.01	µg/l	TM042

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

SOILS

Please note we are only MCERTS accredited for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. Your final report will reflect this, with non-MCERTS results on separate pages.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. If we are instructed to keep samples, a storage charge of £1 (1.5 Euros) per sample per month will be applied until we are asked to dispose of them.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Asbestos screens where requested will be undertaken by a UKAS accredited laboratory.

WATERS

Please note we are not a Drinking Water Inspectorate (DWI) Approved Laboratory . It is important that detection limits are carefully considered when requesting water analysis.

UKAS accreditation applies to tap water, surface water and groundwater only, any other liquids are outside our scope of accreditation

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples. All samples are treated as groundwaters and anlalysis performed on settled samples unless we are instructed otherwise.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any analysis that may be compromised highlighted on your schedule/ report by the use of a symbol.

The use of any of the following symbols indicates that the sample was deviating and the test result may be unreliable:

$ sample temperature on receipt considered inappropriate for analysis requested

^ samples exceeding recomended holding times

& samples received in inappropriate containers (e.g. volatile samples not submitted in VOC jars/vials)

~ no sampling date given, unable to confirm if samples are with acceptable holding times

ABBREVIATIONS and ACRONYMS USED

- UKAS accredited

M - MCERTS accredited

NAD - No Asbestos Detected

ND - None Detected (usually refers to VOC and/SVOC TICs)

SS - Calibrated against a single substance

* - analysis subcontracted to a Jones Environmental approved laboratory.

W - Results expressed on as received basis

\+ Failed AQC results should be considered as indicative only and are not accredited.

++ Result outside calibration range, may be possible to re-run with higher detection limits

T.P Town
Soil & Sed

CHAIN OF CUSTODY

Jones Environmental Laboratory.

CLIENT: O'Callaghan Moran & Associates,
ADDRESS: Granary House, Rutland Street, Cork.
PROJECT MANAGER (PM): Barry Sexton
MOBILE: 00353 - 876119640
PROJECT ID: 09 - 188 - 01
SITE: Tipperary Town Landfill

SAMPLER: B. Sexton
MOBILE:
EMAIL REPORT TO: B. Sexton
cc REPORT TO:
INVOICE TO: (if different to report) OCM
QUOTE NUMBER:
P.O No:

Chain of Custody sheet page 1 of 1

TURNAROUND - please tick
10 DAY ☐ 4 DAY ☐ Other ☐
5 DAY ☐ 3 DAY ☐

FOR LABORATORY USE ONLY
AVERAGE COOL BOX TEMP.(if required):
SAMPLE RECIEPT CONDITION:

SAMPLE INFORMATION (note: S = Soil, W=Water, P=Product/oil)

ANALYSIS REQUIRED including SUITE names

Lab ID	Sample ID	Matrix	Date	Time	Depth in Metres	Preservation	Murphy's Silts	DO, pH, EC	Total Sus. Solids	Ammonia	TON	BOD, COD	Metals	Total Alkalinity	Sulphate	Chloride	Total Cyanide	Fluoride	Pesticides	VOC's, SVOC	PAH	Na, K, P	Total Chromium		
	TP-1	S																							
	TP-4	S					✓																		
	TP-11	S																							
	TP-12	S																							
	TP-15	S					✓																		
	SW-1	W						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

COMMENTS

Notes: e.g. Heavily contaminated samples
e.g. "High PAHs expected".

NOTE: If an MCERTS report is required this must be requested when samples are scheduled.

Metals:
Ca, Mg, Fe, Mn, Cd
Cu, Ni, Pb, Zn, As, B
Hg

RELINQUISHED BY:
Name: Barry Sexton
Of:
Date:
Time:

RECEIVED BY:
Name:
Of:
Date:
Time:

METHOD of SHIPMENT
Consignment note No:
Courier Company:

Health & Safety instructions including known hazards (eg suspected asbestos)

Jones Environmental Laboratory
Unit 3 Deeside Point, Zone 3 Deeside Industrial Park, Deeside, Flintshire CH5 2UA Tel: 01244 833 780

JEL 6863

QF-PM1.1 v2

Jones Environmental Laboratory

Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

Tel: +44 (0) 1244 833780
Fax: +44 (0) 1244 833781

O'Callaghan Moran & Associates
Granary House
Rutland Street
Cork

UKAS TESTING
No.4225

Attention : Barry Sexton

Date : 8th December 2009

Your reference : 09-188-01

Our reference : Test Report 09/3874

Location : Tipperary Town Landfill

Date samples received : 25/11/09

Status : Final Report

Issue : 1

Eight samples were received for analysis on 25th November 2009 which was completed on 8th December 2009. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced.
All interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

J W Farrell- Jones CChem FRSC
Chartered Chemist

Jones Environmental Laboratory

Client Name: O'Callaghan Moran & Associates **Report :** **Liquids**

Reference: 09-188-01

Location: Tipperary Town Landfill

Contact: Barry Sexton **Liquids/products:** V=40ml vial, G=glass bottle, P=plastic bottle

JE Job No.: 09/3874 H=H_2SO_4, Z=ZnAc, N=NaOH, HN=HN0$_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-6	7-12	13-18	19-24	25-30	31-36	37-42	43-48					
Sample ID	MW1	MW2	MW3	MW4	MW5	MW6	MW7	MW8					
Depth	-	-	-	-	-	-	-	-					
COC No / misc													
Containers	V H P G	V H P G	V H P G	V H P G	V H P G	V H P G	V H P G	V H P G					
Sample Date	23/11/09	23/11/09	23/11/09	23/11/09	23/11/09	23/11/09	23/11/09	23/11/09					
Sample Type	Water	Water	Water	Water	Water	Water	Water	Water					
Batch Number	1	1	1	1	1	1	1	1			**LOD**	**Units**	**Method No.**
Date of Receipt	25/11/09	25/11/09	25/11/09	25/11/09	25/11/09	25/11/09	25/11/09	25/11/09					
pH$^{\#}$	8.01	8.50	7.88	78.20	~	8.02	~	8.30			<0.01	pH units	TM19/PM11
Electrical Conductivity$^{\#}$ @25°C	3710	4370	6370	1232	~	1389	~	1490			<100	µS/cm	TM28/PM11
Total Oxidised Nitrogen as N$^{\#}$	<0.05	<0.05	<0.05	1.22	~	42.27	~	<0.05			<0.05	mg/l	TM038W
Ammonia Total as NH3$^{\#}$	70.5	43.5	18.1	0.7	~	0.8	~	0.2			<0.2	mg/l	TM038W
Total Dissolved Solids	~	~	~	472	~	947	~	919			<35	mg/l	TM020W
TOC	~	~	~	5	~	10	~	6			<2	mg/l	TM060W
BOD settled	20	26	9	~	~	~	~	~			<1	mg/l	TM058W
COD	114	183	52	~	~	~	~	~			<7	mg/l	TM057W
Arsenic - dissolved $^{\#}$	19.2	17.1	10.3	6	~	6.6	~	6.6			<2.5	µg/l	TM 030W
Boron - dissolved	945	1917	733	25	~	258	~	20			<12	µg/l	TM 030W
Cadmium - dissolved $^{\#}$	<0.5	<0.5	<0.5	<0.5	~	<0.5	~	<0.5			<0.5	µg/l	TM 030W
Copper - dissolved $^{\#}$	<7	<7	<7	<7	~	<7	~	12			<7	µg/l	TM 030W
Mercury - dissolved $^{\#}$	<1	<1	<1	<1	~	<1	~	<1			<1	µg/l	TM 030W
Nickel - dissolved $^{\#}$	4	15	<2	<2	~	2	~	4			<2	µg/l	TM 030W
Lead - dissolved $^{\#}$	16	5	11	5	~	7	~	8			<5	µg/l	TM 030W
Zinc - dissolved $^{\#}$	4	11	4	<3	~	<3	~	10			<3	µg/l	TM 030W
Iron - dissolved $^{\#}$	81	52	<20	<20	~	<20	~	<20			<20	µg/l	TM 030W
Manganese - dissolved $^{\#}$	903	385	706	116	~	342	~	538			<2	µg/l	TM 030W
Calcium - dissolved	122.30	47.91	166.40	119.10	~	144.4	~	147.7			<0.03	mg/l	TM 030W
Magnesium - dissolved	42.28	28.96	58.08	9.30	~	14.82	~	19.03			<0.02	mg/l	TM 030W
Sulphate$^{\#}$	6.79	100.53	3.15	14.78	~	104.22	~	11.22			<0.05	mg/l	TM038W
Chloride$^{\#}$	235.2	948.6	1703.7	57.9	~	135.9	~	276.2			<0.3	mg/l	TM038W
Fluoride	<0.3	0.3	0.5	<0.3	~	<0.3	~	<0.3			<0.3	mg/l	TM027W
Total Alkalinity as CaCO3$^{\#}$	~	~	~	308	~	388	~	368			<1	mg/l	TM032W
Total Cyanide*	<40	<40	<40	<40	~	<40	~	<40			<40	µg/l	subcontracted
Chromium - total	19.1	2.5	16.6	<1.5	~	<1.5	~	<1.5			<1.5	µg/l	TM 030W
Phosphorous - dissolved $^{\#}$	56	336	21	10	~	12	~	11			<5	µg/l	TM 030W
Potassium - dissolved	74.02	127.00	65.60	1.58	~	5.64	~	1.21			<0.04	mg/l	TM 030W
Sodium - dissolved	100.30	352.50	586.30	40.11	~	101.30	~	81.15			<0.15	mg/l	TM 030W
EPH (C8-C40) (dissolved) $^{\#\,SS}$	352	92	<10	<10	~	<10	~	<10			<10	µg/ l	TM5/PM9
Mineral Oil (interpretation & calculation)	<10	<10	<10	<10	~	<10	~	<10			<10	µg/ l	TM5/PM9

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Client Name: O'Callaghan Moran & Associates

Reference: 09-188-01

Location: Tipperary Town Landfill

Contact: Barry Sexton

JE Job No.: 09/3874

Report : **Liquids**

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H_2SO_4, Z=ZnAc, N=NaOH, HN=$HN0_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-6	7-12	13-18	19-24	25-30	31-36	37-42	43-48					
Sample ID	MW1	MW2	MW3	MW4	MW5	MW6	MW7	MW8					
Depth	-	-	-	-	-	-	-	-					
COC No / misc													
Containers	V H P G	V H P G	V H P G	V H P G	V H P G	V H P G	V H P G	V H P G					
Sample Date	23/11/09	23/11/09	23/11/09	23/11/09	23/11/09	23/11/09	23/11/09	23/11/09					
Sample Type	Water	Water	Water	Water	Water	Water	Water	Water					
Batch Number	1	1	1	1	1	1	1	1			**LOD**	**Units**	**Method No.**
Date of Receipt	25/11/09	25/11/09	25/11/09	25/11/09	25/11/09	25/11/09	25/11/09	25/11/09					
VOCs $^{\#}$	See tab	See tab	See tab	See tab	~	See tab	~	See tab			<1-27	µg/l	TM15/PM10
SVOCs (dissolved)	See tab	See tab	See tab	See tab	~	See tab	~	See tab			<10	µg/l	TM16/PM9
Combined OP & OC Pesticides	See tab	See tab	See tab	See tab	~	See tab	~	See tab			<0.01	µg/l	TM042
PAH 16 (Dissolved) MS													
Naphthalene	42.5	<0.1	<0.1	<0.1	~	<0.1	~	<0.1			<0.1	µg/l	TM4/PM9
Acenaphthylene	<0.08	<0.08	<0.08	<0.08	~	<0.08	~	<0.08			<0.08	µg/l	TM4/PM9
Acenaphthene	1.4	<0.1	<0.1	<0.1	~	<0.1	~	<0.1			<0.1	µg/l	TM4/PM9
Fluorene	0.90	<0.07	<0.07	<0.07	~	<0.07	~	<0.07			<0.07	µg/l	TM4/PM9
Phenanthrene	0.80	<0.07	<0.07	<0.07	~	<0.07	~	<0.07			<0.07	µg/l	TM4/PM9
Anthracene	<0.08	<0.08	<0.08	<0.08	~	<0.08	~	<0.08			<0.08	µg/l	TM4/PM9
Fluoranthene	<0.09	<0.09	<0.09	<0.09	~	<0.09	~	<0.09			<0.09	µg/l	TM4/PM9
Pyrene	<0.12	<0.12	<0.12	<0.12	~	<0.12	~	<0.12			<0.12	µg/l	TM4/PM9
Benz(a)anthracene	<0.09	<0.09	<0.09	<0.09	~	<0.09	~	<0.09			<0.09	µg/l	TM4/PM9
Chrysene	<0.1	<0.1	<0.1	<0.1	~	<0.1	~	<0.1			<0.1	µg/l	TM4/PM9
Benzo(bk)fluoranthene	<0.26	<0.26	<0.26	<0.26	~	<0.26	~	<0.26			<0.26	µg/l	TM4/PM9
Benzo(a)pyrene	<0.12	<0.12	<0.12	<0.12	~	<0.12	~	<0.12			<0.12	µg/l	TM4/PM9
Indeno(123cd)pyrene	<0.1	<0.1	<0.1	<0.1	~	<0.1	~	<0.1			<0.1	µg/l	TM4/PM9
Dibenzo(ah)anthracene	<0.1	<0.1	<0.1	<0.1	~	<0.1	~	<0.1			<0.1	µg/l	TM4/PM9
Benzo(ghi)perylene	<0.12	<0.12	<0.12	<0.12	~	<0.12	~	<0.12			<0.12	µg/l	TM4/PM9
PAH 16 Total	45.60	<1.60	<1.60	<1.60	~	<1.60	~	<1.60			<1.60	µg/l	TM4/PM9

Jones Environmental Laboratory

Client Name: O'Callaghan Moran & Associates

VOC Report : **Liquids**

Reference: 09-188-01

Location: Tipperary Town Landfill

Contact: Barry Sexton

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle

JE Job No.: 09/3874

$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-6	7-12	13-18	19-24	31-36	43-48							
Sample ID	MW1	MW2	MW3	MW4	MW6	MW8							
Depth	-	-	-	-	-	-							
COC No / misc													
Containers	V H P G	V H P G	V H P G	V H P G	V H P G	V H P G							
Sample Date	23/11/09	23/11/09	23/11/09	23/11/09	23/11/09	23/11/09							
Sample Type	Water	Water	Water	Water	Water	Water							
Batch Number	1	1	1	1	1	1							
Date of Receipt	25/11/09	25/11/09	25/11/09	25/11/09	25/11/09	25/11/09					**LOD**	**Units**	**Method No.**
Dichlorodifluoromethane	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
Methyl Tertiary Butyl Ether	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
Chloromethane #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
Vinyl Chloride	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
Bromomethane	<1	<1	<1	<1	<1	<1					<1	µg/l	TM15/PM10
Chloroethane #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
Trichlorofluoromethane #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
1,1-Dichloroethene #	<6	<6	<6	<6	<6	<6					<6	µg/l	TM15/PM10
Carbon Disulphide #	NA	NA	NA	NA	NA	NA					<3	µg/l	TM15/PM10
Dichloromethane #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
trans-1-2-Dichloroethene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
1,1-Dichloroethane #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
cis-1-2-Dichloroethene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
2,2-Dichloropropane	<1	<1	<1	<1	<1	<1					<1	µg/l	TM15/PM10
Bromochloromethane #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
Chloroform #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
1,1,1-Trichloroethane #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
1,1-Dichloropropene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
Carbon tetrachloride #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
1,2-Dichloroethane #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
Benzene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
Trichloroethene	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
1,2-Dichloropropane #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
Dibromomethane #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
Bromodichloromethane #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
cis-1-3-Dichloropropene #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
Toluene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
trans-1-3-Dichloropropene #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
1,1,2-Trichloroethane #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
Tetrachloroethene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
1,3-Dichloropropane #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
Dibromochloromethane #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
1,2-Dibromoethane #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
Chlorobenzene #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
1,1,1,2-Tetrachloroethane #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
Ethylbenzene #	4	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
p/m-Xylene #	9	<5	<5	<5	<5	<5					<5	µg/l	TM15/PM10
o-Xylene #	5	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
Styrene #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
Bromoform #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
Isopropylbenzene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
1,1,2,2-Tetrachloroethane	<4	<4	<4	<4	<4	<4					<4	µg/l	TM15/PM10
Bromobenzene #	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
1,2,3-Trichloropropane #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
Propylbenzene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
2-Chlorotoluene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
1,3,5-Trimethylbenzene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
4-Chlorotoluene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
tert-Butylbenzene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
1,2,4-Trimethylbenzene #	8	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
sec-Butylbenzene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
4-Isopropyltoluene #	10	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
1,3-Dichlorobenzene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
1,4-Dichlorobenzene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
n-Butylbenzene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
1,2-Dichlorobenzene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
1,2-Dibromo-3-chloropropane	<2	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
1,2,4-Trichlorobenzene	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
Hexachlorobutadiene #	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10
Naphthalene	68	<2	<2	<2	<2	<2					<2	µg/l	TM15/PM10
1,2,3-Trichlorobenzene	<3	<3	<3	<3	<3	<3					<3	µg/l	TM15/PM10

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Jones Environmental Laboratory

Client Name: O'Callaghan Moran & Associates **SVOC Report :** **Liquids**
Reference: 09-188-01
Location: Tipperary Town Landfill
Contact: Barry Sexton
JE Job No.: 09/3874

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H_2SO_4, Z=ZnAc, N=NaOH, HN=$HN0_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-6	7-12	13-18	19-24	31-36	43-48					LOD	Units	Method No.
Sample ID	MW1	MW2	MW3	MW4	MW6	MW8							
Depth	-	-	-	-	-	-							
COC No / misc													
Containers	V H P G	V H P G	V H P G	V H P G	V H P G	V H P G							
Sample Date	23/11/09	23/11/09	23/11/09	23/11/09	23/11/09	23/11/09							
Sample Type	Water	Water	Water	Water	Water	Water							
Batch Number	1	1	1	1	1	1							
Date of Receipt	25/11/09	25/11/09	25/11/09	25/11/09	25/11/09	25/11/09							
Phenols													
2-Chlorophenol	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
2-Methylphenol	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
2-Nitrophenol	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
2,4-Dichlorophenol	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
2,4-Dimethylphenol	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
2,4,5-Trichlorophenol	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
2,4,6-Trichlorophenol	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
4-Chloro-3-methylphenol	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
4-Methylphenol	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
4-Nitrophenol	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Pentachlorophenol	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Phenol	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
PAHs													
2-Chloronaphthalene	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
2-Methylnaphthalene	19	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Naphthalene	SEE PAH RESULTS										<10	µg/ l	TM16/PM9
Acenaphthylene											<10	µg/ l	TM16/PM9
Acenaphthene											<10	µg/ l	TM16/PM9
Fluorene											<10	µg/ l	TM16/PM9
Phenanthrene											<10	µg/ l	TM16/PM9
Anthracene											<10	µg/ l	TM16/PM9
Fluoranthene											<10	µg/ l	TM16/PM9
Pyrene											<10	µg/ l	TM16/PM9
Benz(a)anthracene											<10	µg/ l	TM16/PM9
Chrysene											<10	µg/ l	TM16/PM9
Benzo(bk)fluoranthene											<10	µg/ l	TM16/PM9
Benzo(a)pyrene											<10	µg/ l	TM16/PM9
Indeno(123cd)pyrene											<10	µg/ l	TM16/PM9
Dibenzo(ah)anthracene											<10	µg/ l	TM16/PM9
Benzo(ghi)perylene											<10	µg/ l	TM16/PM9
Phthalates													
Bis(2-ethylhexyl) phthalate	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Butylbenzyl phthalate	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Di-n-butyl phthalate	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Di-n-Octyl phthalate	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Diethyl phthalate	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Dimethyl phthalate	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Other SVOCs													
1,2-Dichlorobenzene	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
1,2,4-Trichlorobenzene	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
1,3-Dichlorobenzene	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
1,4-Dichlorobenzene	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
2-Nitroaniline	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
2,4-Dinitrotoluene	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
2,6-Dinitrotoluene	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
3-Nitroaniline	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
4-Bromophenylphenylether	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
4-Chloroaniline	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
4-Chlorophenylphenylether	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
4-Nitroaniline	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Azobenzene	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Bis(2-chloroethoxy)methane	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Bis(2-chloroethyl)ether	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Carbazole	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Dibenzofuran	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Hexachlorobenzene	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Hexachlorobutadiene	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Hexachlorocyclopentadiene	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Hexachloroethane	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Isophorone	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
N-nitrosodi-n-propylamine	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9
Nitrobenzene	<10	<10	<10	<10	<10	<10					<10	µg/ l	TM16/PM9

Client Name: O'Callaghan Moran & Associates

Reference: 09-188-01

Location: Tipperary Town Landfill

Contact: Barry Sexton

JE Job No.: 09/3874

Report - Pesticides - waters

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle

$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-6	7-12	13-18	19-24	31-36	43-48							
Sample ID	MW1	MW2	MW3	MW4	MW6	MW8							
Depth	-	-	-	-	-	-							
COC No / misc													
Containers	V H P G	V H P G	V H P G	V H P G	V H P G	V H P G							
Sample Date	23/11/09	23/11/09	23/11/09	23/11/09	23/11/09	23/11/09							
Sample Type	Water	Water	Water	Water	Water	Water							
Batch Number	1	1	1	1	1	1					**LOD**	**Units**	**Method No.**
Date of Receipt	25/11/09	25/11/09	25/11/09	25/11/09	25/11/09	25/11/09							
Combined Pesticide Suite													
Dichlorvos	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Mevinphos	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Alpha-BHC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Beta-BHC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Gamma-BHC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Diazinon	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Methyl Parathion	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Ethyl Parathion (Parathion)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Heptachlor	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Fenitrothion	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Aldrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Malathion	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Heptachlor Epoxide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Endosulfan I	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Dieldrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
4, 4'-DDE	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Endosulfan II	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
4,4'-DDD	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Ethion	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Endrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Endosulfan Sulphate	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
4,4'-DDT	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Methoxychlor	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Azinphos Methyl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042
Disulfoton	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					<0.01	μg/l	TM042

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

SOILS

Please note we are only MCERTS accredited for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. Your final report will reflect this, with non-MCERTS results on separate pages.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. If we are instructed to keep samples, a storage charge of £1 (1.5 Euros) per sample per month will be applied until we are asked to dispose of them.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Asbestos screens where requested will be undertaken by a UKAS accredited laboratory.

WATERS

Please note we are not a Drinking Water Inspectorate (DWI) Approved Laboratory . It is important that detection limits are carefully considered when requesting water analysis.

UKAS accreditation applies to tap water, surface water and groundwater only, any other liquids are outside our scope of accreditation

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples. All samples are treated as groundwaters and anlalysis performed on settled samples unless we are instructed otherwise.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any analysis that may be compromised highlighted on your schedule/ report by the use of a symbol.

The use of any of the following symbols indicates that the sample was deviating and the test result may be unreliable:

$ sample temperature on receipt considered inappropriate for analysis requested

^ samples exceeding recomended holding times

& samples received in inappropriate containers (e.g. volatile samples not submitted in VOC jars/vials)

~ no sampling date given, unable to confirm if samples are with acceptable holding times

ABBREVIATIONS and ACRONYMS USED

- UKAS accredited
M - MCERTS accredited
NAD - No Asbestos Detected
ND - None Detected (usually refers to VOC and/SVOC TICs)
SS - Calibrated against a single substance
* - analysis subcontracted to a Jones Environmental approved laboratory.
W - Results expressed on as received basis
+ Failed AQC results should be considered as indicative only and are not accredited.
++ Result outside calibration range, may be possible to re-run with higher detection limits

Tip GW+LE

CHAIN OF COUSTODY

CLIENT: O'Callaghan Moran & Associates
ADDRESS: Granary House, Rutland Street, Cork
PROJECT MANAGER (PM): Barry Sexton
MOBILE: 00353-876119640
PROJECT ID: 09-188-01
SITE: Tipperary Town Landfill

SAMPLER: B. Sexton
MOBILE:
EMAIL REPORT TO: B. Sexton
cc REPORT TO:
INVOICE TO: (if different to report) OCM
QUOTE NUMBER:
P.O No:

Jones Environmental Laboratory.

Chain of Custody sheet page ..1.. of ..1..

TURNAROUND - please tick

10 DAY	✓	4 DAY	☐	Other	☐
5 DAY	☐	3 DAY	☐		

FOR LABORATORY USE ONLY
AVERAGE COOL BOX TEMP.(if required):
SAMPLE RECIEPT CONDITION:

SAMPLE INFORMATION (note: S = Soil, W=Water, P=Product/oil)

ANALYSIS REQUIRED including SUITE names

Lab ID	Sample ID	Matrix	Date	Time	Depth in Metres	Preservation	pH, EC	Ammonia	TON	Metals	Sulphate	Chloride	Total Cyanide	Fluoride	VOC, SVOC, PAH	Pesticides	Na, K, P	Total Cr	TDS, TOC	Total Alkalinity	BOD, COD	DRO	Mineral Oil			COMMENTS
																										Notes: e.g. Heavily contaminated samples e.g. "High PAHs expected". *NOTE: If an MCERTS report is required this must be requested when samples are scheduled.*
	HW-1	W	24/1/9				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			
	HW-2	W	"				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			Metals to include
	HW-3	W	"				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			
	HW-4	W	"				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			Co, Mg, Fe, Mn, Cd, Cu,
	HW-5	W	"																							
	HW-6	W	"				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			Ni, Pb, Zn, As, B
	HW-7	W	"																							
	HW-8	W	"				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			Hg

RELINQUISHED BY:
Name:
Of:
Date:
Time:

RECEIVED BY:
Name:
Of:
Date:
Time:

METHOD of SHIPMENT
Consignment note No:
Courier Company:

Health & Safety instructions including known hazards (eg suspected asbestos)

JEL 6851

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Co.Cork

Certificate No.:		352046
Job Ref:		09K05195
Sample Ref No.:	*LSN*	38/66411
Page No.:		1 of 5
Date Received:		23/11/2009
Date Reported:		24/11/2009

TEST REPORT

Sample Description Water - MW-4 - 23/11/09 - 11:20

Date Testing Initiated:	23/11/2009
Category:	MICRO
Sample Condition:	Satisfactory
Order No.:	NA
Supplier Code:	

Test	Result	Unit	Method	Comments	Est.
Total Coliform Count-Colilert	**1,986**	**MPN/100mls**	**MTC121**		
E.COLI Count - Colilert	**10**	**MPN/100mls**	**MTC121**		

All tests are carried out according to our INAB schedule of accreditation.

Comments, opinions and interpretations expressed herein are outside this current scope of INAB accreditation.
Results apply only to samples tested, and as received at the Laboratory.

Signed for and on behalf of Exova (Ireland) Ltd.

Michelle Everard

Michelle Everard
B.Sc (Biosciences)
Snr.Tech Microbiology Division

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.183T

183T

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Certificate No.: 352046
Job Ref: 09K05195
Sample Ref No.: *LSN* 38/66412
Page No.: 2 of 5
Date Received: 23/11/2009
Date Reported: 24/11/2009

TEST REPORT

Sample Description Water - MW-5 - 23/11/09 - 11:35

Date Testing Initiated: 23/11/2009
Category: MICRO
Sample Condition: Satisfactory
Order No.: NA
Supplier Code:

Test	Result	Unit	Method	Comments	Est.
Total Coliform Count-Colilert	**205**	**MPN/100mls**	**MTC121**		
E.COLI Count - Colilert	**21**	**MPN/100mls**	**MTC121**		

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Michelle Everard

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Certificate No.:	352046
Job Ref:	09K05195
Sample Ref No.: *LSN*	38/66413
Page No.:	3 of 5
Date Received:	23/11/2009
Date Reported:	24/11/2009

TEST REPORT

Sample Description	Water - MW-6 - 23/11/09 - 11:45

Date Testing Initiated:	23/11/2009
Category:	MICRO
Sample Condition:	Satisfactory
Order No.:	NA
Supplier Code:	

Test	Result	Unit	Method	Comments	Est.
Total Coliform Count-Colilert	**2,420**	**MPN/100mls**	**MTC121**		
E.COLI Count - Colilert	**10**	**MPN/100mls**	**MTC121**		

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Certificate No.: 352046
Job Ref: 09K05195
Sample Ref No.: *LSN* 38/66414
Page No.: 4 of 5
Date Received: 23/11/2009
Date Reported: 24/11/2009

TEST REPORT

Sample Description Water - MW-7 - 23/11/09 - 12:15

Date Testing Initiated: 23/11/2009
Category: MICRO
Sample Condition: Satisfactory
Order No.: NA
Supplier Code:

Test	Result	Unit	Method	Comments	Est.
Total Coliform Count-Colilert	**248**	**MPN/100mls**	**MTC121**		
E.COLI Count - Colilert	**26**	**MPN/100mls**	**MTC121**		

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Signed for and on behalf of Exova (Ireland) Ltd.

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Certificate No.:		352046
Job Ref:		09K05195
Sample Ref No.:	*LSN*	38/66415
Page No.:		5 of 5
Date Received:		23/11/2009
Date Reported:		24/11/2009

TEST REPORT

Sample Description Water - MW-8 - 23/11/09 - 11:55

Date Testing Initiated: 23/11/2009
Category: MICRO
Sample Condition: Satisfactory
Order No.: NA
Supplier Code:

Test	Result	Unit	Method	Comments	Est.
Total Coliform Count-Colilert	**1,986**	**MPN/100mls**	**MTC121**		
E.COLI Count - Colilert	**50**	**MPN/100mls**	**MTC121**		

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Signed for and on behalf of Exova (Ireland) Ltd.

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TESTING
DETAILED IN SCOPE REG NO.183T

183T

environmental management for business

O' Callaghan Moran & Associates

Tier 3 Environmental Risk Assessment

Former Landfill at Tipperary Town

Prepared For:

South Tipperary County Council

Prepared By: -

O' Callaghan Moran & Associates,
Granary House,
Rutland Street,
Cork.

October 2011

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Appendix 1	**-**	Laboratory Results
Appendix 2	**-**	Ecological Report
Appendix 3	**-**	Remedial Action Plan

1. INTRODUCTION

1.1 Site Description

The site is located in the Townland of Carrownreddy and is within the northern outskirts of Tipperary Town. The waste deposition area was originally a lake that was drained in circa 1940 to allow wastes to be disposed. The site served as the landfill for Tipperary Town from ca1940, until it closed in 1990. It is accessed off the Lake Road and is currently used by Tipperary Town Council as a Depot for road maintenance materials and machinery.

The site occupies 1.8 hectares and contains within it a fenced off area of 0.2 hectares, which was apparently used exclusively for the disposal of wastewater treatment sludge. In addition to the sludges, the other wastes accepted were predominantly from households and businesses.

The southern, and part of the eastern and western boundary is fenced, but there is no visible boundary, other than the raised fill area, on the northern side. There is a steel framed building on site which was used for the storage for piping and other Council materials. Due to vandalism this building is no longer in use and has been boarded up. It is intended to demolish it in the future. Portions of the landfill have been capped with topsoil imported to site in recent years through these materials have not been significantly compacted or graded.

There is a marsh along the north-western, northern and north-eastern boundaries, which was associated with the original lake. The lands in the immediate vicinity to the east, south and west are used for low intensity agriculture, (animal grazing). The lands to the south are also currently used for grazing. The lands to the east of the drain have all been reclaimed along its entire length as far as Lake Road with construction demolition fill.

A halting site, located approximately 150m to the south of the site, contains the nearest occupied residences. There are at least 20 private dwellings within 250m of the northwest and western site boundaries and a newly developed housing estate approximately 250m to the southeast. A residential development (~250 houses) is under construction approximately 200m to the northeast of the site.

It is intended to develop the lands south of the landfill for social housing and light industrial use and the area between the site and the residential estate to the north east for light industrial warehousing. There are no proposals to develop the lands to the west.

1.2 Tier 1 and 2 Assessment

In 2009, South Tipperary County Council (the Council) completed a Tier 1 Assessment of the closed Tipperary Town Landfill in accordance with the 'Code of Practice Environmental risk Assessment for Unregulated Waste Disposal Sites' (CoP) published by the Environmental Protection Agency (Agency).

The Assessment concluded that the site was a Class A – High Risk, due to the risk of leachate migration to surface water and the risk to humans from landfill gas based on the nature of the underlying bedrock.

The Council appointed O'Callaghan Moran & Associates (OCM) to carry out a Tier 2 Assessment, which included Exploratory and Detailed Site Investigations completed in November 2009. The Tier 2 Assessment confirmed that the site was a Class A.- High Risk based on the risk of leachate migration to surface waters. The risk presented by landfill gas was considered to be Moderate, due to the low levels of gas detected outside the fill and the proposal to remove the on-site building.

The main findings of the Tier 1 & 2 Assessments were as follows;

- The Tier 1 assessment identified the underlying bedrock as a Regionally Important Karstified (Rkd) aquifer based on the Geological Survey of Ireland mapping. The logs of the boreholes installed in the Detailed Investigations and the geophysical survey indicate that the bedrock beneath the site is a shaley limestone, which was a locally important aquifer (Ll)

- It is possible that leachate migration is occurring toward the marsh and into a surface water drain to the east that ultimately discharges to the River Ara;

- The impact on surface water quality in the drain is low, with only ammonia exceeding the relevant water quality limit. This is attributed to a combination of natural attenuation within the marsh and the very high rainfall preceding and during the investigations;

- Shallow groundwater movement is towards a low point near the marsh and the marsh is the local groundwater discharge point;

- There is significant dilution of leachate occurring between the body of the waste and the groundwater monitoring wells located within 5-10m of the edge of the waste;

- Water quality in a public groundwater abstraction well, located 1.4km down hydraulic gradient of the site, is good with no evidence of any impact associated with leachate;

- The waste is actively producing landfill gas, with high levels of methane (31-55%v/v) recorded at monitoring wells inside the waste body. However, the levels detected at monitoring points outside the fill were low (1.1 to 1.3% v/v methane at one location) and further monitoring was required to establish the risk posed to off-site receptors, and

- Remedial measures (capping of the waste) may be required to minimise the risk posed by leachate and landfill gas to off-site receptors, but further monitoring (landfill gas, surface water and groundwater) was required to establish the extent of the remediation actions.

The Council submitted the Tier 2 Report to the Agency for comment. The Agency agreed with the conclusion that further monitoring was required to assist in the completion of a quantative risk assessment and determine the required remedial measures. The Agency did not accept the change to the aquifer classification from Regionally Important Karstified (Rkd) to Locally important (Ll) based on the findings of the intrusive investigations and geophysical survey and considered that the GSI mapping took precedence.

The Agency recommended that groundwater levels should be measured to confirm the results of first round of groundwater monitoring and that the potential for a 'swallow hole' near one of the monitoring wells be assessed. The Agency also recommended that an ecology assessment of the marsh and drain should be considered.

In relation to the landfill gas risk, the Agency considered that the risk remained high due to the presence of the building within the site and the proposed capping measures. The Agency recommended that a gas probe survey should be considered in the area north of the landfill, where ground conditions had prevented gas monitoring, ahead of boreholes as a more cost effective method of assessing risk, but boreholes could be installed if the findings of the probe survey warranted them.

1.3 Tier 3Work Scope

OCM developed the following scope for the Tier 3 based on the Tier 2 findings and the Agency's comments;

- Surface water monitoring at additional points up stream and downstream of the landfill.

- Monitoring of leachate levels and quality in two leachate wells (MW-2 and MW-3) within the waste body

- Monitoring water levels and quality in five groundwater wells (MW- 4, 5, 6, 7 and 8) outside the fill area.

- Landfill gas monitoring in the existing leachate and groundwater wells and a spike probe survey of the lands to the north of the landfill.
- An ecological assessment of the marsh and drain.
- Review of the Conceptual Site Model
- Completion of a Generic Quantitative Risk Assessment
- Preparation of Remedial Action Plan

2. MONITORING

2.1 Surface Water

2.1.1 Monitoring Locations

The Tier II Assessment involved monitoring at one location (SW-1) in the drain downstream of the marsh and south of the landfill. Following completion of the Tier II Risk Assessment further monitoring was undertaken by STCC, who undertook new upstream (SW-3) and additional downstream (SW-2) monitoring points to those used by OCM in the Tier II Assessment. SW-3 is the upstream location, SW-2 is in the drain just downstream of the marsh and SW-1 is the downstream sampling location in the drain. A drain located to the south between the landfill and the halting site is identified on the updated monitoring locations Figure. While this drain was identified during site walkover in Tier II it was observed to be completely dry and was constructed to allow drainage into rather than away from the site. It is not considered to be significant in terms of environmental risk presented by the landfill site. The revised monitoring locations are indicated on Figure 2.1.

2.1.2 Methodology

The monitoring was conducted by Council staff on July 13th 2010 and August 17th 2010. In August, the drain was dry and it was not possible to collect samples at SW-2 and SW-3.

2.1.3 Laboratory Analysis

The samples taken on 13th July 2010 were submitted to the Agency laboratory in Kilkenny for analysis for analysis for pH, electrical conductivity, dissolved oxygen, ammonia, nitrite, nitrate, orthophosphate, potassium, sodium, chloride, sulphate, metals, alkalinity, suspended solids, total oxidised nitrogen (TON), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).

The samples taken on August 17th 2010 were analysed at the Council's laboratory in Clonmel, for a reduced range of parameters. This is consistent with the monitoring frequencies for operational landfills, where a full suite is conducted annually, with monitoring for leachate indicator parameters carried out more frequently. The reduced suite included pH, electrical conductivity, chloride, total ammonia, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).

2.1.4 Laboratory Results

The laboratory test reports are contained in Appendix 1 and the results are summarised in Table 2.1. The Table includes, for comparative purposes, the Environmental Quality Standards (EQS) published by the Agency. The EQS are proposed water quality standards and are derived from the EU Directive on Drinking Water Quality 80/778/EEC and the Directive on the Protection of Groundwater against pollution caused by certain dangerous substances 80/66/EEC.

Table 2.1 Surface Water Results, Tipperay Town Landfill

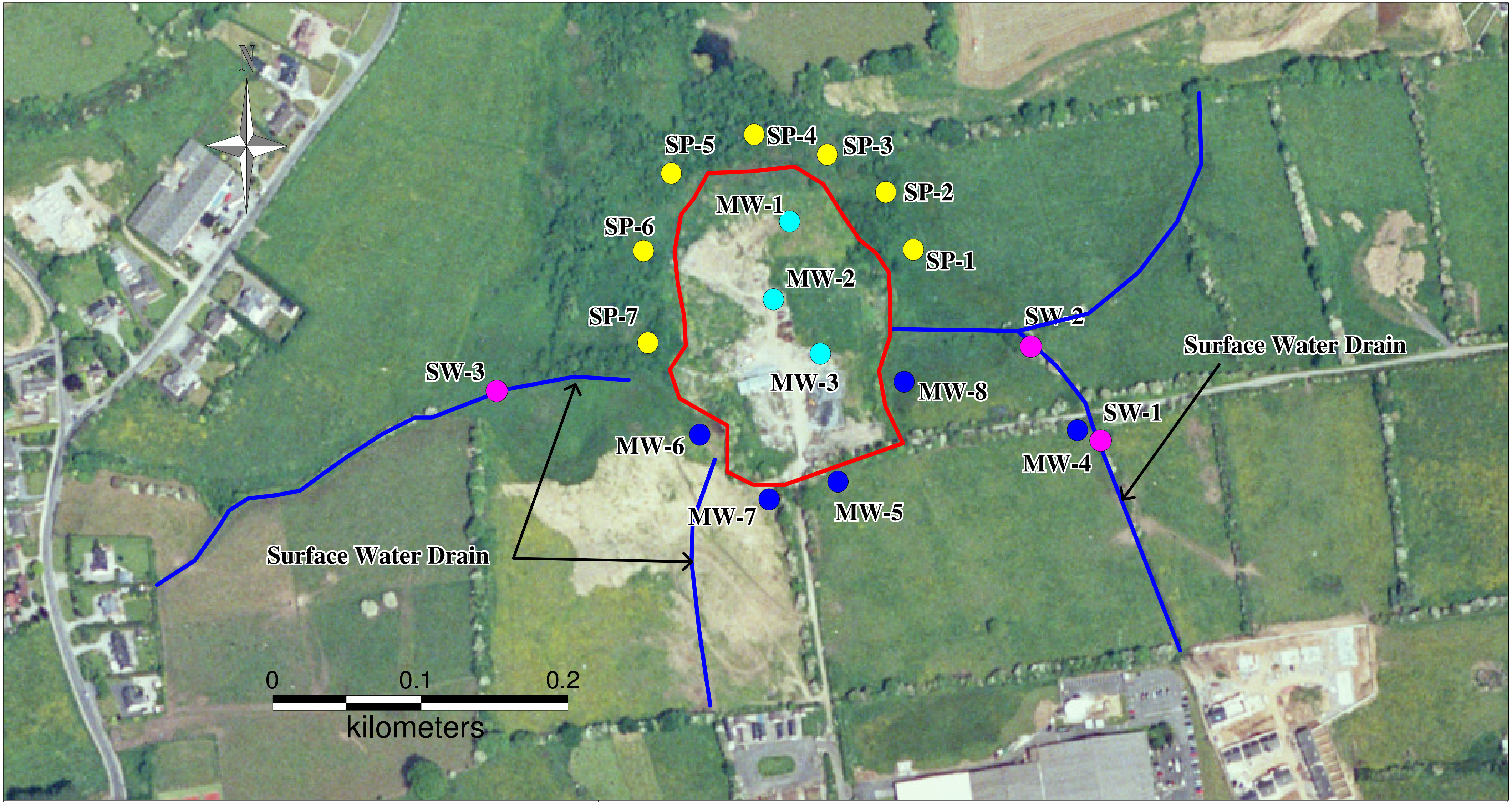
Sample I.D.	Units	SW-1	SW-2	SW-3	SW-1	EQS
		14/07/2010	14/07/2010	14/07/2010	17/08/2010	
pH	pH Units	7.300	7.100	7.600	7.950	4.5-9
Electrical Conductivity	uS/cm	913	969	765	941	-
Arsenic	mg/l	0.002	0.001	0.005	-	0.025
Antimony	mg/l	<0.0005	<0.0005	<0.0005	-	-
Aluminium	mg/l	<0.025	<0.025	0.046	-	-
Barium	mg/l	0.140	0.200	0.210	-	-
Beryllium	mg/l	<0.0005	<0.0005	<0.0005	-	-
Boron	mg/l	0.066	0.083	0.056	-	-
Cadmium	mg/l	<0.0005	<0.0005	<0.0005	-	0.0015
Cobalt	mg/l	0.0005	0.0005	0.0009	-	-
Copper	mg/l	0.0006	0.0008	0.0046	-	0.03
Lead	mg/l	<0.0005	<0.0005	<0.0005	-	0.0072
Manganese	mg/l	0.80	0.84	1.60	-	-
Magnesium	mg/l	0.010	0.011	0.006	-	-
Mercury	mg/l	<0.0005	<0.0005	<0.0005	-	0.00007
Molybdenum	mg/l	<0.0005	<0.0005	<0.0005	-	-
Nickel	mg/l	0.0009	0.0008	0.0023	-	0.02
Iron	mg/l	1.8	2.8	3.4	-	1*
Total Chromium	mg/l	0.014	0.015	0.011	-	0.0047
Selenium	mg/l	0.0008	0.0007	0.0006	-	-
Thallium	mg/l	<0.0005	<0.0005	<0.0005	-	-
Tin	mg/l	<0.001	<0.001	<0.001	-	-
Uranium	mg/l	<0.0005	<0.0005	<0.0005	-	-
Vanadium	mg/l	<0.0005	<0.0005	<0.0005	-	-
Zinc	mg/l	0.018	0.022	0.034	-	0.1
Chloride	mg/l	67.00	83.00	17.00	57.54	250*
Calcium	mg/l	84.00	88.00	110.00	-	-
Orthophosphate	mg/l	0.02	0.29	0.08	-	-
Total Oxidised Nitrogen	mg/l	<0.5	<0.5	<0.5	-	No Ab change
Total Suspended Solids	mg/l	<18.2	34.00	89.00	-	-
Total Alkalinity as CaCO3	mg/l	359.00	391.00	291.00	-	-
BOD	mg/l	3.20	7.10	5.70	7.90	5
COD	mg/l	48.00	73.00	91.00	51.00	-
Potassium	mg/l	6.30	7.20	0.80	-	-
Sodium	mg/l	36.00	43.00	9.30	-	-
Ammonia*	mg/l	6.10	7.50	0.03	4.70	0.02
Nitrite	mg/l	0.01	<0.002	<0.002	-	-

* EQS taken from 1997 report as no EQS exists in 2007 report
ND Denotes Not Detected

There was slightly elevated ammonia at the upstream location on the drain entering the marsh from the west, with higher levels in the drain leaving the marsh.

Manganese and iron exceeded the EQS in all the samples, with the highest levels in the drain upstream of the landfill. Chromium levels exceeded the EQS at all locations.

While the results indicate that leachate may be impacting on the surface water quality downstream of the site, they also indicate an impact on the water quality in the drain entering the marsh from the west and up gradient of the landfill. It is possible that the ammonia levels in the drain are associated with the naturally occurring anoxic conditions in the marsh, which were observed and reported by Ecofact as part of the Ecological Assessment of the marsh that is discussed further in Section 3.



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environmental management for business

CLIENT

South Tipperary County Council

TITLE

Groundwater Landfill Gas Well Locations

Legend
- ● Groundwater Well
- ● Gas Well
- ● Surface Water Location
- ● Spike Probe Location

FIGURE No.

2.1

SCALE

2.2 Leachate

2.2.1 Monitoring Locations

Leachate samples were collected from leachate monitoring wells MW-1 and MW-2, as shown on Figure 2.1.

2.2.2 Methodology

The monitoring was conducted by Council staff on 13th July and the 17th August 2011.

2.2.3 Laboratory Analysis

The samples taken on 13th July 2010 were submitted to the Agency laboratory in Kilkenny for analysis for analysis for pH, electrical conductivity, dissolved oxygen, ammonia, nitrite, nitrate, orthophosphate, potassium, sodium, chloride, sulphate, metals, alkalinity, suspended solids, TON, BOD and COD.

The samples taken on August 17th 2010 were analysed at the Council's laboratory in Clonmel, for a reduced range of parameters that included pH, electrical conductivity, chloride, total ammonia, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).

2.2.4 Laboratory Results

The laboratory test reports are contained in Appendix 1 and the results are summarised in Table 2.1. The Table includes, for comparative purposes, the relevant EQS

Table 2.2 Leachate Results July 13th 2010

Sample I.D. Sample Date	Units	MW-2	MW-3	IGV
Arsenic	µg/l	31	14	10
Aluminium	µg/l	2200	1300	200
Antimony	µg/l	2.7	1.3	-
Barium	µg/l	320	1700	100
Beryllium	µg/l	<0.5	<0.5	-
Boron	µg/l	1600	640	1,000
Cadmium	µg/l	1.3	<0.5	5
Chromium	µg/l	37	49	30
Cobalt	µg/l	7.9	3.8	-
Copper	µg/l	43	30	30
Mercury	µg/l	<0.5	<0.5	1
Molybdenum	µg/l	14	1.1	-
Nickel	µg/l	21	8.7	20
Lead	µg/l	110	95	10
Selenium	µg/l	18	3	-
Thallium	µg/l	<0.5	<0.5	-
Tin	µg/l	1	<1	-
Uranium	µg/l	<0.5	<0.5	9
Vanadium	µg/l	17	9.5	-
Zinc	µg/l	280	190	100
Iron	µg/l	3800	9300	200
Manganese	µg/l	480	510	50
Calcium	mg/l	30	160	200
Magnesium	mg/l	33	44	50
Chloride	mg/l	875	1320	30
Fluoride	mg/l	0.37	0.15	1
Total Alkalinity as CaCO3	mg/l			NAC
Orthophosphate	µg/l	440	160	30
Potassium	mg/l	150.0	62.0	5
Sodium	mg/l	430	650	150
pH	pH units	8.70	7.20	6.5-9.5
Electrical Conductivity	µS/cm	4300	5330	1,000
Total Oxidised Nitrogen	mg/l	<0.5	<0.5	NAC
Ammonia	mg/l	120.00	37.00	0.15
Nitrite	mg/l	<0.002	<0.002	0.1
BOD	mg/l	<30	<30	-
COD	mg/l	562	480	-
Sulphate	mg/l	100	16	200

Table 2.3 Leachate Results August 17th 2010

Sample I.D. Sample Date	Units	MW-2	MW-3
Chloride	mg/l	966	1269.6
pH	pH units	8.78	7.3
Electrical Conductivity	µS/cm	4370	5190
Ammonia	mg/l	133	30.8
BOD	mg/l	25	12
COD	mg/l	241	115

The results confirm the presence of an aged Stage IV leachate.

2.3 Groundwater Monitoring

2.3.1 Monitoring Locations

Groundwater monitoring was conducted at five groundwater wells (MW-4, 5, 6, 7 and 8), whose locations are shown on Figure 2.1.

2.3.2 Methodology

Groundwater samples were collected by Council staff on the 13th July and 17th August 2010. In the July event, MW-7 was not samples as it was inadvertently thought to have been backfilled at that time. In August MW-1 and MW-5, were dry but a sample was obtained from MW-7 following confirmation by OCM that the well was intact. Groundwater level data was conducted by OCM in September 2010.

2.3.3 Laboratory Analysis

The samples collected on 13th July 2010 were submitted to the Agency's laboratory in Kilkenny for analysis for pH, electrical conductivity, dissolved oxygen, ammonia, nitrite, nitrate, orthophosphate, potassium, sodium, chloride, sulphate, alkalinity, metals, TON, BOD and COD.

The samples taken on August 17th 2010 were analysed at the Council's laboratory in Clonmel for a reduced range of parameters, which included pH, electrical conductivity, chloride, total ammonia, BOD and COD.

2.3.4 Laboratory Analysis

The full laboratory test reports are in Appendix 1 and the results are summarised in Tables 2.4 and 2.5. The Tables include Interim Guideline Values (IGV) published by the Agency. The IGVs are not statutory, but were developed to assist in the assessment of impacts on groundwater quality in the context of the implementation of the EU Water Framework Directive. The guidelines are based on, but are more conservative than the Drinking Water quality standards.

Table 2.4 Groundwater Monitoring Results July 13th 2010

Sample I.D. Sample Date	Units	MW-4	MW-5	MW-6	MW-8	IGV
Arsenic	µg/l	1.7	3.4	1.6	6.6	10
Aluminium	µg/l	910	1900	800	290	200
Antimony	µg/l	<0.5	<0.5	<0.5	<0.5	-
Barium	µg/l	240	220	140	1000	100
Beryllium	µg/l	<0.5	<0.5	<0.5	<0.5	-
Boron	µg/l	20	40	120	29	1,000
Cadmium	µg/l	<0.5	<0.5	<0.5	<0.5	5
Chromium	µg/l	21	21	29	24	30
Cobalt	µg/l	1.8	4.5	2.9	2.1	-
Copper	µg/l	4.8	15	8.4	12	30
Mercury	µg/l	<0.5	<0.5	<0.5	<0.5	1
Molybdenum	µg/l	<0.5	<0.5	<0.5	<0.5	-
Nickel	µg/l	4.9	9.3	7.2	8.6	20
Lead	µg/l	6.7	13	6.2	5.4	10
Selenium	µg/l	0.8	<0.5	1	0.9	-
Thallium	µg/l	<0.5	<0.5	<0.5	<0.5	-
Tin	µg/l	<1	<1	<1	<1	-
Uranium	µg/l	0.7	0.5	1.7	1.7	9
Vanadium	µg/l	2	4.8	1.4	1.6	-
Zinc	µg/l	29	48	28	27	100
Iron	µg/l	1300	2500	940	1500	200
Manganese	µg/l	160	360	1400	1500	50
Calcium	mg/l	120	71	150	140	200
Magnesium	mg/l	9	7	13	15	50
Chloride	mg/l	61	279	28	341	30
Fluoride	mg/l	0.07	0.09	0.08	0.09	1
Total Alkalinity as CaCO3	mg/l	408	545	576	407	NAC
Orthophosphate	µg/l	<10	<10	80	60	30
Potassium	mg/l	0.7	1.2	4.8	0.7	5
Sodium	mg/l	45	240	22	160	150
pH	pH units	7.10	7.80	7.00	7.00	6.5-9.5
Electrical Conductivity	µS/cm	936	1748	1110	1916	1,000
Total Oxidised Nitrogen	mg/l	2.01	0.75	4.13	0.53	NAC
Ammonia	mg/l	0.03	0.03	0.37	0.03	0.15
Nitrite	mg/l	<0.002	<0.002	0.004	0.003	0.1
BOD	mg/l	-	-	-	-	-
COD	mg/l	-	-	-	-	-
Sulphate	mg/l	-	-	-	-	200

Elevated aluminium, barium, iron and manganese were detected in all of the wells. Lead was slightly elevated in MW-5. Elevate orthophosphate was detected in MW- 6, and MW-8; sodium in MW-5 and MW-8 and chloride in MW-4, 5 and 8, while electrical conductivity is elevated in all the wells.

Table 2.5 Groundwater Monitoring Results August 17th

Sample I.D. Sample Date	Units	MW-4	MW-6	MW-7	MW-8	IGV
Chloride	mg/l	57.5	37.2	77.1	414	30
pH	pH units	7.25	7.22	7.37	7.16	6.5-9.5
Electrical Conductivity	µS/cm	1147	1147	1146	2110	1,000
Ammonia	mg/l	0.42	0.52	0.11	0.1	0.15
BOD	mg/l	1.3	1.3	0.9	2.7	-
COD	mg/l	23	27	15	28	-

Chloride and electrical conductivity was elevated in all the wells, while ammonia was elevated in MW-4 and MW-6. The data indicates the presence of leachate impact on the groundwater in the subsoil. The contaminant concentrations decrease moving from MW-8, which is close to the waste body, to MW-4 approximately 150m east of the landfill.

2.4 Landfill Gas

2.4.1 Locations

Landfill gas monitoring was conducted included all eight wells (MW-1 to MW-8). A spike probe survey was carried out in the area north of the fill area. The monitoring locations are shown on Figure 2.1

2.4.2 Methodology

The gas monitoring was conducted by Council staff in March, April and May 2010 and by OCM in September 2010. The Council staff used a Geotechnical Instruments GA 2000 gas analyser. OCM used a Gas Data LSMx gas analyser. The meters were calibrated before use. The detection limit is 0.1% for methane, carbon dioxide and oxygen.

The spike probe survey undertaken by OCM in September 2010 involved the use of a steel probe slotted in the lower 0.25m which was driven between 0.5 and 0.75m into the ground at each probe location. The gas analyser was attached to the top of the probe to monitor for landfill gas. During the survey there was no evidence of vegetation die back at the ground surface at any of the probe locations.

2.4.3 Results

The results are presented in Tables 2.6 – 2.8, which, includes guideline limits taken from the Department of the Environment (DOE) publication on the 'Protection of New Buildings and Occupants from Landfill Gas' (1994).

MW-1, MW-2 and MW-3 are within the waste body. Carbon dioxide and methane were detected in all three wells, ranging from 26% to 80.6% for methane, and 1.5% to 16% for carbon dioxide. Oxygen levels ranged from0.8% to 1.4%.

MW-4, MW-5, MW-6, MW-7 and MW-8 are outside the waste body. Methane was not detected in any of the wells. Carbon dioxide was detected in all of the wells, with the concentrations ranging from 0.1% to 5%. The DOE limit of 1.5% was regularly exceeded in MW-4, 6 and 8. The oxygen levels ranged from 2.9% to 22.6%, with the lowest level detected in MW-8.

Table 2.6 Landfill Gas Monitoring Data: November 2009 – September 2010

Well ID	**Methane**							**Carbon Dioxide**						
	23/11/09	02/12/2009	08/12/2009	23/03/2010	23/04/2010	31/05/2010	09/09/2010	23/11/2009	02/12/2009	08/12/2009	23/03/2010	23/04/2010	31/05/2010	09/09/2010
MW-1	31.5	53	52	63.4	75.1	73.6	80.6	12	15	16	16.7	18.7	18	17.2
MW-2	55	55	56	21	38.7	9.3	26.4	3.6	3.9	4.1	3.7	4.1	6.5	5.9
MW-3	35	37.5	38	32.6	34.4	26	27	1.5	3.6	3.7	2.4	3.7	5.6	5.9
MW-4	0	0	0	Water to top	Water to top	0	0	1.9	2.1	2.5	Water to top	Water to top	0.2	0
MW-5	0	0	0	0	0	0	0	1.6	0.9	1	0.1	0.3	0	1.3
MW-6	0	0	0	0	0	0	0	1.8	4	3.6	4.5	4.8	5	3.8
MW-7	0	0	0	Water to top	Water to top	0	0	0	0.9	1	Water to top	Water to top	0	0
MW-8	0.8	1.1	1.3	0.8	0	0.2	0	5	4.5	4.6	2.1	2.3	4.2	1.9
DOE Limit (%)	**1%**							**1.5%**						

Table 2.7 Landfill Gas Monitoring Data: November 2009 – September 2010

Well ID	Oxygen							Barometric Pressure						
	23/11/2009	02/12/2009	08/12/2009	23/03/2010	23/04/2010	31/05/2010	09/09/2010	23/11/2009	02/12/2009	08/12/2009	23/03/2010	23/04/2010	31/05/2010	09/09/2010
MW-1	1.4	1.1	1	3.5	0.3	0.4	0.4	1002	1001	1002	N/m	1002	1006	999
MW-2	1.3	1.1	1.1	4.8	0.4	0.5	0.1	1002	1001	1002	N/m	1002	1006	975
MW-3	1.1	0.8	0.9	3.5	0.4	1.1	0.9	1002	1001	1002	N/m	1002	1006	995
MW-4	22.3	19.9	18.4	Water to top	Water to top	21.4	20.3	1002	1001	1002	Water to top	Water to top	1005	1000
MW-5	18.1	21.8	21.6	20.7	20.9	21.4	18.3	1002	1001	1002	N/m	1002	1006	999
MW-6	21	20.1	20.1	12.2	12	13.9	14	1002	1001	1002	N/m	1002	1006	1000
MW-7	22.6	3.7	19.1	Water to top	Water to top	21.5	20.6	1002	1001	1002	Water to top	Water to top	1006	999
MW-8	2.9	3.6	3.6	10.3	7.8	4.9	1.4	1002	1001	1002	N/m	1002	1006	999
DOE Limit (%)	-							-						

The monitoring confirmed that high methane and carbon dioxide levels are present within the waste, with the highest levels occurring in the northern part of the site of the site around MW-1. There is no evidence of significant methane migration from the fill, with methane only detected at one monitoring point (MW-8) once in the four monitoring events. Slightly elevated carbon dioxide levels were detected in three locations (MW-4, 6 and 8).

Table 2.8 Spike Probe Results September 2010

Spike Probe Points	Methane	Carbon Dioxide	Oxygen	Barometric Pressure
	09/09/2010	09/09/2010	09/09/2010	09/09/2010
SP-1	0	0.2	20.3	987
SP-2	0	0.1	20.8	978
SP-3	0	0.2	20.5	979
SP-4	0	0	20.6	989
SP-5	0	0.2	20.1	999
SP-6	0	0.1	20.4	998
SP-7	0	0	20.6	986
DOE Limit (%)	**1%**	**1.5%**	**-**	**-**

Methane was not detected and carbon dioxide levels were low, typical of background conditions. The results indicate that despite the high methane levels detected in the waste, particularly in the northern portion, there is no evidence of landfill gas migration in the shallow subsurface.

3. ECOLOGICAL SITE SURVEY

An ecological survey was undertaken by Ecofact Ecological Consultants (Ecofact) in September 2010. The Ecofact report is included in Appendix 2 and the main findings are presented below.

The assessment identified the presence of reed swamp (FS1) habitat, with some wet alder / willow woodland (WN6). A small stand of non-native Japanese Knotweed was noted. This habitat is considered to be of high local importance and is connected with the Carrownreddy Lough and associated wetlands, to the north.

There is no data available on the diversity or ecological importance of this habitat or the biodiversity value of Carrownreddy Lough prior to the use of the site as a landfill to provide a benchmark for the current status. However, the botanical community within this habitat is likely to maintain its diversity despite further leachate inputs from the landfill.

Water levels were found to be very low during the assessment, both in the reed swamp habitat and in the land drain, although there was evidence in the botanical community that this habitat is water-logged throughout the year.

It is considered that the surrounding lands currently provide little dilution of leachate to the land drain. This drain was receiving minimal flows from the swamp and was barely flowing on the day of the survey, with pooled water observed in sections downstream. The substrate of the swamp and land drain was found to be anoxic, although this is considered to be a combined function related primarily to the stagnant conditions within the low-lying swamp.

The reed swamp is considered to be providing an important function as a natural attenuation of the leachate from the former landfill. This habitat will require the maintenance of a high water table or permanent standing water for its ongoing viability.

The reed swamp and wet woodland is considered to comprise an important habitat for breeding birds, with at least one pair of moorhens recorded on the day of the survey.

Although water quality in the reed swamp is likely to be affected by the leachate, the botanical community recorded is indicative of a semi-natural habitat. More significant impacts may relate to the macro invertebrate communities present. Based on the observations during the site assessment, which was during low flow conditions, the drain leaving the site appears to be affected by water quality impacts.

4. CONCEPTUAL SITE MODEL & QRA

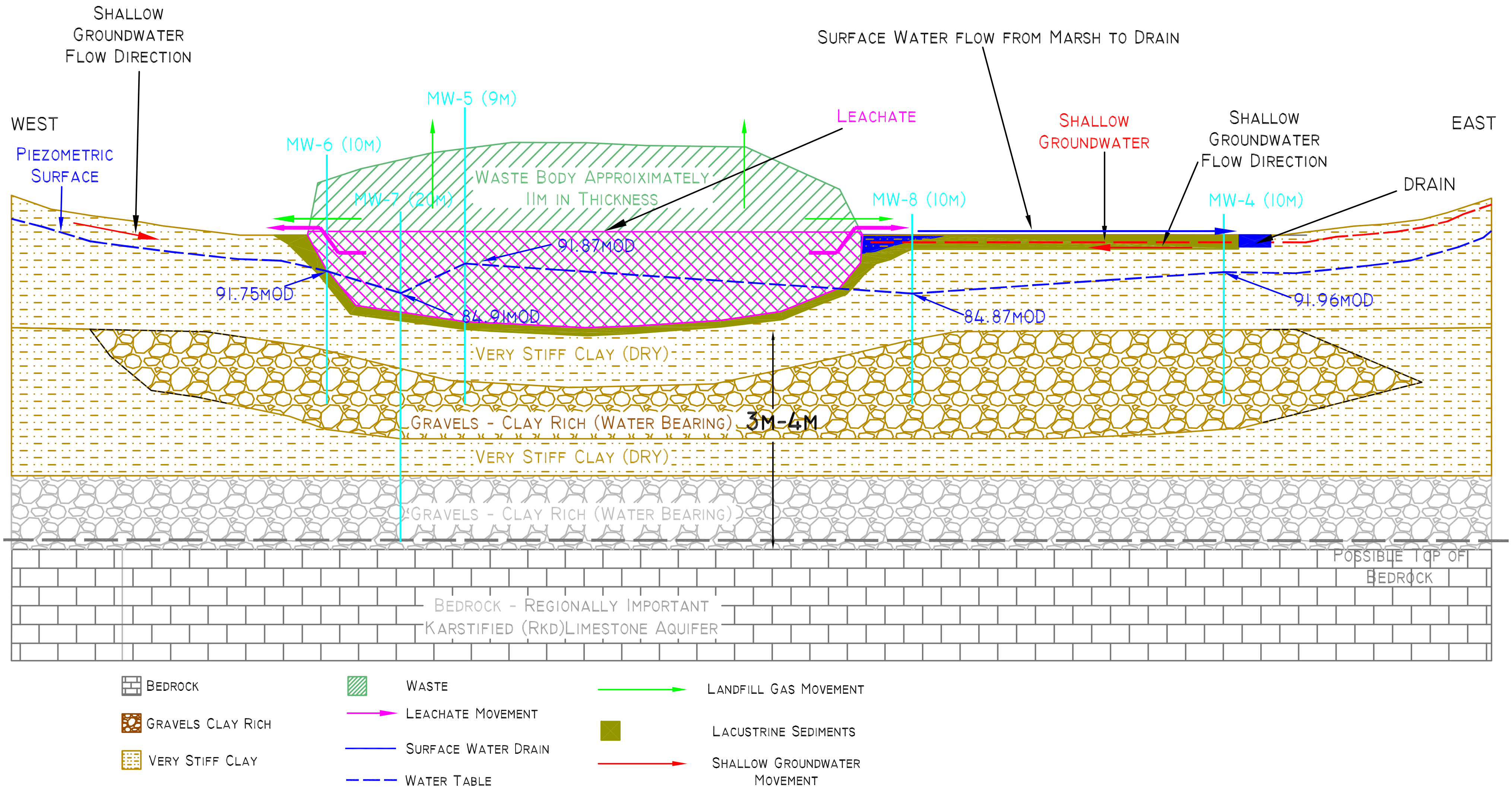
4.1 Tier 3 Revised Conceptual Site Model

The Tier 3 Revised Conceptual Site Model is presented on Figure 4.1. The subsoils at the site consist of a thin layer of lacustrine sediments underlain by a low – to moderate permeability boulder clay and gravel, which in turn are underlain by layer of low permeability hard clays. Beneath the clay is a lower layer of gravels. Based on the field observations and geophysics investigations the gravels appear to be underlain by shaley limestone Ll aquifer. However, for the purposes of this risk assessment and as requested by the Agency it has been assumed that the underlying bedrock is a Regionally Important Karst bedrock (Rkd).

The landfill is at a low point in a local catchment, where both groundwater and surface water discharge into the marsh. During the drilling of the wells outside the landfill (MW-4 -8) the first groundwater strikes were encountered at approximately 8.5m below ground level. The well screens are open to the subsoil and underlying upper gravel formation. The subsoils above the bedrock were observed to be poorly permeable, while the gravels are very permeable and water bearing. It is considered therefore that groundwater level monitoring indicates a variable static water level across the site and that the variations in water levels are indicative of a piezometric head consistent with a partially confined water table in the upper gravel layer beneath the clay. The upper and lower gravel layers are separated by very stiff, dry clay layer.

The leachate level within the waste is higher than the piezometric head in the surrounding natural ground and, as such, there is the potential for leachate to enter the shallow groundwater in the lacustrine sediments and possibly the underlying clays where the lacustrine sediments may have been disturbed when waste was being deposited. However, the low permeability clay subsoil layer beneath the sediments inhibits downward movement and there is no direct pathway to either the underlying deeper gravel formation or the bedrock aquifer. It is likely that because of the low permeability of the subsoils that the preferential flow path is along the surface into the Marsh.

A surface water drain leaves the marsh and flows to the south. This drain is seasonal and occasionally dries up. The direct discharge of contaminated shallow groundwater to the drain is not likely, but there is an indirect discharge as water levels rise in the marsh in the winter period**.**



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CLIENT

SOUTH TIPPERARY COUNTY COUNCIL

TITLE

CONCEPTUAL SITE MODEL

details

FIGURE No.
4.1

SCALE

REV.

Very high landfill gas levels are present within the landfill, but have not been detected in the surrounding subsoils, which indicate that the current landfill gas risk is low. However, because capping of the fill area is likely, remedial action will be required to mitigate leachate impacts and the risk of landfill gas migration which may increase due to the build up gases beneath the cap.

4.2 Surface Water

There are two potential surface water inflow areas to the marsh. The first is a recently dug drain, which appears to originate near the halting site to the south and runs north before turning east into the marsh. There was no flow in this drain in September 2010 but it is possible that there may be some flow in the winter months.

The second inflow originates at the boundary of a private dwelling approximately 400m to the west of the marsh. This may possibly be either a spring or a culverted section of a drain, but as it was not possible to get access to the dwelling, it was not possible to confirm the position.

Water leaves the marsh in a drain on its eastern boundary and flows for c.150m and then turns south and passes beneath the landfill access road (Lake Road) and flows towards a recently constructed residential development, where it is culverted and eventually discharges to the River Ara.

Within the landfill, the leachate levels measured in September 2010 by OCM range from 91.27mOD in MW-1 to 92.25mOD in MW-2 and MW-3. These levels are just below that of the surrounding natural ground (c.92.2mOD). While the levels are lower than those recorded in November 2009, the potential for migration into the marsh during wetter periods remains.

No leachate seepages were observed around the margins of the landfill and the ecological assessment concluded that the marsh area does not appear to have been be significantly impacted by leachate.

The impact of the leachate on water quality in the drain downstream of the site is limited, being confined to elevated ammonia, although there may also be a contribution from the naturally occurring anoxic conditions within the marsh. Iron manganese and chromium exceed the surface water EQS limits but are most likely representative of local background conditions, as the concentrations are similar and in the case of manganese and iron, higher in the drain that enters the marsh upstream of the landfill from the west than those leaving it to southeast.

4.3 Groundwater

The Agency commented on the potential for a swallow hole effect just east of the fill area (MW-8) and required an assessment of this as part of the Tier 3. The direction of groundwater flow is shown on Figure 4.2, which is based on groundwater levels measured by OCM in September 2010.

There is no field evidence of either a swallow hole or other karst features at or in the vicinity of the site and the GSI karst database does not contain any record of any karst features in this area. While the GSI maps indicate that the site in underlain by karstified bedrock, the site investigation data (field observations and geophysical data) indicates it is most likely to be underlain by shaley limestone.

The landfill is located in a former lake that was drained in ca 1940. The groundwater table reflects the local topography, with flow towards the fill area from all directions. This is consistent with groundwater flow towards a lake, which typically occupies a low point in a catchment and acts a discharge area for groundwater.

The groundwater level in MW-7 and 8 (84.91mOD and 84.97mOD respectively) are significantly lower than those in MW-4, 5 and 6 (91.96mOD, 91.87mOD and 91.75mOD respectively). This variation indicates variable piezometric head levels in the subsoil reflecting localized differences in permeabilities.

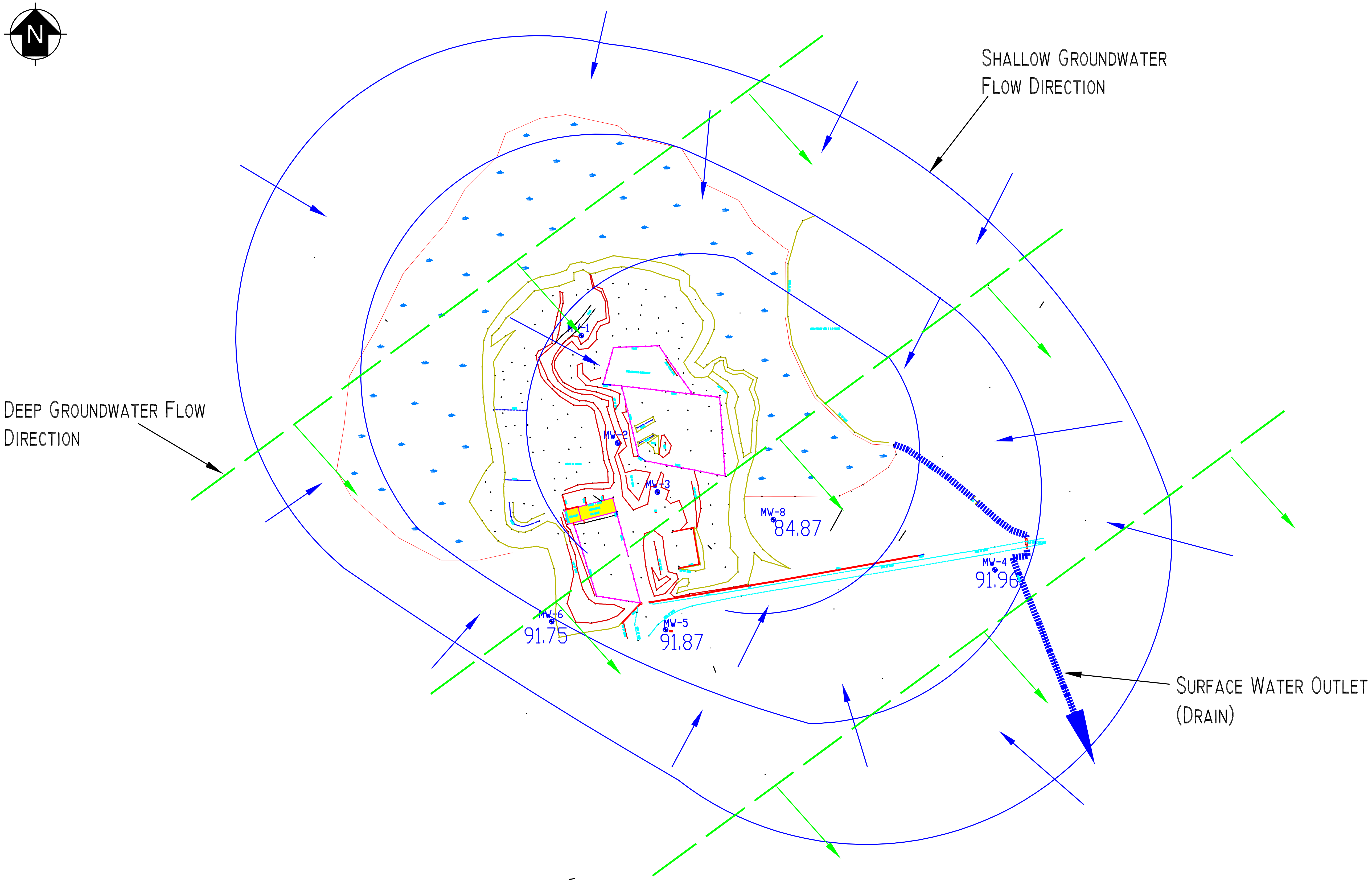
The leachate level in the waste is higher than the groundwater level in the surrounding subsoil. The difference in levels indicates the potential for the migration of leachate from the waste. The very hard, dry boulder clay underlying the landfill probably results in most of the leachate preferentially discharging to marsh where it appears to be significantly attenuated.

The monitoring data has established that leachate is impacting on the shallow groundwater, with elevated manganese, iron, aluminium, barium, ammonia and chloride. However the impacts are significantly attenuated with distance from the fill area. There is no evidence of any impact on the closest water supply well (Tipperary Co-Op) located 1.5 km to the south of the site.

It is likely that because of the topography that the monitoring wells surrounding the site are up hydraulic gradient of the landfill but that they are close enough to be affected by leachate migrating from the margins of the landfill due to the head of leachate in the waste mass perched above the natural gorund. The levels of ammonia, chloride, iron and manganese detected in the wells, compared to those in the leachate, indicates that substantial dilution and attenuation is occurring within 5-10m of the landfill

However the hydraulic gradient indicates movement of groundwater toward rather than away from the landfill. Because the wells are screened to monitoring shallow groundwater flow in the subsoils/gravels, they intercept the shallow leachate plume around the landfill area. Given the thickness of the underlying clays, it is likely that the groundwater in the deeper gravel zone is uncontaminated. It is likely that the direction of groundwater flow in the bedrock is to the southeast following the topographic gradient.

The presence of a relatively low permeability, thick subsoil immediately beneath the waste inhibits the vertical migration to the underlying water bearing gravels. The low permeability clay that underlies the gravels also inhibits the downward movement of any contaminated groundwater to the bedrock.



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CLIENT	South Tipperary County Council
TITLE	INTERPRETED GROUNDWATER FLOW SEPTEMBER 2010
DRAWING No.	4.2
SCALE	
REV.	
NOTES	

4.4 Assessment of Landfill Gas Pathway

The monitoring in the waste body (MW-1, 2 and 3) indicates that methane and carbon dioxide are still being generated at significant levels. The monitoring in the perimeter wells identified carbon dioxide levels ranging from 0.1 - 5%, however methane was only detected at one monitoring point (MW-8) on one occasion. The spike probe survey indicates that gas migration to the north of the landfill is not occurring in the shallow subsurface.

The on-site building is no longer used and it is planned to demolish it in the near future, which will eliminate the risk associated with landfill gas.

A halting site, located approximately 150m to the south of the site, contains the nearest occupied residences. There are at least 20 private dwellings within 250m of the northwest and western site boundaries and a newly developed housing estate approximately 250m to the southeast. A residential development (~250 houses) is under construction approximately 200m to the northeast of the site.

It is intended to develop the lands south of the landfill for social housing and light industrial use and the area between the site and the residential estate to the north east for light industrial warehousing.

Given that remedial measures will include capping of the landfill, the risk posed by landfill gas will increase and must be mitigated.

The in-situ boulder clay surrounding the waste body has a moderate to low permeability, which inhibits gas movement. The water saturated conditions in the marsh along the landfill's north-western, northern and north-eastern margins will also inhibit gas migration and, when water levels drop in drier periods, possibly allow passive ventilation. The nearest existing residences are more than 250 m. The only area where landfill gas migration has the potential to occur to any great extent is to the south, where the nearest occupied buildings (Halting Site) are located.

4.5 Revised Risk Assessment

OCM modified the Tier 2 Assessment based on the Tier 3 findings and the EPA comments. The changes are highlighted in red.

4.6 Revised Risk Assessment

Table 6

Ref	**Source**	*Score*	*Rational*
1a	Leachate	7	▪ <5 hectares ▪ Waste likely to be both municipal & industrial
1b	Gas	7	▪ <5 hectares ▪ Highest rating given as proportion of municipal: industrial wastes is not known.

Table 7

Ref	**Pathways**	*Score*	*Rational*
2a	Groundwater vulnerability	2	▪ GSI data states that the site is rated as having high vulnerability. While the Agency recommended the Extreme vulnerability rating be used, OCM considers the Vulnerability to be High. The risk is to the bedrock aquifer and not the boulder clay subsoil, which is not classified as an aquifer.
2b	Groundwater flow regime	5	▪ Agency states that the aquifer should not be reclassified based on geophysics. OCM has reverted to the aquifer classification as Rkd despite strong field evidence to the contrary
2c	Surface water drainage	2	▪ Landfill is reportedly connected to town surface water drainage system
2d	Landfill gas lateral migration	3	▪ Residences not currently within 250m of site, but could be within 5 years. ▪ Karst bedrock
2e	Landfill gas vertical migration	5	▪ As long as building remains on-site; risk should remain high.

Table 8

Ref	**Receptors**	*Score*	*Rational*
3a	Human presence (leachate)	2	▪ Currently no houses within 250m, there will be within 5 years ▪ Note: All houses can be served by public water
3b	Protected areas	1	▪ No protected areas within 1 km of site ▪ The marsh has been considered as an undesignated GWDTE based on the precautionary approach. ▪ No consultation with the NPWS has taken place.
3c	Aquifer category	5	▪ Agency requires the aquifer to be classified as Rkd
3d	Public water supply	3	▪ Public water supply is greater than 1km away (Tipperary Co-op) ▪ Karst bedrock – but different geological formation ▪ Precautionary approach assumed
3e	Surface water bodies	3	▪ Surface water drain within 50m of site boundary
3f	Human presence (gas)	5	▪ Houses proposed within 50m of site boundary

The site remains High risk for leachate impacts on the surface water system, because of the presence of a pathway from the landfill to the marsh and the outlet drain.

The landfill gas risk has been increased to High, based on the Agency's recommendations that the on-site buildings risk be retained and also due to the proposal to cap the waste. Landfill gas levels may accumulate beneath the cap and increase the risk of migration.

While some impacts have been detected in the groundwater, it is considered likely that the risk posed to the bedrock aquifer is Low.

Note: The table below represents the Tier II Risk rating for this site. SPR1 to 9 represent the leachate risk scores. SPR10 & 11 represent Landfill Gas Risk. The migration pathways are colour coded as follows:

Groundwater & Surface Water	**Groundwater only**	**Surface water only**	**Lateral & Vertical**	
Calculator		**SPR Values**	**Maximum Score**	**Normalised Score**
SPR1	1a x (2a + 2b + 2c) x 3e	189	300	63.00%
SPR2	1a x (2a + 2b + 2c) x 3b	63	300	21.00%
SPR3	1a x (2a + 2b) x 3a	98	240	40.83%
SPR4	1a x (2a + 2b) x 3b	49	240	20.42%
SPR5	1a x (2a + 2b) x 3c	245	400	61.25%
SPR6	1a x (2a + 2b) x 3d	147	560	26.25%
SPR7	1a x (2a + 2b) x 3e	147	240	61.25%
SPR8	1a x 2c x 3e	42	60	70.00%
SPR9	1a x 2c x 3b	14	60	23.33%
SPR10	1b x 2d x 3f	105	150	70.00%
SPR11	1b x 2e x 3f	175	250	70.00%
Overall Risk Score		245		**70.00%**
				A

Risk Classification	**Range of Risk Scores**
Highest Risk (Class A)	**Greater than or equal to 70% for any individual SPR linkage**
Moderate Risk (Class B)	**Between 40-70% for any individual SPR linkage**
Lowest Risk (Class C)	**Less than or equal to 40% for any individual SPR linkage**

Risk Classification	**HIGHEST**

5. CONCLUSIONS

5.1 Surface Water

There is the potential for leachate to migrate from the waste via the lacustrine sediments into the adjoining marsh. Water from the marsh enters a drain that ultimately discharges to the River Ara several kilometres downstream of the site.

The impact of the leachate on water quality in the drain leaving the marsh is limited, being confined to elevated ammonia, although there may also be a contribution from the naturally occurring anoxic conditions within the marsh.

The elevated iron manganese and slightly elevated chromium detected in the samples collected from the drain leaving the landfill site are most likely representative of local background conditions, as similar levels are present in the drain that enters the marsh from the west. There is no water quality data for the drain entering the marsh from the south.

Remedial measures are required to minimise the risk to surface water. Such measures may include the provision of a low permeability cap over the waste. This will reduce rainfall infiltration that generates a leachate head within the waste, which can then enter the lacustrine sediments and flow into the marsh

5.2 Groundwater

Based on the groundwater flow direction data shallow groundwater in the catchment is moving toward a low point in the former lake area and discharging into the marsh. The shallow groundwater and surface water run-off enter the marsh and discharge to the drain along the eastern landfill boundary.

Some leachate impacts have been detected in the shallow groundwater. These are considered to originate as discharges into the subsoil along the margins of the landfill. The leachate migration away from the margins of the landfill is not considered to be significant laterally because of the direction of groundwater flow and vertically because of the presence of hard low permeability boulder clay underlying the lacustrine sediments beneath the landfill.

Given the thickness of the subsoil above the bedrock aquifer, the risk posed to the bedrock aquifer is considered to be Low.

5.3 Landfill Gas

Methane and carbon dioxide are still being generated at significant levels within the waste body, however currently there is no evidence of any significant migration of gas away from fill area.

The on-site building is no longer used and it is planned to demolish it in the near future, which will eliminate the risk associated with landfill gas. There is a Halting Site 150m to the south of the site, but there are no other residential dwellings within 250m. It is possible that at some time in the future the lands immediately surrounding the site could be developed for residential and/or commercial purposes.

The in-situ boulder clay surrounding the waste body has a moderate to low permeability, which inhibits gas movement while the water saturated conditions in the marsh along the landfill's north-western, northern and north-eastern margins also inhibit gas migration in these directions. The only area where landfill gas migration has the potential to occur to any great extent is to the south, where the nearest occupied buildings (Halting Site) are located.

5.4 Ecosystem

The marsh comprised reed swamp (FS1) habitat, with some wet alder / willow woodland (WN6). A small stand of non-native Japanese Knotweed is present. This habitat is considered to be of high local importance and is connected with the Carrownreddy Lough and associated wetlands, to the north. It is also an important habitat for breeding birds.

The reed swamp provides an important function as a natural attenuation of the leachate from the former landfill. This habitat will require the maintenance of a high water table or permanent standing water for its ongoing viability.

There is the potential for the remedial works (placement of low permeability cap over the waste) to encroach into the reed swamp habitat at the existing toe of the landfill. An Appropriate Assessment Screening, completed as part of the ecological assessment and included in the Ecofact Report, conclude that the remedial works will not result in significant impacts affecting the Natura 2000 site network, in particular the River Suir SAC.

The Japanese knotweed on the site will require a management and control. The small stands present on the site would be much easier to treat and control in the short term, rather than allow the spread and colonisation of large areas of the site by this species.

5.5 Risk Category

The site is a Class A High Risk Site, based on the risk to surface water and the risk of landfill gas migration and remedial measures are required to mitigate the risk to surface water.

6. RECOMMENDATIONS

6.1 Surface Water

The source(s) of surface water contamination in the drain entering the marsh from the west should be investigated.

Should surface water flow be observed in the drain entering the marsh from the south the water quality should be monitored to establish its status. It appears that this drain has recently been dug and if the monitoring identifies an impact, the drain should be blocked to prevent discharge to the marsh.

The landfill should be capped to minimise the infiltration of rainfall to the waste. required in some portions of the site but some compacting, grading, surface drainage. The Council has already capped a portion of the fill area but additional compacting and grading of those area may be required.

The alternative to capping the landfill is

a) Do nothing and allow the existing leachate generation within the waste through rainfall infiltration to continue to impact on the surface water drain downstream of the facility.

b) Remove the waste. The environmental impact caused by this option would most likely have a greater impact on the ecology of the wetland and on surface water quality downstream of the site. In addition the financial cost would be much larger than undertaking a remedial solution in-situ.

6.2 Landfill Gas

The existing landfill gas wells should be retained and additional landfill gas ventilation wells installed across the site to minimise the risk of build up of landfill gas pressures and minimise the risk of landfill gas migration.

A landfill gas cut-off trench should be installed along the southern boundary of the capped fill area to minimise the risk of landfill gas migration toward existing and/or future dwellings proposed for this area once the landfill is capped.

Landfill gas monitoring should be undertaken in wells MW5, 6 and 7 at monthly intervals to assess the risk of off-site migration toward the Halting Site and the residential area further south. Should the levels remain low after 12 months the monitoring frequency could be reduced to quarterly in Year 2 and Bi-annually thereafter.

All the gas monitoring wells should be monitored at least annually. If development occurs within 250m of the site boundary, more frequent monitoring may be required.

6.3 Ecology

Plant used in the remedial works should not be allowed to enter the marsh. Ground disturbance within 5-10m of the landfill margins adjacent to the marsh should be minimised using silt curtains and appropriate site fencing.

The Japanese knotweed should be treated and controlled to prevent it from becoming a dominant invasive species in the marsh wetland area.

6.4 Groundwater

Following capping, groundwater monitoring should be undertaken to establish the effectiveness of the works. The monitoring should be at least bi-annual.

6.5 Remedial Works

The scope of the proposed remedial works are set out in the Preliminary Remedial Action Plan in Appendix 3.

APPENDIX 1

Laboratory Analytical Data

Environmental Protection Agency
Regional Inspectorate
Seville Lodge, Callan Road,
Kilkenny

SOUTH TIPPERARY COUNTY COUNCIL
RECEIVED
10 SEP 2010
ENVIRONMENT

Report of: Surface Waters - Tipperary Town Landfill
Report to: South Tipperary Co. Co.
Report date: 07/09/10

Location sampled: Miscellaneous Surface Water
Date sampled: 13/07/2010 Date received: 14/07/2010

Laboratory Ref:		1003149	1003150	1003151
Type of sample:		Misc	Misc	Misc
Sampling point:		SW1 (10-0858)	SW2 (10-0859)	SW3 (10-0860)
Sampled by:		Denis McGuire	Denis McGuire	Denis McGuire
Time Sampled:		14:30	12:15	12:00
Start/End - Dates of Analysis:				
Status of results:		**Final Report**	**Final Report**	**Final Report**
Parameter	**Units**			
Alkalinity-total (as CaCO3)	mg/l CaCO3	359	391	291
Biochemical Oxygen Demand	mg/l O2	3.2	7.1	5.7
Chemical Oxygen Demand	mg/l O2	48	73	91
Conductivity @25°C	µS/cm	913	969	766
Fluoride	mg/l F	nm	nm	nm
Sulphate	mg/l SO4	nm	nm	nm
Aluminium	ug/l	<25	<25	46
Antimony	ug/l	<0.5	<0.5	<0.5
Arsenic	ug/l	1.9	1.3	4.5
Barium	ug/l	140	200	210
Beryllium	ug/l	<0.5	<0.5	<0.5
Boron	ug/l	66	83	56
Cadmium	ug/l	<0.5	<0.5	<0.5
Calcium	mg/l	84	88	110
Chromium	ug/l	14	15	11
Cobalt	ug/l	0.5	0.5	0.9
Copper	ug/l	0.6	0.8	4.6
Iron	ug/l	1800	2800	3400
Lead	ug/l	<0.5	<0.5	0.7
Magnesium	mg/l	10	11	6.2

Laboratory Ref:		1003149	1003150	1003151
Type of sample:		Misc	Misc	Misc
Sampling point:		SW1 (10-0858)	SW2 (10-0859)	SW3 (10-0860)
Sampled by:		Denis McGuire	Denis McGuire	Denis McGuire
Time Sampled:		14:30	12:15	12:00
Start/End - Dates of Analysis:				
Status of results:		**Final Report**	**Final Report**	**Final Report**
Parameter	Units			
Manganese	ug/l	800	840	1600
Mercury	ug/l	<0.5	<0.5	<0.5
Molybdenum	ug/l	<0.5	<0.5	<0.5
Nickel	ug/l	0.9	0.8	2.3
Potassium	mg/l	6.3	7.2	0.8
Selenium	ug/l	0.8	0.7	0.6
Sodium	mg/l	36	43	9.3
Thallium	ug/l	<0.5	<0.5	<0.5
Tin	ug/l	<1	<1	<1
Uranium	ug/l	<0.5	<0.5	1.1
Vanadium	ug/l	<0.5	<0.5	0.6
Zinc	ug/l	18	22	34
Ammonia	mg/l N	6.1	7.5	0.03
Chloride	mg/l Cl	67	83	17
Nitrite (as N)	mg/l N	0.007	<0.002	<0.002
ortho-Phosphate (as P)	mg/l P	0.18	0.29	0.08
Total Oxidised Nitrogen (as N)	mg/l N	<0.50	<0.50	<0.50
pH	pH	7.3	7.1	7.6
Suspended Solids	mg/l	<18.2	34	89

Comments: Surface water samples taken from Tipp town landfill. For South Tipp Co. Co.

1) Results highlighted and in bold are outside specified limits.
2) All Metals Analysed in the EPA Dublin Laboratory,
Cyanide Analysed in the EPA Cork Laboratory.
Phenols Analysed in the EPA Castlebar Laboratory.
3) nm "Not measured"
4) nd "None detected"
5) nt "No time" - Time not recorded
6) tntc "Too numerous to count"
7) F "Field measured parameters"

Signed: Date: 7/9/10

Caroline Bowden, A/Regional Chemist

Environmental Protection Agency
Regional Inspectorate
Seville Lodge, Callan Road,
Kilkenny

Report of: Groundwater - Tipperary Town Landfill
Report to: South Tipperary Co. Co.
Report date: 07/09/10

Location sampled: Miscellaneous Landfill Groundwater
Date sampled: 13/07/2010 Date received: 14/07/2010

		Laboratory Ref:	1003152	1003153	1003154	1003155	
		Type of sample:	Misc	Misc	Misc	Misc	
		Sampling point:	MW8 - 10-0861	MW6 - 10-0862	MW5 - 10-0863	MW4 - 10-0864	
		Sampled by:	Denis McGuire	Denis McGuire	Denis McGuire	Denis McGuire	
		Time Sampled:					
		Start/End - Dates of Analysis:					
		Status of results:	**Final Report**	**Final Report**	**Final Report**	**Final Report**	
Parameter	**Units**	**Limits**					
Alkalinity-total (as CaCO3)	mg/l CaCO3		407	576	545	408	
Conductivity @25°C	µS/cm		1916	1110	1748	936	
Fluoride	mg/l F		0.09	0.08	0.09	0.07	
Sulphate	mg/l SO4		56	41	53	20	
Aluminium	ug/l		290	800	1900	910	
Antimony	ug/l		<0.5	<0.5	<0.5	<0.5	
Arsenic	ug/l		6.6	1.6	3.4	1.7	
Barium	ug/l		1000	140	220	240	
Beryllium	ug/l		<0.5	<0.5	<0.5	<0.5	
Boron	ug/l		29	120	40	20	
Cadmium	ug/l		<0.5	<0.5	<0.5	<0.5	
Calcium	mg/l		140	150	71	120	
Chromium	ug/l		24	29	21	21	
Cobalt	ug/l		2.1	2.9	4.5	1.8	
Copper	ug/l		12	8.4	15	4.8	
Iron	ug/l		1500	940	2500	1300	
Lead	ug/l		5.4	6.2	13	6.7	
Magnesium	mg/l		15	13	6.6	8.5	
Manganese	ug/l		1500	1400	360	160	
Mercury	ug/l		<0.5	<0.5	<0.5	<0.5	

Laboratory Ref:			1003152	1003153	1003154	1003155	
Type of sample:			Misc	Misc	Misc	Misc	
Sampling point:			MW8 - 10-0861	MW6 - 10-0862	MW5 - 10-0863	MW4 - 10-0864	
Sampled by:			Denis McGuire	Denis McGuire	Denis McGuire	Denis McGuire	
Time Sampled:							
Start/End - Dates of Analysis:							
Status of results:			**Final Report**	**Final Report**	**Final Report**	**Final Report**	
Parameter	**Units**	**Limits**					
Molybdenum	ug/l		<0.5	<0.5	<0.5	<0.5	
Nickel	ug/l		8.6	7.2	9.3	4.9	
Potassium	mg/l		0.7	4.8	1.2	0.7	
Selenium	ug/l		0.9	1	<0.5	0.8	
Sodium	mg/l		160	22	240	45	
Thallium	ug/l		<0.5	<0.5	<0.5	<0.5	
Tin	ug/l		<1	<1	<1	<1	
Uranium	ug/l		1.7	1.7	0.5	0.7	
Vanadium	ug/l		1.6	1.4	4.8	2	
Zinc	ug/l		27	28	48	29	
Ammonia	mg/l N		0.03	0.37	0.03	0.03	
Chloride	mg/l Cl		341	28	279	61	
Nitrite (as N)	mg/l N		0.003	0.004	<0.002	<0.002	
ortho-Phosphate (as P)	mg/l P		0.06	0.08	<0.01	0.03	
Total Oxidised Nitrogen (as N)	mg/l N		0.53	4.13	0.75	2.01	
pH	pH		7.0	7.0	7.8	7.1	

Comments:

1) Results highlighted and in bold are outside specified limits.

2) All Metals Analysed in the EPA Dublin Laboratory,
Cyanide Analysed in the EPA Cork Laboratory.
Phenols Analysed in the EPA Castlebar Laboratory.

3) **nm** "Not measured"
4) **nd** "None detected"
5) **nt** "No time" - Time not recorded
6) **tntc** "Too numerous to count"
7) F "Field measured parameters"

Signed: Date: 7/9/10

Caroline Bowden, A/Regional
Chemist

Environmental Protection Agency
Regional Inspectorate
Seville Lodge, Callan Road,
Kilkenny

Report of: Leachate - Tipperary Town Landfill
Report to: South Tipperary Co. Co.
Report date: 07/09/10

Location sampled: Miscellaneous Leachate
Date sampled: 13/07/2010 Date received: 14/07/2010

	Laboratory Ref:	1003156	1003157	
	Type of sample:	Misc	Misc	
	Sampling point:	MW3 - 10-0865	MW2 10-0866	
	Sampled by:	Denis McGuire	Denis McGuire	
	Time Sampled:			
	Start/End - Dates of Analysis:			
	Status of results:	**Final Report**	**Final Report**	
Parameter	**Units**			
Biochemical Oxygen Demand	mg/l O2	<30	<30	
Chemical Oxygen Demand	mg/l O2	480	562	
Conductivity @25°C	µS/cm	5330	4300	
Fluoride	mg/l F	0.15	0.37	
Sulphate	mg/l SO4	16	100	
Aluminium	ug/l	1300	2200	
Antimony	ug/l	1.3	2.7	
Arsenic	ug/l	14	31	
Barium	ug/l	1700	320	
Beryllium	ug/l	<0.5	<0.5	
Boron	ug/l	640	1600	
Cadmium	ug/l	<0.5	1.3	
Calcium	mg/l	160	30	
Chromium	ug/l	49	37	
Cobalt	ug/l	3.8	7.9	
Copper	ug/l	30	43	
Iron	ug/l	9300	3800	
Lead	ug/l	95	110	
Magnesium	mg/l	44	33	
Manganese	ug/l	510	480	

	Laboratory Ref:	1003156	1003157	
	Type of sample:	Misc	Misc	
	Sampling point:	MW3 - 10-0865	MW2 10-0866	
	Sampled by:	Denis McGuire	Denis McGuire	
	Time Sampled:			
	Start/End - Dates of Analysis:			
	Status of results:	**Final Report**	**Final Report**	
Parameter	**Units**			
Mercury	ug/l	<0.5	<0.5	
Molybdenum	ug/l	1.1	14	
Nickel	ug/l	8.7	21	
Potassium	mg/l	62	150	
Selenium	ug/l	3	18	
Sodium	mg/l	650	430	
Thallium	ug/l	<0.5	<0.5	
Tin	ug/l	<1	1	
Uranium	ug/l	<0.5	0.5	
Vanadium	ug/l	9.5	17	
Zinc	ug/l	190	280	
Ammonia	mg/l N	37	120	
Chloride	mg/l Cl	1320	875	
Nitrite (as N)	mg/l N	<0.002	<0.002	
ortho-Phosphate (as P)	mg/l P	0.16	0.44	
Total Oxidised Nitrogen (as N)	mg/l N	<0.50	<0.50	
pH	pH	7.2	8.7	

Comments:

1) Results highlighted and in bold are outside specified limits.

2) All Metals Analysed in the EPA Dublin Laboratory,
Cyanide Analysed in the EPA Cork Laboratory.
Phenols Analysed in the EPA Castlebar Laboratory.

3) **nm** "Not measured"
4) **nd** "None detected"
5) **nt** "No time" - Time not recorded
6) **tntc** "Too numerous to count"
7) **F** "Field measured parameters"

Signed: Date: 7/9/10

Caroline Bowden, A/Regional
Chemist

APPENDIX 2

Ecofact Report

Former Landfill at Tipperary Town

Ecological Assessment
And
Appropriate Assessment Stage 1: Screening

Version: 13th October 2011

ecofact
Environmental Consultants

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TABLE OF CONTENTS

1 INTRODUCTION

The current report provides the results of an ecological assessment undertaken at the former landfill site, on the northern outskirts of Tipperary town at Carrownreddy. The assessment has been undertaken as part of the Tier 3 Risk Assessment for the closed landfill, on behalf of O'Callaghan Moran and Associates. The site has been categorised as being a Class A – High Risk site due to the risk to humans from landfill gas and also due to the potential for leachate migration.

Ecofact Environmental Consultants Ltd. have been commissioned to carry out an ecological assessment of the marsh / reed swamp area adjacent to the closed landfill to evaluate the impacts, if any, of the closed landfill on this area.

Additionally, an Appropriate Assessment Stage 1 Screening has been carried out for the proposed remediation measures to assess whether this proposal is likely to have a significant effect on the Natura 2000 site network. Effects upon the conservation objectives and qualifying interests (including habitats and species) within the affected designated areas are considered. An Appropriate Assessment is required under Article 6 of the Habitats Directive (92/43/EEC), in instances where a plan or project may give rise to significant effects upon a Natura 2000 site. Natura 2000 sites are those identified as sites of European Community importance designated under the Habitats Directive (SACs) or the Birds Directive (SPA).

The current document meets this requirement by providing a Screening Assessment of the proposed remediation works in Appendix 1 of the current report and follows the guidance for screening published by the National Parks and Wildlife Service (NPWS 2009) '*Appropriate Assessment of Plans and Projects in Ireland. Guidance for Planning Authorities'*. The area of marsh / reed swamp habitat adjacent to the landfill, within the study area is not designated within any Natura 2000 site and is not considered within the context of an Appropriate Assessment.

2 METHODOLOGY

A desktop review was carried out to identify features of ecological importance within the study area. Sources included the National Parks and Wildlife Service online database of protected species. A full bibliography of reports and publications used in the desk study are provided in the references section of this report. A review of the published literature was undertaken in order to collate data on the receiving environment, including species and habitats of conservation concern in the study area. The collation of this information, as well as examination of Ordinance Survey mapping, aerial photography and conservation designations from the NPWS online mapping allowed areas of potential ecological importance to be highlighted prior to the field survey.

A site walkover of the closed landfill site was undertaken by a qualified ecologist (MIEEM) with a particular focus on the marsh area and the connection between the landfill site and the existing land drain to the east. This drain was sampled using a sweep net to identify the macroinvertebrate community present, to allow for an evaluation of the biological water quality within the drain. Water levels within the drain were found to be low and the substrate was dominated by silt and decaying vegetation; therefore unsuitable for the application of the EPA Q-value assessment or the EPA Small Streams Risk Score (SSRS) assessment.

Habitats were classified according to habitat descriptions and codes published in the Heritage Council's '*A Guide to Habitats in Ireland*' (Fossitt, 2000). Plant species nomenclature follows Stace '*New Flora of the British Isles*' (1997) and scientific names are given at first mention. An assessment of fauna within the study area was made during the site visit, with particular emphasis on the presence of protected species.

3 RESULTS

3.1 Habitat survey

Habitats recorded from the site are classified according to Fossitt (2000) and are described in detail below. The wetland habitat within the site was surveyed and the results are discussed under the relevant habitat type – Reed / large sedge swamp (FS1).

3.1.1 Improved Agricultural grassland (GA1)

The field directly east of the closed landfill site, containing the southern portion of the reed swamp wetland was characterised as improved agricultural grassland. The field was grazed by horses and floral diversity was low. The sward was dominated by a rye-grass mix *Lolium* sp. with broadleaved herbs typical of this habitat recorded including: Nettle *Urtica dioica*, Creeping buttercup *Ranunculus repens,* Meadow buttercup *Ranunculus acris,* Broad dock *Rumex obtusifolius,* Ragwort *Senecio jacobaea* and Dandelions *Taraxacum officinale agg.*

3.1.2 Reed / Large sedge swamp (FS1)

The marsh habitat referred to in the Tier 3 Risk Assessment was found to be dominated by Bulrush Typha latifolia, with abundant Yellow Iris *Iris pseudacorus*; this results in the classification as a reed / large sedge swamp where the overall diversity within this habitat was found to be species poor. Broad leaved herbs occurred, comprising a small percentage of the overall habitat. Additional species recorded from the swamp and its margins included Floating sweet-grass *Glyceria fluitans,* Yorkshire fog *Holcus lanatus,* Cocksfoot grass *Dactylis glomerata,* Tussock-grass *Deschampsia cespitosa,* Hard rush *Juncus inflexus,* Soft rush *Juncus effusus*, Common marsh-bedstraw *Galium palustre,* Willowherb *Epilobium sp.,* Meadowsweet *Filipendula ulmaria,* Silverweed *Potentilla anserina,* Woody nightshade *Solanum dulcamara*, Water-cress *Rorippa nastutium-aquatica,* Water horsetail *Equisetum fluviatile* (and other Equisetum species), Hemlock water-dropwort *Oenanthe crocata* and Duckweed *Lemna* spp. recorded from the small pools of open water. Alder and willow woodland was recorded from the northern portion of the swamp as described below.

The botanical community recorded from within this swamp habitat is indicative of permanent water-logging, with some standing water evident in pools, although *Lemna* sp. was found to be abundant. Water quality may present a constraint to the naturalness or diversity of flora within this habitat, however, the current community represents a wetland habitat of local ecological importance, both botanically and in relation to the wildlife value it provides (i.e. breeding birds and invertebrates).

3.1.3 Wet willow-alder-ash woodland (WN6)

The northern portion of the reed swamp wetland was found to include alder *Alnus glutinosa* with some willow *Salix* spp. This woodland was not associated with fen peat. This alder woodland would fall within the *Alnus glutinosa – Fillipendula ulmaria* association identified in the NSNW (Perrin *et al*., 2008). This wet woodland is considered to be of high local ecological importance, with cognisance of its connection with Carrownreddy Lough and the associated wetland ecological connectivity.

3.1.4 Drainage ditch (FW4)

Due east of the closed landfill site, the reed swamp was found to discharge to a land drain which flows from the swamp in a south easterly direction. However, on the day of the survey no flow was detectible in the drain due to low water levels. The substrate was found to comprise black, anoxic muds with decaying vegetation (high volume of *Lemna* sp.). A light film of hydrocarbons was evident in standing water where the swamp habitat and the drainage ditch converged. Aquatic macrophyte growth was low, with flora limited to the margins of the drain. Species recorded included Duckweed *Lemna* spp., Water-cress *Rorippa nastutium-aquatica,* Floating sweet-grass *Glyceria fluitans* and Yorkshire fog *Holcus lanatus.*

The land drain is evaluated as being of low ecological importance.

3.1.5 Treeline (WL2)

The line of the drainage ditch to the east of the reed swamp, within the agricultural grassland included a treeline dominated by Ash *Fraxinus excelsior* with some Alder *Alnus glutinosa* and Hawthorn *Crataegus monogyna*. Flora recorded from the understory included Brambles *Rubus fruticosus agg.,* Hart's-tongue Fern *Phyllitis scolopendrium,* Ivy *Hedera helix* and Dog-rose *Rosa canina agg.* This treeline was not continuous along field boundary, although treelines and hawthorns were common along field boundaries within the local context.

The treeline along the land drain is evaluated as being of local ecological importance, although it is fragmented and is not properly connected with the treeline network within the local landscape. The infilling of the surrounding fields with construction and demolition (C&D) waste has disrupted the hedgerow and treeline corridors within the local context.

3.1.6 Spoil and bare ground (ED2)

Directly north of the closed landfill compound an area of open bare ground and spoil was recorded where top-soil material, vegetation cuttings and some C&D waste had recently been dumped. This material was banked along the northern periphery of the elevated landfill, with a turning circle cleared in the centre. Some of this material was found to be slipping down the embankment to the wetland habitat surrounding the northern and eastern perimeter of the closed landfill.

This habitat was evaluated as being of low ecological importance.

3.1.7 Recolonising bare ground (ED3)

A significant portion of the lands to the north and east of the reed swamp wetland comprised recolonising bare ground, where C&D waste was becoming re-vegetated with ruderal broadleaved species. Grass cover was very low. The elevated fill material was well-compacted and it is expected that recolonisation will take a period of years.

Species recorded from within this habitat included Docks, Nettle, Willowherb, Ragwort, Thistle species, Plantain species *Plantago* spp., Lesser Burdock *Arctium minus,* Groundsel *Senecio vulgaris,* Japanese knotweed *Fallopia* japonica (limited to the southeastern corner of the closed landfill site, due south of the reed swamp habitat). Elder *Sambucus nigra,* Buddleja *Buddleja davidii,* Travellers Joy *Clematis vitalba,* Butterbur *Petasites hybridus,* Winter heliotrope *Petasites fragrans* and Brambles *Rubus fruticosus agg.*

This habitat was evaluated as being of low ecological importance.

3.2 Additional ecological observations

The swamp habitat identified along the northern and eastern boundary of the site contains a botanical community identified as compatible with the requirements of whorl snails (*Vertigo* spp.). A screening search for these species was undertaken on the site and none were recorded. It is considered that the background water quality issues at the site are having an impact on the macroinvertebrate communities (both aquatic and semi-aquatic). Given the constraints at the site, it is considered that whorl snail species are unlikely to occur, with no records of these species previously recorded from the study area.

A sweep-net sample was taken from the land drain directly below the discharge from the swamp. An EPA biotic index (Q-value) would not be applicable to this site given the size of the drain and low flow conditions present. However, it is noted that the macroinvertebrate diversity recorded were limited to taxa tolerant of pollution, as shown in Table 1. No pollution sensitive taxa were recorded.

No connection was noted between the land drain on the site and the upper reaches of the Fidaghta River, which flows to the north of the study area. The land drain from the closed landfill site was followed downstream to Rosanna Road where it was culverted below a new residential development. Upstream of the road the drain created a wide area of wet grassland and marsh habitat as shown. No open water or flow was visible in the culvert under the road. According to the EPA Envision online mapping the surface water flows from the marsh area are within the Fidaghta River catchment. However, from onsite walkover studies undertaken by O'Callaghan Moran & Associates, it has been determined that these flows are to the Ara River catchment, which flows to the south of Tipperary town.

Table 1 Macroinvertebrates recorded during the sweep-net sampling at the land-drain due east of the Tipperary closed landfill.

Group / organism	Pollution sensitivity group	Functional group	Abundance
TRUE FLIES (Diptera)			
Family Chironomidae			
Green chironomid	C	Filtering collector	Common
Chironomous sp.	E	Filtering collector	Common
SNAILS (Mollusca, Gastropoda)			
Ramshorn Snail (Family Planorbidae)			
Planorbis sp.	C	Scraper	Present
Family Lymnaeidae			
Lymnaea peregra	D	Filtering collector	Fair numbers
MUSSELS (Mollucsa, Lamellibranchiata)			
Orb/Pea Mussels (Sphaeridae)	D	Filtering collector	Present
CRUSTACEANS (Crustacea)			
Isopoda (Family Asellidae)			
Asellus aquaticus	D	Shredder	Common
LEECHES (Hirudinae)			
Family Glossiphonidae			
Helobdella stagnalis	D	Predator	Present
TUBIFICID WORMS	D	Collector	Common

No observations or evidence of protected mammals were recorded during the site survey and it is considered unlikely that the site is important for protected species. The standing water within the swamp habitat provides suitable habitat for frogs and newts, although neither species were recorded on the day of the survey.

The invasive, non-native species Japanese knotweed *Fallopia japonica* was recorded from the south eastern corner of the closed landfill site, adjacent to the laneway. The disturbed nature of the site provides ideal habitat for the spread of this species which will require further management and control.

4 DISCUSSION

The ecological assessment of the wetland habitat at the former landfill at Tipperary town has identified the presence of reed swamp (FS1) habitat, with some wet alder / willow woodland (WN6). This habitat is evaluated as being of high local importance and is connected with the Carrownreddy Lough and associated wetlands, to the north. There is no data available on the diversity or ecological importance of this habitat or the biodiversity value of Carrownreddy Lough prior to the landfill, to provide a benchmark for the current situation at this reed swamp. However, the botanical community within this habitat is likely to maintain its diversity despite any further leachate inputs from the landfill (based on the current situation).

Water levels were found to be very low on the site during the current assessment, both in the reed swamp habitat and in the land drain, although there was evidence in the botanical community that this habitat is water-logged throughout the year.

It is considered that the surrounding lands are currently providing little dilution of leachate to the land drain which was receiving minimal flows from the swamp and was barely flowing on the day of the survey, with pooled water observed in sections downstream. The substrate of the swamp and land drain were found to be anoxic, although this is considered to be a combined function related primarily to the stagnant conditions within the low-lying swamp.

The reed swamp is considered to be providing an important function as a natural attenuation of the leachate from the former landfill, in agreement with the findings of the '*Tier 2 Detailed Site Investigation*' (OCM, 2009). This habitat will require the maintenance of a high water table or permanent standing water for its ongoing viability.

Although water quality in the reed swamp is likely to be affected by the leachate from the reed swamp, the botanical community recorded is indicative of a semi-natural habitat. More significant impacts may relate to the macroinvertebrate communities present. This reed swamp and wet woodland is considered to comprise an important habitat for breeding birds, with at least one pair of moorhens recorded on the day of the survey.

Based on the current one-off site visit during low flow conditions, the land drain on the site appeared to be affected by water quality impacts requiring further remediation measures during the Tier 3 Risk Assessment.

The proposed remediation at the landfill site will require the placement of a 0.5-1m cap across the whole of the landfill. There is the potential for these works to encroach into the reed swamp habitat at the existing toe of the landfill. Impacts affecting the reed swamp will be reduced by restricting machinery access to the top of the existing landfill and avoiding any machinery within the wetland area. There remains the potential for some disturbance at the perimeter of the existing landfill i.e. within 5-10m of the landfill margins in the west, north and east of the landfill with the potential for silt and clay run-off during the capping process. This will be mitigated against effectively using silt curtains and appropriate site fencing. Following the completion of capping the revegetation of the landfill will stabilize sediments on the banks of the landfill.

There is an overall beneficial impact to the reedbed habitat at this location arising from the proposed remediation works, where leachate and surface water runoff will be minimized by the proposed works resulting in an improvement in water quality within this water dependant habitat. There will be further downstream impacts benefiting the Ara River, in the local context. There are no impacts affecting the reedbed / wetland habitat at this site which would have any effects on the Natura 2000 site network. This semi-aquatic habitat is not designated within any Natura 2000 site and is indirectly connected to the River Suir SAC via the land drain and the Ara River, which is a tributary of the Aherlow River.

With regard to the Appropriate Assessment Screening Report (see Appendix 1) it is concluded that the proposed Tier 3 Remediation works for the former Tipperary Landfill will not result in significant impacts affecting the Natura 2000 site network, in particular the River Suir SAC. Therefore it is not considered necessary for the ‘Appropriate Assessment’ process to proceed to Stage 2. Impacts arising from the proposed works are evaluated as being limited to the local context and would not extend in significance to the SAC which is located approximately 16 river kilometres downstream of the landfill site. Any beneficial impacts arising from the proposed remediation works would affect the Ara River within the local context; however, it is considered that this would not have any significant positive impact on the River Suir SAC, downstream of the Ara and Aherlow Rivers.

The Japanese knotweed on the site will require a management and control strategy for inclusion in the Remediation Measures during Tier 3. The small stands present on the site would be much easier to treat and control in the short term, rather than allow the spread and colonisation of large areas of the site by this species.

REFERENCES

European Commission (2001) *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 Commission Environment DG

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PLATES

Plate 1 View of the agricultural grassland to the east of the closed landfill. The swamp habitat is visible in the centre left of the image, where it meets the land drain, along the treeline (centre).

Plate 2 View of the eastern portion of the reed swamp, where it discharges to the land drain. Emergent flora within the swamp and drain were searched for whorl snails.

Plate 3 Water levels in the land drain were found to be very low, with no noticable flow.

Plate 4 View west from the elevated C&D waste spoil. The swamp habitat is visible in the centre of the image, with the elevated closed landfill in the background.

Plate 5 View north across the recolonising bare ground of the C&D waste spoil.

Plate 6 View of the drier margins of the swamp where the C&D spoil has altered the water table.

Plate 7 View of the *Typha* dominated swamp directly east of the closed landfill.

Plate 8 *Typha* dominated swamp with Alder woodland along the northern line of the closed landfill. *Juncus* was common along the interface between the drier C&D spoil and the reed swamp wetland.

Plate 9 The northern portion of the swamp, view west. Alder and willow wet woodland was recorded from within the permanent wetland habitat.

Plate 10 Limited open areas of water were noted. Duckweed was found to be abundant wherever they occurred. Moorhens were recorded from within the swamp.

Plate 11 Japanese knotweed was recorded along the road margin at the south eastern corner of the closed landfill site. It is considered that the site presents suitable habitat for the spread of this species, which will continue if unmanaged.

Plate 12 View of the old buildings and material storage on the closed landfill site.

Plate 13 A view north showing the fenced compound on the closed landfill site. The swamp habitat is located to the east (right of the image).

Plate 14 To the north of the fenced compound on the landfill there is an area of freshly dumped topsoil, construction waste and vegetation. This is piled along the embankment at the edge of the swamp habitat.

Plate 15 The dumped material was found to be unstable and slipping downslope into the swamp habitat. It is expected that suspended solids and run-off from this waste is washing down into the swamp.

Plate 16 The land drain due south of the landfill was found to be impounded. No flow was recorded from the drain downstream. Pooled water was recorded directly adjacent to the road.

Plate 17 View north from Rosanna Road. No flow was recorded from the land drain due south of the closed landfill, at Rosanna Road. The construction of new residential developments as depicted and across the road to the south are likely to have altered the flow of this drain. The wet grassland / marsh habitat visible in this image is attributed to frequent high water levels within the land drain.

Appendix 1 Appropriate Assessment Screening Report

Table A1.1 Appropriate Assessment Screening Matrix for the proposed Tier 3 remediation works at the former Tipperary Landfill, Tipperary Town

Screening matrix	
Brief description of the project or plan	The current Tier 3 remediation works proposal for the former landfill at Carrownreddy, Tipperary Town has identified the need for the placement of a 0.5-1m cap across the whole of the landfill. Currently the site has been categorised as being a Class A – High Risk site due to the risk to humans from landfill gas and also due to the potential for leachate migration. The remediation works proposed will not require dewatering or alteration of the local drainage network. The net effect of capping would be an improvement in water quality reaching the local drainage network and a reduction in leachate, as rainwater is diverted from the waste mass.
Brief description of the Natura 2000 site network	The former landfill at Tipperary Town is located within 15km of the following Natura 2000 sites: -The Lower River Shannon SAC (002165), approximately 10km due north -The Galtee Mountains SAC (000646), approximately 9km due south -Moanour Mountain (002257), approximately 6km due southwest None of these designated Natura 2000 sites are connected to the former landfill site, either geographically or via hydrological or hydrogeological connections. The former landfill site is within the River Suir catchment and a drainage channel adjacent has been found to be connected to the Ara River (and not the Fidaghta River as shown on EPA Envision mapping). The Ara River is a tributary of the Aherlow River which confluences with the River Suir. The Ara River flows to the south of Tipperary Town; within one kilometre of the former landfill site at its closest point. The Ara River meets the Aherlow River, which is designated within the River Suir SAC, approximately 15 river kilometres downstream of Tipperary Town. Therefore the River Suir SAC is the only designated Natura 2000 site with any connection to the former landfill site; with regard to the indirect connection between the site and the SAC via the Ara River.
Assessment criteria	
Describe the individual elements of the project (either alone or in combination with other plans or projects) likely to give rise to impacts on the Natura 2000 site.	The proposed Tier 3 remediation works at the former landfill site will require capping of the landfill site to minimise run-off and leachate entering the drainage network. There is potential for the proposed works to cause disturbance to the drainage regime within the former landfill site, with the associated potential for the mobilisation of settled leachate material into the drainage network during the construction phase. The mobilisation of leachate material within the land drain adjacent to the site may result in the transportation of suspended solids and leachate pollutants to the Ara River, with the further potential for the transportation of this material downstream to the Aherlow River within the SAC.

Describe any likely direct, indirect or secondary impacts of the project (either alone or in combination with other plans or projects) on the Natura 2000 site by virtue of: • size and scale; • land-take; • distance from the Natura 2000 site or key features of the site; • resource requirements (water abstraction etc.); • emissions (disposal to land, water or air); • excavation requirements; • Transportation requirements; • duration of construction, operation, decommissioning, etc.; • other.	There are no likely direct impacts of the proposed remediation works affecting the River Suir SAC, as there are no direct connections to the SAC, neither are there any land-take requirements within a designated Natura 2000 site. There are no resource requirements, emissions, excavation requirements or transportation requirements likely to give rise to direct impacts on any Natura 2000 site. There are no likely indirect or secondary impacts arising from the proposed works which may affect the Natura 2000 site network, or the River Suir SAC in particular, with regard to the size and scale of the proposed works; land take; resource requirements, excavation requirements, transportation requirements or the duration of the proposed works. Indirect impacts in relation to emissions from the proposed site to water and the distance to the River Suir Natura 2000 site are identified as being relevant. However, the distance between the site and the SAC is approximately 15 river kilometres downstream; where the connection between the site and the Ara River is via a small, low capacity land drain.
Describe any likely changes to the site arising as a result of: • reduction of habitat area: • disturbance to key species; • habitat or species fragmentation; • reduction in species density; • changes in key indicators of conservation value (water quality etc.); • climate change.	From the current assessment there are no likely changes to the River Suir SAC arising as a result of any reduction in habitat area or disturbance to key species. The proposed works do not give rise to the likelihood for habitat or species fragmentation or a reduction in species density within the SAC. There are no likely changes to the key indicators of conservation value i.e. water quality within the SAC, located 15 river kilometres downstream of the site. In fact it is considered that the proposed works will have a beneficial impact on water quality within the Ara catchment with the minimisation of leachate and run-off from the existing un-capped landfill (as identified in the Tier 2 Hydrogeological Report).
Describe any likely impacts on the Natura 2000 site as a whole in terms of: • interference with the key relationships that define the structure of the site; • interference with key relationships that define the function of the site.	The current assessment has identified that the proposed remediation works at the former Tipperary Landfill site will not have any direct, indirect or secondary / cumulative impact on the Natura 2000 site network, or the River Suir SAC in particular, with regard to interference with the key relationships defining the structure and function of the site. Furthermore there are significant beneficial impacts arising from the proposed works with regard to water quality within the undesignated Ara catchment. The area of marsh habitat adjacent to the landfill, within the study area is not designated within any Natura 2000 site and is not considered within the context of an Appropriate Assessment.
Provide indicators of significance as a result of the identification of effects set out above in terms of: • loss; • fragmentation; • disruption/disturbance; • change to key elements of the site (e.g. water quality).	The proposed remediation works at the former Tipperary Landfill site will not have any significant impacts, direct, indirect or cumulative on the River Suir SAC in terms of loss or fragmentation. There will be no significant impacts with regard to disturbance or disruption of the conservation interests and key relationships of the site. There will be no significant impacts arising which would result a change to the key elements of the site (i.e. water quality). In fact it is considered that the proposed remediation works would result in a positive impact on water quality in the Ara River downstream of the works. However, this is considered unlikely to result in any perceptible change in water quality in the River Aherlow, given the distance and dilution between the Aherlow and the landfill site.
Describe from the above those elements of the project or plan, or combination of elements, where the above impacts are likely to be	There are no impacts arising from the proposed remediation works likely to significantly affect the Natura 2000 site network. There is no potential for direct impacts on any Natura 2000 site arising from the proposed works and indirect impacts are limited to the hydrological connection between the site and the River Suir SAC. However, the connecting

<table>
<tr><td>significant or where the scale or magnitude of impacts is not known.</td><td colspan="3">watercourses (land drain and Ara River) and the distance (approx. 15Rkm) between the site and the SAC, results in the conclusion that there will be no significant impacts arising.</td></tr>
<tr><td colspan="4">Finding of no significant effects report matrix</td></tr>
<tr><td>Is the project or plan directly connected with or necessary to the management of the site (provide details)?</td><td colspan="3">The proposed Tier 3 remediation works are not directly connected with or necessary to the management of the River Suir SAC.</td></tr>
<tr><td>Are there other projects or plans that together with the project or plan being assessed could affect the site (provide details)?</td><td colspan="3">There are no other projects or plans in the Ara River catchment, or the River Aherlow / River Suir catchment which could give rise to cumulative impacts affecting the SAC, as there are no significant impacts identified arising from the proposed works in isolation and the scale of the proposed works with respect to the Ara River are considered to be imperceptible positive, due to the minimisation of leachate and surface water run-off.</td></tr>
<tr><td colspan="4">The assessment of significance of effects</td></tr>
<tr><td>Describe how the project or plan (alone or in combination) is likely to affect the Natura 2000 site.</td><td colspan="3">The proposed Tier 3 remediation works are considered to have no significant impact on the River Suir SAC. There are imperceptible positive impacts identified for the Ara River, which is a tributary of the River Aherlow, with regard to the minimisation of leachate and surface water run-off – however this is not considered to be of a scale that would be quantified within the River Suir SAC, downstream of the confluence between these watercourses.</td></tr>
<tr><td>Explain why these effects are not considered significant.</td><td colspan="3">The small size and scale of the proposed works, combined with the limited hydrological connection to the Ara River within the River Suir catchment (Aherlow sub-catchment) is considered to be the primary limiting factor in relation to the significance of effects. The distance of the proposed works to the SAC (approximately 15 river kilometres) also results in significant river recovery and dilution within the Ara River, in the event of any downstream dispersion of leachate or polluting material. It is not considered likely that this would give rise to any significant effects within the River Suir SAC.</td></tr>
<tr><td colspan="4">Data collected to carry out the assessment</td></tr>
<tr><td>Who carried out the assessment</td><td colspan="3"><i>ECOFCACT Environmental Consultants Ltd., on behalf of O'Callaghan Moran and Associates</i></td></tr>
<tr><td rowspan="2"></td><td>Sources of data</td><td>Level of assessment completed</td><td>Where can the full results of the assessment be accessed and viewed?</td></tr>
<tr><td><i>National Parks and Wildlife Service (NPWS):</i> <i>http://www.npws.ie</i></td><td><i>Article 6 Screening Assessment</i></td><td>The full Assessment is contained within the current document.</td></tr>
<tr><td colspan="4">Overall conclusions</td></tr>
<tr><td colspan="4">The proposed Tier 3 Remediation works for the former Tipperary Landfill will not result in significant impacts affecting the Natura 2000 site network, in particular the River Suir SAC. Therefore it is not considered necessary for the 'Appropriate Assessment' process to proceed to Stage 2. Impacts arising from the proposed works are evaluated as being limited to the local context and would not extend in significance to the SAC which is located approximately 15 river kilometres downstream of the landfill site. Any beneficial impacts arising from the proposed remediation works would affect the undesignated Ara River within the local context; however, it is considered that this would not have any significant positive impact on the River Suir SAC, downstream of the confluence of the Ara River with the Aherlow River.</td></tr>
</table>

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NPWS (2009) *Appropriate Assessment of Plans and Projects in Ireland. Guidance for Planning Authorities*. Department of the Environment, Heritage and Local Government, Ireland.

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APPENDIX 3

Remedial Action Plan

environmental management for business

O' Callaghan Moran & Associates

PRELIMINARY

REMEDIAL ACTION PLAN

TIPPERARY TOWN LANDFILL

Prepared For: -

South Tipperary County Council.,

Prepared By: -

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October 2011

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DRAWINGS

1. INTRODUCTION

The Tier 3 Risk Assessment of the former Tipperary Town Landfill categorised the site as High Risk due to the potential for leachate impact on surface water quality and landfill gas migration. The assessment identified that remedial measures, including the capping of the fill area and the installation of a landfill gas control measures were required.

The report presents the preliminary design of the remedial measures and forms part of the Tier 3 Risk Assessment Report that will be submitted to the Environmental Protection Agency (Agency) as part of the Unregulated Landfill Certification process.

The preliminary design is based on the Agency's Landfill Manuals on Landfill Site Design (2000) and Landfill Restoration and Aftercare (1999) which presents guidance on landfill closure and restoration measures.

2. LANDFILL CAP

2.1 Restoration Profile

The site topography is illustrated on Drawing No. 1.The placement of both the waste and existing cover material has resulted in a landform which generally falls from a central plateau ranging from 97-99mOD in all directions to the surrounding natural ground.

The natural ground forms a low depression which was the original lake but the ground level is higher to the south and west. It is approximately 96mOD along the southern boundary with the landfill. Along the northwest landfill boundary with the marsh the natural ground level is approximately 91.8mOD. The natural ground in the east and also rises up away from the landfill. The lands to the east have been reclaimed with construction/demolition waste which has raised the profile by approximately 1-1.5m to the east of the site.

Within the landfill there are a number of stockpiles of construction demolition waste in the western part of the site that have not been graded. The northwestern portion of the landfill contains a fenced-off sludge disposal area, which is overgrown with vegetation. The southern section of the landfill is occupied by a gravel covered hard stand area which was used as a parking compound for plant when the site was operational. There is an un-occupied building located to the northwest of the parking compound.

Approximately 50% of the site has been covered with soil and vegetated. However, the cover is not uniform in thickness and has not been properly graded to enhance surface water run-off. The existing layout is shown on Drawings 1 and 4.

The proposed finished profile, which is shown on Drawing No. 2, comprises a uniform shallow (1:25) gradient from the south to the north. This gradient will assist surface water drainage. It is the Council's preference that the site be restored as grassland. Given the relatively small area that will be restored, ca 1.8 ha, and the overall size of the site (ca 1.5 ha) it is not necessary to provide hedgerows to subdivide the land into smaller fields and it will not be necessary to plant trees.

Grass is the most suitable vegetation as it provides all year round soil cover and promotes the development of a soil structure and animal grazing is the intended use identified by the landowner. This land use also minimises the potential for soil damage as it does not require field work during late autumn, winter or early spring.

2.2 Design Objectives

The design objectives were to minimise the infiltration of incident rainfall into the waste mass, which is considered to be the primary source of leachate generation at the site, ensure that the site was suitable for the end-use and minimise the long term aftercare maintenance.

2.3 Options

An assessment of suitable capping system options for the site was carried out taking into consideration the Agency's Landfill Manuals on Landfill Site Design and Landfill Restoration and Aftercare and the findings of the Tier 2 and 3 investigations.

The recommended capping design for non-hazardous landfill includes a minimum total topsoil and subsoil thickness of 1 m overlying a drainage layer of minimum thickness of 0.5 m, a low permeability barrier and a landfill gas collection layer. The thickness of the layers is intended to allow for post closure settlement and the installation of pollution control systems.

However, given the age of the landfill and the total depth 11.5m the likelihood of significant future settlement is low. While landfill gas is being generated, this is primarily associated with limited area used for sludge disposal with localised source areas for landfill gas elsewhere. However, in those areas the gas levels are likely to be reducing over time. Some portions of the site have already been covered by subsoils. It is unlikely therefore that a 1 m thickness of subsoils and topsoil and a gas collection layer across the entire site is required.

The Landfill Manual on Site Design recommends that the barrier layer consist of either a low hydraulic conductivity mineral layer or a synthetic layer such as a flexible membrane liner (FML) or geosynthetic clay liner (GCL). The minimum thickness of the mineral layer should be 0.6 m with a hydraulic conductivity of $1x10^{-9}$m/s. Where a geosynthetic material is used, it should provide the equivalent protection.

The use of FMLs and GCLs requires the installation of perimeter anchor trenches that would cause significant disturbance of the marsh adjoining the fill area. Therefore, a mineral layer comprising a 0.6 m engineered clay cap (ECC) is the preferred barrier layer.

2.4 Surface Water Management

Rainfall infiltrating through the subsoils in the capping system will be collected in the drainage layer that overlies the low permeability layer and flow along the contours to a perimeter swale. Surface run-off from the capped area will also be intercepted by the swale. The water will infiltrate to ground in the swale and feed into the marsh. This will assist in maintaining the high water table needed to sustain the marsh habitat.

2.5 Proposed Capping System

The proposed capping system is shown on Drawing No.2 comprises the following: -

- 0.15 m topsoil,
- 0.5 m subsoil,
- 0.3 m drainage layer (hydraulic conductivity $1x10^{-4}m/s$),
- 0.6 m engineered clay layer (hydraulic conductivity $1x10^{-9}m/s$).
- 0.3m gas collection layer

2.6 Works Programme

Given the size of the site the low permeability barrier, drainage layer, subsoils and top soils will be installed in one phase and as part of one contract. The seeding of the topsoil will be included in the contract. As there are no on-site sources of subsoil or topsoil, imported soils will have to be used. The materials for use in the drainage and barrier layers must also be imported.

A detailed design and specification will be prepared for the works, which will include a construction quality assurance plan and a construction method statement. The plan will include specifications for the materials to be used in the capping system and the quality control and assurance methods and testing that must be applied to ensure that the system is installed properly. The detailed design will be submitted to the Agency for its approval prior to the works commencing.

The installation of the capping system will be supervised by a competent person who will prepare a construction quality assurance validation report upon the completion of the works. At this time, it is estimated that the works can be completed in 4 - 6 weeks.

2.7 Aftercare Stage

Based on the age and limited extent of the fill, no appreciable degree of post closure settlement is expected. Given the local rainfall amounts and the proposed restoration profile erosion of the capping materials will not be a significant issue.

The Council will carry out regular inspections of the site in the aftercare period to monitor for settlement or erosion, which could impact on the integrity of the capping system. In the unlikely event of significant settlement or erosion, the Council will immediately undertake remedial work, subject to the agreement of the landowner/occupier.

The aftercare monitoring programme will include groundwater and landfill gas monitoring in wells adjoining the site and landfill gas and leachate level monitoring in the wells inside the waste. Initially it is proposed to conduct the monitoring bi-annually, after which the data be reviewed to establish trends.

3. LANDFILL GAS CONTROLS

Significant landfill gas concentrations have been recorded in the three monitoring wells located in the body of the waste body, however there is no evidence of any lateral migration from the fill area. This is most likely due to the fact that landfill gas can vent freely to atmosphere, thereby minimizing the accumulation of gas and build up of pressure within the waste, which is the main driver for gas migration.

3.1 Design Objectives

The design objectives were to minimise the risk of landfill gas migration towards the nearest occupied dwellings following the installation of the capping system, to protect future development, and have low maintenance requirements.

3.2 Options

An assessment of suitable control options for the site was carried out taking into consideration the Agency's Landfill Manuals and the findings of the Tier 2 and 3 investigations.

While the concentrations of methane measured within the waste body are high, given the age and size and depth of the fill area, the volumes of gas being generated are not sufficient to sustain active abstraction and flaring and utilisation.

The in-situ boulder clay surrounding the waste body has a moderate to low permeability, which inhibits gas movement while the water saturated conditions in the marsh along the landfill's north-western, northern and north-eastern margins also inhibit gas migration in these directions.

The only area where landfill gas migration has the potential to occur to any great extent is to the south, where the nearest occupied buildings (Halting Site) are located. Future development of residential and commercial use is also planned for these lands.

The most effective control measure for the site is a combination of a gas collection layer incorporated into the capping system, passive vents installed within the waste body and a cut off trench install outside the landfill footprint around the south western, southern and south eastern edges of the fill. The gas collection layer is required to encourage gas flow towards the vents and vent to atmosphere. The cut-off trench is intended to intercept gas migration to the south and allow it to vent to atmosphere.

3.3 Proposed Controls

The proposed gas control measures incorporated into the capping system are shown on Drawing No 3. The location of the cut-off trench is shown on Drawing No 4. Drawing No. 5 shows the detail of the Gas Cut-Off trench.

The cut off trench will be excavated to a maximum depth of 2m below ground level. The trench should be excavated in a manner that allows short sections to be excavated, lined and backfilled without the need for leaving the trench open for extended periods of time. The trench will be set back away from the waste mass where possible by at least 2m and will extend into the marsh area along the western portion of the site.

All sharp objects and protrusions, such as large stones, roots and the like, shall be removed from the floor and the side of the excavation to be lined, i.e. opposite side to the waste. Where necessary these surfaces shall be 'dressed' to provide a smooth and even surface free of protrusions. The floor of the excavation should be trimmed to remove all loose debris and objects potentially deleterious to the liner. Any waste and soil arising from the excavations shall be used in other earthworks on the site or disposed at a suitably licensed facility as appropriate

The trench will be lined with geosynthetic clay liner (GCL) and covered by a protective geotextile before being backfilled with granular material. The GCL will be cut to the correct length as required and lowered into the excavation so that it lines the surface away from the waste. The GCL will be overlapped by a minimum 300mm. Following installation of the GCL, a protective geotextile shall be placed on top

Following completion of the lining works, the trench will be backfilled with venting stone to the top of trench.

3.4 Works Programme

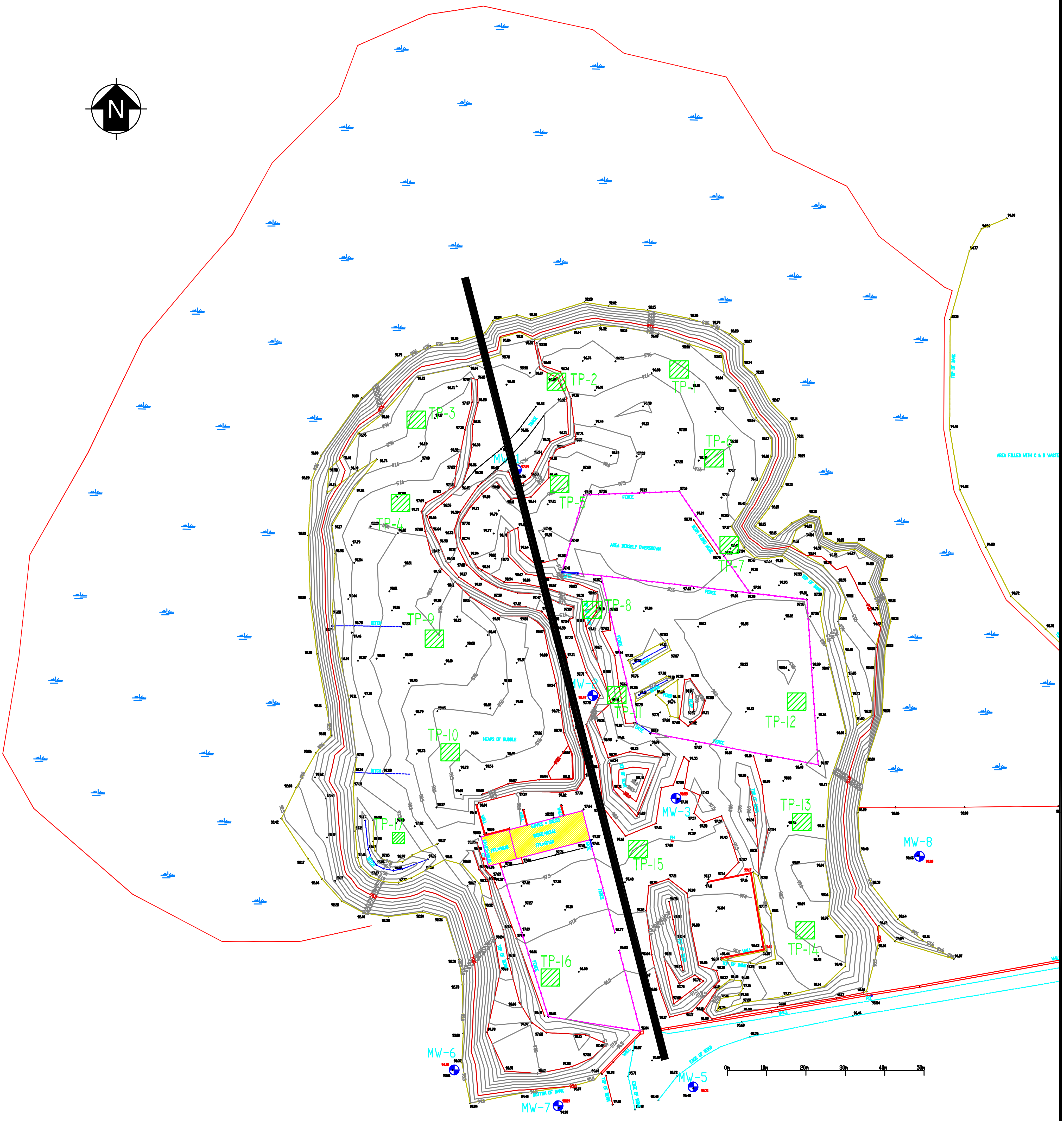
A detailed design and specification will be prepared for the works, which will include a construction quality assurance plan and a construction method statement. The plan will include specifications for the materials to be used in the installation of gas control measures and the quality control and assurance methods and testing that must be applied to ensure that the system is installed properly. The detailed design will be submitted to the Agency for its approval prior to the works commencing.

The installation of the cut off-trench will be supervised by a competent person who will prepare a construction quality assurance validation report upon the completion of the works. At this time it is estimated that the works can be completed in 2-4 weeks

3.5 Aftercare Stage

The Council will carry out regular inspections of the site in the aftercare period to monitor for settlement or erosion, which could impact on the integrity of the gas control system. In the unlikely event of significant settlement or erosion, the Council will immediately undertake remedial work, subject to the agreement of the landowner/occupier.

DRAWINGS



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email : info@ocallaghanmoran.com

CLIENT

South Tipperary County Council

DETAILS

Figure No.

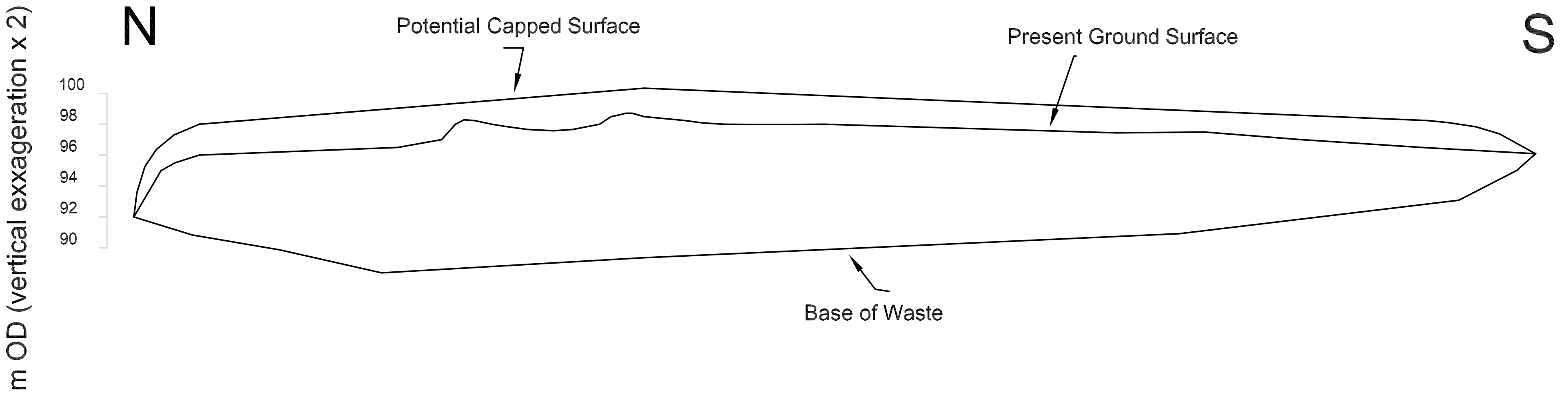
1

TITLE

SITE TOPOGRAPHY

SCALE

1:1,000



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South Tipperary County Council

TITLE

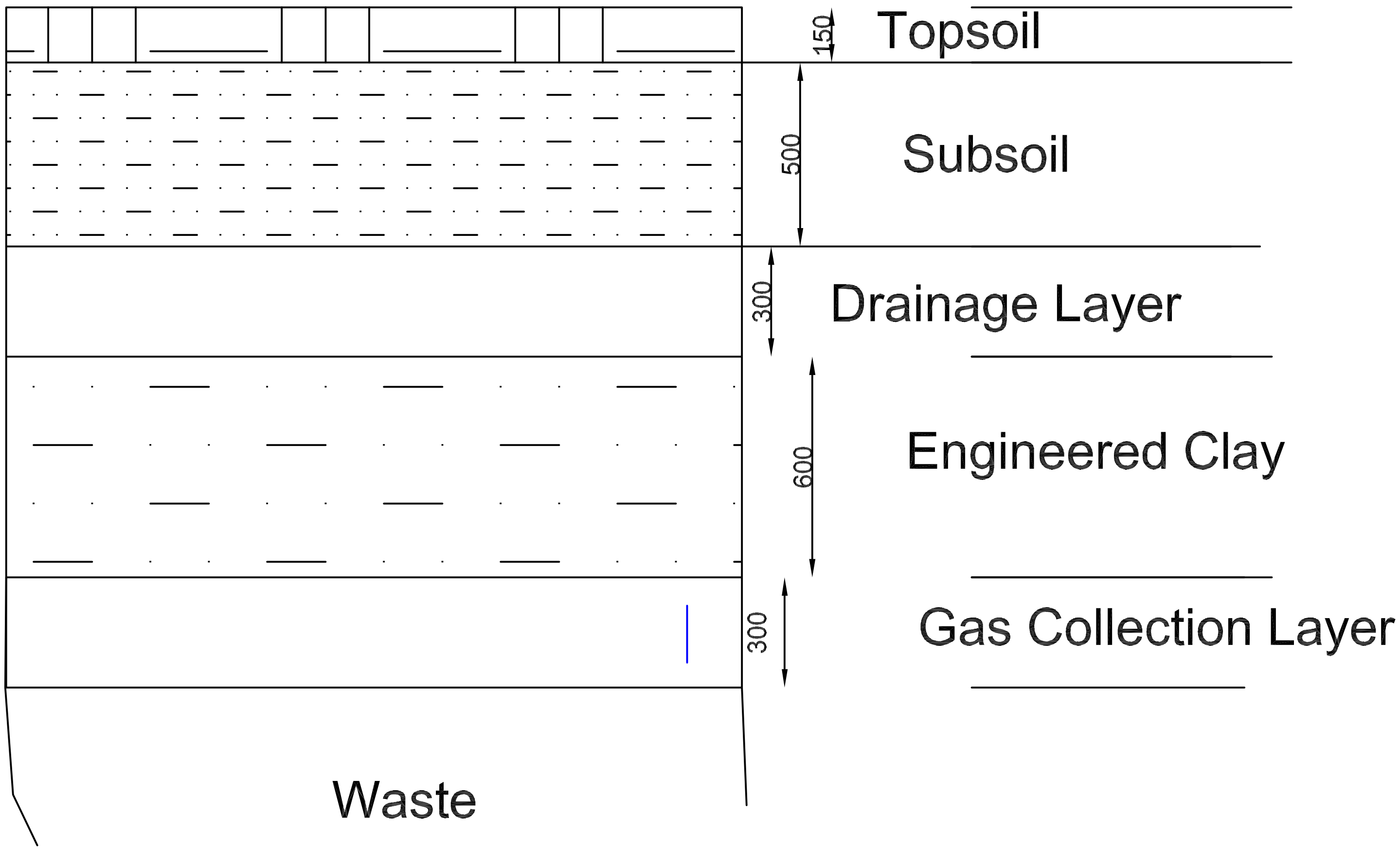
Proposed Finished Profile

details

FIGURE No.
2

SCALE
1:800

REV.



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CLIENT
South Tipperary County Council

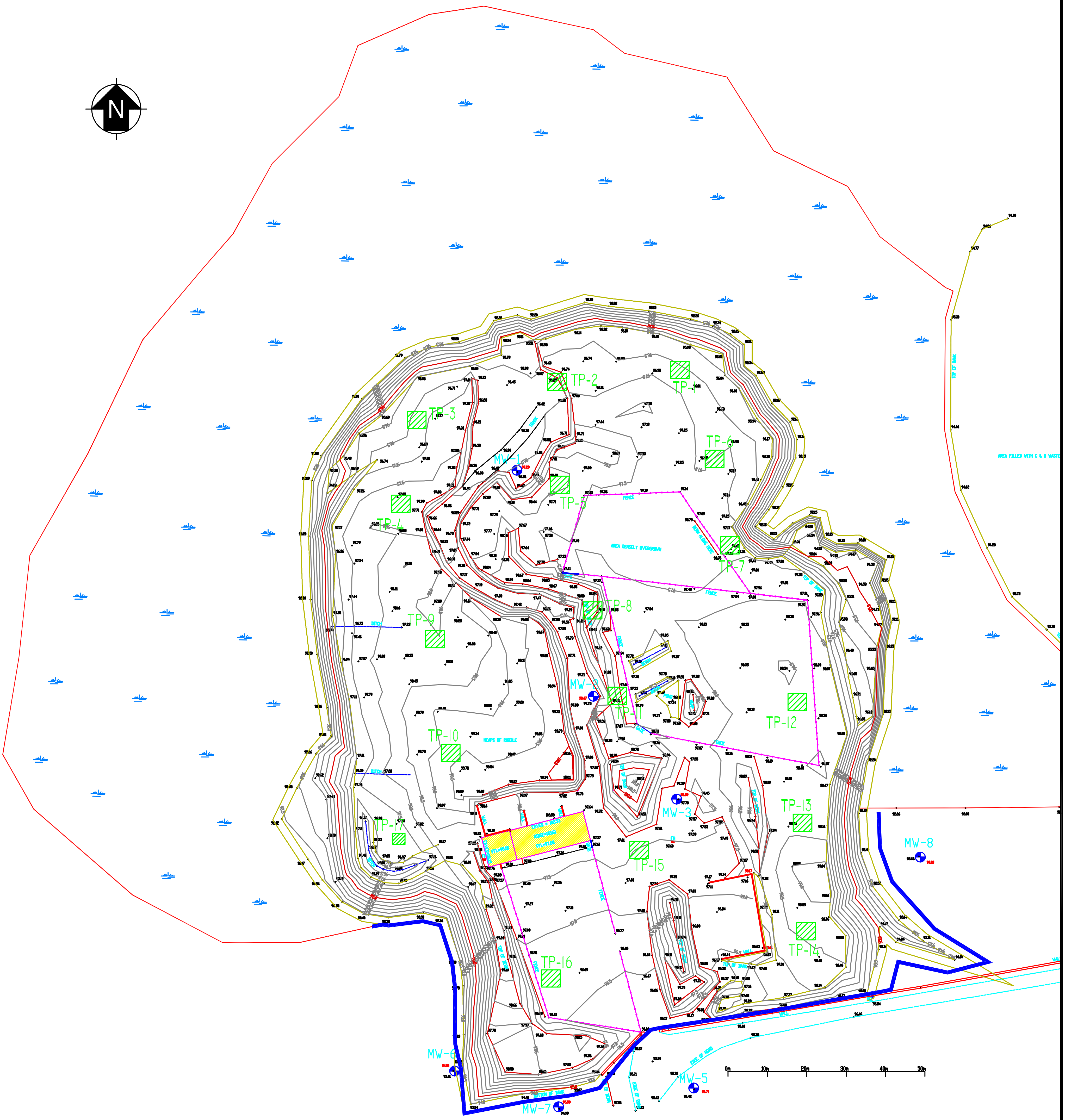
TITLE
Proposed Capping System

details

FIGURE No.
3

SCALE
1:20

REV.



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SOUTH TIPPERARY COUNTY COUNCIL

TITLE

SITE LAYOUT AND TRENCH LOACTION

DETAILS

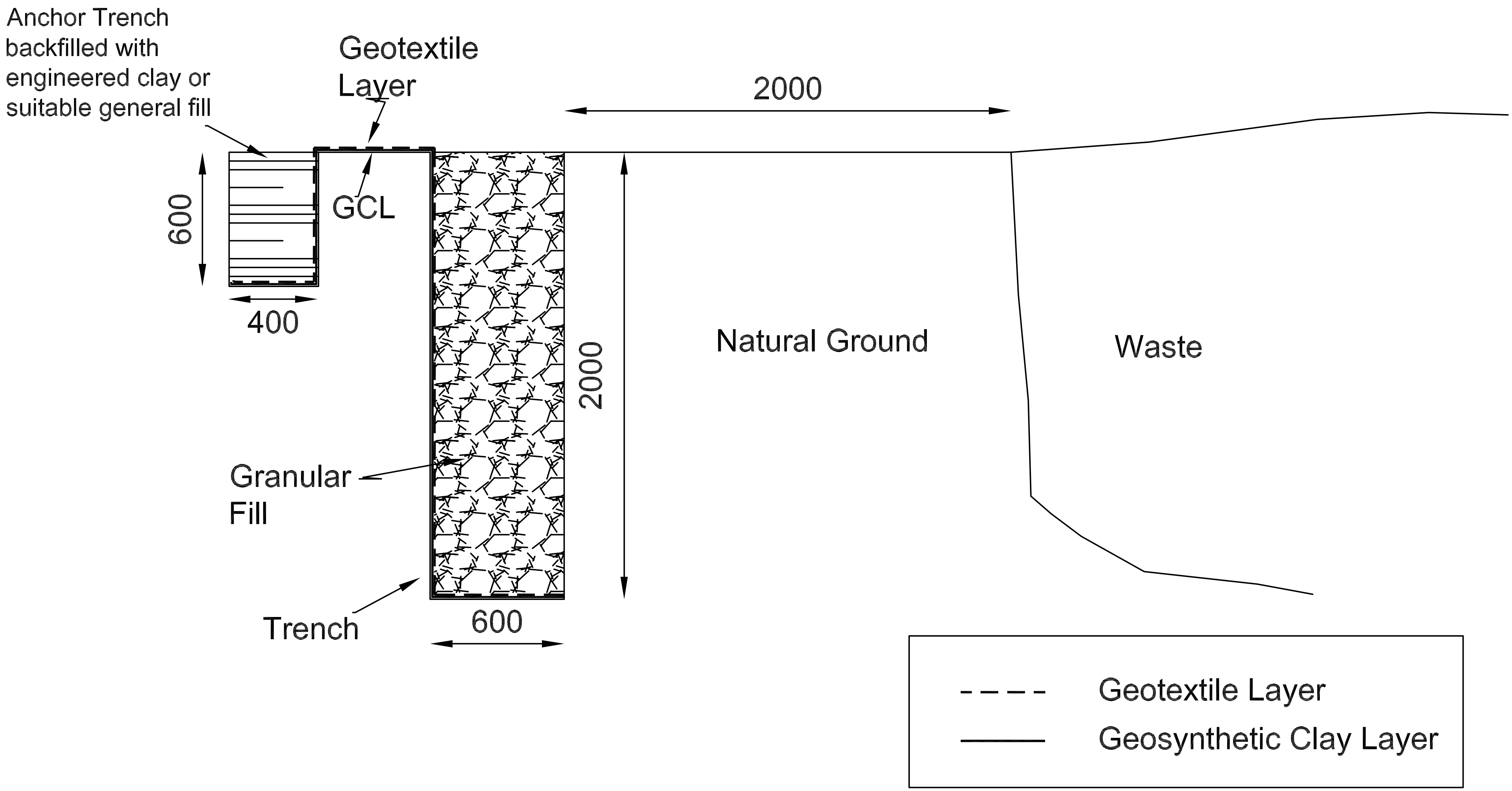
Gas Trench

Figure No.

4

SCALE

1:1,000



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CLIENT	South Tipperary County Council	details	FIGURE No. 5
TITLE	Gas Cut-Off Trench Detail		SCALE 1:25	REV.

ADDENDUM TO THE TIER 3 ENVIRONMENTAL RISK ASSESSMENT: TIPPERARY TOWN HISTORIC LANDFILL

TIPPERARY COUNCTY COUNCIL

SEPTEMBER 2018

Comhairle Contae Thiobraid Árann
Tipperary County Council

FEHILY
TIMONEY
& COMPANY

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1 INTRODUCTION

1.1 Background & Scope

A Tier 3 Environmental Risk Assessment (ERA) on Tipperary Town Historic Landfill was undertaken by O'Callaghan Moran & Associates (OCM) in October 2011, the ERA included an Appropriate Assessment (AA) Screening Report.

In August 2018, the EPA requested that the ERA be revised to take account of additional environmental monitoring that was undertaken since the submission of the ERA and 2015

This document is prepared as an addendum to the Tier 3 ERA prepared by OCM, to include for the TCC/EPA monitoring data results, an updated ERA and an assessment of the classification of the site.

2 TIER 3 ENVIRONMENTAL RISK ASSESSMENT SUMMARY

A Tier 3 Environmental risk assessment was undertaken by OCM in October 2011 in accordance with the EPA Code of Practice for Unregulated Waste Disposal sites and is attached in Appendix 1.

The OCM ERA relied upon the following works completed by OCM and TCC:

- Desk Study (Tier 1 Desk Study undertaken by TCC)
- Site Investigations (as part of Tier 2 undertaken by OCM)
    - Trial Pitting and trenching to determine extents of waste
    - Installation of groundwater monitoring wells
    - Installation of leachate monitoring well
    - Geophysical Survey
- Environmental Monitoring
- Quantitative Risk Assessments

2.1 Desk Study and Site investigations

The desk study and site investigations undertaken confirm the previous use of the site as an historic landfill. The site was classified High Risk (Class A) due to the risk posed to surface water, as surface water drains are within 50m of the site. Impact on surface water was considered low, however it was determined leachate migration into the wetland surrounding the site and land drains is possible.

The impact on groundwater was also considered low. Very stiff clay was observed during the installation of monitoring wells; hence it was assumed that this clay layer above the bedrock inhibits the vertical migration of leachate to bedrock. Significant dilution of leachate was noted between the landfill and groundwater, based on the substantial reduction in manganese, chloride and ammonia concentrations measured between the leachate wells in the waste and the monitoring wells located beyond of the waste body. Water quality was monitored at the public groundwater abstraction located 1.4km down gradient of the landfill site and was considered good.

It was recommended from the Tier 2 produced by OCM that landfill gas, surface water quality and groundwater quality be monitored over a longer time period to establish the extent of remediation required.

2.2 OCM Tier 3 Environmental Monitoring (2010)

Site monitoring undertaken by OCM comprised of the following:

- Two rounds of surface water monitoring (SW1 – SW3), on July 13th 2010 and August 17th 2010;
- Two rounds of leachate monitoring (MH1 – MH3), on July 13th 2010 and August 17th 2010. The second round was analysed for a reduced list of parameters;
- Two rounds of groundwater monitoring (MH4 – MH8), on July 13th 2010 and August 17th 2010. The second round was analysed for a reduced list of parameters.
- Gas monitoring was conducted by TCC staff in March, April and May 2010 and by OCM in September 2010.
- Assessment of surface water flow directions

It was noted that SW2 and SW3 were not sampled on August 17th 2010 as the drain was dry.

2.2.1 Surface Water Monitoring Results

Elevated levels of ammonia, iron, manganese and chromium were recorded in the surface water monitoring results. The elevated levels of iron, manganese and chromium were mostly like due do elevated background concentrations as these parameters had similar levels recorded in the upstream monitoring location.

2.2.2 Leachate Monitoring Results

Multiple parameters within the leachate monitoring results of the Tier 3 exceeded the EPA Interim Guideline Values (IGVs) for Groundwater. OCM reported that these results confirmed the presence of an aged Stage IV leachate in the monitoring wells.

2.2.3 Groundwater Monitoring Results

The following parameters were noted to exceed the EPA IGVs. These are not statutory limit values but are useful to determine impacts on groundwater quality in the context of the EU Water Framework Directive.

Parameters exceeding IGVs July 13th 2010:

- MW4: Aluminium, barium, conductivity, iron, manganese, chloride
- MW5: Aluminium, barium, conductivity, iron, manganese, lead, sodium, chloride
- MW6: Aluminium, barium, conductivity, iron, manganese, ortho-phosphate
- MW8: Aluminium, barium, conductivity, iron, manganese, ortho-phosphate, sodium, chloride

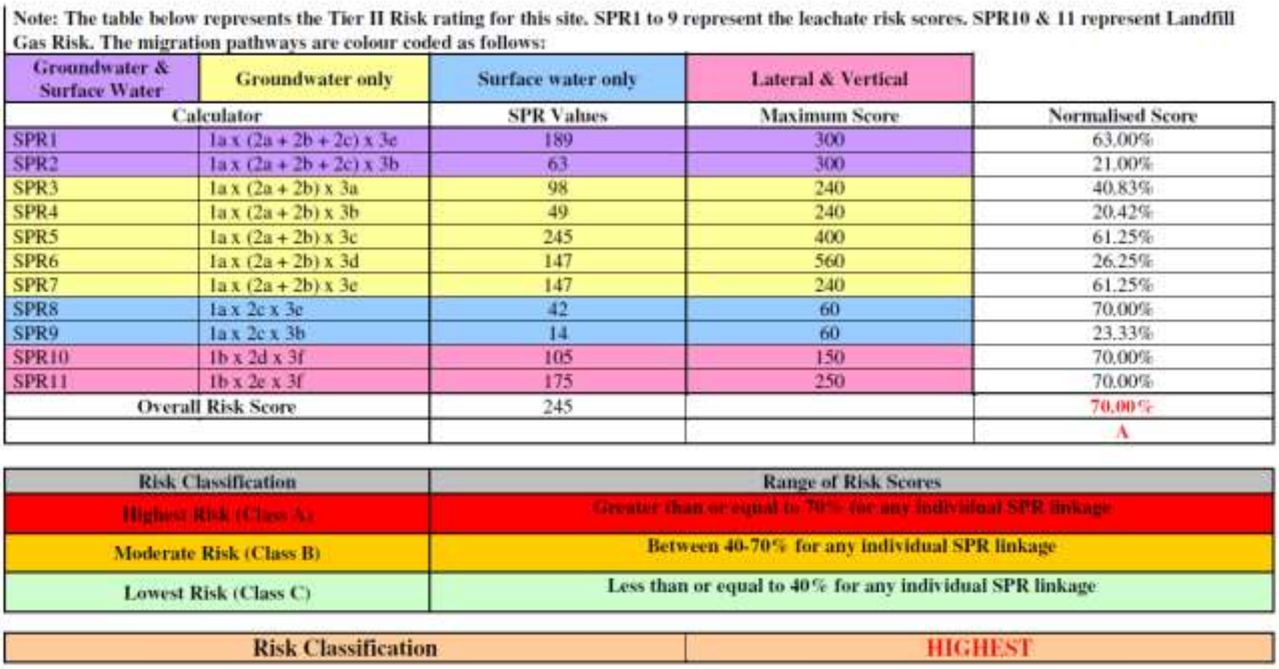
Parameters exceeding IGVs August 17th 2010:

- MW4: Ammonia, conductivity, chloride
- MW6: Ammonia, conductivity, chloride
- MW7: Conductivity, chloride
- MW8: Conductivity, chloride

2.3 Tier 3 Quantitative Risk Assessment

OCM presented a revised risk assessment in the Tier 3 report, modified from the Tier 2 Assessment based on the Tier 3 findings and feedback from the EPA. The site was classified as High risk, as shown in Figure 2.1 below. The high-risk classification was associated with leachate and landfill gas risk. Leachate was designated a high risk due to potential leachate impacts on surface water because of the pathway present in the form of the drain at the south east of the site. The landfill gas risk was due to the building present on site, although out of use.

The risk rating is shown in Figure 2.1.



Note: The table below represents the Tier II Risk rating for this site. SPR1 to 9 represent the leachate risk scores. SPR10 & 11 represent Landfill Gas Risk. The migration pathways are colour coded as follows:

Groundwater & Surface Water	Groundwater only	Surface water only	Lateral & Vertical

Calculator		SPR Values	Maximum Score	Normalised Score
SPR1	1a x (2a + 2b + 2c) x 3e	189	300	63.00%
SPR2	1a x (2a + 2b + 2c) x 3b	63	300	21.00%
SPR3	1a x (2a + 2b) x 3a	98	240	40.83%
SPR4	1a x (2a + 2b) x 3b	49	240	20.42%
SPR5	1a x (2a + 2b) x 3c	245	400	61.25%
SPR6	1a x (2a + 2b) x 3d	147	560	26.25%
SPR7	1a x (2a + 2b) x 3e	147	240	61.25%
SPR8	1a x 2c x 3e	42	60	70.00%
SPR9	1a x 2c x 3b	14	60	23.33%
SPR10	1b x 2d x 3f	105	150	70.00%
SPR11	1b x 2e x 3f	175	250	70.00%
Overall Risk Score		245		70.00%
				A

Risk Classification	Range of Risk Scores
Highest Risk (Class A)	Greater than or equal to 70% for any individual SPR linkage
Moderate Risk (Class B)	Between 40-70% for any individual SPR linkage
Lowest Risk (Class C)	Less than or equal to 40% for any individual SPR linkage

Risk Classification	HIGHEST

Figure 2-1: OCM Tier 3 Risk Rating

2.4 OCM Tier 3 Conclusions & Recommendations

The OCM Tier 3 report presented the following conclusions on surface water, groundwater and landfill gas. The report also included recommendations for remediation measures. The proposed recommendations and remediation measures are outlined below.

2.4.1 Surface Water

The OCM Tier 3 concluded that the impact of leachate on SW quality in the drain leaving the wetland is limited as only elevated Ammonia recorded. Elevated levels of iron, manganese and chromium were also detected in the surface water samples; however, it was concluded that this was mostly like due do elevated background concentrations as these parameters had similar levels recorded in the upstream monitoring location.

Remedial measures recommended to minimise risk to surface water included:

- Installation of a low permeability cap over the waste to reduce rainwater infiltration and hence decrease the leachate head generated within the waste;
- Investigation of the source of contamination in drain entering site from the west (upstream monitoring point);
- Further observations to determine surface water flow in drain entering the site from the south and monitor water quality to establish its status. (This drain was noted as dry during the Tier 3 assessment.)

2.4.2 Groundwater

The OCM Tier 3 concluded that there were some leachate impacts detected in shallow groundwater and due to the thickness of the subsoil above the bedrock aquifer, the risk posed to the bedrock aquifer was considered Low. Lateral leachate migration away from the margins of the landfill were considered insignificant due to the direction of GW flow and vertically because of hard low permeability clay underlying the site.

It was recommended the groundwater be monitored biannually following capping of the landfill.

2.4.3 Landfill Gas

The OCM Tier 3 concluded that methane and carbon dioxide were still being generated at significant levels within the waste body. No significant migration of gas away from landfill area was detected.

OCM Tier 3 recommended the following works to reduce the risk of landfill gas:

- Maintain existing gas wells and install additional landfill gas ventilation wells installed across the site to minimise the risk of build-up of landfill gas and minimise the risk of landfill gas migration;
- Install a landfill gas cut-off trench along the southern boundary of the capped fill area;
- Monitor all gas monitoring wells at least annually.

3 UPDATED ENVIRONMENTAL RISK ASSESSMENT

An update to the Tier 3 Environmental Risk Assessment undertaken by OCM is presented in the following subsections. The Tier 3 is being updated following a Stage 1 AA Screening undertaken by FT in June 2018 which analysed and presented monitoring data collected by TCC and the EPA between 2011 and 2015 at Tipperary Town Historic Landfill.

3.1 Appropriate Assessment

FT was retained by TCC to undertake a Stage 1 Appropriate Assessment (AA) Screening in May2018 to evaluate the potential impact(s) of the proposed Tipperary Town historic landfill remediation on the European sites located within a 15km radius. The surface water flow regime was observed on site and monitoring results collected by the EPA and TCC between 2011 and 2015 for surface water and leachate were presented in the Appropriate Assessment.

The results of this analysis are presented in Section 3.2.

3.2 Environmental Monitoring 2011- 2015 & Results

Surface water, leachate and groundwater were sampled between 2011 and 2015 by the EPA and TCC as per the monitoring locations presented in the Tier 3 report. Figure 3.1 shows the environmental monitoring locations at the site.

The surface water monitoring locations are SW1, SW2 and SW3.

SW3 is upstream of the landfill, located along the Fidaghta watercourse/drain where it enters the marsh to the west of the landfill. SW2 is located at the outflow of the marsh on the eastern side, at the beginning of the Spital-land watercourse/land drain. SW1 is located downstream of this point to the south, downstream of the Carrownreddy Road underpass.

Three leachate monitoring wells MW1, MW2 and MW3 are located within the landfill. The groundwater monitoring wells MW5, MW6, MW7 and MW8 are located around the south perimeter of the site and MW4 is located adjacent to SW1.

Monitoring results were not available for some monitoring locations due to low water levels on the day of sampling. The list of parameters analysed by the EPA and TCC varied between monitoring events.

The complete surface water, leachate and groundwater quality monitoring results are presented Appendix 2 to this document. A review of the results is presented below.

3.2.1 Surface Water

Surface water quality sampling was undertaken by TCC and the EPA across the 2011 to 2015 period.

The results reviewed for this revised ERA were taken on the following dates; 17/08/10; quarterly between December 2011 and May 2014; 23/07/14; 01/10/14 and 21/09/15. Results from all monitoring periods listed above are included in Appendix 2.

Overall the results of surface water monitoring presented were considered inconclusive in determining the impact of the landfill on surrounding water bodies. The results suggest that while there is some evidence of contamination at locations downstream of the landfill, there is also evidence to suggest that run-off from the surrounding agricultural land is impacting on water quality at monitoring locations upstream and downstream of the landfill.

The potential for indirect impacts due to the transport of emissions in the form of leachate and/or suspended solids along the hydrological corridor identified (via the Spital-Land, Ara, and Aherlow) to the Lower River Suir SAC requires consideration. In considering this potential for impacts to occur upon the Lower River Suir SAC, the in-stream distance between the landfill site and the Lower River Suir SAC (18.2 km) and given the small size and low capacity of the Spital-Land watercourse means any such impacts are extremely unlikely.

3.2.2 Leachate

The following leachate monitoring results carried out by TCC/EPA in the period 2011 -2015 are available; monitoring at MW1 and MW2 only on 23/07/14, monitoring at locations MW2 and MW3 on 17/08/10 (chloride only), monitoring at MW2 and MW3 on 01/10/14, monitoring at locations MW1 and MW2 in 21/09/15.

All rounds of leachate monitoring are included in Appendix 2.

While small variations are noted, the results obtained in these sampling rounds are generally below the minimum overall range of methanogenic leachate composition as outlined in Table 7.2 of the EPA's Landfill Operational Practice Guidance Manual, 1997. These results indicate that leachate quality is typical of weak leachate sampled from large landfills, as outlined in the Landfill Operational Practices Guidance Manual, EPA 1997 and EPA Manual on Landfill Site Design (2000).

3.2.3 Groundwater

Groundwater was sampled by TCC/EPA at MW4 and MW8 on 23/07/14, at MW4 and MW6 on 01/10/14 and at MW4, MW5 and MW6 on 21/09/15. The results of the sampling are included in Appendix 2.

The results of the groundwater monitoring in 2014 and 2015 were compared to the EPA IGVs as per the OCM Tier 3 report, as discussed in Section 2.3.2.

The following parameters were in exceedance of the IGVs:

Parameters exceeding IGVs July 23rd 2014:

- MW4: Chloride, aluminium, barium, iron, manganese
- MW8: conductivity, ammonia, chloride, ortho-phosphate, arsenic, barium, iron, manganese, mercury

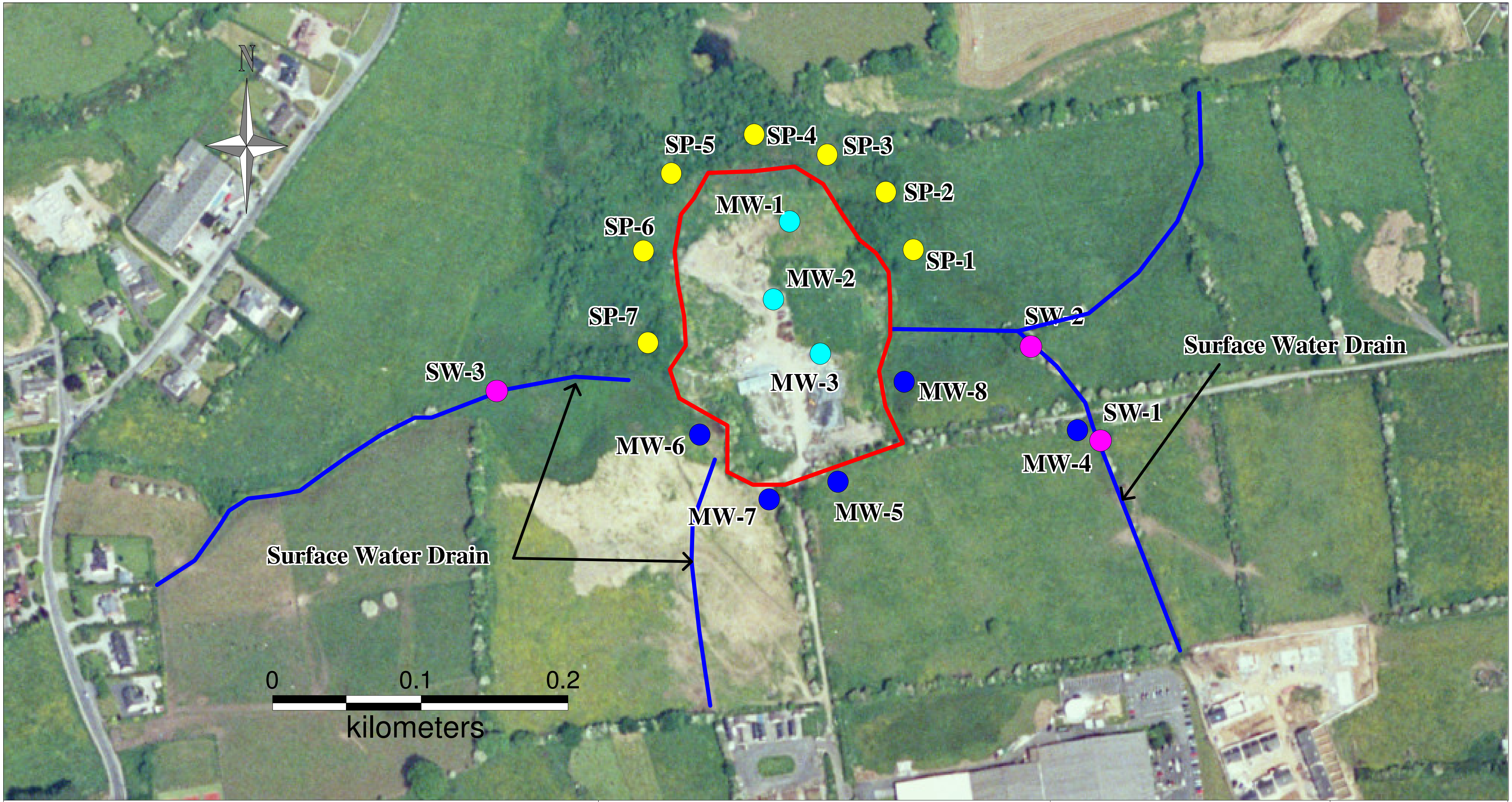
Parameters exceeding IGVs October 1st 2014:

- MW4: Conductivity
- MW6: Chloride

Parameters exceeding IGVs September 21st 2014:

- MW4: no exceedance
- MW5: Conductivity, chloride, calcium, sodium
- MW6: Conductivity, chloride, aluminium, calcium, manganese, potassium

All parameters that exceeded the IGVs in the 2014/2015 monitoring were also recorded in exceedance in the OCM Tier 3 monitoring results, with the addition of arsenic, mercury and potassium.



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CLIENT

South Tipperary County Council

TITLE

Groundwater Landfill Gas Well Locations

Legend

- ● **Groundwater Well**
- ● **Gas Well**
- ● **Surface Water Location**
- ● **Spike Probe Location**

FIGURE No.

2.1

SCALE

3.2.4 Confirmation of Flow Regime

The flow regime presented in the 2011 OCM Tier 3 report was confirmed by FT during a site walkover on the 3rd May 2018 and is indicated in Figure 3.2 and 3.3. It was observed that the wetland surrounding the landfill mound drains from the south-western side into the Spital-Land watercourse, which flows south towards Tipperary town for c. 265 m before being channelled underground at the northern boundary of Rosanna Close housing estate. Due to the surrounding topography, the channel is assumed to continue underneath Tipperary town to join the Ara, which in turn joins the Aherlow, which flows into the Lower River Suir SAC c. 18.2 km downstream of the historical landfill site. The drain identified in the Tier 3 entering the site from the south was confirmed to flow from south to north and drain into the wetland area surrounding the landfill site.

This flow regime observed is in contradiction with the EPA watercourse mapping, which depicts the Fidaghta stream flowing from the west of the site, to continue east beyond the eastern side of the wetland, being joined by the Spital-Land stream, which is depicted flowing north from the town. The steams meet to continue to flow south east, eventually joining the River Suir. This is not the case as the actual onsite surface water flow regime was determined during the site visit. Large volumes of spoil have been deposited on the site, raising the land level, which may have altered the course of these streams. The headwaters of the Fidaghta are not located at the north-eastern corner of the wetland as indicated by the EPA, due to either a mapping error, or the deposition of spoil historically which may have altered to course of stream in this area (see flow mapping in Figures 3.2 & 3.3).

Map Path: R:\Map Production\2017\P0563\Workspace\AA\P0563_Fig3-1_Habitats_A3.mxd

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
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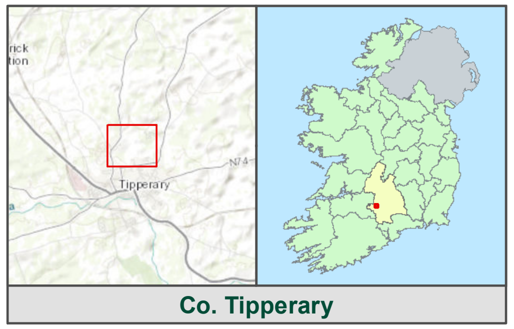

Co. Tipperary

Legend

- 🟥 Landfill Boundary
- ⬚ Indicative Footprint of Remedial Works
- ● WL1/WL2: Hedgerows / Treelines
- FW2: Depositing/Lowland Rivers
- FW4: Drainage Ditches
- ▨ BL3: Buildings and Artificial
- ▨ ED2/ED3/WS1: Spoil and Bare Ground / Recolonising Bare Ground / Scrub
- ▨ ED2/ED3: Spoil and Bare Ground / Recolonising Bare Ground
- ▨ ED2: Spoil and Bare Ground
- ▨ FS1: Reed and Large Sedge Swamps
- ▨ GA1/ED3: Improved Agricultural Grassland / Recolonising Bare Ground
- 🟩 GA1: Improved Agricultural
- ▨ GS2: Dry Meadows and Grassy Verges
- ▨ GS4: Wet Grassland
- ▨ WD1: (Mixed) Broadleaved
- ▨ WN6: Wet Willow-Alder-Ash
- ▨ WS1: Scrub

Figure Title
Habitats

Figure No. 3.1

Project
Tipperary Town Historical Landfill Remediation

Client
Tipperary County Council

Scale 1:3,500 **Page Size** A3

Revision A **Date** 14/06/2018

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Map Path: R:\Map Production\2017\P0563\Workspace\AA\P0563_Fig3-2_SurfaceWaterAndLeachateSamplingPoints_A3.mxd

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
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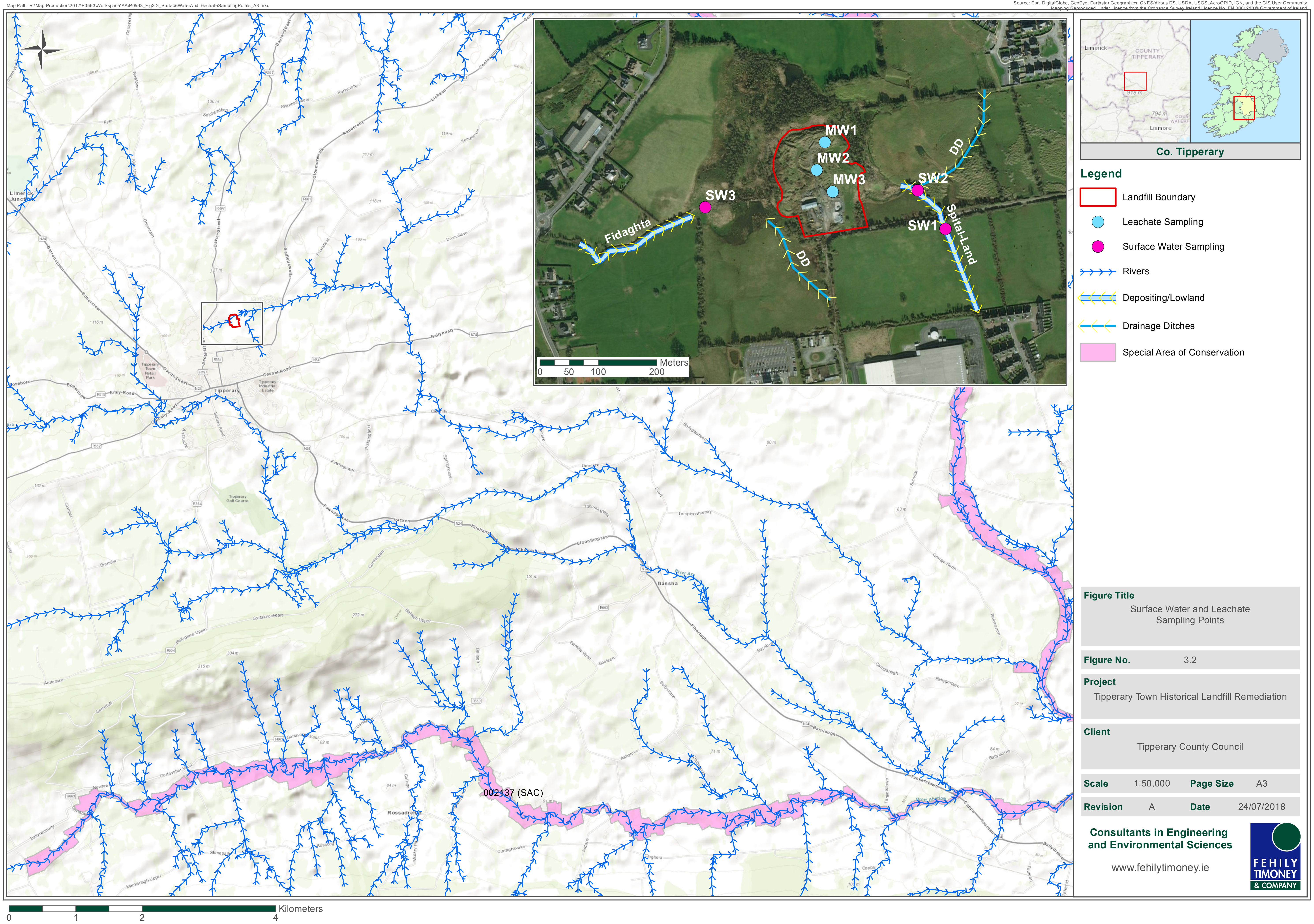

Figure Title	Surface Water and Leachate Sampling Points
Figure No.	3.2
Project	Tipperary Town Historical Landfill Remediation
Client	Tipperary County Council

Scale	1:50,000	**Page Size**	A3
Revision	A	**Date**	24/07/2018

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3.3 Updated Risk Assessment

The risk assessment rating presented in the OCM Tier 3 is updated in Table 3.1 and Table 3.2 below. The ERA is updated based on the results of the additional surface water, groundwater and leachate monitoring undertaken in the period 2011 -2015 since the original OCM.

The risk assessment is undertaken in accordance with the EPA CoP.

Table 3.1: Risk Classification Calculation

EPA Ref	Risk	Points	Rationale
1a	Leachate; source/hazard scoring matrix, based on waste footprint.	7	Based on an estimated waste footprint of >1 and ≤5 ha and a site that accepted domestic and industrial waste.
1b	Landfill gas; source/hazard scoring matrix, based on waste footprint.	7	Based on an estimated waste footprint of >1 and ≤5 ha and a site that accepted domestic and industrial waste.
2a	Leachate migration: Pathway (Vertical)	2	GSI describes the groundwater vulnerability as High across the entire site.
2b	Leachate migration: Pathway (Horizontal)	5	The bedrock is classified by the GSI as a Regionally Important Karstified (Rkd) aquifer.
2c	Leachate migration: Pathway (Surface water drainage)	2	Direct connection between the waste body and surface water stream.
2d	Landfill gas: Pathway (Lateral migration potential)	3	No residences within 250m of site; Karst bedrock, made ground
2e	Landfill gas: Pathway (Upwards migration potential)	5	No buildings above waste body; Made ground
3a	Leachate migration: Receptor (Human presence)	2	Dwellings present greater than 50m but less than 250m of the waste body. Note: All houses can be served by public water
3b	Leachate migration: Receptor (Protected areas – SWDTE or GWDTE) (Surface water/ groundwater dependent terrestrial ecosystems)	1	The nearest SAC/pNHA is located greater than 1 km from the waste body. The marsh has been considered as an undesignated GWDTE based on the precautionary approach
3c	Leachate migration: Receptor (Aquifer category – Resource potential)	5	The bedrock is classified by the GSI as a Regionally Important Karstified (Rkd) aquifer.
3d	Leachate migration: Receptor (Public water supplies – other than private wells)	3	Public water supply is greater than 1km away (Tipperary Co-op) Karst bedrock – but different geological formation
3e	Leachate migration: Receptor (Surface water bodies)	3	Surface water drain within 50m of site boundary
3f	Landfill Gas: Receptor (Human presence)	5	Empty building on site.

Table 3.2: Normalised Score of S-P-R Linkage

Calculator		S-P-R Values	Maximum Score	Linkage	Normalised Score
Leachate migration through combined groundwater and surface water pathways					
SPR1	1a x (2a + 2b + 2c) x 3e	7 x (2+5+2) x 3 = **189**	300	Leachate => surface water	63%
SPR2	1a x (2a + 2b + 2c) x 3b	7 x (2+5+2) x 1 = **63**	300	Leachate => SWDTE	21%
Leachate migration through groundwater pathway					
SPR3	1a x (2a + 2b) x 3a	7 x (2+5) x 2 = 9**8**	240	Leachate => human presence	41%
SPR4	1a x (2a + 2b) x 3b	7 x (2+5) x 1 = **49**	240	Leachate => GWDTE	20%
SPR5	1a x (2a + 2b) x 3c	7 x (2+5) x 5 = **245**	400	Leachate => Aquifer	61%
SPR6	1a x (2a + 2b) x 3d	7 x (2+5) x 3 = **147**	560	Leachate => Surface Water	26%
SPR7	1a x (2a + 2b) x 3e	7 x (2+5) x 3 = 105	240	Leachate => SWDTE	61%
Leachate migration through surface water pathway					
SPR8	1a x 2c x 3e	7 x 2 x 3 = **42**	60	Leachate => Surface Water	**70%**
SPR9	1a x 2c x 3b	7 x 2 x 1 = **14**	60	Leachate => SWDTE	20%
Landfill gas migration pathway (lateral & vertical)					
SPR10	1b x 2d x 3f	7 x 3 x 5 = **105**	150	Landfill Gas => Human Presence	**70%**
SPR11	1b x 2e x 3f	7 x 5 x 5 = **175**	250	Landfill Gas => Human Presence	**70%**
Site maximum S-P-R Score					**70%**
Risk Classification					**A - Highest**

Table 3.2 shows the maximum S-P-R scoring for the site is **70%.**

The following are the risk classifications applied:

Highest Risk (Class A)	Greater than 70 for any individual SPR linkage
Moderate Risk (Class B)	41-69 for any individual SPR linkage
Lowest Risk (Class C)	Less than 40 for any individual SPR linkage

Based on this, the site can be classified as a **high-risk classification (Class A)**, confirming the risk assessment assigned to the site in the 2011 OCM Tier 3 report as presented in Section 2.2.

The EPA describes these sites as having "a high risk or high level of uncertainty, which requires further examination through Risk Assessment Methodology Tier 2".

3.4 Updated Remediation Recommendations

The remediation recommendations presented in the OCM Tier 3 reported were reviewed by FT following the updated risk assessment.

3.4.1 Surface Water

The updated risk assessment following the analysis of monitoring data between 2011 and 2015 confirms the requirement for remedial measures as recommended in the OCM Tier 3. The recommended remedial measures to reduce the impact to surface water were:

- Install a low permeability cap over the waste to reduce rainwater infiltration and hence decrease the leachate head generated within the waste;
- Investigate source of contamination in drain entering site from the west (upstream monitoring point)

The updated risk assessment confirms this requirement.

3.4.2 Groundwater

The installation of an engineered landfill capping over the waste area as previously recommended to reduce rainwater infiltration into the waste body, reducing leachate generation and hence reducing impacts on the groundwater quality.

Further to this, a program of groundwater monitoring on a biannual following capping of the landfill was recommended.

The updated risk assessment confirms this requirement.

3.4.3 Landfill Gas

Updates monitoring results for landfill gas were not available to include in this report. FT however agree with the recommendations made in the OCM Tier 3 to reduce the risk of landfill gas are still appropriate given the nature of the interred waste and the proximity of receptors. The recommended remedial measures to reduce the impact to surface water were:

- Maintain existing gas wells and install additional landfill gas ventilation wells installed across the site to minimise the risk of build-up of landfill gas and minimise the risk of landfill gas migration;
- Install a landfill gas cut-off trench along the southern boundary of the capped fill area;
- Monitor all gas monitoring wells at least annually.

The updated risk assessment confirms this requirement.

4 CONCLUSION

This document was prepared as an addendum to the Tier 3 prepared by OCM in 2011, to include for monitoring data results gathered since the Tier 3 was completed and was consequently used to update the ERA and classification of the site. The revised ERA accounts for environmental monitoring undertaken by TCC and the EPA between 2011 and 2015 of groundwater monitoring wells, leachate wells and surface water sampling points.

The Tier 3, undertaken by OCM included leachate, surface water, groundwater and landfill gas monitoring, analysis of these results and a revision of the ERA presented in the Tier 2 report. The Tier 3 classified the site as High Risk (Class A) due to risks to surface water and landfill gas migration. It was concluded from the surface water monitoring results that the risk posed to the surface water quality was low, however there are surface water drains present within 50m of the site. The risk of landfill gas migration was assigned due to the building located on the site, although it is unused and will be demolished.

To account for the environmental monitoring undertaken by TCC and the EPA between 2011 and 2015 an update of the ERA and site classification the following tasks were undertaken:

- Review of the following data collected between 2011 and 2015
    - Surface water monitoring results
    - Groundwater monitoring results
    - Leachate monitoring results
- Confirmation of the flow regime of land drains surrounding the site
- ERA review and update
- Review of remediation options presented in the Tier 3

The analysis of the surface water monitoring results was considered inconclusive in determining the impact of the landfill on surrounding water bodies. The results suggest that while there is some evidence of contamination at locations downstream of the landfill, there is also evidence to suggest that run-off from the surrounding agricultural land is impacting on water quality at monitoring locations upstream and downstream of the landfill.

The flow regime observed in the AA and the Tier 3 is in contradiction with the EPA watercourse mapping. Large volumes of spoil have been deposited on the site, raising the land level, which may have altered the course of these streams. The headwaters of the Fidaghta are not located at the north-eastern corner of the wetland as indicated by the EPA, due to either a mapping error, or the deposition of spoil historically which may have altered to course of stream in this area and have not been recorded.

The groundwater monitoring results available from TCC and the EPA exceeded the groundwater IGVs for all parameters measured in exceeded in the Tier 3 Report, with the addition of arsenic, mercury and potassium. The Tier 3 concluded that there were some leachate impacts detected in shallow groundwater, however due to the thickness of the subsoil above the bedrock aquifer, the risk posed to the bedrock aquifer was considered Low.

It was determined from the leachate monitoring results that the leachate quality is typical of weak leachate sampled from large landfills, as outlined in the Landfill Operational Practices Guidance Manual, EPA 1997 and EPA Manual on Landfill Site Design (2000).

The risk assessment classification determined in the OCM Tier 3 was reviewed and updated by FT based on the available 2011-2015 monitoring data. The results of the updated ERA indicate the site retains its a high-risk classification (Class A). In consideration of the site retaining its high-risk status FT also reviewed the original 2011 remediation measures.

The remediation options recommended in 2011 are endorsed by FT following this review include:

- Installation of an engineered cap over the waste body to reduce rain infiltration to minimise the generation of leachate and the impact to groundwater and surface water;
- Biannual groundwater monitoring after landfill cap is installed;
- Installation of gas ventilation wells installed across the site to minimise the risk of build-up of landfill gas and minimise the risk of landfill gas migration;
- Install a landfill gas cut-off trench along the southern boundary of the capped fill area;
- Annual gas monitoring.

Appendix 1

OCM Tier 3 Environmental Risk Assessment

environmental management for business

O' Callaghan Moran & Associates

Tier 3 Environmental Risk Assessment

Former Landfill at Tipperary Town

Prepared For:

South Tipperary County Council

Prepared By: -

O' Callaghan Moran & Associates,
Granary House,
Rutland Street,
Cork.

October 2011

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1. INTRODUCTION

1.1 Site Description

The site is located in the Townland of Carrownreddy and is within the northern outskirts of Tipperary Town. The waste deposition area was originally a lake that was drained in circa 1940 to allow wastes to be disposed. The site served as the landfill for Tipperary Town from ca1940, until it closed in 1990. It is accessed off the Lake Road and is currently used by Tipperary Town Council as a Depot for road maintenance materials and machinery.

The site occupies 1.8 hectares and contains within it a fenced off area of 0.2 hectares, which was apparently used exclusively for the disposal of wastewater treatment sludge. In addition to the sludges, the other wastes accepted were predominantly from households and businesses.

The southern, and part of the eastern and western boundary is fenced, but there is no visible boundary, other than the raised fill area, on the northern side. There is a steel framed building on site which was used for the storage for piping and other Council materials. Due to vandalism this building is no longer in use and has been boarded up. It is intended to demolish it in the future. Portions of the landfill have been capped with topsoil imported to site in recent years through these materials have not been significantly compacted or graded.

There is a marsh along the north-western, northern and north-eastern boundaries, which was associated with the original lake. The lands in the immediate vicinity to the east, south and west are used for low intensity agriculture, (animal grazing). The lands to the south are also currently used for grazing. The lands to the east of the drain have all been reclaimed along its entire length as far as Lake Road with construction demolition fill.

A halting site, located approximately 150m to the south of the site, contains the nearest occupied residences. There are at least 20 private dwellings within 250m of the northwest and western site boundaries and a newly developed housing estate approximately 250m to the southeast. A residential development (~250 houses) is under construction approximately 200m to the northeast of the site.

It is intended to develop the lands south of the landfill for social housing and light industrial use and the area between the site and the residential estate to the north east for light industrial warehousing. There are no proposals to develop the lands to the west.

1.2 Tier 1 and 2 Assessment

In 2009, South Tipperary County Council (the Council) completed a Tier 1 Assessment of the closed Tipperary Town Landfill in accordance with the 'Code of Practice Environmental risk Assessment for Unregulated Waste Disposal Sites' (CoP) published by the Environmental Protection Agency (Agency).

The Assessment concluded that the site was a Class A – High Risk, due to the risk of leachate migration to surface water and the risk to humans from landfill gas based on the nature of the underlying bedrock.

The Council appointed O'Callaghan Moran & Associates (OCM) to carry out a Tier 2 Assessment, which included Exploratory and Detailed Site Investigations completed in November 2009. The Tier 2 Assessment confirmed that the site was a Class A.- High Risk based on the risk of leachate migration to surface waters. The risk presented by landfill gas was considered to be Moderate, due to the low levels of gas detected outside the fill and the proposal to remove the on-site building.

The main findings of the Tier 1 & 2 Assessments were as follows;

- The Tier 1 assessment identified the underlying bedrock as a Regionally Important Karstified (Rkd) aquifer based on the Geological Survey of Ireland mapping. The logs of the boreholes installed in the Detailed Investigations and the geophysical survey indicate that the bedrock beneath the site is a shaley limestone, which was a locally important aquifer (Ll)

- It is possible that leachate migration is occurring toward the marsh and into a surface water drain to the east that ultimately discharges to the River Ara;

- The impact on surface water quality in the drain is low, with only ammonia exceeding the relevant water quality limit. This is attributed to a combination of natural attenuation within the marsh and the very high rainfall preceding and during the investigations;

- Shallow groundwater movement is towards a low point near the marsh and the marsh is the local groundwater discharge point;

- There is significant dilution of leachate occurring between the body of the waste and the groundwater monitoring wells located within 5-10m of the edge of the waste;

- Water quality in a public groundwater abstraction well, located 1.4km down hydraulic gradient of the site, is good with no evidence of any impact associated with leachate;

- The waste is actively producing landfill gas, with high levels of methane (31-55%v/v) recorded at monitoring wells inside the waste body. However, the levels detected at monitoring points outside the fill were low (1.1 to 1.3% v/v methane at one location) and further monitoring was required to establish the risk posed to off-site receptors, and

- Remedial measures (capping of the waste) may be required to minimise the risk posed by leachate and landfill gas to off-site receptors, but further monitoring (landfill gas, surface water and groundwater) was required to establish the extent of the remediation actions.

The Council submitted the Tier 2 Report to the Agency for comment. The Agency agreed with the conclusion that further monitoring was required to assist in the completion of a quantative risk assessment and determine the required remedial measures. The Agency did not accept the change to the aquifer classification from Regionally Important Karstified (Rkd) to Locally important (Ll) based on the findings of the intrusive investigations and geophysical survey and considered that the GSI mapping took precedence.

The Agency recommended that groundwater levels should be measured to confirm the results of first round of groundwater monitoring and that the potential for a 'swallow hole' near one of the monitoring wells be assessed. The Agency also recommended that an ecology assessment of the marsh and drain should be considered.

In relation to the landfill gas risk, the Agency considered that the risk remained high due to the presence of the building within the site and the proposed capping measures. The Agency recommended that a gas probe survey should be considered in the area north of the landfill, where ground conditions had prevented gas monitoring, ahead of boreholes as a more cost effective method of assessing risk, but boreholes could be installed if the findings of the probe survey warranted them.

1.3 Tier 3Work Scope

OCM developed the following scope for the Tier 3 based on the Tier 2 findings and the Agency's comments;

- Surface water monitoring at additional points up stream and downstream of the landfill.

- Monitoring of leachate levels and quality in two leachate wells (MW-2 and MW-3) within the waste body

- Monitoring water levels and quality in five groundwater wells (MW- 4, 5, 6, 7 and 8) outside the fill area.

- Landfill gas monitoring in the existing leachate and groundwater wells and a spike probe survey of the lands to the north of the landfill.
- An ecological assessment of the marsh and drain.
- Review of the Conceptual Site Model
- Completion of a Generic Quantitative Risk Assessment
- Preparation of Remedial Action Plan

2. MONITORING

2.1 Surface Water

2.1.1 Monitoring Locations

The Tier II Assessment involved monitoring at one location (SW-1) in the drain downstream of the marsh and south of the landfill. Following completion of the Tier II Risk Assessment further monitoring was undertaken by STCC, who undertook new upstream (SW-3) and additional downstream (SW-2) monitoring points to those used by OCM in the Tier II Assessment. SW-3 is the upstream location, SW-2 is in the drain just downstream of the marsh and SW-1 is the downstream sampling location in the drain. A drain located to the south between the landfill and the halting site is identified on the updated monitoring locations Figure. While this drain was identified during site walkover in Tier II it was observed to be completely dry and was constructed to allow drainage into rather than away from the site. It is not considered to be significant in terms of environmental risk presented by the landfill site. The revised monitoring locations are indicated on Figure 2.1.

2.1.2 Methodology

The monitoring was conducted by Council staff on July 13th 2010 and August 17th 2010. In August, the drain was dry and it was not possible to collect samples at SW-2 and SW-3.

2.1.3 Laboratory Analysis

The samples taken on 13th July 2010 were submitted to the Agency laboratory in Kilkenny for analysis for analysis for pH, electrical conductivity, dissolved oxygen, ammonia, nitrite, nitrate, orthophosphate, potassium, sodium, chloride, sulphate, metals, alkalinity, suspended solids, total oxidised nitrogen (TON), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).

The samples taken on August 17th 2010 were analysed at the Council's laboratory in Clonmel, for a reduced range of parameters. This is consistent with the monitoring frequencies for operational landfills, where a full suite is conducted annually, with monitoring for leachate indicator parameters carried out more frequently. The reduced suite included pH, electrical conductivity, chloride, total ammonia, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).

2.1.4 Laboratory Results

The laboratory test reports are contained in Appendix 1 and the results are summarised in Table 2.1. The Table includes, for comparative purposes, the Environmental Quality Standards (EQS) published by the Agency. The EQS are proposed water quality standards and are derived from the EU Directive on Drinking Water Quality 80/778/EEC and the Directive on the Protection of Groundwater against pollution caused by certain dangerous substances 80/66/EEC.

Table 2.1 Surface Water Results, Tipperay Town Landfill

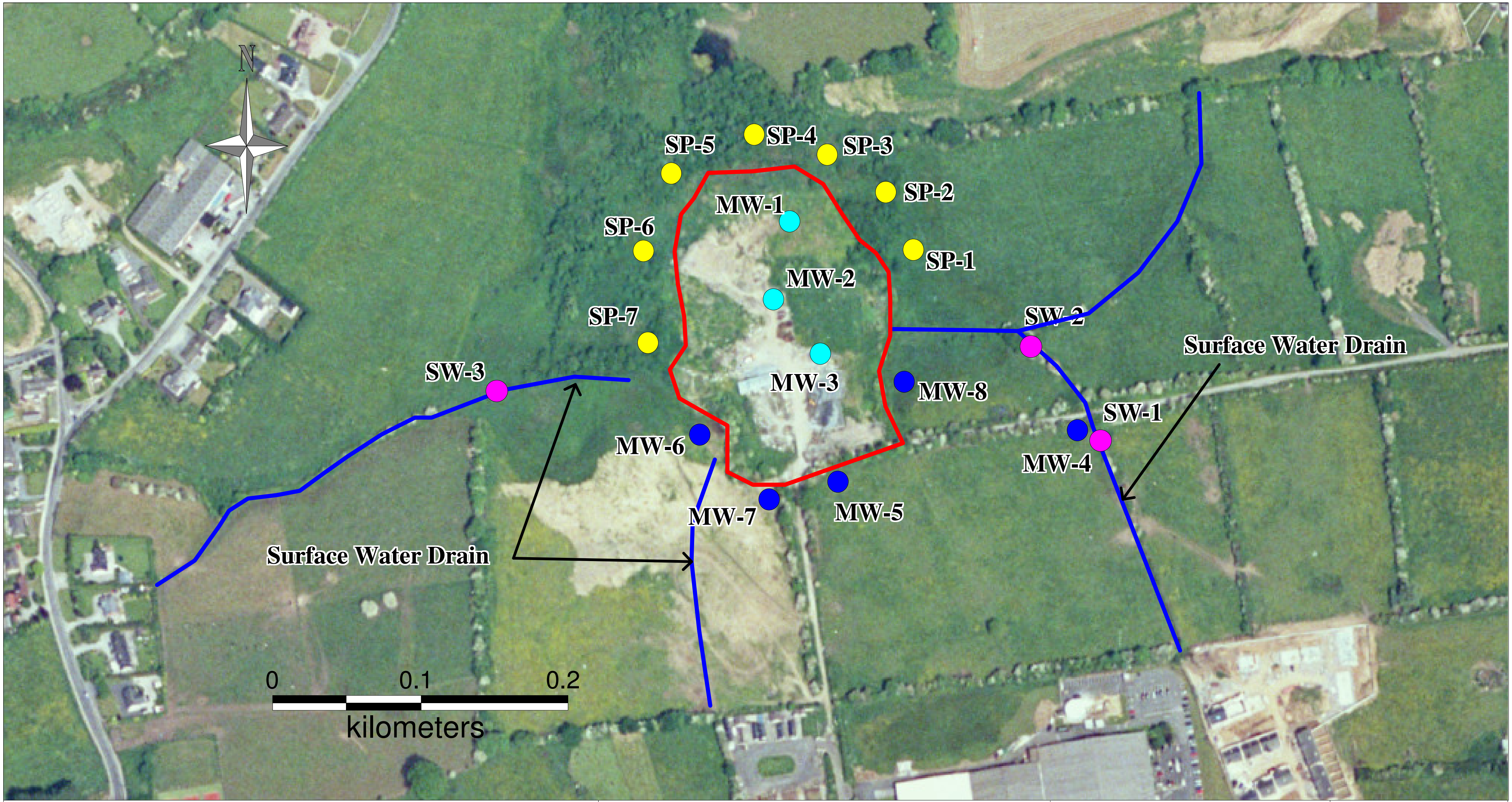
Sample I.D.	Units	SW-1	SW-2	SW-3	SW-1	EQS
		14/07/2010	14/07/2010	14/07/2010	17/08/2010	
pH	pH Units	7.300	7.100	7.600	7.950	4.5-9
Electrical Conductivity	uS/cm	913	969	765	941	-
Arsenic	mg/l	0.002	0.001	0.005	-	0.025
Antimony	mg/l	<0.0005	<0.0005	<0.0005	-	-
Aluminium	mg/l	<0.025	<0.025	0.046	-	-
Barium	mg/l	0.140	0.200	0.210	-	-
Beryllium	mg/l	<0.0005	<0.0005	<0.0005	-	-
Boron	mg/l	0.066	0.083	0.056	-	-
Cadmium	mg/l	<0.0005	<0.0005	<0.0005	-	0.0015
Cobalt	mg/l	0.0005	0.0005	0.0009	-	-
Copper	mg/l	0.0006	0.0008	0.0046	-	0.03
Lead	mg/l	<0.0005	<0.0005	<0.0005	-	0.0072
Manganese	mg/l	0.80	0.84	1.60	-	-
Magnesium	mg/l	0.010	0.011	0.006	-	-
Mercury	mg/l	<0.0005	<0.0005	<0.0005	-	0.00007
Molybdenum	mg/l	<0.0005	<0.0005	<0.0005	-	-
Nickel	mg/l	0.0009	0.0008	0.0023	-	0.02
Iron	mg/l	1.8	2.8	3.4	-	1*
Total Chromium	mg/l	0.014	0.015	0.011	-	0.0047
Selenium	mg/l	0.0008	0.0007	0.0006	-	-
Thallium	mg/l	<0.0005	<0.0005	<0.0005	-	-
Tin	mg/l	<0.001	<0.001	<0.001	-	-
Uranium	mg/l	<0.0005	<0.0005	<0.0005	-	-
Vanadium	mg/l	<0.0005	<0.0005	<0.0005	-	-
Zinc	mg/l	0.018	0.022	0.034	-	0.1
Chloride	mg/l	67.00	83.00	17.00	57.54	250*
Calcium	mg/l	84.00	88.00	110.00	-	-
Orthophosphate	mg/l	0.02	0.29	0.08	-	-
Total Oxidised Nitrogen	mg/l	<0.5	<0.5	<0.5	-	No Ab change
Total Suspended Solids	mg/l	<18.2	34.00	89.00	-	-
Total Alkalinity as CaCO3	mg/l	359.00	391.00	291.00	-	-
BOD	mg/l	3.20	7.10	5.70	7.90	5
COD	mg/l	48.00	73.00	91.00	51.00	-
Potassium	mg/l	6.30	7.20	0.80	-	-
Sodium	mg/l	36.00	43.00	9.30	-	-
Ammonia*	mg/l	6.10	7.50	0.03	4.70	0.02
Nitrite	mg/l	0.01	<0.002	<0.002	-	-

* EQS taken from 1997 report as no EQS exists in 2007 report
ND Denotes Not Detected

There was slightly elevated ammonia at the upstream location on the drain entering the marsh from the west, with higher levels in the drain leaving the marsh.

Manganese and iron exceeded the EQS in all the samples, with the highest levels in the drain upstream of the landfill. Chromium levels exceeded the EQS at all locations.

While the results indicate that leachate may be impacting on the surface water quality downstream of the site, they also indicate an impact on the water quality in the drain entering the marsh from the west and up gradient of the landfill. It is possible that the ammonia levels in the drain are associated with the naturally occurring anoxic conditions in the marsh, which were observed and reported by Ecofact as part of the Ecological Assessment of the marsh that is discussed further in Section 3.



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environmental management for business

CLIENT

South Tipperary County Council

TITLE

Groundwater Landfill Gas
Well Locations

Legend
- ● **Groundwater Well**
- ● **Gas Well**
- ● **Surface Water Location**
- ● **Spike Probe Location**

FIGURE No.

2.1

SCALE

2.2 Leachate

2.2.1 Monitoring Locations

Leachate samples were collected from leachate monitoring wells MW-1 and MW-2, as shown on Figure 2.1.

2.2.2 Methodology

The monitoring was conducted by Council staff on 13th July and the 17th August 2011.

2.2.3 Laboratory Analysis

The samples taken on 13th July 2010 were submitted to the Agency laboratory in Kilkenny for analysis for analysis for pH, electrical conductivity, dissolved oxygen, ammonia, nitrite, nitrate, orthophosphate, potassium, sodium, chloride, sulphate, metals, alkalinity, suspended solids, TON, BOD and COD.

The samples taken on August 17th 2010 were analysed at the Council's laboratory in Clonmel, for a reduced range of parameters that included pH, electrical conductivity, chloride, total ammonia, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).

2.2.4 Laboratory Results

The laboratory test reports are contained in Appendix 1 and the results are summarised in Table 2.1. The Table includes, for comparative purposes, the relevant EQS

Table 2.2 Leachate Results July 13th 2010

Sample I.D.	Units	MW-2	MW-3	IGV
Sample Date				
Arsenic	µg/l	31	14	10
Aluminium	µg/l	2200	1300	200
Antimony	µg/l	2.7	1.3	-
Barium	µg/l	320	1700	100
Beryllium	µg/l	<0.5	<0.5	-
Boron	µg/l	1600	640	1,000
Cadmium	µg/l	1.3	<0.5	5
Chromium	µg/l	37	49	30
Cobalt	µg/l	7.9	3.8	-
Copper	µg/l	43	30	30
Mercury	µg/l	<0.5	<0.5	1
Molybdenum	µg/l	14	1.1	-
Nickel	µg/l	21	8.7	20
Lead	µg/l	110	95	10
Selenium	µg/l	18	3	-
Thallium	µg/l	<0.5	<0.5	-
Tin	µg/l	1	<1	-
Uranium	µg/l	<0.5	<0.5	9
Vanadium	µg/l	17	9.5	-
Zinc	µg/l	280	190	100
Iron	µg/l	3800	9300	200
Manganese	µg/l	480	510	50
Calcium	mg/l	30	160	200
Magnesium	mg/l	33	44	50
Chloride	mg/l	875	1320	30
Fluoride	mg/l	0.37	0.15	1
Total Alkalinity as CaCO3	mg/l			NAC
Orthophosphate	µg/l	440	160	30
Potassium	mg/l	150.0	62.0	5
Sodium	mg/l	430	650	150
pH	pH units	8.70	7.20	6.5-9.5
Electrical Conductivity	µS/cm	4300	5330	1,000
Total Oxidised Nitrogen	mg/l	<0.5	<0.5	NAC
Ammonia	mg/l	120.00	37.00	0.15
Nitrite	mg/l	<0.002	<0.002	0.1
BOD	mg/l	<30	<30	-
COD	mg/l	562	480	-
Sulphate	mg/l	100	16	200

Table 2.3 Leachate Results August 17th 2010

Sample I.D. Sample Date	Units	MW-2	MW-3
Chloride	mg/l	966	1269.6
pH	pH units	8.78	7.3
Electrical Conductivity	µS/cm	4370	5190
Ammonia	mg/l	133	30.8
BOD	mg/l	25	12
COD	mg/l	241	115

The results confirm the presence of an aged Stage IV leachate.

2.3 Groundwater Monitoring

2.3.1 Monitoring Locations

Groundwater monitoring was conducted at five groundwater wells (MW-4, 5, 6, 7 and 8), whose locations are shown on Figure 2.1.

2.3.2 Methodology

Groundwater samples were collected by Council staff on the 13th July and 17th August 2010. In the July event, MW-7 was not samples as it was inadvertently thought to have been backfilled at that time. In August MW-1 and MW-5, were dry but a sample was obtained from MW-7 following confirmation by OCM that the well was intact. Groundwater level data was conducted by OCM in September 2010.

2.3.3 Laboratory Analysis

The samples collected on 13th July 2010 were submitted to the Agency's laboratory in Kilkenny for analysis for pH, electrical conductivity, dissolved oxygen, ammonia, nitrite, nitrate, orthophosphate, potassium, sodium, chloride, sulphate, alkalinity, metals, TON, BOD and COD.

The samples taken on August 17th 2010 were analysed at the Council's laboratory in Clonmel for a reduced range of parameters, which included pH, electrical conductivity, chloride, total ammonia, BOD and COD.

2.3.4 Laboratory Analysis

The full laboratory test reports are in Appendix 1 and the results are summarised in Tables 2.4 and 2.5. The Tables include Interim Guideline Values (IGV) published by the Agency. The IGVs are not statutory, but were developed to assist in the assessment of impacts on groundwater quality in the context of the implementation of the EU Water Framework Directive. The guidelines are based on, but are more conservative than the Drinking Water quality standards.

Table 2.4 Groundwater Monitoring Results July 13th 2010

Sample I.D. Sample Date	Units	MW-4	MW-5	MW-6	MW-8	IGV
Arsenic	µg/l	1.7	3.4	1.6	6.6	10
Aluminium	µg/l	910	1900	800	290	200
Antimony	µg/l	<0.5	<0.5	<0.5	<0.5	-
Barium	µg/l	240	220	140	1000	100
Beryllium	µg/l	<0.5	<0.5	<0.5	<0.5	-
Boron	µg/l	20	40	120	29	1,000
Cadmium	µg/l	<0.5	<0.5	<0.5	<0.5	5
Chromium	µg/l	21	21	29	24	30
Cobalt	µg/l	1.8	4.5	2.9	2.1	-
Copper	µg/l	4.8	15	8.4	12	30
Mercury	µg/l	<0.5	<0.5	<0.5	<0.5	1
Molybdenum	µg/l	<0.5	<0.5	<0.5	<0.5	-
Nickel	µg/l	4.9	9.3	7.2	8.6	20
Lead	µg/l	6.7	13	6.2	5.4	10
Selenium	µg/l	0.8	<0.5	1	0.9	-
Thallium	µg/l	<0.5	<0.5	<0.5	<0.5	-
Tin	µg/l	<1	<1	<1	<1	-
Uranium	µg/l	0.7	0.5	1.7	1.7	9
Vanadium	µg/l	2	4.8	1.4	1.6	-
Zinc	µg/l	29	48	28	27	100
Iron	µg/l	1300	2500	940	1500	200
Manganese	µg/l	160	360	1400	1500	50
Calcium	mg/l	120	71	150	140	200
Magnesium	mg/l	9	7	13	15	50
Chloride	mg/l	61	279	28	341	30
Fluoride	mg/l	0.07	0.09	0.08	0.09	1
Total Alkalinity as CaCO3	mg/l	408	545	576	407	NAC
Orthophosphate	µg/l	<10	<10	80	60	30
Potassium	mg/l	0.7	1.2	4.8	0.7	5
Sodium	mg/l	45	240	22	160	150
pH	pH units	7.10	7.80	7.00	7.00	6.5-9.5
Electrical Conductivity	µS/cm	936	1748	1110	1916	1,000
Total Oxidised Nitrogen	mg/l	2.01	0.75	4.13	0.53	NAC
Ammonia	mg/l	0.03	0.03	0.37	0.03	0.15
Nitrite	mg/l	<0.002	<0.002	0.004	0.003	0.1
BOD	mg/l	-	-	-	-	-
COD	mg/l	-	-	-	-	-
Sulphate	mg/l	-	-	-	-	200

Elevated aluminium, barium, iron and manganese were detected in all of the wells. Lead was slightly elevated in MW-5. Elevate orthophosphate was detected in MW- 6, and MW-8; sodium in MW-5 and MW-8 and chloride in MW-4, 5 and 8, while electrical conductivity is elevated in all the wells.

Table 2.5 Groundwater Monitoring Results August 17th

Sample I.D. Sample Date	Units	MW-4	MW-6	MW-7	MW-8	IGV
Chloride	mg/l	57.5	37.2	77.1	414	30
pH	pH units	7.25	7.22	7.37	7.16	6.5-9.5
Electrical Conductivity	µS/cm	1147	1147	1146	2110	1,000
Ammonia	mg/l	0.42	0.52	0.11	0.1	0.15
BOD	mg/l	1.3	1.3	0.9	2.7	-
COD	mg/l	23	27	15	28	-

Chloride and electrical conductivity was elevated in all the wells, while ammonia was elevated in MW-4 and MW-6. The data indicates the presence of leachate impact on the groundwater in the subsoil. The contaminant concentrations decrease moving from MW-8, which is close to the waste body, to MW-4 approximately 150m east of the landfill.

2.4 Landfill Gas

2.4.1 Locations

Landfill gas monitoring was conducted included all eight wells (MW-1 to MW-8). A spike probe survey was carried out in the area north of the fill area. The monitoring locations are shown on Figure 2.1

2.4.2 Methodology

The gas monitoring was conducted by Council staff in March, April and May 2010 and by OCM in September 2010. The Council staff used a Geotechnical Instruments GA 2000 gas analyser. OCM used a Gas Data LSMx gas analyser. The meters were calibrated before use. The detection limit is 0.1% for methane, carbon dioxide and oxygen.

The spike probe survey undertaken by OCM in September 2010 involved the use of a steel probe slotted in the lower 0.25m which was driven between 0.5 and 0.75m into the ground at each probe location. The gas analyser was attached to the top of the probe to monitor for landfill gas. During the survey there was no evidence of vegetation die back at the ground surface at any of the probe locations.

2.4.3 Results

The results are presented in Tables 2.6 – 2.8, which, includes guideline limits taken from the Department of the Environment (DOE) publication on the 'Protection of New Buildings and Occupants from Landfill Gas' (1994).

MW-1, MW-2 and MW-3 are within the waste body. Carbon dioxide and methane were detected in all three wells, ranging from 26% to 80.6% for methane, and 1.5% to 16% for carbon dioxide. Oxygen levels ranged from0.8% to 1.4%.

MW-4, MW-5, MW-6, MW-7 and MW-8 are outside the waste body. Methane was not detected in any of the wells. Carbon dioxide was detected in all of the wells, with the concentrations ranging from 0.1% to 5%. The DOE limit of 1.5% was regularly exceeded in MW-4, 6 and 8. The oxygen levels ranged from 2.9% to 22.6%, with the lowest level detected in MW-8.

Table 2.6 Landfill Gas Monitoring Data: November 2009 – September 2010

Well ID	**Methane**							**Carbon Dioxide**						
	23/11/09	02/12/2009	08/12/2009	23/03/2010	23/04/2010	31/05/2010	09/09/2010	23/11/2009	02/12/2009	08/12/2009	23/03/2010	23/04/2010	31/05/2010	09/09/2010
MW-1	31.5	53	52	63.4	75.1	73.6	80.6	12	15	16	16.7	18.7	18	17.2
MW-2	55	55	56	21	38.7	9.3	26.4	3.6	3.9	4.1	3.7	4.1	6.5	5.9
MW-3	35	37.5	38	32.6	34.4	26	27	1.5	3.6	3.7	2.4	3.7	5.6	5.9
MW-4	0	0	0	Water to top	Water to top	0	0	1.9	2.1	2.5	Water to top	Water to top	0.2	0
MW-5	0	0	0	0	0	0	0	1.6	0.9	1	0.1	0.3	0	1.3
MW-6	0	0	0	0	0	0	0	1.8	4	3.6	4.5	4.8	5	3.8
MW-7	0	0	0	Water to top	Water to top	0	0	0	0.9	1	Water to top	Water to top	0	0
MW-8	0.8	1.1	1.3	0.8	0	0.2	0	5	4.5	4.6	2.1	2.3	4.2	1.9
DOE Limit (%)	**1%**							**1.5%**						

Table 2.7 Landfill Gas Monitoring Data: November 2009 – September 2010

Well ID	Oxygen							Barometric Pressure						
	23/11/2009	02/12/2009	08/12/2009	23/03/2010	23/04/2010	31/05/2010	09/09/2010	23/11/2009	02/12/2009	08/12/2009	23/03/2010	23/04/2010	31/05/2010	09/09/2010
MW-1	1.4	1.1	1	3.5	0.3	0.4	0.4	1002	1001	1002	N/m	1002	1006	999
MW-2	1.3	1.1	1.1	4.8	0.4	0.5	0.1	1002	1001	1002	N/m	1002	1006	975
MW-3	1.1	0.8	0.9	3.5	0.4	1.1	0.9	1002	1001	1002	N/m	1002	1006	995
MW-4	22.3	19.9	18.4	Water to top	Water to top	21.4	20.3	1002	1001	1002	Water to top	Water to top	1005	1000
MW-5	18.1	21.8	21.6	20.7	20.9	21.4	18.3	1002	1001	1002	N/m	1002	1006	999
MW-6	21	20.1	20.1	12.2	12	13.9	14	1002	1001	1002	N/m	1002	1006	1000
MW-7	22.6	3.7	19.1	Water to top	Water to top	21.5	20.6	1002	1001	1002	Water to top	Water to top	1006	999
MW-8	2.9	3.6	3.6	10.3	7.8	4.9	1.4	1002	1001	1002	N/m	1002	1006	999
DOE Limit (%)	-							-						

The monitoring confirmed that high methane and carbon dioxide levels are present within the waste, with the highest levels occurring in the northern part of the site of the site around MW-1. There is no evidence of significant methane migration from the fill, with methane only detected at one monitoring point (MW-8) once in the four monitoring events. Slightly elevated carbon dioxide levels were detected in three locations (MW-4, 6 and 8).

Table 2.8 Spike Probe Results September 2010

Spike Probe Points	Methane	Carbon Dioxide	Oxygen	Barometric Pressure
	09/09/2010	**09/09/2010**	**09/09/2010**	**09/09/2010**
SP-1	0	0.2	20.3	987
SP-2	0	0.1	20.8	978
SP-3	0	0.2	20.5	979
SP-4	0	0	20.6	989
SP-5	0	0.2	20.1	999
SP-6	0	0.1	20.4	998
SP-7	0	0	20.6	986
DOE Limit (%)	**1%**	**1.5%**	**-**	**-**

Methane was not detected and carbon dioxide levels were low, typical of background conditions. The results indicate that despite the high methane levels detected in the waste, particularly in the northern portion, there is no evidence of landfill gas migration in the shallow subsurface.

3. ECOLOGICAL SITE SURVEY

An ecological survey was undertaken by Ecofact Ecological Consultants (Ecofact) in September 2010. The Ecofact report is included in Appendix 2 and the main findings are presented below.

The assessment identified the presence of reed swamp (FS1) habitat, with some wet alder / willow woodland (WN6). A small stand of non-native Japanese Knotweed was noted. This habitat is considered to be of high local importance and is connected with the Carrownreddy Lough and associated wetlands, to the north.

There is no data available on the diversity or ecological importance of this habitat or the biodiversity value of Carrownreddy Lough prior to the use of the site as a landfill to provide a benchmark for the current status. However, the botanical community within this habitat is likely to maintain its diversity despite further leachate inputs from the landfill.

Water levels were found to be very low during the assessment, both in the reed swamp habitat and in the land drain, although there was evidence in the botanical community that this habitat is water-logged throughout the year.

It is considered that the surrounding lands currently provide little dilution of leachate to the land drain. This drain was receiving minimal flows from the swamp and was barely flowing on the day of the survey, with pooled water observed in sections downstream. The substrate of the swamp and land drain was found to be anoxic, although this is considered to be a combined function related primarily to the stagnant conditions within the low-lying swamp.

The reed swamp is considered to be providing an important function as a natural attenuation of the leachate from the former landfill. This habitat will require the maintenance of a high water table or permanent standing water for its ongoing viability.

The reed swamp and wet woodland is considered to comprise an important habitat for breeding birds, with at least one pair of moorhens recorded on the day of the survey.

Although water quality in the reed swamp is likely to be affected by the leachate, the botanical community recorded is indicative of a semi-natural habitat. More significant impacts may relate to the macro invertebrate communities present. Based on the observations during the site assessment, which was during low flow conditions, the drain leaving the site appears to be affected by water quality impacts.

4. CONCEPTUAL SITE MODEL & QRA

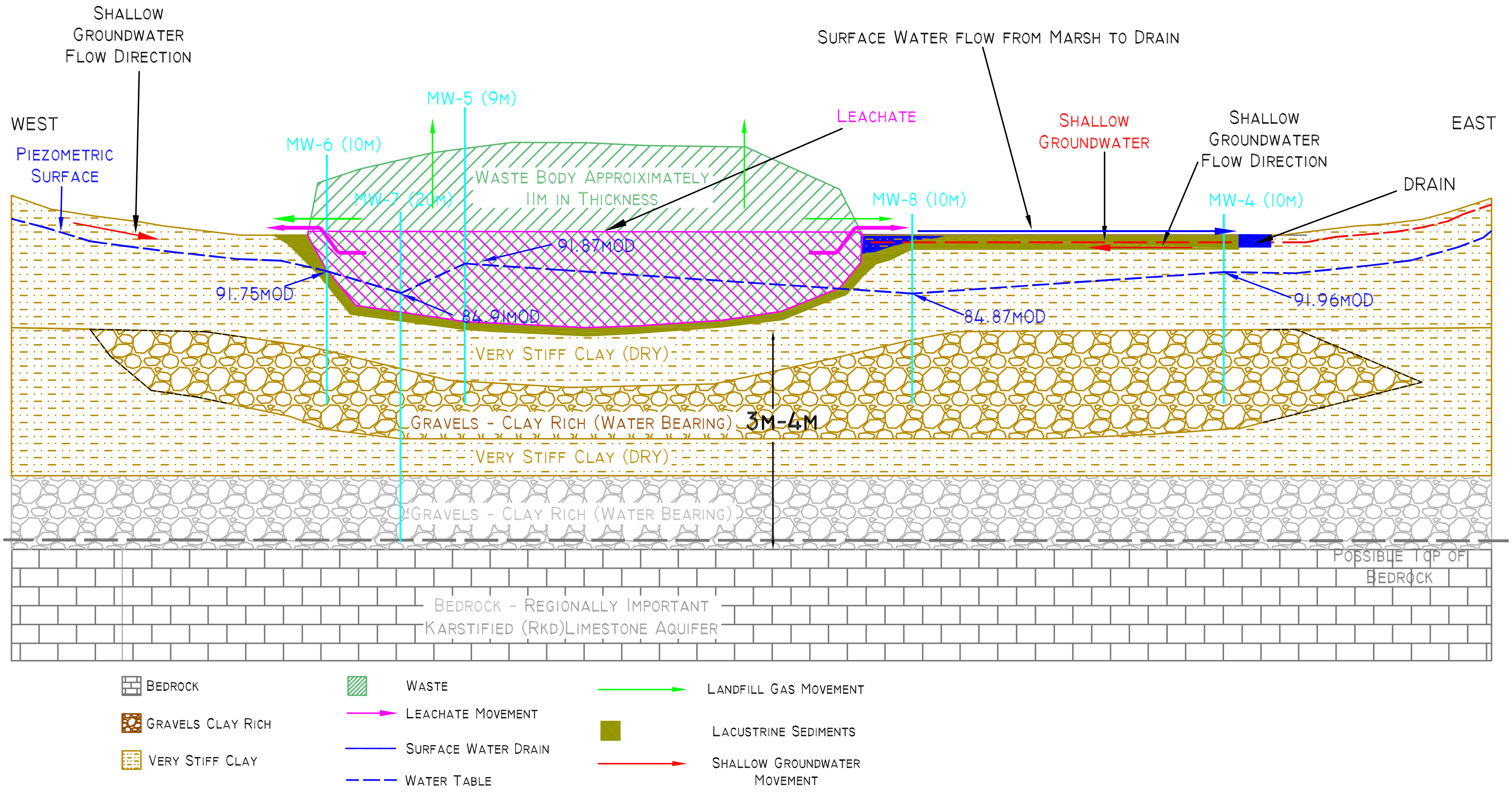
4.1 Tier 3 Revised Conceptual Site Model

The Tier 3 Revised Conceptual Site Model is presented on Figure 4.1. The subsoils at the site consist of a thin layer of lacustrine sediments underlain by a low – to moderate permeability boulder clay and gravel, which in turn are underlain by layer of low permeability hard clays. Beneath the clay is a lower layer of gravels. Based on the field observations and geophysics investigations the gravels appear to be underlain by shaley limestone Ll aquifer. However, for the purposes of this risk assessment and as requested by the Agency it has been assumed that the underlying bedrock is a Regionally Important Karst bedrock (Rkd).

The landfill is at a low point in a local catchment, where both groundwater and surface water discharge into the marsh. During the drilling of the wells outside the landfill (MW-4 -8) the first groundwater strikes were encountered at approximately 8.5m below ground level. The well screens are open to the subsoil and underlying upper gravel formation. The subsoils above the bedrock were observed to be poorly permeable, while the gravels are very permeable and water bearing. It is considered therefore that groundwater level monitoring indicates a variable static water level across the site and that the variations in water levels are indicative of a piezometric head consistent with a partially confined water table in the upper gravel layer beneath the clay. The upper and lower gravel layers are separated by very stiff, dry clay layer.

The leachate level within the waste is higher than the piezometric head in the surrounding natural ground and, as such, there is the potential for leachate to enter the shallow groundwater in the lacustrine sediments and possibly the underlying clays where the lacustrine sediments may have been disturbed when waste was being deposited. However, the low permeability clay subsoil layer beneath the sediments inhibits downward movement and there is no direct pathway to either the underlying deeper gravel formation or the bedrock aquifer. It is likely that because of the low permeability of the subsoils that the preferential flow path is along the surface into the Marsh.

A surface water drain leaves the marsh and flows to the south. This drain is seasonal and occasionally dries up. The direct discharge of contaminated shallow groundwater to the drain is not likely, but there is an indirect discharge as water levels rise in the marsh in the winter period**.**



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CLIENT

SOUTH TIPPERARY COUNTY COUNCIL

TITLE

CONCEPTUAL SITE MODEL

details

FIGURE No.

4.1

SCALE

REV.

Very high landfill gas levels are present within the landfill, but have not been detected in the surrounding subsoils, which indicate that the current landfill gas risk is low. However, because capping of the fill area is likely, remedial action will be required to mitigate leachate impacts and the risk of landfill gas migration which may increase due to the build up gases beneath the cap.

4.2 Surface Water

There are two potential surface water inflow areas to the marsh. The first is a recently dug drain, which appears to originate near the halting site to the south and runs north before turning east into the marsh. There was no flow in this drain in September 2010 but it is possible that there may be some flow in the winter months.

The second inflow originates at the boundary of a private dwelling approximately 400m to the west of the marsh. This may possibly be either a spring or a culverted section of a drain, but as it was not possible to get access to the dwelling, it was not possible to confirm the position.

Water leaves the marsh in a drain on its eastern boundary and flows for c.150m and then turns south and passes beneath the landfill access road (Lake Road) and flows towards a recently constructed residential development, where it is culverted and eventually discharges to the River Ara.

Within the landfill, the leachate levels measured in September 2010 by OCM range from 91.27mOD in MW-1 to 92.25mOD in MW-2 and MW-3. These levels are just below that of the surrounding natural ground (c.92.2mOD). While the levels are lower than those recorded in November 2009, the potential for migration into the marsh during wetter periods remains.

No leachate seepages were observed around the margins of the landfill and the ecological assessment concluded that the marsh area does not appear to have been be significantly impacted by leachate.

The impact of the leachate on water quality in the drain downstream of the site is limited, being confined to elevated ammonia, although there may also be a contribution from the naturally occurring anoxic conditions within the marsh. Iron manganese and chromium exceed the surface water EQS limits but are most likely representative of local background conditions, as the concentrations are similar and in the case of manganese and iron, higher in the drain that enters the marsh upstream of the landfill from the west than those leaving it to southeast.

4.3 Groundwater

The Agency commented on the potential for a swallow hole effect just east of the fill area (MW-8) and required an assessment of this as part of the Tier 3. The direction of groundwater flow is shown on Figure 4.2, which is based on groundwater levels measured by OCM in September 2010.

There is no field evidence of either a swallow hole or other karst features at or in the vicinity of the site and the GSI karst database does not contain any record of any karst features in this area. While the GSI maps indicate that the site in underlain by karstified bedrock, the site investigation data (field observations and geophysical data) indicates it is most likely to be underlain by shaley limestone.

The landfill is located in a former lake that was drained in ca 1940. The groundwater table reflects the local topography, with flow towards the fill area from all directions. This is consistent with groundwater flow towards a lake, which typically occupies a low point in a catchment and acts a discharge area for groundwater.

The groundwater level in MW-7 and 8 (84.91mOD and 84.97mOD respectively) are significantly lower than those in MW-4, 5 and 6 (91.96mOD, 91.87mOD and 91.75mOD respectively). This variation indicates variable piezometric head levels in the subsoil reflecting localized differences in permeabilities.

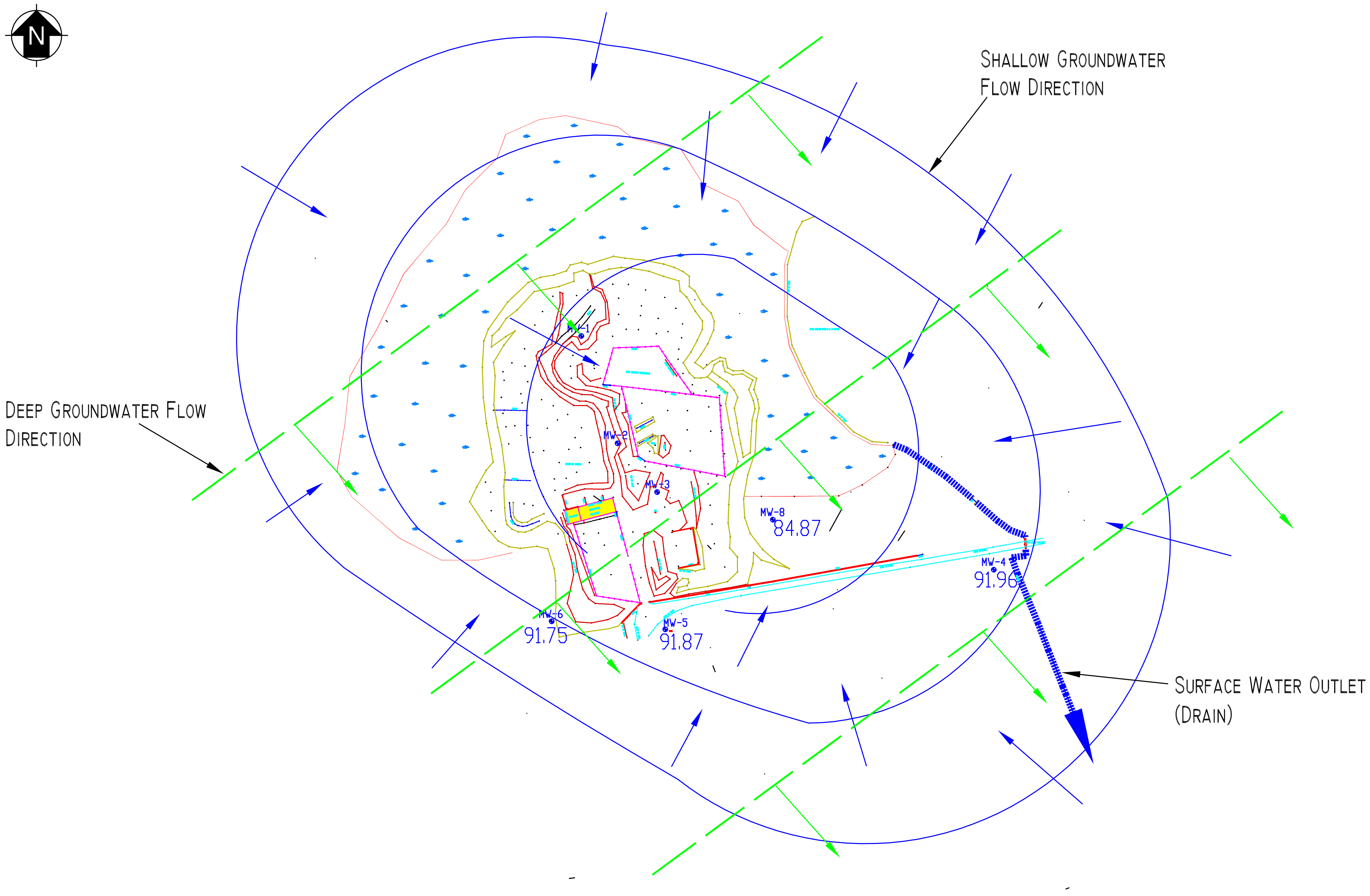
The leachate level in the waste is higher than the groundwater level in the surrounding subsoil. The difference in levels indicates the potential for the migration of leachate from the waste. The very hard, dry boulder clay underlying the landfill probably results in most of the leachate preferentially discharging to marsh where it appears to be significantly attenuated.

The monitoring data has established that leachate is impacting on the shallow groundwater, with elevated manganese, iron, aluminium, barium, ammonia and chloride. However the impacts are significantly attenuated with distance from the fill area. There is no evidence of any impact on the closest water supply well (Tipperary Co-Op) located 1.5 km to the south of the site.

It is likely that because of the topography that the monitoring wells surrounding the site are up hydraulic gradient of the landfill but that they are close enough to be affected by leachate migrating from the margins of the landfill due to the head of leachate in the waste mass perched above the natural gorund. The levels of ammonia, chloride, iron and manganese detected in the wells, compared to those in the leachate, indicates that substantial dilution and attenuation is occurring within 5-10m of the landfill

However the hydraulic gradient indicates movement of groundwater toward rather than away from the landfill. Because the wells are screened to monitoring shallow groundwater flow in the subsoils/gravels, they intercept the shallow leachate plume around the landfill area. Given the thickness of the underlying clays, it is likely that the groundwater in the deeper gravel zone is uncontaminated. It is likely that the direction of groundwater flow in the bedrock is to the southeast following the topographic gradient.

The presence of a relatively low permeability, thick subsoil immediately beneath the waste inhibits the vertical migration to the underlying water bearing gravels. The low permeability clay that underlies the gravels also inhibits the downward movement of any contaminated groundwater to the bedrock.



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CLIENT
South Tipperary County Council

DRAWING No.
4.2

NOTES

TITLE
INTERPRETED GROUNDWATER FLOW
SEPTEMBER 2010

SCALE

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4.4 Assessment of Landfill Gas Pathway

The monitoring in the waste body (MW-1, 2 and 3) indicates that methane and carbon dioxide are still being generated at significant levels. The monitoring in the perimeter wells identified carbon dioxide levels ranging from 0.1 - 5%, however methane was only detected at one monitoring point (MW-8) on one occasion. The spike probe survey indicates that gas migration to the north of the landfill is not occurring in the shallow subsurface.

The on-site building is no longer used and it is planned to demolish it in the near future, which will eliminate the risk associated with landfill gas.

A halting site, located approximately 150m to the south of the site, contains the nearest occupied residences. There are at least 20 private dwellings within 250m of the northwest and western site boundaries and a newly developed housing estate approximately 250m to the southeast. A residential development (~250 houses) is under construction approximately 200m to the northeast of the site.

It is intended to develop the lands south of the landfill for social housing and light industrial use and the area between the site and the residential estate to the north east for light industrial warehousing.

Given that remedial measures will include capping of the landfill, the risk posed by landfill gas will increase and must be mitigated.

The in-situ boulder clay surrounding the waste body has a moderate to low permeability, which inhibits gas movement. The water saturated conditions in the marsh along the landfill's north-western, northern and north-eastern margins will also inhibit gas migration and, when water levels drop in drier periods, possibly allow passive ventilation. The nearest existing residences are more than 250 m. The only area where landfill gas migration has the potential to occur to any great extent is to the south, where the nearest occupied buildings (Halting Site) are located.

4.5 Revised Risk Assessment

OCM modified the Tier 2 Assessment based on the Tier 3 findings and the EPA comments. The changes are highlighted in red.

4.6 Revised Risk Assessment

Table 6

Ref	**Source**	*Score*	*Rational*
1a	Leachate	7	▪ <5 hectares ▪ Waste likely to be both municipal & industrial
1b	Gas	7	▪ <5 hectares ▪ Highest rating given as proportion of municipal: industrial wastes is not known.

Table 7

Ref	**Pathways**	*Score*	*Rational*
2a	Groundwater vulnerability	2	▪ GSI data states that the site is rated as having high vulnerability. While the Agency recommended the Extreme vulnerability rating be used, OCM considers the Vulnerability to be High. The risk is to the bedrock aquifer and not the boulder clay subsoil, which is not classified as an aquifer.
2b	Groundwater flow regime	5	▪ Agency states that the aquifer should not be reclassified based on geophysics. OCM has reverted to the aquifer classification as Rkd despite strong field evidence to the contrary
2c	Surface water drainage	2	▪ Landfill is reportedly connected to town surface water drainage system
2d	Landfill gas lateral migration	3	▪ Residences not currently within 250m of site, but could be within 5 years. ▪ Karst bedrock
2e	Landfill gas vertical migration	5	▪ As long as building remains on-site; risk should remain high.

Table 8

Ref	**Receptors**	*Score*	*Rational*
3a	Human presence (leachate)	2	▪ Currently no houses within 250m, there will be within 5 years ▪ Note: All houses can be served by public water
3b	Protected areas	1	▪ No protected areas within 1 km of site ▪ The marsh has been considered as an undesignated GWDTE based on the precautionary approach. ▪ No consultation with the NPWS has taken place.
3c	Aquifer category	5	▪ Agency requires the aquifer to be classified as Rkd
3d	Public water supply	3	▪ Public water supply is greater than 1km away (Tipperary Co-op) ▪ Karst bedrock – but different geological formation ▪ Precautionary approach assumed
3e	Surface water bodies	3	▪ Surface water drain within 50m of site boundary
3f	Human presence (gas)	5	▪ Houses proposed within 50m of site boundary

The site remains High risk for leachate impacts on the surface water system, because of the presence of a pathway from the landfill to the marsh and the outlet drain.

The landfill gas risk has been increased to High, based on the Agency's recommendations that the on-site buildings risk be retained and also due to the proposal to cap the waste. Landfill gas levels may accumulate beneath the cap and increase the risk of migration.

While some impacts have been detected in the groundwater, it is considered likely that the risk posed to the bedrock aquifer is Low.

Note: The table below represents the Tier II Risk rating for this site. SPR1 to 9 represent the leachate risk scores. SPR10 & 11 represent Landfill Gas Risk. The migration pathways are colour coded as follows:

Groundwater & Surface Water	**Groundwater only**	**Surface water only**	**Lateral & Vertical**	
Calculator		**SPR Values**	**Maximum Score**	**Normalised Score**
SPR1	1a x (2a + 2b + 2c) x 3e	189	300	63.00%
SPR2	1a x (2a + 2b + 2c) x 3b	63	300	21.00%
SPR3	1a x (2a + 2b) x 3a	98	240	40.83%
SPR4	1a x (2a + 2b) x 3b	49	240	20.42%
SPR5	1a x (2a + 2b) x 3c	245	400	61.25%
SPR6	1a x (2a + 2b) x 3d	147	560	26.25%
SPR7	1a x (2a + 2b) x 3e	147	240	61.25%
SPR8	1a x 2c x 3e	42	60	70.00%
SPR9	1a x 2c x 3b	14	60	23.33%
SPR10	1b x 2d x 3f	105	150	70.00%
SPR11	1b x 2e x 3f	175	250	70.00%
Overall Risk Score		245		**70.00%**
				A

Risk Classification	**Range of Risk Scores**
Highest Risk (Class A)	**Greater than or equal to 70% for any individual SPR linkage**
Moderate Risk (Class B)	**Between 40-70% for any individual SPR linkage**
Lowest Risk (Class C)	**Less than or equal to 40% for any individual SPR linkage**

Risk Classification	**HIGHEST**

5. CONCLUSIONS

5.1 Surface Water

There is the potential for leachate to migrate from the waste via the lacustrine sediments into the adjoining marsh. Water from the marsh enters a drain that ultimately discharges to the River Ara several kilometres downstream of the site.

The impact of the leachate on water quality in the drain leaving the marsh is limited, being confined to elevated ammonia, although there may also be a contribution from the naturally occurring anoxic conditions within the marsh.

The elevated iron manganese and slightly elevated chromium detected in the samples collected from the drain leaving the landfill site are most likely representative of local background conditions, as similar levels are present in the drain that enters the marsh from the west. There is no water quality data for the drain entering the marsh from the south.

Remedial measures are required to minimise the risk to surface water. Such measures may include the provision of a low permeability cap over the waste. This will reduce rainfall infiltration that generates a leachate head within the waste, which can then enter the lacustrine sediments and flow into the marsh

5.2 Groundwater

Based on the groundwater flow direction data shallow groundwater in the catchment is moving toward a low point in the former lake area and discharging into the marsh. The shallow groundwater and surface water run-off enter the marsh and discharge to the drain along the eastern landfill boundary.

Some leachate impacts have been detected in the shallow groundwater. These are considered to originate as discharges into the subsoil along the margins of the landfill. The leachate migration away from the margins of the landfill is not considered to be significant laterally because of the direction of groundwater flow and vertically because of the presence of hard low permeability boulder clay underlying the lacustrine sediments beneath the landfill.

Given the thickness of the subsoil above the bedrock aquifer, the risk posed to the bedrock aquifer is considered to be Low.

5.3 Landfill Gas

Methane and carbon dioxide are still being generated at significant levels within the waste body, however currently there is no evidence of any significant migration of gas away from fill area.

The on-site building is no longer used and it is planned to demolish it in the near future, which will eliminate the risk associated with landfill gas. There is a Halting Site 150m to the south of the site, but there are no other residential dwellings within 250m. It is possible that at some time in the future the lands immediately surrounding the site could be developed for residential and/or commercial purposes.

The in-situ boulder clay surrounding the waste body has a moderate to low permeability, which inhibits gas movement while the water saturated conditions in the marsh along the landfill's north-western, northern and north-eastern margins also inhibit gas migration in these directions. The only area where landfill gas migration has the potential to occur to any great extent is to the south, where the nearest occupied buildings (Halting Site) are located.

5.4 Ecosystem

The marsh comprised reed swamp (FS1) habitat, with some wet alder / willow woodland (WN6). A small stand of non-native Japanese Knotweed is present. This habitat is considered to be of high local importance and is connected with the Carrownreddy Lough and associated wetlands, to the north. It is also an important habitat for breeding birds.

The reed swamp provides an important function as a natural attenuation of the leachate from the former landfill. This habitat will require the maintenance of a high water table or permanent standing water for its ongoing viability.

There is the potential for the remedial works (placement of low permeability cap over the waste) to encroach into the reed swamp habitat at the existing toe of the landfill. An Appropriate Assessment Screening, completed as part of the ecological assessment and included in the Ecofact Report, conclude that the remedial works will not result in significant impacts affecting the Natura 2000 site network, in particular the River Suir SAC.

The Japanese knotweed on the site will require a management and control. The small stands present on the site would be much easier to treat and control in the short term, rather than allow the spread and colonisation of large areas of the site by this species.

5.5 Risk Category

The site is a Class A High Risk Site, based on the risk to surface water and the risk of landfill gas migration and remedial measures are required to mitigate the risk to surface water.

6. RECOMMENDATIONS

6.1 Surface Water

The source(s) of surface water contamination in the drain entering the marsh from the west should be investigated.

Should surface water flow be observed in the drain entering the marsh from the south the water quality should be monitored to establish its status. It appears that this drain has recently been dug and if the monitoring identifies an impact, the drain should be blocked to prevent discharge to the marsh.

The landfill should be capped to minimise the infiltration of rainfall to the waste. required in some portions of the site but some compacting, grading, surface drainage. The Council has already capped a portion of the fill area but additional compacting and grading of those area may be required.

The alternative to capping the landfill is

a) Do nothing and allow the existing leachate generation within the waste through rainfall infiltration to continue to impact on the surface water drain downstream of the facility.

b) Remove the waste. The environmental impact caused by this option would most likely have a greater impact on the ecology of the wetland and on surface water quality downstream of the site. In addition the financial cost would be much larger than undertaking a remedial solution in-situ.

6.2 Landfill Gas

The existing landfill gas wells should be retained and additional landfill gas ventilation wells installed across the site to minimise the risk of build up of landfill gas pressures and minimise the risk of landfill gas migration.

A landfill gas cut-off trench should be installed along the southern boundary of the capped fill area to minimise the risk of landfill gas migration toward existing and/or future dwellings proposed for this area once the landfill is capped.

Landfill gas monitoring should be undertaken in wells MW5, 6 and 7 at monthly intervals to assess the risk of off-site migration toward the Halting Site and the residential area further south. Should the levels remain low after 12 months the monitoring frequency could be reduced to quarterly in Year 2 and Bi-annually thereafter.

All the gas monitoring wells should be monitored at least annually. If development occurs within 250m of the site boundary, more frequent monitoring may be required.

6.3 Ecology

Plant used in the remedial works should not be allowed to enter the marsh. Ground disturbance within 5-10m of the landfill margins adjacent to the marsh should be minimised using silt curtains and appropriate site fencing.

The Japanese knotweed should be treated and controlled to prevent it from becoming a dominant invasive species in the marsh wetland area.

6.4 Groundwater

Following capping, groundwater monitoring should be undertaken to establish the effectiveness of the works. The monitoring should be at least bi-annual.

6.5 Remedial Works

The scope of the proposed remedial works are set out in the Preliminary Remedial Action Plan in Appendix 3.

APPENDIX 1

Laboratory Analytical Data

Environmental Protection Agency
Regional Inspectorate
Seville Lodge, Callan Road,
Kilkenny

SOUTH TIPPERARY COUNTY COUNCIL
RECEIVED
10 SEP 2010
ENVIRONMENT

Report of: Surface Waters - Tipperary Town Landfill
Report to: South Tipperary Co. Co.
Report date: 07/09/10

Location sampled: Miscellaneous Surface Water
Date sampled: 13/07/2010 Date received: 14/07/2010

	Laboratory Ref:	1003149	1003150	1003151
	Type of sample:	Misc	Misc	Misc
	Sampling point:	SW1 (10-0858)	SW2 (10-0859)	SW3 (10-0860)
	Sampled by:	Denis McGuire	Denis McGuire	Denis McGuire
	Time Sampled:	14:30	12:15	12:00
	Start/End - Dates of Analysis:			
	Status of results:	**Final Report**	**Final Report**	**Final Report**
Parameter	**Units**			
Alkalinity-total (as CaCO3)	mg/l CaCO3	359	391	291
Biochemical Oxygen Demand	mg/l O2	3.2	7.1	5.7
Chemical Oxygen Demand	mg/l O2	48	73	91
Conductivity @25°C	µS/cm	913	969	766
Fluoride	mg/l F	nm	nm	nm
Sulphate	mg/l SO4	nm	nm	nm
Aluminium	ug/l	<25	<25	46
Antimony	ug/l	<0.5	<0.5	<0.5
Arsenic	ug/l	1.9	1.3	4.5
Barium	ug/l	140	200	210
Beryllium	ug/l	<0.5	<0.5	<0.5
Boron	ug/l	66	83	56
Cadmium	ug/l	<0.5	<0.5	<0.5
Calcium	mg/l	84	88	110
Chromium	ug/l	14	15	11
Cobalt	ug/l	0.5	0.5	0.9
Copper	ug/l	0.6	0.8	4.6
Iron	ug/l	1800	2800	3400
Lead	ug/l	<0.5	<0.5	0.7
Magnesium	mg/l	10	11	6.2

	Laboratory Ref:	1003149	1003150	1003151
	Type of sample:	Misc	Misc	Misc
	Sampling point:	SW1 (10-0858)	SW2 (10-0859)	SW3 (10-0860)
	Sampled by:	Denis McGuire	Denis McGuire	Denis McGuire
	Time Sampled:	14:30	12:15	12:00
	Start/End - Dates of Analysis:			
	Status of results:	**Final Report**	**Final Report**	**Final Report**
Parameter	**Units**			
Manganese	ug/l	800	840	1600
Mercury	ug/l	<0.5	<0.5	<0.5
Molybdenum	ug/l	<0.5	<0.5	<0.5
Nickel	ug/l	0.9	0.8	2.3
Potassium	mg/l	6.3	7.2	0.8
Selenium	ug/l	0.8	0.7	0.6
Sodium	mg/l	36	43	9.3
Thallium	ug/l	<0.5	<0.5	<0.5
Tin	ug/l	<1	<1	<1
Uranium	ug/l	<0.5	<0.5	1.1
Vanadium	ug/l	<0.5	<0.5	0.6
Zinc	ug/l	18	22	34
Ammonia	mg/l N	6.1	7.5	0.03
Chloride	mg/l Cl	67	83	17
Nitrite (as N)	mg/l N	0.007	<0.002	<0.002
ortho-Phosphate (as P)	mg/l P	0.18	0.29	0.08
Total Oxidised Nitrogen (as N)	mg/l N	<0.50	<0.50	<0.50
pH	pH	7.3	7.1	7.6
Suspended Solids	mg/l	<18.2	34	89

Comments: Surface water samples taken from Tipp town landfill. For South Tipp Co. Co.

1) Results highlighted and in bold are outside specified limits.
2) All Metals Analysed in the EPA Dublin Laboratory,
Cyanide Analysed in the EPA Cork Laboratory.
Phenols Analysed in the EPA Castlebar Laboratory.
3) nm "Not measured"
4) nd "None detected"
5) nt "No time" - Time not recorded
6) tntc "Too numerous to count"
7) F "Field measured parameters"

Signed:

Date: 7/9/10

Caroline Bowden, A/Regional Chemist

Environmental Protection Agency
Regional Inspectorate
Seville Lodge, Callan Road,
Kilkenny

Report of: Groundwater - Tipperary Town Landfill
Report to: South Tipperary Co. Co.
Report date: 07/09/10

Location sampled: Miscellaneous Landfill Groundwater
Date sampled: 13/07/2010 Date received: 14/07/2010

		Laboratory Ref:	1003152	1003153	1003154	1003155	
		Type of sample:	Misc	Misc	Misc	Misc	
		Sampling point:	MW8 - 10-0861	MW6 - 10-0862	MW5 - 10-0863	MW4 - 10-0864	
		Sampled by:	Denis McGuire	Denis McGuire	Denis McGuire	Denis McGuire	
		Time Sampled:					
		Start/End - Dates of Analysis:					
		Status of results:	**Final Report**	**Final Report**	**Final Report**	**Final Report**	
Parameter	**Units**	**Limits**					
Alkalinity-total (as CaCO3)	mg/l CaCO3		407	576	545	408	
Conductivity @25°C	µS/cm		1916	1110	1748	936	
Fluoride	mg/l F		0.09	0.08	0.09	0.07	
Sulphate	mg/l SO4		56	41	53	20	
Aluminium	ug/l		290	800	1900	910	
Antimony	ug/l		<0.5	<0.5	<0.5	<0.5	
Arsenic	ug/l		6.6	1.6	3.4	1.7	
Barium	ug/l		1000	140	220	240	
Beryllium	ug/l		<0.5	<0.5	<0.5	<0.5	
Boron	ug/l		29	120	40	20	
Cadmium	ug/l		<0.5	<0.5	<0.5	<0.5	
Calcium	mg/l		140	150	71	120	
Chromium	ug/l		24	29	21	21	
Cobalt	ug/l		2.1	2.9	4.5	1.8	
Copper	ug/l		12	8.4	15	4.8	
Iron	ug/l		1500	940	2500	1300	
Lead	ug/l		5.4	6.2	13	6.7	
Magnesium	mg/l		15	13	6.6	8.5	
Manganese	ug/l		1500	1400	360	160	
Mercury	ug/l		<0.5	<0.5	<0.5	<0.5	

		Laboratory Ref:	1003152	1003153	1003154	1003155	
		Type of sample:	Misc	Misc	Misc	Misc	
		Sampling point:	MW8 - 10-0861	MW6 - 10-0862	MW5 - 10-0863	MW4 - 10-0864	
		Sampled by:	Denis McGuire	Denis McGuire	Denis McGuire	Denis McGuire	
		Time Sampled:					
		Start/End - Dates of Analysis:					
		Status of results:	**Final Report**	**Final Report**	**Final Report**	**Final Report**	
Parameter	**Units**	**Limits**					
Molybdenum	ug/l		<0.5	<0.5	<0.5	<0.5	
Nickel	ug/l		8.6	7.2	9.3	4.9	
Potassium	mg/l		0.7	4.8	1.2	0.7	
Selenium	ug/l		0.9	1	<0.5	0.8	
Sodium	mg/l		160	22	240	45	
Thallium	ug/l		<0.5	<0.5	<0.5	<0.5	
Tin	ug/l		<1	<1	<1	<1	
Uranium	ug/l		1.7	1.7	0.5	0.7	
Vanadium	ug/l		1.6	1.4	4.8	2	
Zinc	ug/l		27	28	48	29	
Ammonia	mg/l N		0.03	0.37	0.03	0.03	
Chloride	mg/l Cl		341	28	279	61	
Nitrite (as N)	mg/l N		0.003	0.004	<0.002	<0.002	
ortho-Phosphate (as P)	mg/l P		0.06	0.08	<0.01	0.03	
Total Oxidised Nitrogen (as N)	mg/l N		0.53	4.13	0.75	2.01	
pH	pH		7.0	7.0	7.8	7.1	

Comments:

1) Results highlighted and in bold are outside specified limits.

2) All Metals Analysed in the EPA Dublin Laboratory,
Cyanide Analysed in the EPA Cork Laboratory.
Phenols Analysed in the EPA Castlebar Laboratory.

3) **nm** "Not measured"
4) **nd** "None detected"
5) **nt** "No time" - Time not recorded
6) **tntc** "Too numerous to count"
7) **F** "Field measured parameters"

Signed: Date: 7/9/10

Caroline Bowden, A/Regional
Chemist

Environmental Protection Agency
Regional Inspectorate
Seville Lodge, Callan Road,
Kilkenny

Report of: Leachate - Tipperary Town Landfill
Report to: South Tipperary Co. Co.
Report date: 07/09/10

Location sampled: Miscellaneous Leachate
Date sampled: 13/07/2010 Date received: 14/07/2010

Laboratory Ref:		1003156	1003157	
Type of sample:		Misc	Misc	
Sampling point:		MW3 - 10-0865	MW2 10-0866	
Sampled by:		Denis McGuire	Denis McGuire	
Time Sampled:				
Start/End - Dates of Analysis:				
Status of results:		**Final Report**	**Final Report**	
Parameter	**Units**			
Biochemical Oxygen Demand	mg/l O2	<30	<30	
Chemical Oxygen Demand	mg/l O2	480	562	
Conductivity @25°C	µS/cm	5330	4300	
Fluoride	mg/l F	0.15	0.37	
Sulphate	mg/l SO4	16	100	
Aluminium	ug/l	1300	2200	
Antimony	ug/l	1.3	2.7	
Arsenic	ug/l	14	31	
Barium	ug/l	1700	320	
Beryllium	ug/l	<0.5	<0.5	
Boron	ug/l	640	1600	
Cadmium	ug/l	<0.5	1.3	
Calcium	mg/l	160	30	
Chromium	ug/l	49	37	
Cobalt	ug/l	3.8	7.9	
Copper	ug/l	30	43	
Iron	ug/l	9300	3800	
Lead	ug/l	95	110	
Magnesium	mg/l	44	33	
Manganese	ug/l	510	480	

		Laboratory Ref:	1003156	1003157	
		Type of sample:	Misc	Misc	
		Sampling point:	MW3 - 10-0865	MW2 10-0866	
		Sampled by:	Denis McGuire	Denis McGuire	
		Time Sampled:			
		Start/End - Dates of Analysis:			
		Status of results:	**Final Report**	**Final Report**	
Parameter		**Units**			
	Mercury	ug/l	<0.5	<0.5	
	Molybdenum	ug/l	1.1	14	
	Nickel	ug/l	8.7	21	
	Potassium	mg/l	62	150	
	Selenium	ug/l	3	18	
	Sodium	mg/l	650	430	
	Thallium	ug/l	<0.5	<0.5	
	Tin	ug/l	<1	1	
	Uranium	ug/l	<0.5	0.5	
	Vanadium	ug/l	9.5	17	
	Zinc	ug/l	190	280	
	Ammonia	mg/l N	37	120	
	Chloride	mg/l Cl	1320	875	
	Nitrite (as N)	mg/l N	<0.002	<0.002	
	ortho-Phosphate (as P)	mg/l P	0.16	0.44	
	Total Oxidised Nitrogen (as N)	mg/l N	<0.50	<0.50	
	pH	pH	7.2	8.7	

Comments:

1) Results highlighted and in bold are outside specified limits.

2) All Metals Analysed in the EPA Dublin Laboratory,
Cyanide Analysed in the EPA Cork Laboratory.
Phenols Analysed in the EPA Castlebar Laboratory.

3) **nm** "Not measured"
4) **nd** "None detected"
5) **nt** "No time" - Time not recorded
6) **tntc** "Too numerous to count"
7) **F** "Field measured parameters"

Signed: Date: 7/9/10

Caroline Bowden, A/Regional
Chemist

APPENDIX 2

Ecofact Report

Former Landfill at Tipperary Town

Ecological Assessment
And
Appropriate Assessment Stage 1: Screening

Version: 13th October 2011

ecofact
Environmental Consultants

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TABLE OF CONTENTS

1 INTRODUCTION

The current report provides the results of an ecological assessment undertaken at the former landfill site, on the northern outskirts of Tipperary town at Carrownreddy. The assessment has been undertaken as part of the Tier 3 Risk Assessment for the closed landfill, on behalf of O'Callaghan Moran and Associates. The site has been categorised as being a Class A – High Risk site due to the risk to humans from landfill gas and also due to the potential for leachate migration.

Ecofact Environmental Consultants Ltd. have been commissioned to carry out an ecological assessment of the marsh / reed swamp area adjacent to the closed landfill to evaluate the impacts, if any, of the closed landfill on this area.

Additionally, an Appropriate Assessment Stage 1 Screening has been carried out for the proposed remediation measures to assess whether this proposal is likely to have a significant effect on the Natura 2000 site network. Effects upon the conservation objectives and qualifying interests (including habitats and species) within the affected designated areas are considered. An Appropriate Assessment is required under Article 6 of the Habitats Directive (92/43/EEC), in instances where a plan or project may give rise to significant effects upon a Natura 2000 site. Natura 2000 sites are those identified as sites of European Community importance designated under the Habitats Directive (SACs) or the Birds Directive (SPA).

The current document meets this requirement by providing a Screening Assessment of the proposed remediation works in Appendix 1 of the current report and follows the guidance for screening published by the National Parks and Wildlife Service (NPWS 2009) '*Appropriate Assessment of Plans and Projects in Ireland. Guidance for Planning Authorities'*. The area of marsh / reed swamp habitat adjacent to the landfill, within the study area is not designated within any Natura 2000 site and is not considered within the context of an Appropriate Assessment.

2 METHODOLOGY

A desktop review was carried out to identify features of ecological importance within the study area. Sources included the National Parks and Wildlife Service online database of protected species. A full bibliography of reports and publications used in the desk study are provided in the references section of this report. A review of the published literature was undertaken in order to collate data on the receiving environment, including species and habitats of conservation concern in the study area. The collation of this information, as well as examination of Ordinance Survey mapping, aerial photography and conservation designations from the NPWS online mapping allowed areas of potential ecological importance to be highlighted prior to the field survey.

A site walkover of the closed landfill site was undertaken by a qualified ecologist (MIEEM) with a particular focus on the marsh area and the connection between the landfill site and the existing land drain to the east. This drain was sampled using a sweep net to identify the macroinvertebrate community present, to allow for an evaluation of the biological water quality within the drain. Water levels within the drain were found to be low and the substrate was dominated by silt and decaying vegetation; therefore unsuitable for the application of the EPA Q-value assessment or the EPA Small Streams Risk Score (SSRS) assessment.

Habitats were classified according to habitat descriptions and codes published in the Heritage Council's '*A Guide to Habitats in Ireland*' (Fossitt, 2000). Plant species nomenclature follows Stace '*New Flora of the British Isles*' (1997) and scientific names are given at first mention. An assessment of fauna within the study area was made during the site visit, with particular emphasis on the presence of protected species.

3 RESULTS

3.1 Habitat survey

Habitats recorded from the site are classified according to Fossitt (2000) and are described in detail below. The wetland habitat within the site was surveyed and the results are discussed under the relevant habitat type – Reed / large sedge swamp (FS1).

3.1.1 Improved Agricultural grassland (GA1)

The field directly east of the closed landfill site, containing the southern portion of the reed swamp wetland was characterised as improved agricultural grassland. The field was grazed by horses and floral diversity was low. The sward was dominated by a rye-grass mix *Lolium* sp. with broadleaved herbs typical of this habitat recorded including: Nettle *Urtica dioica*, Creeping buttercup *Ranunculus repens,* Meadow buttercup *Ranunculus acris,* Broad dock *Rumex obtusifolius,* Ragwort *Senecio jacobaea* and Dandelions *Taraxacum officinale agg.*

3.1.2 Reed / Large sedge swamp (FS1)

The marsh habitat referred to in the Tier 3 Risk Assessment was found to be dominated by Bulrush Typha latifolia, with abundant Yellow Iris *Iris pseudacorus*; this results in the classification as a reed / large sedge swamp where the overall diversity within this habitat was found to be species poor. Broad leaved herbs occurred, comprising a small percentage of the overall habitat. Additional species recorded from the swamp and its margins included Floating sweet-grass *Glyceria fluitans,* Yorkshire fog *Holcus lanatus,* Cocksfoot grass *Dactylis glomerata,* Tussock-grass *Deschampsia cespitosa,* Hard rush *Juncus inflexus,* Soft rush *Juncus effusus*, Common marsh-bedstraw *Galium palustre,* Willowherb *Epilobium sp.,* Meadowsweet *Filipendula ulmaria,* Silverweed *Potentilla anserina,* Woody nightshade *Solanum dulcamara*, Water-cress *Rorippa nastutium-aquatica,* Water horsetail *Equisetum fluviatile* (and other Equisetum species), Hemlock water-dropwort *Oenanthe crocata* and Duckweed *Lemna* spp. recorded from the small pools of open water. Alder and willow woodland was recorded from the northern portion of the swamp as described below.

The botanical community recorded from within this swamp habitat is indicative of permanent water-logging, with some standing water evident in pools, although *Lemna* sp. was found to be abundant.
Water quality may present a constraint to the naturalness or diversity of flora within this habitat, however, the current community represents a wetland habitat of local ecological importance, both botanically and in relation to the wildlife value it provides (i.e. breeding birds and invertebrates).

3.1.3 Wet willow-alder-ash woodland (WN6)

The northern portion of the reed swamp wetland was found to include alder *Alnus glutinosa* with some willow *Salix* spp. This woodland was not associated with fen peat. This alder woodland would fall within the *Alnus glutinosa – Fillipendula ulmaria* association identified in the NSNW (Perrin *et al*., 2008). This wet woodland is considered to be of high local ecological importance, with cognisance of its connection with Carrownreddy Lough and the associated wetland ecological connectivity.

3.1.4 Drainage ditch (FW4)

Due east of the closed landfill site, the reed swamp was found to discharge to a land drain which flows from the swamp in a south easterly direction. However, on the day of the survey no flow was detectible in the drain due to low water levels. The substrate was found to comprise black, anoxic muds with decaying vegetation (high volume of *Lemna* sp.). A light film of hydrocarbons was evident in standing water where the swamp habitat and the drainage ditch converged. Aquatic macrophyte growth was low, with flora limited to the margins of the drain. Species recorded included Duckweed *Lemna* spp., Water-cress *Rorippa nastutium-aquatica,* Floating sweet-grass *Glyceria fluitans* and Yorkshire fog *Holcus lanatus.*

The land drain is evaluated as being of low ecological importance.

3.1.5 Treeline (WL2)

The line of the drainage ditch to the east of the reed swamp, within the agricultural grassland included a treeline dominated by Ash *Fraxinus excelsior* with some Alder *Alnus glutinosa* and Hawthorn *Crataegus monogyna*. Flora recorded from the understory included Brambles *Rubus fruticosus agg.,* Hart's-tongue Fern *Phyllitis scolopendrium,* Ivy *Hedera helix* and Dog-rose *Rosa canina agg.* This treeline was not continuous along field boundary, although treelines and hawthorns were common along field boundaries within the local context.

The treeline along the land drain is evaluated as being of local ecological importance, although it is fragmented and is not properly connected with the treeline network within the local landscape. The infilling of the surrounding fields with construction and demolition (C&D) waste has disrupted the hedgerow and treeline corridors within the local context.

3.1.6 Spoil and bare ground (ED2)

Directly north of the closed landfill compound an area of open bare ground and spoil was recorded where top-soil material, vegetation cuttings and some C&D waste had recently been dumped. This material was banked along the northern periphery of the elevated landfill, with a turning circle cleared in the centre. Some of this material was found to be slipping down the embankment to the wetland habitat surrounding the northern and eastern perimeter of the closed landfill.

This habitat was evaluated as being of low ecological importance.

3.1.7 Recolonising bare ground (ED3)

A significant portion of the lands to the north and east of the reed swamp wetland comprised recolonising bare ground, where C&D waste was becoming re-vegetated with ruderal broadleaved species. Grass cover was very low. The elevated fill material was well-compacted and it is expected that recolonisation will take a period of years.

Species recorded from within this habitat included Docks, Nettle, Willowherb, Ragwort, Thistle species, Plantain species *Plantago* spp., Lesser Burdock *Arctium minus,* Groundsel *Senecio vulgaris,* Japanese knotweed *Fallopia* japonica (limited to the southeastern corner of the closed landfill site, due south of the reed swamp habitat). Elder *Sambucus nigra,* Buddleja *Buddleja davidii,* Travellers Joy *Clematis vitalba,* Butterbur *Petasites hybridus,* Winter heliotrope *Petasites fragrans* and Brambles *Rubus fruticosus agg.*

This habitat was evaluated as being of low ecological importance.

3.2 Additional ecological observations

The swamp habitat identified along the northern and eastern boundary of the site contains a botanical community identified as compatible with the requirements of whorl snails (*Vertigo* spp.). A screening search for these species was undertaken on the site and none were recorded. It is considered that the background water quality issues at the site are having an impact on the macroinvertebrate communities (both aquatic and semi-aquatic). Given the constraints at the site, it is considered that whorl snail species are unlikely to occur, with no records of these species previously recorded from the study area.

A sweep-net sample was taken from the land drain directly below the discharge from the swamp. An EPA biotic index (Q-value) would not be applicable to this site given the size of the drain and low flow conditions present. However, it is noted that the macroinvertebrate diversity recorded were limited to taxa tolerant of pollution, as shown in Table 1. No pollution sensitive taxa were recorded.

No connection was noted between the land drain on the site and the upper reaches of the Fidaghta River, which flows to the north of the study area. The land drain from the closed landfill site was followed downstream to Rosanna Road where it was culverted below a new residential development. Upstream of the road the drain created a wide area of wet grassland and marsh habitat as shown. No open water or flow was visible in the culvert under the road. According to the EPA Envision online mapping the surface water flows from the marsh area are within the Fidaghta River catchment. However, from onsite walkover studies undertaken by O'Callaghan Moran & Associates, it has been determined that these flows are to the Ara River catchment, which flows to the south of Tipperary town.

Table 1 Macroinvertebrates recorded during the sweep-net sampling at the land-drain due east of the Tipperary closed landfill.

Group / organism	Pollution sensitivity group	Functional group	Abundance
TRUE FLIES (Diptera)			
Family Chironomidae			
Green chironomid	C	Filtering collector	Common
Chironomous sp.	E	Filtering collector	Common
SNAILS (Mollusca, Gastropoda)			
Ramshorn Snail (Family Planorbidae)			
Planorbis sp.	C	Scraper	Present
Family Lymnaeidae			
Lymnaea peregra	D	Filtering collector	Fair numbers
MUSSELS (Mollucsa, Lamellibranchiata)			
Orb/Pea Mussels (Sphaeridae)	D	Filtering collector	Present
CRUSTACEANS (Crustacea)			
Isopoda (Family Asellidae)			
Asellus aquaticus	D	Shredder	Common
LEECHES (Hirudinae)			
Family Glossiphonidae			
Helobdella stagnalis	D	Predator	Present
TUBIFICID WORMS	D	Collector	Common

No observations or evidence of protected mammals were recorded during the site survey and it is considered unlikely that the site is important for protected species. The standing water within the swamp habitat provides suitable habitat for frogs and newts, although neither species were recorded on the day of the survey.

The invasive, non-native species Japanese knotweed *Fallopia japonica* was recorded from the south eastern corner of the closed landfill site, adjacent to the laneway. The disturbed nature of the site provides ideal habitat for the spread of this species which will require further management and control.

4 DISCUSSION

The ecological assessment of the wetland habitat at the former landfill at Tipperary town has identified the presence of reed swamp (FS1) habitat, with some wet alder / willow woodland (WN6). This habitat is evaluated as being of high local importance and is connected with the Carrownreddy Lough and associated wetlands, to the north. There is no data available on the diversity or ecological importance of this habitat or the biodiversity value of Carrownreddy Lough prior to the landfill, to provide a benchmark for the current situation at this reed swamp. However, the botanical community within this habitat is likely to maintain its diversity despite any further leachate inputs from the landfill (based on the current situation).

Water levels were found to be very low on the site during the current assessment, both in the reed swamp habitat and in the land drain, although there was evidence in the botanical community that this habitat is water-logged throughout the year.

It is considered that the surrounding lands are currently providing little dilution of leachate to the land drain which was receiving minimal flows from the swamp and was barely flowing on the day of the survey, with pooled water observed in sections downstream. The substrate of the swamp and land drain were found to be anoxic, although this is considered to be a combined function related primarily to the stagnant conditions within the low-lying swamp.

The reed swamp is considered to be providing an important function as a natural attenuation of the leachate from the former landfill, in agreement with the findings of the '*Tier 2 Detailed Site Investigation*' (OCM, 2009). This habitat will require the maintenance of a high water table or permanent standing water for its ongoing viability.

Although water quality in the reed swamp is likely to be affected by the leachate from the reed swamp, the botanical community recorded is indicative of a semi-natural habitat. More significant impacts may relate to the macroinvertebrate communities present. This reed swamp and wet woodland is considered to comprise an important habitat for breeding birds, with at least one pair of moorhens recorded on the day of the survey.

Based on the current one-off site visit during low flow conditions, the land drain on the site appeared to be affected by water quality impacts requiring further remediation measures during the Tier 3 Risk Assessment.

The proposed remediation at the landfill site will require the placement of a 0.5-1m cap across the whole of the landfill. There is the potential for these works to encroach into the reed swamp habitat at the existing toe of the landfill. Impacts affecting the reed swamp will be reduced by restricting machinery access to the top of the existing landfill and avoiding any machinery within the wetland area. There remains the potential for some disturbance at the perimeter of the existing landfill i.e. within 5-10m of the landfill margins in the west, north and east of the landfill with the potential for silt and clay run-off during the capping process. This will be mitigated against effectively using silt curtains and appropriate site fencing. Following the completion of capping the revegetation of the landfill will stabilize sediments on the banks of the landfill.

There is an overall beneficial impact to the reedbed habitat at this location arising from the proposed remediation works, where leachate and surface water runoff will be minimized by the proposed works resulting in an improvement in water quality within this water dependant habitat. There will be further downstream impacts benefiting the Ara River, in the local context. There are no impacts affecting the reedbed / wetland habitat at this site which would have any effects on the Natura 2000 site network. This semi-aquatic habitat is not designated within any Natura 2000 site and is indirectly connected to the River Suir SAC via the land drain and the Ara River, which is a tributary of the Aherlow River.

With regard to the Appropriate Assessment Screening Report (see Appendix 1) it is concluded that the proposed Tier 3 Remediation works for the former Tipperary Landfill will not result in significant impacts affecting the Natura 2000 site network, in particular the River Suir SAC. Therefore it is not considered necessary for the ‘Appropriate Assessment’ process to proceed to Stage 2. Impacts arising from the proposed works are evaluated as being limited to the local context and would not extend in significance to the SAC which is located approximately 16 river kilometres downstream of the landfill site. Any beneficial impacts arising from the proposed remediation works would affect the Ara River within the local context; however, it is considered that this would not have any significant positive impact on the River Suir SAC, downstream of the Ara and Aherlow Rivers.

The Japanese knotweed on the site will require a management and control strategy for inclusion in the Remediation Measures during Tier 3. The small stands present on the site would be much easier to treat and control in the short term, rather than allow the spread and colonisation of large areas of the site by this species.

REFERENCES

European Commission (2001) *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 Commission Environment DG

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PLATES

Plate 1 View of the agricultural grassland to the east of the closed landfill. The swamp habitat is visible in the centre left of the image, where it meets the land drain, along the treeline (centre).

Plate 2 View of the eastern portion of the reed swamp, where it discharges to the land drain. Emergent flora within the swamp and drain were searched for whorl snails.

Plate 3 Water levels in the land drain were found to be very low, with no noticable flow.

Plate 4 View west from the elevated C&D waste spoil. The swamp habitat is visible in the centre of the image, with the elevated closed landfill in the background.

Plate 5 View north across the recolonising bare ground of the C&D waste spoil.

Plate 6 View of the drier margins of the swamp where the C&D spoil has altered the water table.

Plate 7 View of the *Typha* dominated swamp directly east of the closed landfill.

Plate 8 *Typha* dominated swamp with Alder woodland along the northern line of the closed landfill. *Juncus* was common along the interface between the drier C&D spoil and the reed swamp wetland.

Plate 9 The northern portion of the swamp, view west. Alder and willow wet woodland was recorded from within the permanent wetland habitat.

Plate 10 Limited open areas of water were noted. Duckweed was found to be abundant wherever they occurred. Moorhens were recorded from within the swamp.

Plate 11 Japanese knotweed was recorded along the road margin at the south eastern corner of the closed landfill site. It is considered that the site presents suitable habitat for the spread of this species, which will continue if unmanaged.

Plate 12 View of the old buildings and material storage on the closed landfill site.

Plate 13 A view north showing the fenced compound on the closed landfill site. The swamp habitat is located to the east (right of the image).

Plate 14 To the north of the fenced compound on the landfill there is an area of freshly dumped topsoil, construction waste and vegetation. This is piled along the embankment at the edge of the swamp habitat.

Plate 15 The dumped material was found to be unstable and slipping downslope into the swamp habitat. It is expected that suspended solids and run-off from this waste is washing down into the swamp.

Plate 16 The land drain due south of the landfill was found to be impounded. No flow was recorded from the drain downstream. Pooled water was recorded directly adjacent to the road.

Plate 17 View north from Rosanna Road. No flow was recorded from the land drain due south of the closed landfill, at Rosanna Road. The construction of new residential developments as depicted and across the road to the south are likely to have altered the flow of this drain. The wet grassland / marsh habitat visible in this image is attributed to frequent high water levels within the land drain.

Appendix 1 Appropriate Assessment Screening Report

Table A1.1 Appropriate Assessment Screening Matrix for the proposed Tier 3 remediation works at the former Tipperary Landfill, Tipperary Town

Screening matrix	
Brief description of the project or plan	The current Tier 3 remediation works proposal for the former landfill at Carrownreddy, Tipperary Town has identified the need for the placement of a 0.5-1m cap across the whole of the landfill. Currently the site has been categorised as being a Class A – High Risk site due to the risk to humans from landfill gas and also due to the potential for leachate migration. The remediation works proposed will not require dewatering or alteration of the local drainage network. The net effect of capping would be an improvement in water quality reaching the local drainage network and a reduction in leachate, as rainwater is diverted from the waste mass.
Brief description of the Natura 2000 site network	The former landfill at Tipperary Town is located within 15km of the following Natura 2000 sites: -The Lower River Shannon SAC (002165), approximately 10km due north -The Galtee Mountains SAC (000646), approximately 9km due south -Moanour Mountain (002257), approximately 6km due southwest None of these designated Natura 2000 sites are connected to the former landfill site, either geographically or via hydrological or hydrogeological connections. The former landfill site is within the River Suir catchment and a drainage channel adjacent has been found to be connected to the Ara River (and not the Fidaghta River as shown on EPA Envision mapping). The Ara River is a tributary of the Aherlow River which confluences with the River Suir. The Ara River flows to the south of Tipperary Town; within one kilometre of the former landfill site at its closest point. The Ara River meets the Aherlow River, which is designated within the River Suir SAC, approximately 15 river kilometres downstream of Tipperary Town. Therefore the River Suir SAC is the only designated Natura 2000 site with any connection to the former landfill site; with regard to the indirect connection between the site and the SAC via the Ara River.
Assessment criteria	
Describe the individual elements of the project (either alone or in combination with other plans or projects) likely to give rise to impacts on the Natura 2000 site.	The proposed Tier 3 remediation works at the former landfill site will require capping of the landfill site to minimise run-off and leachate entering the drainage network. There is potential for the proposed works to cause disturbance to the drainage regime within the former landfill site, with the associated potential for the mobilisation of settled leachate material into the drainage network during the construction phase. The mobilisation of leachate material within the land drain adjacent to the site may result in the transportation of suspended solids and leachate pollutants to the Ara River, with the further potential for the transportation of this material downstream to the Aherlow River within the SAC.

Describe any likely direct, indirect or secondary impacts of the project (either alone or in combination with other plans or projects) on the Natura 2000 site by virtue of: • size and scale; • land-take; • distance from the Natura 2000 site or key features of the site; • resource requirements (water abstraction etc.); • emissions (disposal to land, water or air); • excavation requirements; • Transportation requirements; • duration of construction, operation, decommissioning, etc.; • other.	There are no likely direct impacts of the proposed remediation works affecting the River Suir SAC, as there are no direct connections to the SAC, neither are there any land-take requirements within a designated Natura 2000 site. There are no resource requirements, emissions, excavation requirements or transportation requirements likely to give rise to direct impacts on any Natura 2000 site. There are no likely indirect or secondary impacts arising from the proposed works which may affect the Natura 2000 site network, or the River Suir SAC in particular, with regard to the size and scale of the proposed works; land take; resource requirements, excavation requirements, transportation requirements or the duration of the proposed works. Indirect impacts in relation to emissions from the proposed site to water and the distance to the River Suir Natura 2000 site are identified as being relevant. However, the distance between the site and the SAC is approximately 15 river kilometres downstream; where the connection between the site and the Ara River is via a small, low capacity land drain.
Describe any likely changes to the site arising as a result of: • reduction of habitat area: • disturbance to key species; • habitat or species fragmentation; • reduction in species density; • changes in key indicators of conservation value (water quality etc.); • climate change.	From the current assessment there are no likely changes to the River Suir SAC arising as a result of any reduction in habitat area or disturbance to key species. The proposed works do not give rise to the likelihood for habitat or species fragmentation or a reduction in species density within the SAC. There are no likely changes to the key indicators of conservation value i.e. water quality within the SAC, located 15 river kilometres downstream of the site. In fact it is considered that the proposed works will have a beneficial impact on water quality within the Ara catchment with the minimisation of leachate and run-off from the existing un-capped landfill (as identified in the Tier 2 Hydrogeological Report).
Describe any likely impacts on the Natura 2000 site as a whole in terms of: • interference with the key relationships that define the structure of the site; • interference with key relationships that define the function of the site.	The current assessment has identified that the proposed remediation works at the former Tipperary Landfill site will not have any direct, indirect or secondary / cumulative impact on the Natura 2000 site network, or the River Suir SAC in particular, with regard to interference with the key relationships defining the structure and function of the site. Furthermore there are significant beneficial impacts arising from the proposed works with regard to water quality within the undesignated Ara catchment. The area of marsh habitat adjacent to the landfill, within the study area is not designated within any Natura 2000 site and is not considered within the context of an Appropriate Assessment.
Provide indicators of significance as a result of the identification of effects set out above in terms of: • loss; • fragmentation; • disruption/disturbance; • change to key elements of the site (e.g. water quality).	The proposed remediation works at the former Tipperary Landfill site will not have any significant impacts, direct, indirect or cumulative on the River Suir SAC in terms of loss or fragmentation. There will be no significant impacts with regard to disturbance or disruption of the conservation interests and key relationships of the site. There will be no significant impacts arising which would result a change to the key elements of the site (i.e. water quality). In fact it is considered that the proposed remediation works would result in a positive impact on water quality in the Ara River downstream of the works. However, this is considered unlikely to result in any perceptible change in water quality in the River Aherlow, given the distance and dilution between the Aherlow and the landfill site.
Describe from the above those elements of the project or plan, or combination of elements, where the above impacts are likely to be	There are no impacts arising from the proposed remediation works likely to significantly affect the Natura 2000 site network. There is no potential for direct impacts on any Natura 2000 site arising from the proposed works and indirect impacts are limited to the hydrological connection between the site and the River Suir SAC. However, the connecting

significant or where the scale or magnitude of impacts is not known.	watercourses (land drain and Ara River) and the distance (approx. 15Rkm) between the site and the SAC, results in the conclusion that there will be no significant impacts arising.		
Finding of no significant effects report matrix			
Is the project or plan directly connected with or necessary to the management of the site (provide details)?	The proposed Tier 3 remediation works are not directly connected with or necessary to the management of the River Suir SAC.		
Are there other projects or plans that together with the project or plan being assessed could affect the site (provide details)?	There are no other projects or plans in the Ara River catchment, or the River Aherlow / River Suir catchment which could give rise to cumulative impacts affecting the SAC, as there are no significant impacts identified arising from the proposed works in isolation and the scale of the proposed works with respect to the Ara River are considered to be imperceptible positive, due to the minimisation of leachate and surface water run-off.		
The assessment of significance of effects			
Describe how the project or plan (alone or in combination) is likely to affect the Natura 2000 site.	The proposed Tier 3 remediation works are considered to have no significant impact on the River Suir SAC. There are imperceptible positive impacts identified for the Ara River, which is a tributary of the River Aherlow, with regard to the minimisation of leachate and surface water run-off – however this is not considered to be of a scale that would be quantified within the River Suir SAC, downstream of the confluence between these watercourses.		
Explain why these effects are not considered significant.	The small size and scale of the proposed works, combined with the limited hydrological connection to the Ara River within the River Suir catchment (Aherlow sub-catchment) is considered to be the primary limiting factor in relation to the significance of effects. The distance of the proposed works to the SAC (approximately 15 river kilometres) also results in significant river recovery and dilution within the Ara River, in the event of any downstream dispersion of leachate or polluting material. It is not considered likely that this would give rise to any significant effects within the River Suir SAC.		
Data collected to carry out the assessment			
Who carried out the assessment	*ECOFCACT Environmental Consultants Ltd., on behalf of O'Callaghan Moran and Associates*		
	Sources of data	Level of assessment completed	Where can the full results of the assessment be accessed and viewed?
	National Parks and Wildlife Service (NPWS): http://www.npws.ie	*Article 6 Screening Assessment*	The full Assessment is contained within the current document.
Overall conclusions			
The proposed Tier 3 Remediation works for the former Tipperary Landfill will not result in significant impacts affecting the Natura 2000 site network, in particular the River Suir SAC. Therefore it is not considered necessary for the 'Appropriate Assessment' process to proceed to Stage 2. Impacts arising from the proposed works are evaluated as being limited to the local context and would not extend in significance to the SAC which is located approximately 15 river kilometres downstream of the landfill site. Any beneficial impacts arising from the proposed remediation works would affect the undesignated Ara River within the local context; however, it is considered that this would not have any significant positive impact on the River Suir SAC, downstream of the confluence of the Ara River with the Aherlow River.			

References

NPWS (2009) *Appropriate Assessment of Plans and Projects in Ireland. Guidance for Planning Authorities*. Department of the Environment, Heritage and Local Government, Ireland.

European Commission (2001) *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 Commission Environment DG

APPENDIX 3

Remedial Action Plan

environmental management for business

O' Callaghan Moran & Associates

PRELIMINARY

REMEDIAL ACTION PLAN

TIPPERARY TOWN LANDFILL

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DRAWINGS

1. INTRODUCTION

The Tier 3 Risk Assessment of the former Tipperary Town Landfill categorised the site as High Risk due to the potential for leachate impact on surface water quality and landfill gas migration. The assessment identified that remedial measures, including the capping of the fill area and the installation of a landfill gas control measures were required.

The report presents the preliminary design of the remedial measures and forms part of the Tier 3 Risk Assessment Report that will be submitted to the Environmental Protection Agency (Agency) as part of the Unregulated Landfill Certification process.

The preliminary design is based on the Agency's Landfill Manuals on Landfill Site Design (2000) and Landfill Restoration and Aftercare (1999) which presents guidance on landfill closure and restoration measures.

2. LANDFILL CAP

2.1 Restoration Profile

The site topography is illustrated on Drawing No. 1.The placement of both the waste and existing cover material has resulted in a landform which generally falls from a central plateau ranging from 97-99mOD in all directions to the surrounding natural ground.

The natural ground forms a low depression which was the original lake but the ground level is higher to the south and west. It is approximately 96mOD along the southern boundary with the landfill. Along the northwest landfill boundary with the marsh the natural ground level is approximately 91.8mOD. The natural ground in the east and also rises up away from the landfill. The lands to the east have been reclaimed with construction/demolition waste which has raised the profile by approximately 1-1.5m to the east of the site.

Within the landfill there are a number of stockpiles of construction demolition waste in the western part of the site that have not been graded. The northwestern portion of the landfill contains a fenced-off sludge disposal area, which is overgrown with vegetation. The southern section of the landfill is occupied by a gravel covered hard stand area which was used as a parking compound for plant when the site was operational. There is an un-occupied building located to the northwest of the parking compound.

Approximately 50% of the site has been covered with soil and vegetated. However, the cover is not uniform in thickness and has not been properly graded to enhance surface water run-off. The existing layout is shown on Drawings 1 and 4.

The proposed finished profile, which is shown on Drawing No. 2, comprises a uniform shallow (1:25) gradient from the south to the north. This gradient will assist surface water drainage. It is the Council’s preference that the site be restored as grassland. Given the relatively small area that will be restored, ca 1.8 ha, and the overall size of the site (ca 1.5 ha) it is not necessary to provide hedgerows to subdivide the land into smaller fields and it will not be necessary to plant trees.

Grass is the most suitable vegetation as it provides all year round soil cover and promotes the development of a soil structure and animal grazing is the intended use identified by the landowner. This land use also minimises the potential for soil damage as it does not require field work during late autumn, winter or early spring.

2.2 Design Objectives

The design objectives were to minimise the infiltration of incident rainfall into the waste mass, which is considered to be the primary source of leachate generation at the site, ensure that the site was suitable for the end-use and minimise the long term aftercare maintenance.

2.3 Options

An assessment of suitable capping system options for the site was carried out taking into consideration the Agency's Landfill Manuals on Landfill Site Design and Landfill Restoration and Aftercare and the findings of the Tier 2 and 3 investigations.

The recommended capping design for non-hazardous landfill includes a minimum total topsoil and subsoil thickness of 1 m overlying a drainage layer of minimum thickness of 0.5 m, a low permeability barrier and a landfill gas collection layer. The thickness of the layers is intended to allow for post closure settlement and the installation of pollution control systems.

However, given the age of the landfill and the total depth 11.5m the likelihood of significant future settlement is low. While landfill gas is being generated, this is primarily associated with limited area used for sludge disposal with localised source areas for landfill gas elsewhere. However, in those areas the gas levels are likely to be reducing over time. Some portions of the site have already been covered by subsoils. It is unlikely therefore that a 1 m thickness of subsoils and topsoil and a gas collection layer across the entire site is required.

The Landfill Manual on Site Design recommends that the barrier layer consist of either a low hydraulic conductivity mineral layer or a synthetic layer such as a flexible membrane liner (FML) or geosynthetic clay liner (GCL). The minimum thickness of the mineral layer should be 0.6 m with a hydraulic conductivity of $1x10^{-9}$m/s. Where a geosynthetic material is used, it should provide the equivalent protection.

The use of FMLs and GCLs requires the installation of perimeter anchor trenches that would cause significant disturbance of the marsh adjoining the fill area. Therefore, a mineral layer comprising a 0.6 m engineered clay cap (ECC) is the preferred barrier layer.

2.4 Surface Water Management

Rainfall infiltrating through the subsoils in the capping system will be collected in the drainage layer that overlies the low permeability layer and flow along the contours to a perimeter swale. Surface run-off from the capped area will also be intercepted by the swale. The water will infiltrate to ground in the swale and feed into the marsh. This will assist in maintaining the high water table needed to sustain the marsh habitat.

2.5 Proposed Capping System

The proposed capping system is shown on Drawing No.2 comprises the following: -

- 0.15 m topsoil,
- 0.5 m subsoil,
- 0.3 m drainage layer (hydraulic conductivity $1x10^{-4}m/s$),
- 0.6 m engineered clay layer (hydraulic conductivity $1x10^{-9}m/s$).
- 0.3m gas collection layer

2.6 Works Programme

Given the size of the site the low permeability barrier, drainage layer, subsoils and top soils will be installed in one phase and as part of one contract. The seeding of the topsoil will be included in the contract. As there are no on-site sources of subsoil or topsoil, imported soils will have to be used. The materials for use in the drainage and barrier layers must also be imported.

A detailed design and specification will be prepared for the works, which will include a construction quality assurance plan and a construction method statement. The plan will include specifications for the materials to be used in the capping system and the quality control and assurance methods and testing that must be applied to ensure that the system is installed properly. The detailed design will be submitted to the Agency for its approval prior to the works commencing.

The installation of the capping system will be supervised by a competent person who will prepare a construction quality assurance validation report upon the completion of the works. At this time, it is estimated that the works can be completed in 4 - 6 weeks.

2.7 Aftercare Stage

Based on the age and limited extent of the fill, no appreciable degree of post closure settlement is expected. Given the local rainfall amounts and the proposed restoration profile erosion of the capping materials will not be a significant issue.

The Council will carry out regular inspections of the site in the aftercare period to monitor for settlement or erosion, which could impact on the integrity of the capping system. In the unlikely event of significant settlement or erosion, the Council will immediately undertake remedial work, subject to the agreement of the landowner/occupier.

The aftercare monitoring programme will include groundwater and landfill gas monitoring in wells adjoining the site and landfill gas and leachate level monitoring in the wells inside the waste. Initially it is proposed to conduct the monitoring bi-annually, after which the data be reviewed to establish trends.

3. LANDFILL GAS CONTROLS

Significant landfill gas concentrations have been recorded in the three monitoring wells located in the body of the waste body, however there is no evidence of any lateral migration from the fill area. This is most likely due to the fact that landfill gas can vent freely to atmosphere, thereby minimizing the accumulation of gas and build up of pressure within the waste, which is the main driver for gas migration.

3.1 Design Objectives

The design objectives were to minimise the risk of landfill gas migration towards the nearest occupied dwellings following the installation of the capping system, to protect future development, and have low maintenance requirements.

3.2 Options

An assessment of suitable control options for the site was carried out taking into consideration the Agency's Landfill Manuals and the findings of the Tier 2 and 3 investigations.

While the concentrations of methane measured within the waste body are high, given the age and size and depth of the fill area, the volumes of gas being generated are not sufficient to sustain active abstraction and flaring and utilisation.

The in-situ boulder clay surrounding the waste body has a moderate to low permeability, which inhibits gas movement while the water saturated conditions in the marsh along the landfill's north-western, northern and north-eastern margins also inhibit gas migration in these directions.

The only area where landfill gas migration has the potential to occur to any great extent is to the south, where the nearest occupied buildings (Halting Site) are located. Future development of residential and commercial use is also planned for these lands.

The most effective control measure for the site is a combination of a gas collection layer incorporated into the capping system, passive vents installed within the waste body and a cut off trench install outside the landfill footprint around the south western, southern and south eastern edges of the fill. The gas collection layer is required to encourage gas flow towards the vents and vent to atmosphere. The cut-off trench is intended to intercept gas migration to the south and allow it to vent to atmosphere.

3.3 Proposed Controls

The proposed gas control measures incorporated into the capping system are shown on Drawing No 3. The location of the cut-off trench is shown on Drawing No 4. Drawing No. 5 shows the detail of the Gas Cut-Off trench.

The cut off trench will be excavated to a maximum depth of 2m below ground level. The trench should be excavated in a manner that allows short sections to be excavated, lined and backfilled without the need for leaving the trench open for extended periods of time. The trench will be set back away from the waste mass where possible by at least 2m and will extend into the marsh area along the western portion of the site.

All sharp objects and protrusions, such as large stones, roots and the like, shall be removed from the floor and the side of the excavation to be lined, i.e. opposite side to the waste. Where necessary these surfaces shall be 'dressed' to provide a smooth and even surface free of protrusions. The floor of the excavation should be trimmed to remove all loose debris and objects potentially deleterious to the liner. Any waste and soil arising from the excavations shall be used in other earthworks on the site or disposed at a suitably licensed facility as appropriate

The trench will be lined with geosynthetic clay liner (GCL) and covered by a protective geotextile before being backfilled with granular material. The GCL will be cut to the correct length as required and lowered into the excavation so that it lines the surface away from the waste. The GCL will be overlapped by a minimum 300mm. Following installation of the GCL, a protective geotextile shall be placed on top

Following completion of the lining works, the trench will be backfilled with venting stone to the top of trench.

3.4 Works Programme

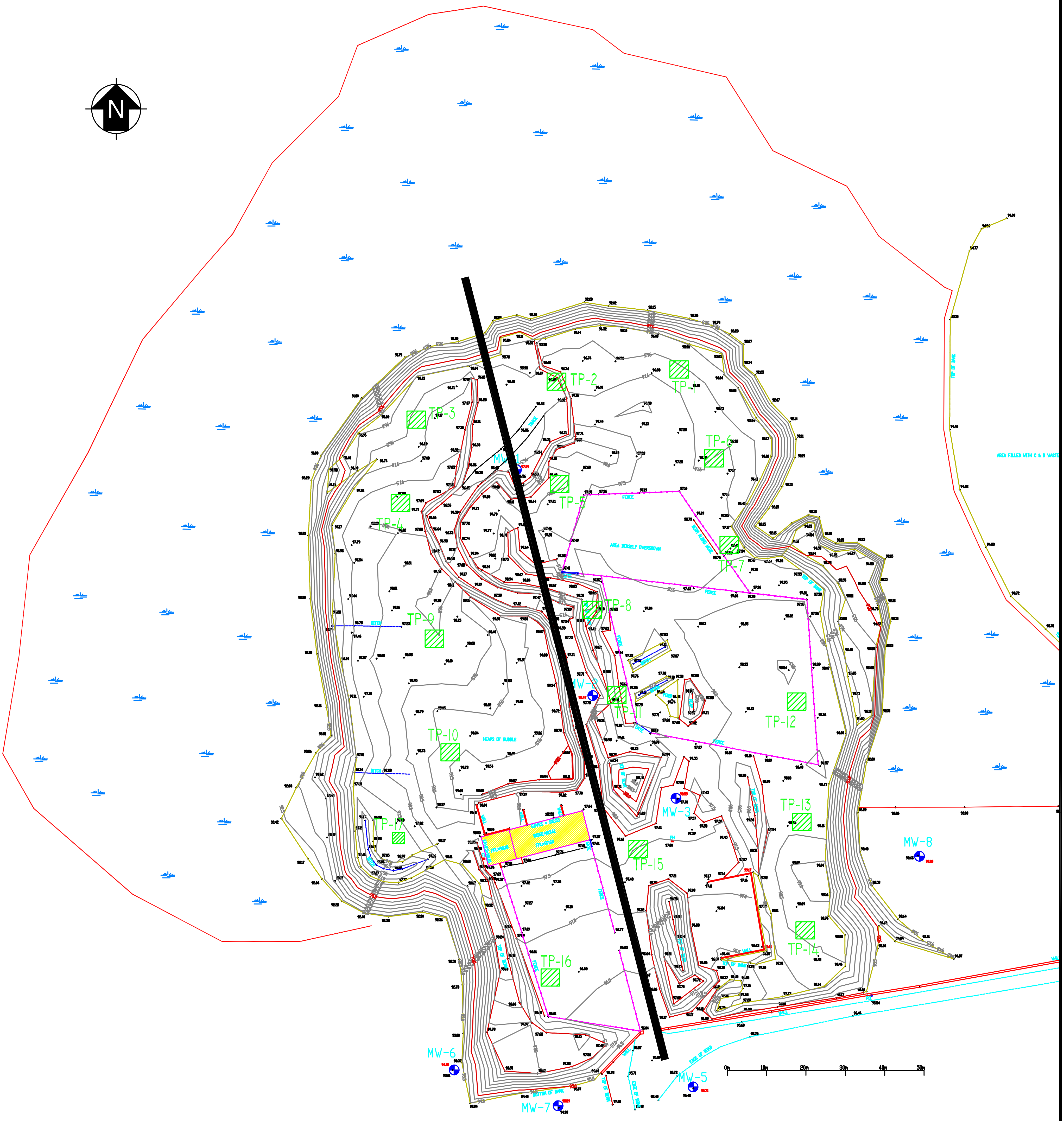
A detailed design and specification will be prepared for the works, which will include a construction quality assurance plan and a construction method statement. The plan will include specifications for the materials to be used in the installation of gas control measures and the quality control and assurance methods and testing that must be applied to ensure that the system is installed properly. The detailed design will be submitted to the Agency for its approval prior to the works commencing.

The installation of the cut off-trench will be supervised by a competent person who will prepare a construction quality assurance validation report upon the completion of the works. At this time it is estimated that the works can be completed in 2-4 weeks

3.5 Aftercare Stage

The Council will carry out regular inspections of the site in the aftercare period to monitor for settlement or erosion, which could impact on the integrity of the gas control system. In the unlikely event of significant settlement or erosion, the Council will immediately undertake remedial work, subject to the agreement of the landowner/occupier.

DRAWINGS



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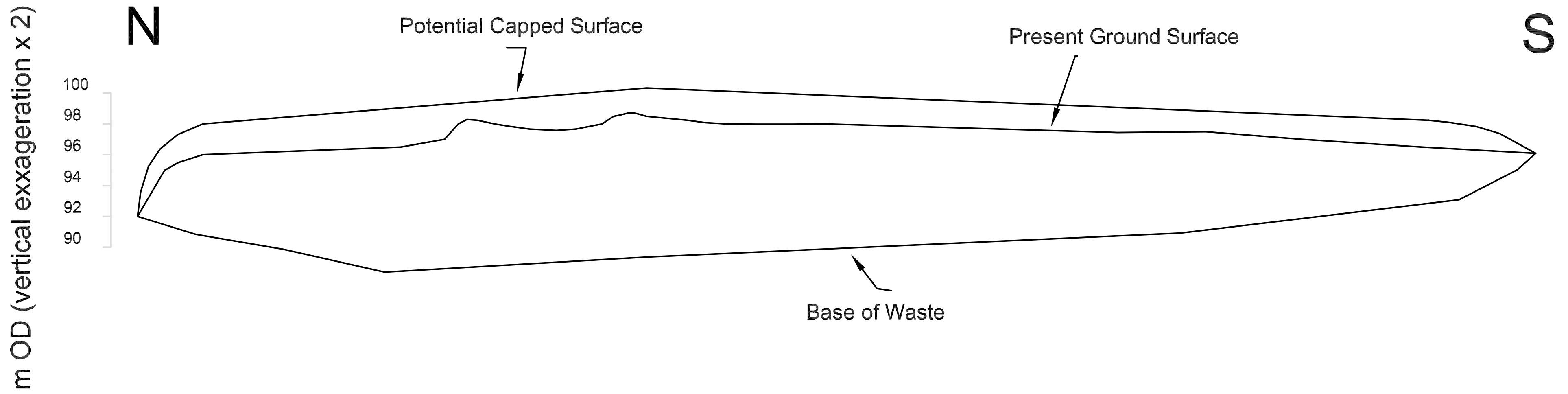
CLIENT	SOUTH TIPPERARY COUNTY COUNCIL
TITLE	SITE TOPOGRAPHY
DETAILS	
Figure No.	1
SCALE	1:1,000



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CLIENT

South Tipperary County Council

TITLE

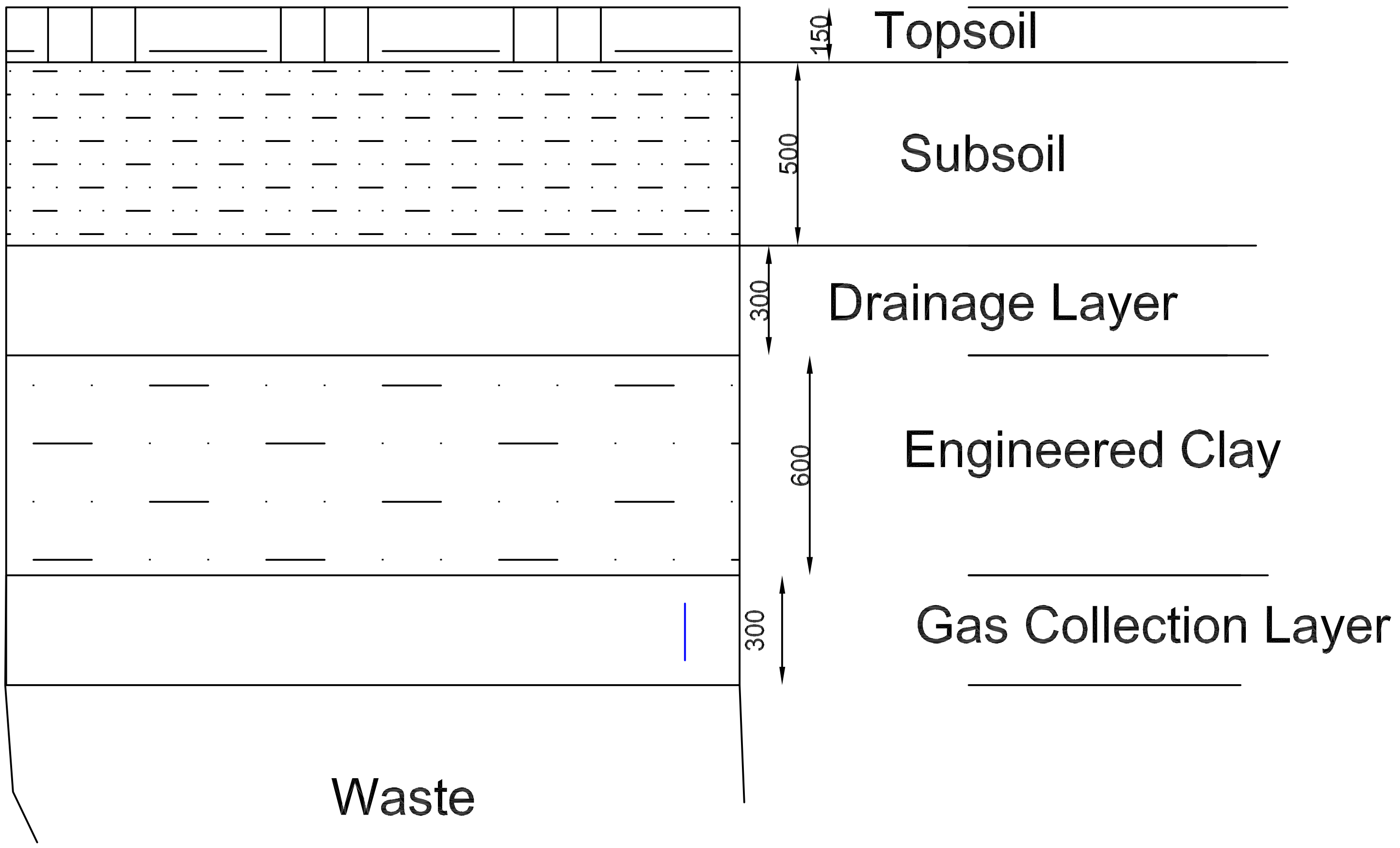
Proposed Finished Profile

details

FIGURE No.
2

SCALE
1:800

REV.



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CLIENT
South Tipperary County Council

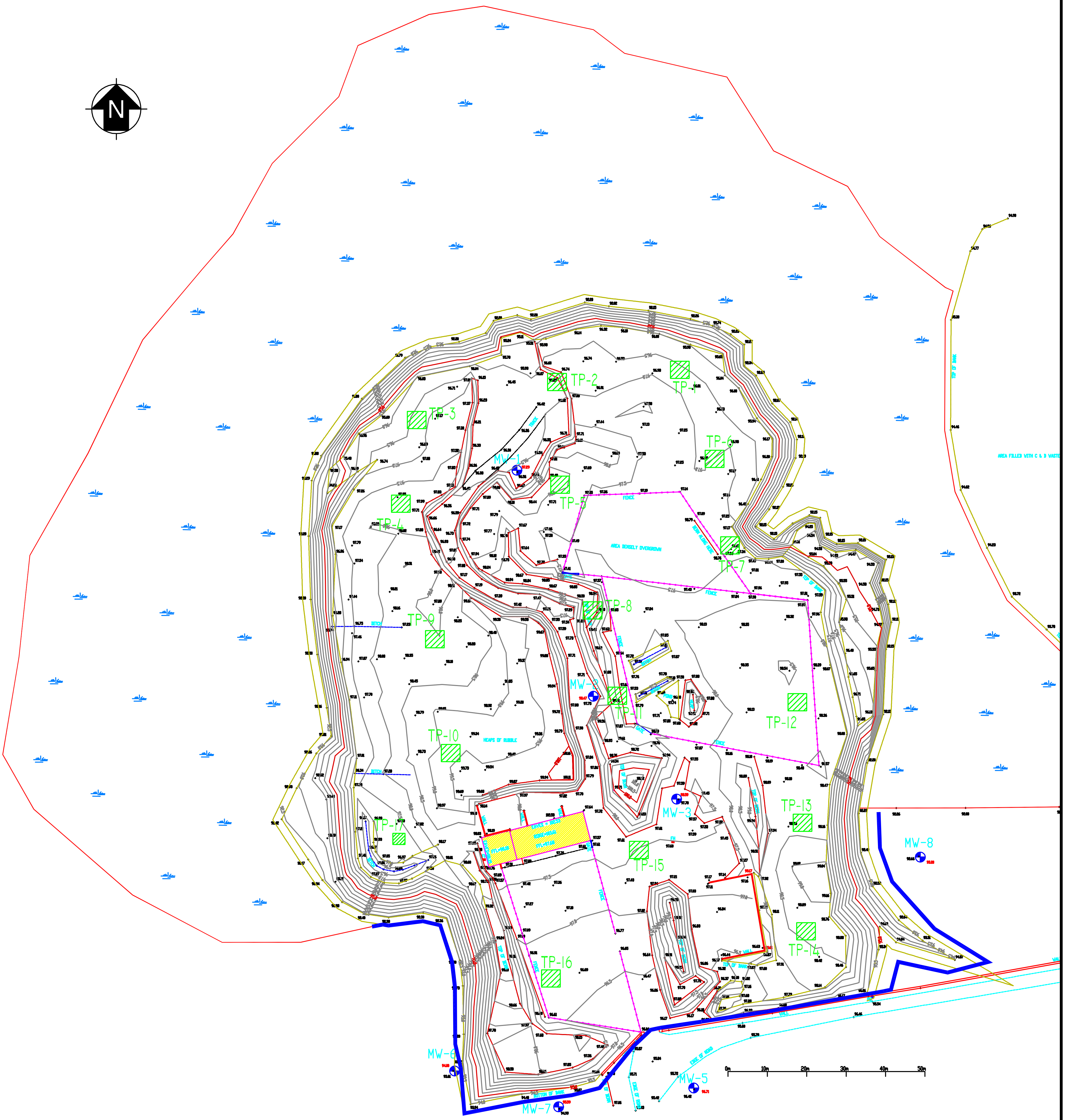
TITLE
Proposed Capping System

details

FIGURE No.
3

SCALE
1:20

REV.



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SOUTH TIPPERARY COUNTY COUNCIL

TITLE

SITE LAYOUT AND TRENCH LOACTION

DETAILS

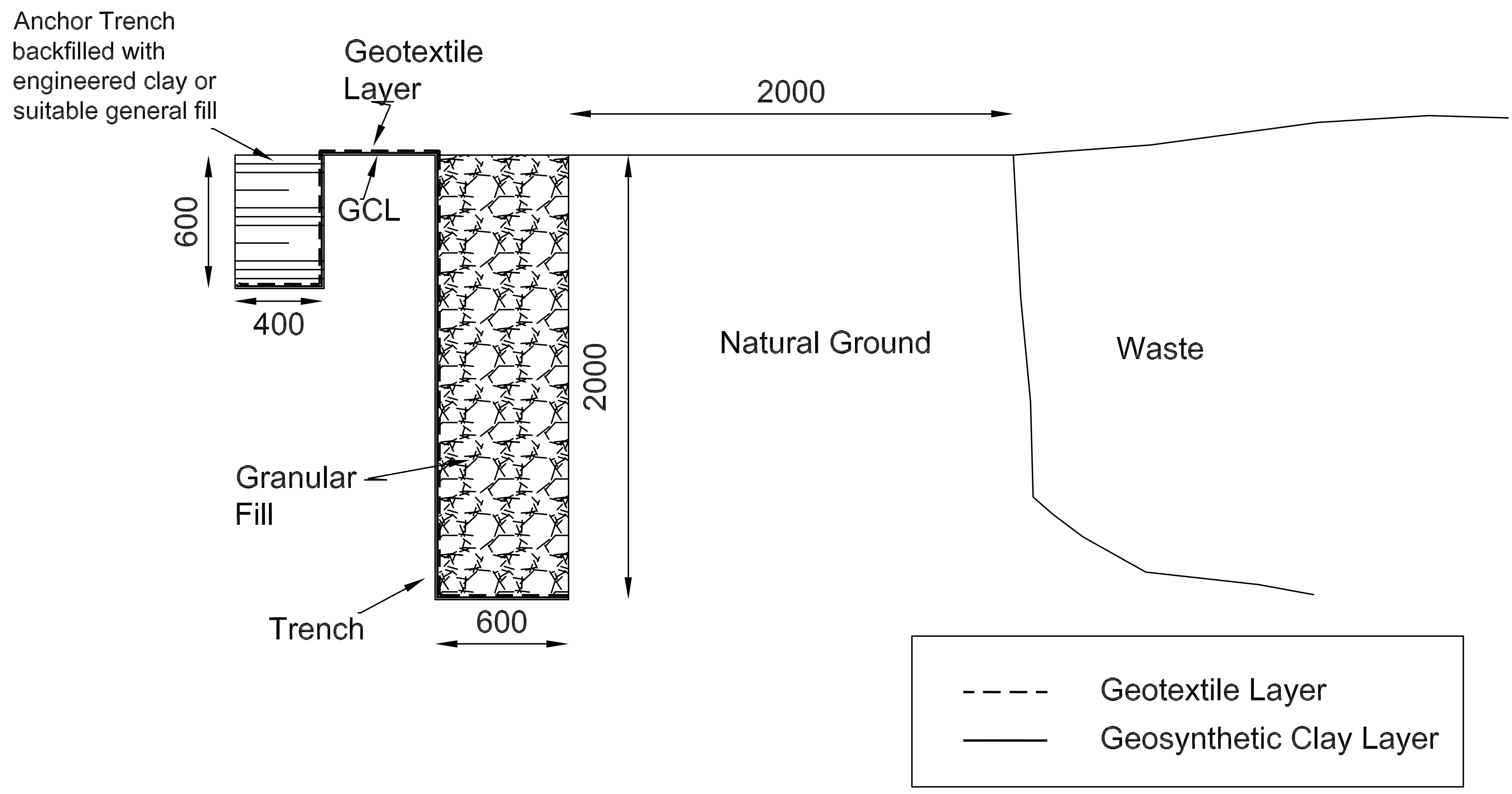
Gas Trench

Figure No.

4

SCALE

1:1,000



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CLIENT
South Tipperary County Council

TITLE
Gas Cut-Off Trench Detail

details

FIGURE No.
5

SCALE
1:25

REV.

Appendix 2

Monitoring Results

Surface Water Monitoring Reports 2010 - 2014

Sample Date	14/05/14		22/01/14		12/12/13		
Sample Location	SW1	SW2	SW1	SW2	SW1	SW2	SW3
Cond. (µs/cm)			482	636	782	782	781
BOD (mg/L)		1.13	0.21	0.79	1.04	0.84	5.03
COD (mg/L)	28	25	25	18			
Ammonical Nitrogen (mg/L)			0.18	0.86	3.7	3.65	0
Chloride (mg/L)			94	65	45	48	21
Iron (µg/L)			720	320	3700	2950	1165
Manganese (µg/L)			214	112	770	655	385
Ortho-Phosphate PO4 (mg/L)					0.655	0.655	0.371
pH	7.752	7.772	7.85	7.85			
Suspended Solids (mg/L)					22	18	100
Total Suspended Solids (mg/L)		2	20	2			

Sample Date	26/09/13			08/05/13			24/01/13		
Sample Location	**SW1**	**SW2**	**SW3**	**SW1**	**SW2**	**SW3**	**SW1**	**SW2**	**SW3**
Cond. (µs/cm)		747	510	324	461	312	648	639	657
BOD (mg/L)		7.49	1.29	1.5	0.1	1.9	0.82	0.74	0.78
COD (mg/L)		66	34	18	24	21	21.9	21.2	18.8
Ammonical Nitrogen (mg/L)		0.37	0.2	0.32	0.5	0	1.4394	1.6485	0.0635
Chloride (mg/L)		74.9	17.65	31	50	14.3	18.13	19.56	28.63
Iron (µg/L)		640	1030	400	410	900	220	130	340
Manganese (µg/L)		785	348	225	294	155	149	134	261
Ortho-Phosphate PO4 (mg/L)									
pH	7.3	7.52	7.82	7.384	7.498	7.657	7.388	7.273	7.995
Suspended Solids (mg/L)									
Total Suspended Solids (mg/L)		16	13	7	6	29	0	0	6
Dissolved Oxygen % Saturation		1.8	4.7						

Sample Date	11/12/12			19/09/12			04/04/12		
Sample Location	**SW1**	**SW2**	**SW3**	**SW1**	**SW2**	**SW3**	**SW1**	**SW2**	**SW3**
Cond. (µs/cm)	688	676	684	642	745	749	803	888	954
BOD (mg/L)	0.26	0.06	0.42	0	0	0	3	1.04	6.07
COD (mg/L)	24.7	17.1	22.3	42	36	39			
Ammonical Nitrogen (mg/L)	0.089	1.83	1.36	1.4056	2.73	2.94	3.23	4.52	
Chloride (mg/L)	43.9	33.88	30.5	11.93	40.56	25.29			
Iron (µg/L)	1020	80	720	4750	410	1250	570	40	16300
Manganese (µg/L)	312	144	176	289	313	398	12	22	1510
Ortho-Phosphate PO4 (mg/L)							0.15	0.15	0.21
pH	7.902	7.206	7.175	7.68	7.253	7.331			
Suspended Solids (mg/L)							12	6	216
Total Suspended Solids (mg/L)	29	2	17						
Dissolved Oxygen % Saturation									

Sample Date	18/01/12			09/12/11			17/08/10		
Sample Location	**SW1**	**SW2**	**SW3**	**SW1**	**SW2**	**SW3**	**MW2**	**MW3**	**SW1**
Cond. (µs/cm)	728	721	472	606	581	498			
BOD (mg/L)	4.87	6.42	31.2	2.85	1.23	44.1			
COD (mg/L)	6.5	14.5	191	27.6	27.3	310.2			
Ammonical Nitrogen (mg/L)	1.2127	1.25	0.76	1.16	1.53	0.82			
Chloride (mg/L)	24	28	5				966	1269.6	57.5
Iron (µg/L)	260	240	9150	270	250	780			
Manganese (µg/L)	154	149	257	147	144	499			
Ortho-Phosphate PO4 (mg/L)				0.04	0.02	0.03			
pH	7.51	7.48	6.83						
Suspended Solids (mg/L)				5	8	260			
Total Suspended Solids (mg/L)	2	1	50						
Dissolved Oxygen % Saturation									

Leachate, Groundwater and Surface Water Monitoring Results 2014- 2015

Sample Date		23/07/2014						
Sample Location	**Unit**	**MW1**	**MW2**	**SW1**	**SW2**	**MW4**	**MW8**	**GW IGV**
Temperature	°C	15.4	18.8	17.8	17.7	14.3	14.8	
Dissolved Oxygen (as %Sat)	-	nm	nm	95	25	-	-	NAC
pH	pH	7.3	8.6	7.4	7.4	7	7	6.5-9.5
Conductivity @25°C	µS/cm	4780	3140	797	965	758	1243	1000
1,1,1,2-Tetrachloroethane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1,1-Trichloroethane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1,2,2-Tetrachloroethane	µg/l	<1	<1	<1	<1	<1	<1	
1,1,2-Trichloroethane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1-Dichloroethane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1-Dichloroethene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1-Dichloropropene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2,3-Trichlorobenzene	µg/l	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
1,2,3-Trichloropropane	µg/l	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	
1,2,4-Trichlorobenzene	µg/l	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
1,2,4-Trimethylbenzene	µg/l	2.8	2	<0.5	<0.5	<0.5	<0.5	
1,2-Dibromo-3-Chloropropane	µg/l	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	
1,2-Dibromoethane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2-Dichlorobenzene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2-Dichloroethane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2-Dichloropropane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,3,5-Trimethylbenzene	µg/l	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	
1,3-Dichlorobenzene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,3-Dichloropropane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,4-Dichlorobenzene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
2,2-Dichloropropane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
2-Chlorotoluene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
4-Chlorotoluene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
4-Isopropyltoluene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Benzene	µg/l	0.8	2	<0.5	<0.5	<0.5	<0.5	
Bromobenzene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromochloromethane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromodichloromethane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromoform	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromomethane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
c-1,2-Dichloroethene	µg/l	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	
c-1,3-Dichloropropene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Carbon Tetrachloride	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Chlorobenzene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Chloroform	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Dibromochloromethane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	

Sample Date		23/07/2014						
Sample Location	**Unit**	**MW1**	**MW2**	**SW1**	**SW2**	**MW4**	**MW8**	**GW IGV**
Dibromomethane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Dichlorodifluoromethane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Dichloromethane	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Ethylbenzene	µg/l	1.2	1.5	<0.5	0.7	0.9	0.8	
Hexachlorobutadiene	µg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Isopropylbenzene	µg/l	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	
m,p-Xylene	µg/l	1.1	0.8	<0.5	<0.5	<0.5	0.5	
Naphthalene	µg/l	4.5	<0.5	<0.5	<0.5	<0.5	<0.5	
n-Butylbenzene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
n-Propylbenzene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
o-Xylene	µg/l	1.4	1	<0.5	<0.5	<0.5	<0.5	
sec-Butylbenzene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Styrene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
t-1,2-Dichloroethene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
t-1,3-Dichloropropene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
tert-Butylbenzene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Tetrachloroethene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Toluene	µg/l	1.7	7	<0.5	<0.5	0.9	<0.5	
Trichloroethene	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Trichlorofluoromethane	µg/l	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	
Vinyl Chloride	µg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Ammonia	mg/l N	260	82	4.2	6.7	<0.020	0.062	0.15
Chloride	mg/l Cl	370	564	43	64	40	120	30
ortho-Phosphate	mg/l P	<0.010	0.37	0.21	0.1	<0.010	0.069	0.03
Total Oxidised Nitrogen	mg/l N	<0.20	<0.20	0.26	<0.20	1.1	<0.20	NAC
Chemical Oxygen Demand	mg/l O2	776	220	40	144	308	3910	
BOD	mg/l O2	28	23	<6	8.2	<50	<600	
Suspended Solids	-	-	-	23	244	-	-	
Alkalinity-total	mg/l CaCO3	-	-	350	400	323	455	NAC
Fluoride	mg/l F	<2.0	<2.0	<0.20	<0.20	<0.20	<0.4	1
Sulphate	mg/l SO4	<20.0	50	14	5	14	35	200
Aluminium	ug/l	580	1300	11	14	4900	180	200
Arsenic	ug/l	4.7	8.1	1.7	1.5	3	21	10
Barium	ug/l	180	210	130	160	240	620	100
Beryllium	ug/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Boron	ug/l	1400	1400	68	120	29	48	1000
Cadmium	ug/l	0.7	0.49	<0.020	<0.020	0.16	0.29	5
Calcium	mg/l	160	30	120	130	130	140	200
Cobalt	ug/l	12	3.7	<1.0	<1.0	2.1	1.3	
Iron	ug/l	4300	2700	1800	3900	3700	2300	1000
Lead	ug/l	20	46	<1.0	<1.0	7.5	2.3	10
Magnesium	mg/l	89	34	11	14	9	14	50

Sample Date		23/07/2014						
Sample Location	**Unit**	**MW1**	**MW2**	**SW1**	**SW2**	**MW4**	**MW8**	**GW IGV**
Manganese	ug/l	620	290	1100	1300	130	1700	50
Nickel	ug/l	16	13	<1.0	<1.0	6.9	5.1	20
Potassium	mg/l	200	130	6.5	10	2.9	0.91	5
Selenium	ug/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Sodium	mg/l	280	400	27	40	33	110	150
Strontium	ug/l	600	260	210	220	170	240	
Thallium	ug/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Uranium	ug/l	<1.0	<1.0	<1.0	<1.0	<1.0	2.6	9
Vanadium	ug/l	4.2	5.8	<1.0	<1.0	8.9	<1.0	
Mercury	ug/l	<0.50	<0.50	<0.50	<0.50	<0.50	2.8	1
Antimony	ug/l	1.1	1.9	<1.0	<1.0	<1.0	<1.0	
Chromium	ug/l	13	7.6	2	1.5	9.2	3	30
Copper	ug/l	6.3	18	<1.0	<1.0	7.7	26	30
Molybdenum	ug/l	1.3	8.3	<1.0	<1.0	<1.0	<1.0	
Zinc	ug/l	59	140	18	26	39	34	100
Total Organic Carbon (mg/l C)	mg/l C	-	-	-	-	2	8.7	NAC
E Coli (per 100ml)	per 100ml	-	-	-	-	<10	310	
Total coliforms (no/100ml)	No/100 ml	-	-	-	-	41	>24000	

Sample Date	**01/10/2014**					
Sample Location	**MW2**	**MW3**	**SW1**	**MW4**	**MW6**	**GW IGV**
Cond. (μs/cm)	3240	4680	801	811	1024	1000
BOD (mg/L)	8.4	22	6.5	<6	<8	
COD (mg/L)	128	181	51	21	33	
Ammoniacal Nitrogen (mg/L)	81	250	0.69	0.021	0.06	0.15
Chloride (mg/L)	626	349	56	43	30	30
Ortho-Phosphate PO4 (mg/L)	0.5	0.014	0.26	<0.010	<0.010	0.03
pH	8.9	7.1	7.7	7.3	6.8	6.5-9.5
Suspended Solids (mg/L)			49	-	-	NAC
Cyanide (mg/L)	<0.05		<0.05			
Temperature (°C)	12.3	12.6	12.9	13.1	13.2	
DO (% saturation)	nm	nm	58	32	45	
Nitrite (mg/ L N)	<0.004	<0.004	0.005	<0.004	0.044	0.1
Total Oxidised Nitrogen (mg/L N)	<0.20	<0.20	<0.20	2.2	3.1	
Alkalinity-Total (mg/L CaCO3)			325	349	481	NAC
1,1,1,2-Tetrachloroethane (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1,1-Trichloroethane (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1,2,2-Tetrachloroethane (μg/L)	<1	<1	<1	<1	<1	
1,1,2-Trichloroethane (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1-Dichloroethane (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1-Dichloroethene (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1-Dichloropropene (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2,3-Trichlorobenzene (μg/L)	<0.4	<0.4	<0.4	<0.4	<0.4	
1,2,3-Trichloropropane (μg/L)	<0.6	<0.6	<0.6	<0.6	<0.6	
1,2,4-Trichlorobenzene (μg/L)	<0.4	<0.4	<0.4	<0.4	<0.4	
1,2,4-Trimethylbenzene (μg/L)	4	3.5	<0.5	<0.5	<0.5	
1,2-Dibromo-3-Chloropropane (μg/L)	<1.3	<1.3	<1.3	<1.3	<1.3	
1,2-Dibromoethane (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2-Dichlorobenzene (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2-Dichloroethane (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2-Dichloropropane (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
1,3,5-Trimethylbenzene (μg/L)	1	<0.5	<0.5	<0.5	<0.5	
1,3-Dichlorobenzene (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
1,3-Dichloropropane (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
1,4-Dichlorobenzene (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
2,2-Dichloropropane (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
2-Chlorotoluene (μg/L)	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**<0.5**	
4-Chlorotoluene (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
4-Isopropyltoluene (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	

Sample Date	01/10/2014					
Sample Location	**MW2**	**MW3**	**SW1**	**MW4**	**MW6**	**GW IGV**
Benzene (µg/L)	1.5	<0.5	<0.5	<0.5	<0.5	
Bromobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromochloromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromodichloromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromoform (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromomethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
c-1,2-Dichloroethene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
c-1,3-Dichloropropene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Carbon Tetrachloride (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Chlorobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Chloroform (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Dibromochloromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Dibromomethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Dichlorodifluoromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Dichloromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Ethylbenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Hexachlorobutadiene (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	
Isopropylbenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
m,p-Xylene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Naphthalene (µg/L)	0.5	<0.5	<0.5	<0.5	<0.5	
n-Butylbenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
n-Propylbenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
o-Xylene (µg/L)	<0.5	0.8	<0.5	<0.5	<0.5	
sec-Butylbenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Styrene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
t-1,2-Dichloroethene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
t-1,3-Dichloropropene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
tert-Butylbenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Tetrachloroethene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Toluene (µg/L)	1.8	<0.5	<0.5	<0.5	<0.5	
Trichloroethene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
Trichlorofluoromethane (µg/L)	<0.6	<0.6	<0.6	<0.6	<0.6	
Vinyl Chloride (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	
E Coli (per 100ml)	-	-	-	<10	<10	
Total coliforms (No/100 ml)	-	-	-	470	>24000	
Total Organic Carbon (mg/l C)	-	-	-	2.5	5.9	

Sample Date	21/09/2015							
Sample Location	**MW1**	**MW2**	**SW1**	**SW2**	**MW4**	**MW5**	**MW6**	**GW IGV**
Cond. (µs/cm)	3000	2930	759	806	742	3950	1107	1000
BOD (mg/L)	<6	36	5.6	3.1	<6	<6	<10	
COD (mg/L)	116	145	41	44	104	78	174	
Ammonical Nitrogen (mg/L)	160	77	1.4	1.7	<0.020	<0.020	0.12	0.15
Chloride (mg/L)	157	534	69	84	28	1070	37	30
Ortho-Phosphate PO4 (mg/L)	<0.010	0.41	0.14	0.15	<0.010	<0.010	<0.010	0.03
pH	6.9	9	6.5	7	6.7	6.9	6.7	6.5-9.5
Suspended Solids (mg/L)	-	-	<20	<8	-	-	-	
Cyanide (mg/L)	<0.05	<0.05	<0.05	<0.05	-	-	-	
Temperature (°C)	12.8	12	11.7	12.5	12.2	12.4	12.7	
DO (% saturation)	nm	nm	33	23	42.0	56.0	84.0	
Total Oxidised Nitrogen (mg/L N)	<0.20	<0.20	0.2	<0.20	0.61	0.42	5	NAC
Alkalinity-Total (mg/L CaCO3)	1360	553	273	286	337	293	479	NAC
1,1,1,2-Tetrachloroethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1,1-Trichloroethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1,2,2-Tetrachloroethane (µg/L)	<1	<1	<1	<1	<1	<1	<1	
1,1,2-Trichloroethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1-Dichloroethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1-Dichloroethene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,1-Dichloropropene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2,3-Trichlorobenzene (µg/L)	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
1,2,3-Trichloropropane (µg/L)	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	
1,2,4-Trichlorobenzene (µg/L)	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	
1,2,4-Trimethylbenzene (µg/L)	4.3	2.2	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2-Dibromo-3-Chloropropane (µg/L)	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	
1,2-Dibromoethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2-Dichlorobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2-Dichloroethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,2-Dichloropropane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,3,5-Trimethylbenzene (µg/L)	<0.5	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	
1,3-Dichlorobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,3-Dichloropropane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
1,4-Dichlorobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
2,2-Dichloropropane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
2-Chlorotoluene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
4-Chlorotoluene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
4-Isopropyltoluene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Benzene (µg/L)	1.3	2.8	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromochloromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromodichloromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Bromoform (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	

Sample Date	21/09/2015							
Sample Location	**MW1**	**MW2**	**SW1**	**SW2**	**MW4**	**MW5**	**MW6**	**GW IGV**
Bromomethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
c-1,2-Dichloroethene (µg/L)	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
c-1,3-Dichloropropene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Carbon Tetrachloride (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Chlorobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Chloroform (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Copper (µg/L)	1	5.1	<1.0	<1.0	1.2	3.7	4.3	30
Dibromochloromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Dibromomethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Dichlorodifluoromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Dichloromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Ethylbenzene (µg/L)	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Hexachlorobutadiene (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Isopropylbenzene (µg/L)	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
m,p-Xylene (µg/L)	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Naphthalene (µg/L)	0.6	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
n-Butylbenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
n-Propylbenzene (µg/L)	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
o-Xylene (µg/L)	1.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
sec-Butylbenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Styrene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
t-1,2-Dichloroethene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
t-1,3-Dichloropropene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
tert-Butylbenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Tetrachloroethene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Toluene (µg/L)	1.3	2.4	<0.5	0.8	<0.5	1.3	<0.5	
Trichloroethene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Trichlorofluoromethane (µg/L)	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	
Vinyl Chloride (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Fluoride (mg/L)	<1	<1	<0.20	0.2	0.23	<1	0.22	1
Sulphate (mg/L)	17	87	12	4	10	51	47	200
Aluminium (µg/L)	42	140	16	<10	110	160	220	200
Arsenic (µg/L)	<1.0	3.8	<1.0	<1	<1.0	<1.0	<1.0	10
Barium (µg/L)	110	110	91	95	140	560	140	100
Beryllium (µg/L)	<1.0	<1.0	<1.0	<1	<1.0	<1.0	<1.0	
Boron (µg/L)	420	1700	92	97	32	56	140	1000
Cadmium (µg/L)	<0.020	0.1	<0.020	<0.02	0.03	0.02	0.32	5
Calcium (mg/L)	200	31	110	110	140	310	220	200
Cobalt (µg/L)	4.1	1.6	<1.0	<1.0	<1.0	<1.0	1.5	
Iron (µg/L)	4300	440	660	700	140	140	300	1000
Lead (µg/L)	<0.1	3.2	<1.0	<1.0	<1.0	<1.0	3.8	10
Magnesium (mg/L)	50	22	9.2	10	8.1	29	18	50
Manganese (µg/L)	780	170	330	330	9.3	11	1100	50

Sample Date	**21/09/2015**							
Sample Location	**MW1**	**MW2**	**SW1**	**SW2**	**MW4**	**MW5**	**MW6**	**GW IGV**
Nickel (µg/L)	<1.0	5.6	<1.0	<1.0	<1.0	<1.0	3.5	20
Potassium (mg/L)	98	130	8.2	9.9	0.75	2.8	5.2	5
Selenium (µg/L)	1.5	1.5	1.2	<1.0	1.2	8.1	2.1	
Sodium (mg/L)	61	380	40	52	23	630	22	150
Strontium (µg/L)	870	510	190	200	170	460	380	
Thallium (µg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Uranium (µg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.6	9
Vanadium (µg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Mercury (µg/L)	<0.50	0.6	<0.50	<0.5	<0.50	<0.50	0.52	1
Antimony (µg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Chromium (µg/L)	1.1	1.1	<1.0	<1.0	<1.0	<1.0	1.1	30
Molybdenum (µg/L)	<1.0	23	<0.1	<1.0	<1.0	<1.0	<1.0	
Zinc (µg/L)	10	17	9	8.8	11	11	14	100
E Coli (per 100ml)	-	-	-	-	10	31	<10	
Total coliforms (No/100 ml)	-	-	-	-	1100	>24000	17000	
Total Organic Carbon (mg/l C)	-	-	-	-	2	2	7	NAC

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APPENDIX 3

EPA AA Screening determination

Appropriate Assessment Screening Determination

In accordance with Regulation 42(1) of the European Communities (Birds and Natural Habitats) Regulations, 2011, S.I. No. 477 of 2011, the Agency has undertaken Appropriate Assessment screening to assess, in view of best scientific knowledge and the conservation objectives of the site, if the activity, individually or in combination with other plans or projects is likely to have a significant effect on a European Site. In this context, particular attention was paid to the European Site listed below.

Licence/Permit Application Details:

Reg. No.	H0004-01
Applicant Name:	Tipperary County Council
Location of Facility:	Carrownreddy, County Tipperary
Certificate of Authorisation Application Date:	28/11/2011
European Site assessed:	Lower River Suir SAC (site code 002137)
Date of AA Screening Determination:	01/11/2018

AA Screening Determination:

That the activity is not directly connected with or necessary to the management of any European site and that it cannot be excluded, on the basis of objective information, that the activity, individually or in combination with other plans or projects, will have a significant effect on any European site and accordingly determined that an Appropriate Assessment of the activity is required.

The reason for this determination is as follows:

- The closed landfill site is connected hydrologically to the Lower River Suir SAC (002137).
- Leachate monitoring results showed multiple parameters exceeded the EPA Interim Guideline Values (IGVs) for Groundwater.
- Elevated levels of ammonia, iron, manganese and chromium were recorded in the surface water monitoring results.

Date: 01 / 11 / 2018

Dr Magnus Amajirionwu
Office of Environmental Sustainability

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APPENDIX 4

Aquatic Ecology Report

Aquatic Ecological Assessment of Watercourses Downstream of the Tipperary Historical Landfill Site

May 2020

Prepared by:
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Rahan,
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1.0 INTRODUCTION

1.1 Background

Sweeney Consultancy was commissioned by Fehily Timoney & Company Consultants, to undertake an aquatic ecological assessment of watercourses downstream of the historical landfill site on the northern side of Tipperary Town.

1.2 Subject Site and Watercourses

The subject site and downstream watercourses are shown in Appendix 2 and Appendix 3. The site is in the catchment of the River Suir (EPA Catchment Code 16). On the eastern side of the historical landfill site, there is an area of swamp, which is drained by a channel flowing southwards to the urban area of Tipperary Town, where the flow is culverted. Flowing water emerges from under the N24 road at ITM 589532 635511 and enters the River Ara at ITM 589464 635469. As this is the only flowing drain entering the Ara on the left-hand side of this section of the river, it is presumed that it is the flow from the subject site. From the point where the drain enters the Ara, the river meanders in an overall south-easterly direction for c. 15km to its confluence with the Aherlow River at ITM 60264 629782 (Appendix 3). The Aherlow River flows to the main channel of the River Suir, c.6km farther downstream.

The Aherlow River is included in the Lower River Suir Special Area of Conservation (SAC 002137), designated under the EU Natural Habitats Regulations (Special Areas of Conservation) for the protection of the Qualifying Interests listed in Appendix 4. Of these, Old sessile oak woods with Ilex and Blechnum in British Isles (Habitat Code 91A0), Taxus baccata woods of the British Isles (Habitat Code 91J0), Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) (Habitat Code 91E0) and Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels (Habitat Code 6430) occur along the banks of the River Suir farther downstream, while Atlantic salt meadows (Glauco-Puccinellietalia maritimae) (Habitat Code 1330) and Mediterranean salt meadows (Juncetalia maritimi) (Habitat Code 1410) are found in saline conditions in the Suir Estuary. These six habitats are therefore not relevant to the current project. Similarly, Twaite Shad (*Alosa fallax*) (Species Code 1103) and Allis Shad (*Alosa fallax*) (Species Code 1102) are anadromous fish, which, in the River Suir occur upstream only as far as the weir in Clonmel (Patrick Kilfeather, IFI, retired, *pers. comm.*).

The possible presence and status of the following aquatic Qualifying Interests of SAC 002137 were considered to warrant further investigation:
Floating River Vegetation (Habitat Code 3260).
Atlantic Salmon (*Salmo salar*) (Species Code 1106).
Brook Lamprey (*Lampetra planeri*) (Species Code 1096)
River Lamprey (*Lampetra fluviatilis*) (Species Code 1099).
Sea Lamprey (*Pertomyzon marinus*) (Species Code 1095)
Otter (*Lutra lutra*) (Species Code 1355).
Freshwater Pearl Mussel (*Margaritifera margaritifera*) (Species Code 1029).
White-clawed Crayfish (*Austropotamobius pallipes*) (Species Code 1092).

1.3 Other Protected Species

The Wildlife Act (1976) and Wildlife Amendment Act (2000) are the principle mechanism for the legislative protection of wildlife in Ireland and outline strict protection for species that have significant conservation value. In summary, the Wildlife Acts protect species from injury, disturbance and damage to breeding and resting sites. All species listed in the Wildlife Acts must, therefore, be a material consideration in the planning process. The Flora (Protection) Order, 2015 is an important piece of national legislation for the protection wild flora, which makes it illegal to cut, uproot or damage a listed species in any way or to alter, damage or interfere in any way with their habitats. This protection applies wherever the species listed in the Schedules of the Order are found.

The International Union for the Conservation of Nature (IUCN) provides a global approach for evaluating the conservation status of species to inform and catalyse action for biodiversity conservation through the Red List of Threatened Species. The Red List is a therefore an important reference in identifying species under threat that do not necessarily have strict protected under specific nature conservation legislation.

2.0 METHODOLOGY

2.1 Desk Study

A desk study was undertaken to review all available published data on European and nationally designated aquatic sites for nature conservation within the zone of influence. While the main zone of influence is generally taken to be within 5km downstream (Escauriaza *et al.*, 2017), for the purposes of this study, the aquatic habitat down to the Aherlow River is considered. Published data was cross-referenced with publicly available maps and aerial orthophotography from Ordnance Survey Ireland (OSI), the National Parks & Wildlife Service (NPWS) and the Environmental Protection Agency (EPA) to identify important aquatic ecological features.

2.2 Field Surveys

Aquatic ecological surveys were conducted on 18/05/2020 and 19/05/2020 along the watercourses downstream of the subject site, adhering to Best Practice Guidance for Habitat Survey and Mapping (Smith *et al.*, 2011) to gather information regarding habitat composition, species presence and ecological conditions.

The main aquatic plant species were recorded and the presence of any plant species listed in the Flora Protection Order (2015) was checked for. To illustrate the general habitat quality, photographs were taken with a digital camera.

The presence and vulnerability to impacts of protected aquatic species is largely dependant on the physical habitat conditions within the river, but prevailing water quality can also be critical for pollution-sensitive species. Therefore, the biological water quality of the River Ara was assessed by the Q-scheme methodology (EPA, 2019) at a suitable sampling location downstream of the confluence of the drain from the subject site (see Appendix 2). Published past EPA biological water quality monitoring data for this watercourse were also examined.

The status of protected aquatic and semi-aquatic species possibly occurring in or alongside the River Ara for 1km downstream of the drain from the subject site (see Appendix 2), at five bridges farther downstream on this river (see Appendix 4) and in the Aherlow River downstream of the confluence was assessed as follows:

- The presence of the freshwater pearl mussel (*Margaritifera margaritifera*) was checked for by a survey carried out under a Stage 1/2 licence (Licence No. C15/2020) from the National Parks and Wildlife Service. The riverbed was searched visually, using a Perspex-bottomed viewer. Available records on the wider distribution of the freshwater pearl mussel (*Margaritifera margaritifera*) in the Suir catchment were checked.
- A licensed survey (Licence No. C29/2020) was carried out to check for the white-clawed crayfish (*Austropotamobius pallipes*), following the methodology of Peay (2003). The habitat quality for this species was assessed, based on the criteria outlined by Holdich (2003). Available records were checked and information on the current state of crayfish plague in the Suir catchment was sought.
- The habitat quality for salmonids (*Salmo salar* and *Salmo trutta*) was assessed, based on the criteria outlined by Kennedy (1984) and by Bardonnet and Baglinière (2000) for the physical instream requirements of these species for spawning, nursery and adult habitat.
- The habitat quality for of lamprey species, was assessed, based on the criteria outlined by Maitland (1980) and by Johns (2002) for the physical instream requirements of these species for spawning, nursery and adult habitat. Where suitable nursery habitat was found, sand/silt was dredged with a hand-net (mesh size 2mm) to check for ammocoete lamprey presence. Available data on lamprey species in the River Ara and in the lower Suir catchment were checked.
- The habitat quality for kingfisher (*Alcedo atthis*), a species listed on Annex I of the EU Birds Directive, was assessed, based on the criteria outlined by Boag (1982) and by Morrison (1989). Visual evidence of the presence of this species was noted.
- The suitability of the habitats for dipper (*Cinclus cinclus*) and grey wagtail (*Motacilla cinerea*) was assessed by the criteria of Morrison (1998) and possible nest sites were searched and visual evidence of the presence of this species was noted.
- The presence of the otter (*Lutra lutra*) was checked for by a survey of the riverbank for holts or couching sites and an examination of hard bankside surfaces for the presence of spraints and bankside mud/sand for imprints. A Bushnell HD trail camera was set overnight on 18/05/2020 at the first bridge downstream on the River Ara, with a view of the river and riverbanks. The habitat quality for otters was assessed, based on the criteria outlined by Chanin (2003).

- Invasive alien plant species listed on the Third Schedule of the EC (Birds & Natural Habitats) Regulations 2011 were checked for along riverbanks.

2.3 Consultations

Sean Breen, Conservation Ranger, National Parks and Wildlife Service (NPWS), was contacted by telephone to discuss local information on the site and downstream watercourses.

3.0 RESULTS

3.1 Sites Designated or Proposed for Designation under EU or Irish Law

The subject site is not within any Natura 2000 site. The nearest such site with direct connectivity to the subject site is the Lower River Suir Special Area of Conservation (SAC 002137) c. 15km downstream of the point at which the drain from the subject site enters the River Ara. There are no other aquatic Natura 2000 sites downstream of the subject site. The Site Synopsis for SAC 002137 (Version 13.12.2013) and the Conservation Objectives (Version 28.03.2017) for the site are available on http://www.npws.ie/protected-sites/sac/002137.

3.2 Aquatic Habitat Survey Results

On the eastern side of the site of the historical landfill, there is an area of marsh (Photo 1, Appendix 5). This marsh drains via a silty channel flowing southwards along a field boundary (Photo 2). At the time of fieldwork, the flow rate was very slow and filamentous algae dominated the channel. Banksides are grazed by equines. The aquatic habitat is unsuitable for any protected species and no protected terrestrial plant species are present. This small watercourse then passes through c. 1km of culvert before emerging from under the N24 road, after which it flows for c. 100m along a field boundary (Photo 3) to its confluence with the River Ara at ITM 589464 635469 (see Appendix 2). The open sections of this drain are classified by the Fossitt (2000) system as FW4. The flow type of River Ara in the 1km section downstream of the drain consists mainly of moderate glide over a substratum of stone and silt (Photo 7), with a few short shallow and faster-flowing sections, such as at the railway crossing and downstream of the bridge by the WWTP entrance (Photo 5). Downstream of this bridge, the natural flow is interrupted by a low hydrometric weir (Photo 6). Near the downstream end of the 1km section, there is a crossing point for cattle (Photo 8),which is causing some added siltation. At Cordangan Bridge (Photo 9), the N24 Bridge (Photo 10) and Bansha Bridge (Photo 11), there are fast-flowing stretches of riffle over cobble and gravel. At the lowermost two bridges the River Ara consists of slower-flowing and deeper glide (Photos 12 & 13). By the Fossitt (2000) system, the River Ara is classified as Habitat Code FW1/FW2. The Aherlow River in the vicinity of the Ara confluence (Photo 14) is fast-flowing over a stony substratum. It is classified as Habitat Code FW1.

3.3 Flora Survey Results

The area of marsh on the eastern side of the site of the historical landfill is dominated by yellow flag, *Iris pseudacorus* and reedmace, *Typha latifolia*, with some meadowsweet, *Filipendula ulmaria*, and tussock sedge, *Carex paniculata.* The most common in-stream aquatic macrophytes present along the 1km stretch of the River Ara surveyed downstream of the drain are bur reeds, *Sparganium emersum* and *S. erectum.* Some curly-leaf pondweed, *Potamogeton crispus* is also present in deeper sections. In shallower, faster stretches, two filamentous algae, *Cladophora sp.* and *Vaucheria sp.*, are found. At the bridges farther downstream water crowfoot (*Ranunculus* subgenus *Batrachium* agg.), occurs in patches, along with the bryophytes *Fontinalis antipyretica*, *Platyhypnidium riparoides* and *Leptodyctium riparium.* Emergent marginal vegetation includes fool's water cress (*Apium nodiflorum*), watercress (*Nasturtium officinale*), and reed canary grass (*Phalaris arundinacea*). No plant species listed on the Flora (Protection) Order was recorded. The instream vegetation in the sections of river surveyed do not conform to the SAC 002137 Qualifying Interest habitat type "*Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation*", which is to be found in the main channel of the River Suir below the Aherlow River confluence (*pers. obs.*).

3.4 Water Quality Results

3.4.1 Biological Water Quality Results

Results of the biological water quality assessment is presented in Appendix 6. At the bridge upstream of the WWTP outfall (EPA Station 16A03 0300), the river was found to be at Q3, indicating poor ecological quality. Pollution sensitive species from Groups A and B are absent. Chironomidae (non-biting midge larvae) from Group C dominate the fauna, indicating that the fauna was impacted by a pollution incident in recent months. This is possibly related to a dairy discharge which turned the river white and which was reported to Inland Fisheries Ireland (Sean Breen, NPWS, *pers. comm.*). Other Group C species common in occurrence are the freshwater shrimp, *Gammarus duebeni*, freshwater mites (Hydrachnidae) and flatworms (Tricladida). A relatively high representation of Group D species, mainly the water slater, *Asellus aquaticus,* and the orb mussel, *Sphaerium corneum,* brings the Q-value down to the lower end of the Q3 range, close to Q2-3.

EPA Q-values recorded in the River Ara for the Rivers Monitoring Programme are presented in Appendix 7. The 2014 and 2017 assessments were carried out by Sweeney Consultancy, on contract to EPA. The biological water quality at Station 16A03 0300 has been unsatisfactory on every one of the 17 assessment occasions since 1971. In 2017, the Q-value here had declined to Q2-3 from the Q3 recorded from 2003 to 2014. Also in 2017, the two station assessed farther downstream on the Ara while less severely polluted, were still in unsatisfactory ecological condition (Q3-4). Overall, the River Ara has been one of the worst polluted rivers in the Suir catchment since recording of biological water quality began.

3.5 Fauna Survey Results

3.5.1: Freshwater Pearl Mussel (*Margaritifera margaritifera*) Survey Results

In accordance with The European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009, ecological quality objectives are set for the freshwater pearl mussel habitat of 27 listed rivers. In the Suir catchment, the only river included on this list is the Clodiagh in Waterford.

As would be expected due to the poor water quality, no freshwater pearl mussels were found in the River Ara. In the Aherlow River, downstream of the Ara confluence, several empty pairs of joined shells were found. A single live freshwater pearl mussel was found at ITM 600356 629798.

3.5.2: Atlantic Salmon (*Salmo salar*) Survey Results

Salmon need EPA Class A water: Q values Q4 to Q5 (Curtis *et al.*, 2009). The water quality of the River Ara would preclude salmon from this river. Salmon occur in the Aherlow River (*pers. obs*.).

3.5.3: Brown Trout (*Salmo trutta*) Survey Results

While there are some small stretches of river in the vicinity of Tipperary Town, in which the physical habitat would be suitable for trout spawning, the poor water quality would preclude this. No trout were observed here during fieldwork. Farther downstream, at the N24 bridge and below, there is some good trout habitat and, while the water quality is still unsatisfactory, trout can tolerate EPA Class B water. Some trout were observed in the lower stretches of the River Ara.

3.5.4: Sea Lamprey (*Petromyzon marinus*), River Lamprey (*Lampetra fluviatilis*) and Brook Lamprey (*Lampetra planeri*) Survey Results.

In the River Suir, adult sea lampreys are reported to occur in the lower reaches, up to 8km upstream of Clonmel (Kurz and Costello, 1999). This corresponds well with the findings of O'Connor (2007), whose survey showed the main distribution of sea lamprey ammocoetes to be in the main channel of the Suir, between Caher and Clonmel. O'Connor (2007) found juvenile brook/river lamprey at a site in the lower part of the Ara River, but none at a site near Tipperary Town. No lamprey ammocoetes were found in muddy sediments sampled in the fieldwork for the current survey.

3.5.5: White-Clawed Crayfish (*Austropotamobius pallipes*) Survey Results.

No crayfish were found at any of the sites surveyed in the River Ara or in the Aherlow River. In a 2017 licensed survey of crayfish at EPA river monitoring sites, reported to NPWS, Sweeney Consultancy recorded no crayfish at any of the four sites surveyed on the Ara River, but a high density of crayfish in the Aherlow River downstream of the Ara confluence. However, in 2017, crayfish plague spread through the lower parts of the River Suir main channel and some of the lower tributaries. This spread continued upstream, killing crayfish throughout the main channel and tributaries. (Sean Breen, NPWS *pers. comm.*). It therefore appears that this infection has now wiped out all crayfish downstream of the subject site.

3.5.6: Otter (*Lutra lutra*) Survey Results.

No evidence of otter presence was found from the subject site to 1km downstream of the point where the drain enters the River Ara. No otters were recorded on the camera trap placed overnight on the bridge beside the WWTP entrance. The National Biodiversity Data Centre (NBDC) website does not show any record of otters close to Tipperary Town. This absence of otters here is to be expected, where prey is scarce and human disturbance relatively high. An otter spraint was found on a rock just downstream of Cordangan Bridge. Otters are plentiful in the Aherlow River (*pers. obs.*).

3.5.7: Kingfisher (*Alcedo atthis*) Survey Results

A kingfisher nest burrow (Photo 4, Appendix 5) is located at ITM 589451 635427, c. 60m downstream of the point where the drain enters the river. The male kingfisher was observed on several occasions (see cover photo) and the female was seen leaving the nest burrow. The river holds good numbers of minnow and sticklebacks, which are suitable prey items for kingfishers.

3.5.8: Dipper (*Cinclus cinclus*) Survey Results

No dipper nests were found at any of the bridges. A dipper was observed downstream of Bansha Bridge.

3.5.9: Grey Wagtail (*Motacilla cinerea*) Survey Results

A pair of grey wagtails were observed at the railway bridge at ITM 589561 635296, but no nest was found.

3.5.10: Little Egret (*Egretta garzetta*) Survey Results

A single little egret was observed downstream of the WWTP. No nest was found.

3.6 Invasive Species Survey Results

Under Section 49 (2) of S.I. No. 477 of 2011, the European Communities (Birds and Natural Habitats) Regulations 2011, it is an offence to allow or cause to disperse, any plant which is included in Part 1 of the Third Schedule of this S.I. No invasive plant species was found along the riverbanks.

4.0 CONCLUSIONS

The drain from the subject site, culverted throughout most of its length and with no protected species and low biodiversity, is of very low ecological importance.

The River Ara is in poor condition in the vicinity of Tipperary Town. The only significant issue to be considered here is the presence of nesting kingfishers. Farther downstream, this river improves somewhat, but is still of only moderate ecological importance.

The Aherlow River, within SAC 002137, is of International importance.

APPENDIX 1

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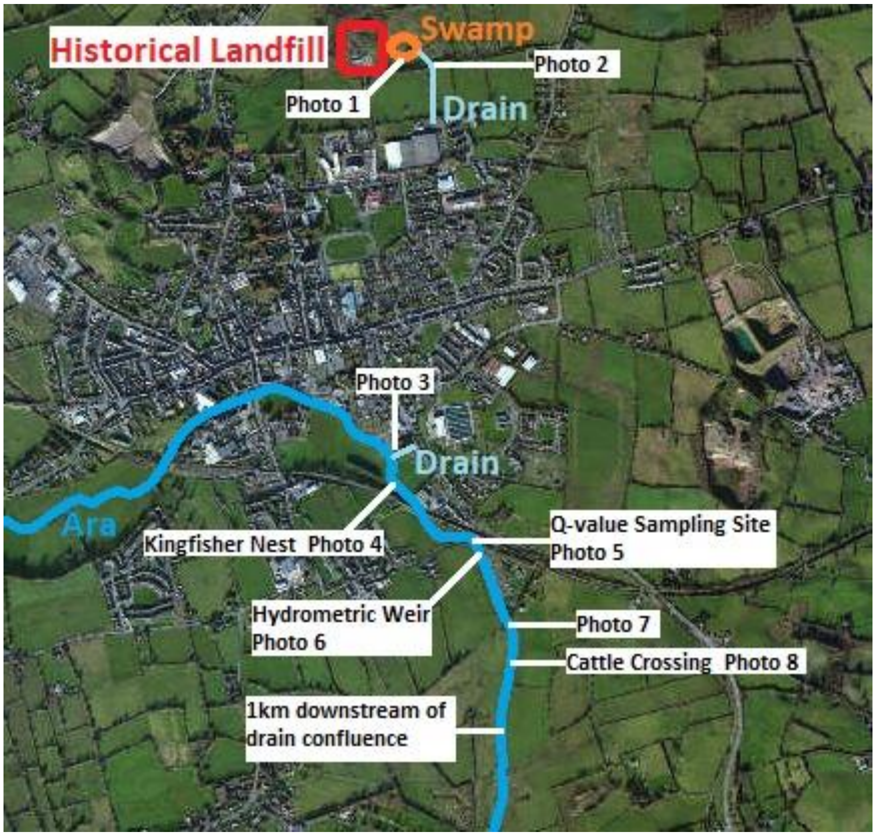
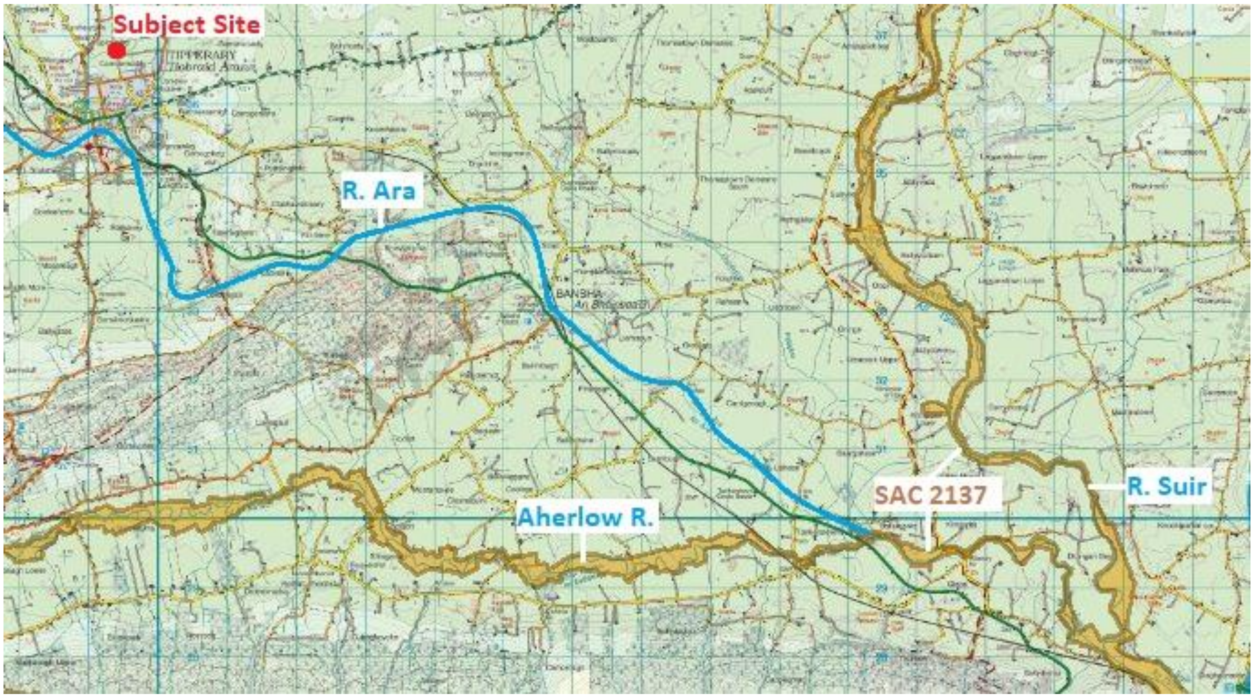
APPENDIX 2

SATELLITE IMAGE IN PROXIMITY TO SUBJECT



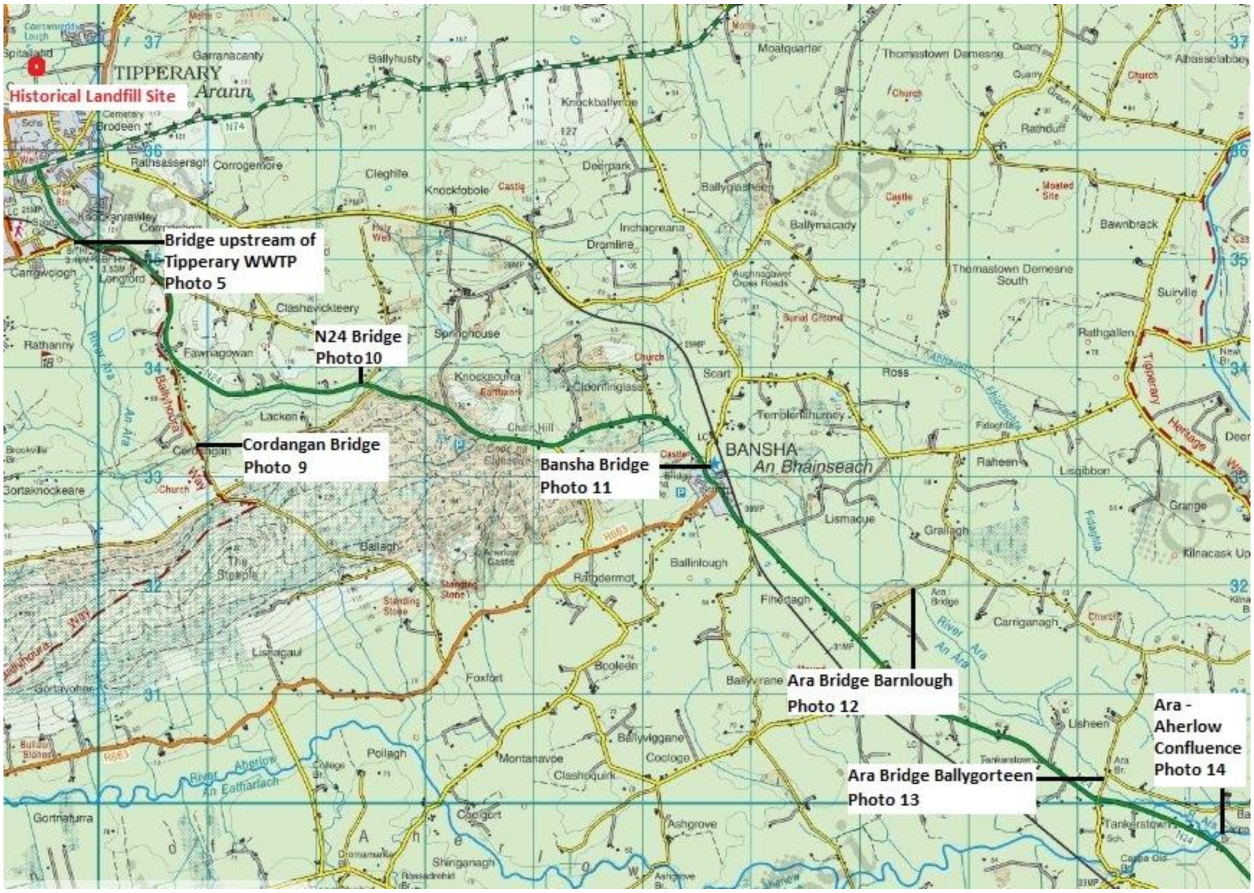
APPENDIX 3

RIVERS AND SAC DOWNSTREAM OF SUBJECT SITE



APPENDIX 4

SURVEY LOCATIONS DOWNSTREAM



Historical Landfill Site

Bridge upstream of Tipperary WWTP Photo 5

N24 Bridge Photo 10

Cordangan Bridge Photo 9

Bansha Bridge Photo 11

Ara Bridge Barnlough Photo 12

Ara Bridge Ballygorteen Photo 13

Ara - Aherlow Confluence Photo 14

APPENDIX 5

PHOTOGRAPHS

Photo 1: Swamp area east of subject site

Photo 2: Drain upstream of culvert

Photo 3: Drain between N24 and River Ara

Photo 4: Kingfisher nest burrow

Photo 5: Biological Water Quality sampling site

Photo 6: Hydrometric weir

Photo 7: Glide habitat

Photo 8: Cattle crossing point

Photo 9: Downstream of Cordangan Bridge

Photo 10: Upstream of N24 Bridge

Photo 11: Downstream of Bansha Bridge

Photo 12: Upstream of Ara Bridge, Barnlough

Photo 13: Downstream of Ara Bridge, Ballygorteen

Photo 14: Ara – Aherlow confluence

APPENDIX 6

Biological Water Quality

6a

Sampling Site Details

Photo No.	5
Location	Downstream of 1st bridge, upstream of WWTP outfall.
EPA Site Code	16A030300
Grid Ref. (ITM)	589722 635198
Sampling Depth (cm.)	20
Substrate (%)	Cobble (65-250mm): 30 Coarse Gravel (17-64mm): 20 Fine Gravel (2-16mm): 20 Sand (<2mm): 10 Silt (<0.06mm): 20
Flow Type	Riffle: 50% Glide: 50%
Instream Vegetation (% cover)	*Vaucheria sp.* 60 *Cladophora sp.* 15 *Phalaris arundinacea* 3 *Potamogeton crispus* 2
Shade	None

6b

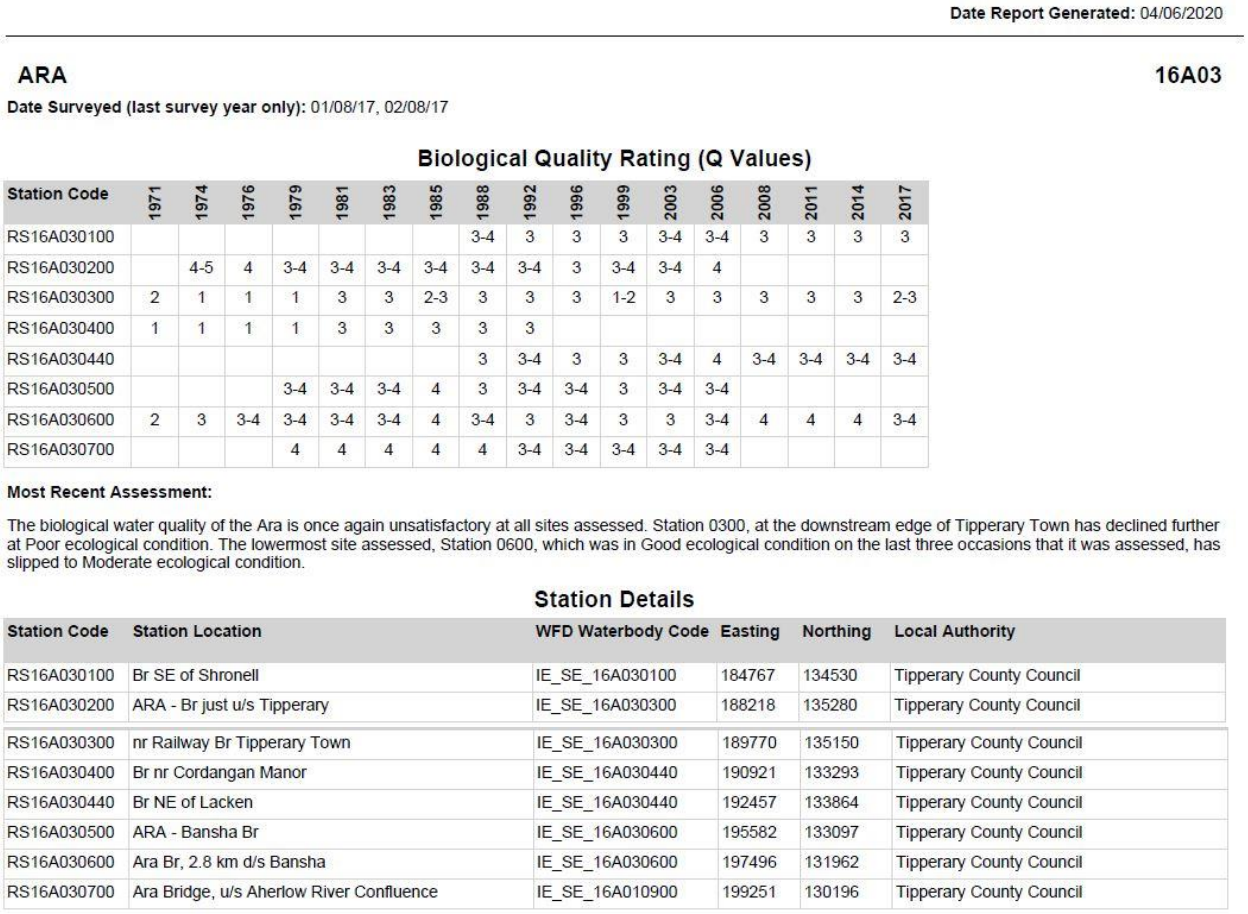
Macroinvertebrate Community Composition

Relative abundance expressed as D: Dominant; N: Numerous; C: Common; F: Few; SS: Single Specimen

TAXON	
Group A (Sensitive)	
	None
Group B (Less Sensitive)	
	None
Group C (Relatively Tolerant)	
Tricladida	C
Lumbriculidae	F
Valvata piscinalis	SS
Hydrachnidae	C
Gammarus sp.	C
Tipula sp.	SS
Ceratopogonidae	SS
Chironomidae (ex. *Chironomus*)	D
Group D (Very Tolerant)	
Sphaerium corneum	C
Helobdella stagnails	SS
Erpobdella sp.	F
Asellus aquaticus	C
Group E (Most Tolerant)	
	None
Q-value	**Q3**

APPENDIX 7

EPA Biological Water Quality Data, R. Ara



Date Report Generated: 04/06/2020

ARA **16A03**

Date Surveyed (last survey year only): 01/08/17, 02/08/17

Biological Quality Rating (Q Values)

Station Code	1971	1974	1976	1979	1981	1983	1985	1988	1992	1996	1999	2003	2006	2008	2011	2014	2017
RS16A030100								3-4	3	3	3	3-4	3-4	3	3	3	3
RS16A030200		4-5	4	3-4	3-4	3-4	3-4	3-4	3-4	3	3-4	3-4	4				
RS16A030300	2	1	1	1	3	3	2-3	3	3	3	1-2	3	3	3	3	3	2-3
RS16A030400	1	1	1	1	3	3	3	3	3								
RS16A030440								3	3-4	3	3	3-4	4	3-4	3-4	3-4	3-4
RS16A030500				3-4	3-4	3-4	4	3	3-4	3-4	3	3-4	3-4				
RS16A030600	2	3	3-4	3-4	3-4	3-4	4	3-4	3	3-4	3	3	3-4	4	4	4	3-4
RS16A030700				4	4	4	4	4	3-4	3-4	3-4	3-4	3-4				

Most Recent Assessment:

The biological water quality of the Ara is once again unsatisfactory at all sites assessed. Station 0300, at the downstream edge of Tipperary Town has declined further at Poor ecological condition. The lowermost site assessed, Station 0600, which was in Good ecological condition on the last three occasions that it was assessed, has slipped to Moderate ecological condition.

Station Details

Station Code	Station Location	WFD Waterbody Code	Easting	Northing	Local Authority
RS16A030100	Br SE of Shronell	IE_SE_16A030100	184767	134530	Tipperary County Council
RS16A030200	ARA - Br just u/s Tipperary	IE_SE_16A030300	188218	135280	Tipperary County Council
RS16A030300	nr Railway Br Tipperary Town	IE_SE_16A030300	189770	135150	Tipperary County Council
RS16A030400	Br nr Cordangan Manor	IE_SE_16A030440	190921	133293	Tipperary County Council
RS16A030440	Br NE of Lacken	IE_SE_16A030440	192457	133864	Tipperary County Council
RS16A030500	ARA - Bansha Br	IE_SE_16A030600	195582	133097	Tipperary County Council
RS16A030600	Ara Br, 2.8 km d/s Bansha	IE_SE_16A030600	197496	131962	Tipperary County Council
RS16A030700	Ara Bridge, u/s Aherlow River Confluence	IE_SE_16A010900	199251	130196	Tipperary County Council

Cover Photo: Male kingfisher on the River Ara, upstream of the railway bridge.

FEHILY
TIMONEY

CONSULTANTS IN ENGINEERING,
ENVIRONMENTAL SCIENCE
& PLANNING

APPENDIX 5

Invasive Species Treatment and Monitoring

OUTLINE INVASIVE SPECIES MANAGEMENT PLAN FOR TIPPERARY TOWN HISTORICAL LANDFILL REMEDIATION, CO. TIPPERARY

JULY 2018

Comhairle Contae Thiobraid Árann
Tipperary County Council

FEHILY
TIMONEY
& COMPANY

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1 INTRODUCTION

Tipperary County Council commissioned Fehily Timoney & Company (FT) to prepare an outline Invasive Species Management Plan for the proposed remediation of Tipperary Town Landfill site, Co. Tipperary (see Figure 1-2). Fehily Timoney & Company (FT) has prepared this outline Invasive Species Management Plan (ISMP) to comply with Regulations 49 and 50 of the European Communities (Birds and Natural Habitats) Regulations 2011 (not to cause the spread of non-native invasive plant species listed in schedule III), and to ensure non-native invasive plant species not listed in schedule III are not spread to Natura 2000 sites. The report outlines a programme for the control, eradication and monitoring of invasive species at landholdings of and adjacent to Tipperary Town Landfill site, Co. Tipperary.

In keeping with the third schedule of S.I. No. 477/2011 European Communities (Birds and Natural Habitats) Regulations 2011, the overall aim of this management plan is to put in place systems to contain the spread of invasive species within the Tipperary Town Landfill and adjacent lands, to eradicate the invasive species from within the landfill footprint and adjacent lands, and to ensure they are not spread during of the remediation of the landfill. This document provides background information on the non-native invasive species, location mapping methodology used and results of the extent of the species within the landfill footprint and adjacent landholdings.

In Ireland, the spread and propagation of species listed the third schedule of S.I. No. 477/2011 European Communities (Birds and Natural Habitats) Regulations 2011 is an offence. Under Regulation 49 (2) - Save in accordance with a licence granted under paragraph (7), any person who plants, disperses, allows or causes to disperse, spreads or otherwise causes to grow in any place specified in relation to such plant in the third column of Part 1 of the Third Schedule, any plant which is included in Part 1 of the Third Schedule, shall be guilty of an offence. Under Regulation 50 it is an offence to transport a vector material listed in Part 3 of the Third Schedule except under licence; in the case of this site this would apply to soil or spoil taken from places infested with Japanese Knotweed (*Fallopia japonica*) and/or Spanish bluebell *Hyacinthoides hispanca*.

This document provides background information on the non-native invasive species present, mapping of their location, and their extent within the site. It provides a legal context, sources of information including policy and guidelines to which cognisance has been paid, and the means of eradicating the species from site safely using prevention, containment, treatment, monitoring, follow up treatment, record keeping and appropriate disposal.

1.1 Site Description

The historical landfill site is in the townland of Carrownreddy immediately north of Tipperary town, partially within a wetland surrounded by agricultural lands adjacent to the town. The site is accessed from the east via the Carrownreddy road, which is a cul de sac accessed from the R661. The historical landfill consists of a mound which rises out of a natural hollow, part of which has been infilled with waste over the years. The land to the west, east and north is noticeably lower, with the mound of waste which is now mainly capped with spoil and rubble dropping suddenly towards the surrounding wetland at its edges.

The wetland surrounding the landfill mound drains from the south-western side into the Spital-Land watercourse, which flows south towards Tipperary town for c. 265 m before being channelled underground at the northern boundary of Rosanna Close housing estate. Due to the surrounding topography, the channel is assumed to continue underneath Tipperary town to join the Ara, which in turn joins the Aherlow, which flows into the Lower River Suir SAC c. 18.2 km downstream of the historical landfill site. This flow regime was confirmed during a site walkover on the 3rd May 2018.

This flow regime is in contradiction with the EPA watercourse mapping, which indicates that the Spatial-Land flows from south to north to join the Fidaghta watercourse which would drain the wetland surrounding the landfill and flows south east, eventually joining the River Suir. The headwaters of the Fidaghta are not located at the north-eastern corner of the wetland as indicated by the EPA, due to either a mapping error, or the deposition of spoil historically which may have altered to course of stream in this area. The soil underlying and surrounding the landfill mound is peat varying between 1-3m deep; beneath this, a stratum of clay forms an impermeable layer.

Invasive species are present on and around the landfill footprint. These are likely to have been introduced through the unregulated placement of soil.

1.1.1 Invasive species

Preliminary surveys have identified the presence of invasive species at the site, with Japanese knotweed *Fallopia japonica*, Spanish bluebell *Hyacinthoides hispanica* and winter heliotrope *Petasites fragrans* being of principle concern. It is proposed to undertake works to remove and appropriately dispose of all invasive species at the site. To this end, final invasive management plan will be prepared for the site by a suitably qualified contractor and approved by FT. Operations will include the excavation and disposal of areas of soil infested with Japanese Knotweed in accordance with relevant standards. All works are to be undertaken by a suitably qualified contractor.

1.2 Proposed Works

Tipperary County Council have responsibility for the remediation of Tipperary Town Landfill, located in the Townland of Carrownreddy, Tipperary Town. The landfill is a historic landfill having received waste from Tipperary Town from the 1940's to c. 1990. Waste deposited at the site is understood to comprise municipal and commercial wastes to depths of approximately 9m to 12m. Tipperary Town Council currently occupy part of the site as a depot for the storage of road maintenance materials and machinery. Other lands adjoining the site are primarily associated with low intensity agriculture. A marsh/wetland area surrounds the site on all sides except along the southern boundary and along part of the south-eastern boundary.

It is proposed to remediate the existing historic landfill site to the satisfaction of the EPA in line with current site's draft remediation plan. The final remediation plan for the site will be subject to EPA's approval but it is not envisaged to be substantively different from the draft remediation plan submitted. The remediation works will include:

- Invasive Species Management
- Demolition of Existing Structures
- Grading/Profiling OF Existing Side Slopes
- Profiling of Existing Site Area
- Installation of Engineered Landfill Capping System
- Installation of Landfill Gas Venting Trench
- Installation of Passive Landfill Gas Venting System
- Installation of Leachate Management Infrastructure, if required

Works of concern are the movement of soil containing viable material from invasive species which includes the demolition of existing structures (and subsequent movement of material), the regrading and profiling the top and sides of the landfill (which will involve movement of existing materials onsite) and the capping of the landfill.

Map Path: R:\Map Production\2017\P0563\Workspace\AA\P0563_Fig1-1_SiteLocation_A3.mxd

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
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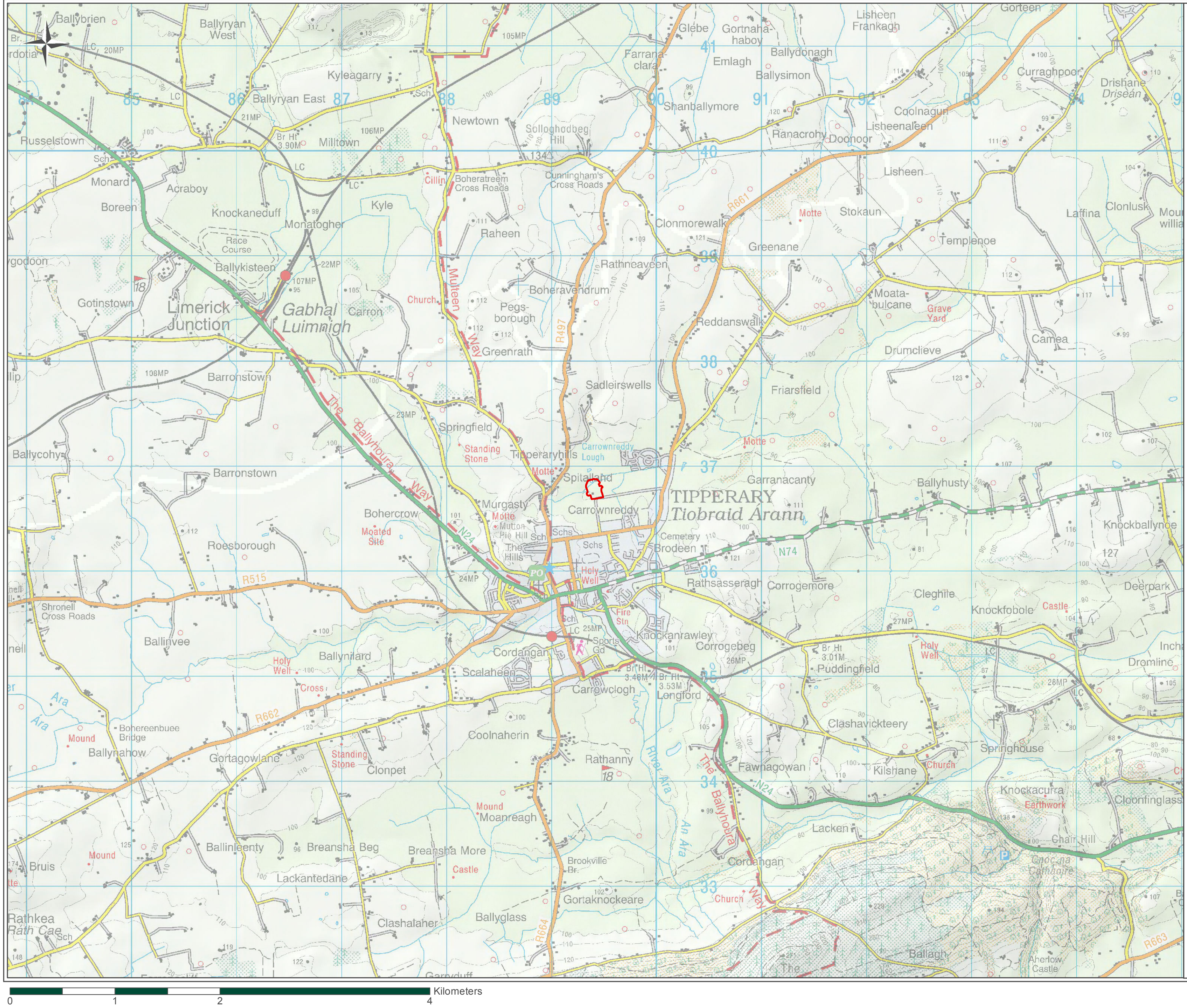

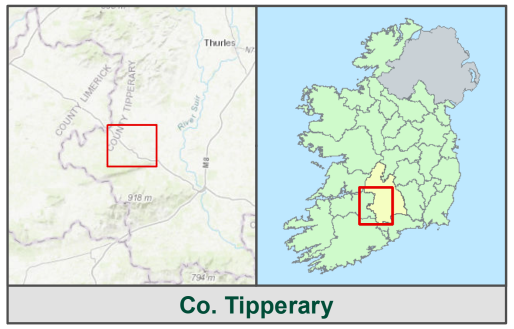

Co. Tipperary

Legend

🟥 Landfill Boundary

Figure Title	Site Location
Figure No.	1.1
Project	Tipperary Town Historical Landfill Remediation
Client	Tipperary County Council
Scale	1:35,000
Page Size	A3
Revision	A
Date	14/06/2018

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2 METHODOLOGY

2.1 Legislative Context

In Ireland the spread and propagation of species listed the third schedule of S.I. No. 477/2011 European Communities (Birds and Natural Habitats) Regulations 2011 is an offence. Japanese knotweed and Spanish bluebell are listed in the third schedule. Under Regulation 49 (2) - *Save in accordance with a licence granted under paragraph (7), any person who plants, disperses, allows or causes to disperse, spreads or otherwise causes to grow in any place specified in relation to such plant in the third column of Part 1 of the Third Schedule, any plant which is included in Part 1 of the Third Schedule, shall be guilty of an offence*.

2.2 Relevant Guidance

The methodology and guidance for this management plan has been devised in consideration of the following relevant guidance:

- PCA, (2014). Code of Practice for the Management of Japanese knotweed. Version 2.7. November 2014. Property Care Association.
- Kelly, J., Maguire, C.M. and Cosgrove, P.J., Muir, R.A. (2015). Best Practice Management Guidelines Japanese knotweed *Fallopia japonica*. Prepared for NIEA and NPWS as part of Invasive Species Ireland.
- NRA, (2010). Guidelines on the Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads. Revision 1, December 2010. National Roads Authority.
- Tu, M., (2009). Assessing and Managing Species within Protected Areas. Protected Area Quick Guide Series. Editor J., Ervin, Arlington, VA. The Nature Conservancy, 40 pp.
- Stokes *et al*., (2004). Invasive Species in Ireland. Unpublished report to Environment and Heritage Service and National Parks and Wildlife Service. Quercus, Queens University Belfast, Belfast.

2.3 Desktop Study

A desktop study was carried out to identify existing records of Invasive flora species adjacent to the site, habitat suitability of the site for the invasive species and nearby river bodies. This study allows the surveyor to narrow down the source of the species introduction and its likelihood of spreading within and outside of the site. The following sources of information were used:

- Invasive Species Ireland website http://invasivespeciesireland.com/
- OSI Aerial photography and 1:50000 mapping;
- National Parks and Wildlife Service (NPWS) mapping;
- National Biodiversity Data Centre (NBDC) mapping;
- Environmental Protection Agency (EPA) water quality data and CORINE 2012 data

2.4 Mapping and Evaluation of Invasive Species

A site survey was undertaken 3rd May 2018 (Table 2-1 provides further information). A visual inspection of the extent of the species was undertaken by an experienced ecologist. The location and extent of the invasive species of principle concern and one-off records were recorded using a handheld GPS. Mapping of Butterfly-bush *Buddleija davidii* was not considered practical, due to its presence throughout the site.

Table 2-1: Baseline Field Assessment Details

Date:	Ecologist	Weather Conditions:
03/05/2018	BOD	Cloud: 8/8; wind: F1; precipitation: none; visibility: excellent

3 INVASIVE SPECIES ACCOUNTS

The International Union for Conservation of Nature (IUCN) in their 'IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species' 2000 paper describes non-native invasive species (referred to as an invasive species) as "an alien species which becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity".

The six invasive species listed below were recorded at the historical landfill site and on the adjacent landholdings. Accounts of these species, summaries their ecology, growth and management periods, and distribution are included below.

- Japanese Knotweed (*Fallopia japonica*)
- Winter Heliotrope (*Petasites fragrans*)
- Spanish Bluebell (*Hyacinthoides hispanica*)
- Cherry Laurel (*Prunus laurocerasus*)
- Montbretia (*Crocosmia* X *crocosmiflora*)
- Snowberry (*Symphoricarpos albus*)
- Butterfly-bush (*Buddleija davidii*)

3.1 Japanese Knotweed (*Fallopia japonica*)

According to the Invasive Species Ireland Project who have carried out a risk assessment of Japanese Knotweed (*Fallopia japonica*), which is distributed throughout the island of Ireland (see Plate 1 below), the species is "one of the highest risk (most unwanted) non-native invasive species in Ireland". The species poses a risk to in open and riparian areas where it spreads rapidly to form dense stands, excluding native vegetation and prohibiting regeneration. This process has been known to reduce diversity and alter semi-natural and locally important habitats for wildlife. Once stands become established, they are extremely persistent and difficult to remove. Japanese Knotweed can grow through weaknesses in both tarmac and concrete. Population clusters must be completely removed, under appropriate licencing, before construction or specific projects within the site can begin (ISI, 2018).

3.1.1 Species ecology

Although Japanese Knotweed plants flower, all flowers in Ireland and Britain are female, precluding the possibility of sexual reproduction. The means of spread is entirely through the movement of rhizomes or rhizome fragments in soil or cut stems. Japanese Knotweed has an extraordinary ability to spread vegetative from crown, stem and rhizome (underground root) if disturbed. Even tiny amounts of cut stem, crown or rhizome can produce a new plant. Controlling the spread of the species is therefore dependent on preventing the spread of the stem, crown or rhizome. Japanese Knotweed causes numerous impacts, both ecological and economic. It is capable of outcompeting native plants and blocking commuting corridors of native mammals, and damaging buildings, tarmacadam and concrete. In waterways, it can block and reduce water flow, increasing the risk of flooding. In winter, when it dies back, it can leave riverbanks bare and open to erosion.

Red/purple shoots appear early in spring, which in some cases resemble an asparagus-like appearance but, as the canes grow, the leaves unfurl and the plant takes its more characteristic appearance. The mature canes are like bamboo, being hollow, and have a characteristic pattern of purple speckles.

The leaves are shield-shaped with pointed tips and a flat base, arranged in a zig-zag formation. The plant can grow to over 3m in height. Flowering occurs in late summer/autumn (End July – typically August) and consists of small creamy white flowers. During the winter the leaves die back and reveal orange/brown woody erect stems. Rhizomes are bright orange inside and can extend to a depth of 3m and a width of 7m around the visible growth above ground. Plate 1 below displays characteristic features of Japanese Knotweed.

Japanese knotweed in flower

Stem is zig-zag formation

Newly emerging Japanese knotweed

Dead hollow stems of Japanese knotweed

Plate 1: Characteristic features of Japanese Knotweed

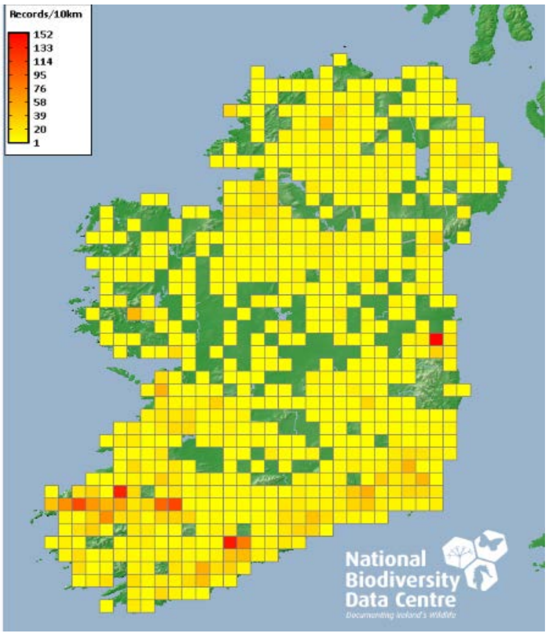
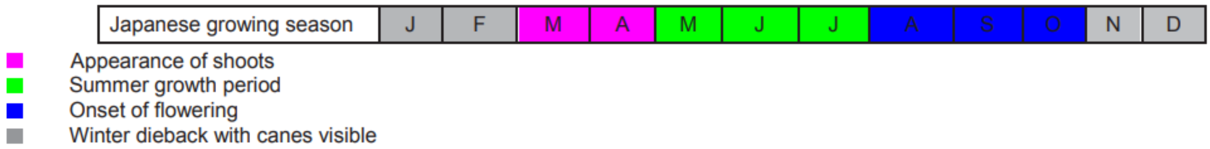


Figure 3-1: Distribution of Japanese Knotweed throughout Ireland

3.1.2 Growth/treatment Timeframe

Japanese Knotweed shoots typically appear between March and April. During this time energy stores from the root system are used to facilitate initial growth. The summer growth period commences in May and lasts until July, typical growth occurs during this time. Flowering begins in August and lasts until October. During this time the pale flowers can be seen. Plate 2 displays a summary of the plants growing season.

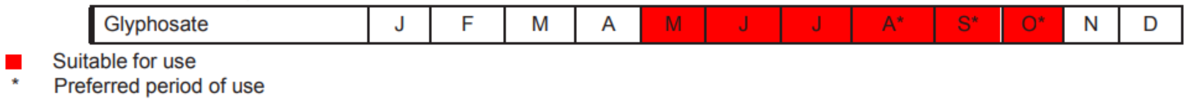


Japanese growing season	J	F	M	A	M	J	J	A	S	O	N	D

🟪 Appearance of shoots
🟩 Summer growth period
🟦 Onset of flowering
▨ Winter dieback with canes visible

Plate 2: Japanese Knotweed Growth season summary (Kelly, et al., 2015).

Plate 3 indicates the suitable period which glyphosate herbicide is used to remove Japanese Knotweed. It is suitable to use glyphosate herbicide on knotweed between the months of May and October, with August, September and October being the preferred months of use.



Glyphosate	J	F	M	A	M	J	J	A*	S*	O*	N	D

🟥 Suitable for use
* Preferred period of use

Plate 3: Japanese Knotweed Growth season summary (Kelly, et al., 2015).

3.2 Spanish Bluebell (*Hyacinthoides hispanica*)

3.2.1 Species ecology

Spanish Bluebell (*Hyacinthoides hispanica*) is native to the Iberian Peninsula. It was introduced into Brittan and Ireland as an ornamental plant but since has become invasive. The main threats associated with the species include hybridisation with the native Bluebell (*Hyacinthoides non-scripta*) and their ability to spread out competes other flora thus limiting the species diversity of an area.

The species is abundant in terrestrial dry woodlands and gardens. The species, unlike Japanese Knotweed, can spread both by seed and vegetatively, thought the growth of roots leading to new bulbs being formed. The Native and Spanish Bluebell are closely related species, thus making hybridisation easier, which is has negative implications for the native population.

Spanish Bluebell is perennial herb with white spherical bulbs. It has narrow green leaves of 20 to 50cm in length. Each bulb has 4-6 leaves which become erect before flowering, then later in the season collapse. Their bell-shaped flowers are visible from April to June and are a lilac to blue in colour. Anthers, within the flower are blue, in comparison to those of the native species which are creamy white. The Spanish Bluebell dies back once seeds have been produced in late summer.

Native Bluebell Spanish Bluebell

Plate 4: Displaying similarities between Spanish and Native Bluebell (Paul, 2016)

3.2.2 Timeframe

The optimal time for treatment is in spring, before flowers emerge; this will prevent the plant reproducing sexually, and setting seed.

3.3 Winter heliotrope (*Petasites fragrans*)

3.3.1 Species ecology

Winter Heliotrope (*Petasites fragrans*) is an invasive plant species, native to North Africa and the Mediterranean (Devlin, 2018). It often forms dense carpets of kidney-shaped leaves, 20-50cm wide, and is not often confused with other species. Heliotrope prefers damp areas and embankments, both within waste ground areas and cultivated land. It can often be found along roadways and drains.

These deciduous plants produce large roundish leaves up to 30cm in diameter. These are downy underneath. Its pale pink flowers have a distinctive sweet smell and flower in December and January. Foliage forms a dense carpet with a height of approximately 30cm. Its rhizomatous root system allows vegetative spreading. Plate 5 displays some characteristic features of Winter Heliotrope. The heliotrope plants in Ireland are all clone males, originating from a single male through fragmentation. These male plants are unable to produce seeds and thus rely on root systems and fragmentation to spread.

The species is thought to be widespread, but under recorded, in Ireland. Thought to have been introduced in the 1800s, first reported in pre-1866 records, it's believed that the species was originally either planted as winter ground cover or as a foodplant for bees (Reynolds, 2002).

Once Winter Heliotrope becomes established, it forms dense carpets which inhibit and outcompete other vegetation, causing reduced biodiversity and cover of native species. This plant is mainly spread vegetatively, with small parts of rhizomes capable of producing new plants.

Foliage and flowers

Foliage

Plate 5: Characteristic features of Winter Heliotrope (Source: Transport Infrastructure Ireland)

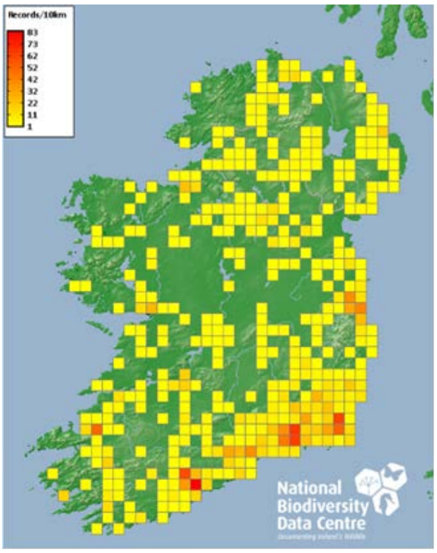


Plate 6: Distribution of Winter Heliotrope throughout Ireland (Source: National Biodiversity Data Centre)

3.3.2 Timeframe

Winter heliotrope can be treated at any time of year, once the extent of growth has been mapped when leaves are present.

3.4 Cherry Laurel (*Prunus laurocerasus*)

3.4.1 Species ecology

Evergreen shrub which forms dense thickets comprised of either a single stem or multiple stems (especially if it has been trimmed). Thick evergreen 5-15cm long oblong-ovate leaves; glossy green on surface and pale underneath. Leaves arranged alternately on short leaf stalks and leaf edges are toothed with pointed at tips. Small white fragrant flowers are held in clusters (racemes) and flowers are comprised of 5 petals any many yellow stamens. Fruit are purple/black and Cherry like and held in clusters. See Plate 7 below shows the defining features of Cherry Laurel.

Clusters of white flowers

This evergreen leaves alternate on stem with short leaf stalks.

Fruit in clusters.

Plate 7: Characteristics of Cherry Laurel (Source: Kingcounty.gov)

3.4.2 Timeframe

Cherry laurel can be cut down at any time of year; the herbicide glyphosate can also be applied throughout the year, however May to October inclusive is a sub-optimal period. Of principle concern when cutting and/or moving vegetation or surrounding soil would be the movement of viable seeds. As such the optimal time for cutting would be outside the flowering and fruiting period.

3.5 Montbretia (*Crocosmia X crocosmiflora*)

Montbretia (*Crocosmia* X *crocosmiflora*) is an invasive perennial which grows from underground corms. The X within its scientific name indicated that it is a hybridised species. The species was developed in France for horticultural use, it has since escaped and has become naturalised throughout Ireland. Montbretia can survive in most habitat types such as wet grassland, gardens and roadside.

In the case of most other such invasives, Montbretia uses its fast growth rates to outcompete and dominate the habitats which its introduced. This dominance can cause impact to native species and processes within these habitats. Dense tussocks of Montbretia can prevent the regeneration of seedlings and saplings, thus preventing natural re-generation of the habitat (DAFM, 2016).

3.5.1 Species ecology

Montbretia flowers are reddish to orange in colour, they can be between 25 to 55mm long and are arranged loosely along two opposite sides of the flower stem, in a zig-zag formation. They have a hollow tubular corolla with six petals, with green leaves described as ‘grass-like’, long and narrow. The leaves are soft, hairless, have pointed tips and can be 30-80cm long.

Montbretia spreads vegetatively throughout introduced habitats through underground corms and rhizome fragments. The corm is bulb-like and stores energy for survival during the winter months. It is estimated that each Montbretia plant can produce 14 new corms annually. These corms are thought to break off from the parent plant, thus spreading further into the habitat. The corms, corm fragments and rhizomes can be spread unintentionally as a result of ground disturbance, dumping of garden waste and by attaching to machinery.

The species is also capable of producing viable seed, providing a further means of spread.

3.5.2 Timeframe

Montbretia grows begins in early spring with leaves sprouting from the ground in March. The plant flowers between July and September. The most effective time to remove Montbretia is just before full flowering occurs in summer (DAFM, 2016).

Plate 8: Montbretia (Source: DAFM)

Plate 9: Montbretia flower arrangement and leaf (Source: Wildflowers of Ireland)

3.6 Snowberry (*Symphoricarpos albus*)

Snowberry is an invasive, often overlooked, species which is often present in hedgerows. Other than its pale white fruit, the species seems to blend in to the other species within the habitat. Snowberry is a twiggy and straggly plant which can reach over 2.5m high, often suspended using suckers.

Snowberry impacts habitats and species through forming dense thickets which outcompete native vegetation.

3.6.1 Species ecology

Snowberry produces small pale-pink ‘funnel-shaped’ flowers with 5 pale-petalled flowers (4-6mm across) in short, which flower from June to September. Its oval leaves are small and untoothed. In autumn its berries are round (1.5-2cm diameter) and white when ripe, of which each contain 2 seeds. This plant was introduced from North America. Interestingly, it is thought that bird species within Ireland have not yet adapted to feed upon berries of such a colour, as no native plant in Ireland holds ripe white berries.

3.6.2 Timeframe

Snowberry comes into flower from June to September; their berries are ripe in Autumn. As such, the optimal time for treatment would be outside the flowering and fruiting period.

Plate 10: Snowberry flower (Devlin, 2018)

Plate 11: Snowberry berry and leaves (Source: GBNNSS)

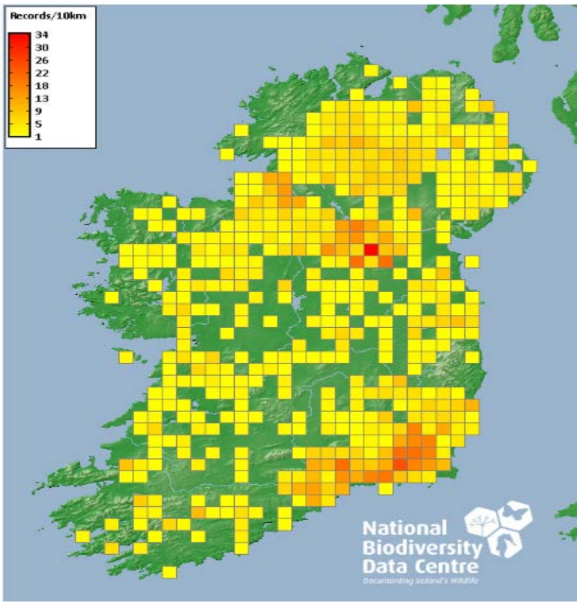


Plate 12: Distribution records of Snowberry in Ireland (Source: National Biodiversity Data Centre)

3.7 Butterfly-bush (*Buddleia davidii*)

The Butterfly-bush is a multi-stemmed shrub which can reach 4m in height. From June to September, the arching branches bear conical panicles of lilac flowers, which may occasionally be white, pink, red or purple. Leaves are long and serrated along the edges. In the winter, flower heads and seed capsules remain despite the plant being deciduous. Up to 3 million seeds are produced per plant and can remain dormant in the soil for many years. Plate 13 displays characteristic features of the Butterfly-bush.

Butterfly-bush is common throughout Ireland. It spreads through abundant seed dispersal by wind and draught behind vehicles. While being a valuable source of nectar, especially for butterflies, *Buddleia* can cause structural damage to buildings by rooting in cracks in masonry.

Plate 13: Characteristic features of Butterfly-bush (Source: Wildflowers of Ireland)

3.7.1 Timeframe

Optimal time for treatment and/or movement of material would be outside of flowering and seed-bearing periods.

4 EXISTING ENVIRONMENT

4.1 Desktop records

Historical records of invasive species from the relevant national datasets were assessed through the National Biodiversity Data Centre. Three invasive species were identified within both 2 and 10km grid squares encompassing the site (listed in table 4-1 below).

No other invasive flora species were historically recorded within these areas.

Table 4-1: Historical Invasive species records in within 10km (grid R83) and 2km (grid R38Y) of the site

Grid(s)	Species	Date of record	Dataset	Invasive Impact
R38Y and R38	Japanese Knotweed (*Fallopia japonica*)	18/10/2012	National Invasive Species Database	High
R83	Giant-rhubarb (*Gunnera tinctoria*)	30/05/2006	River Biologists' Database (EPA)	High
R83	Sycamore (*Acer pseudoplatanus*)	25/07/2007	Species Data from the National Vegetation Database	Medium

4.1.1 Japanese Knotweed records

A review of Japanese Knotweed records retrieved from Biodiversity Ireland website's[1] online database was undertaken within the landfill site and its adjacent surroundings. Records of invasive flora within 2km and 10km grid squares (R38Y and R38, respectively), encompassing the site, were assessed. Japanese Knotweed was recorded both during survey of the site and in historical records.

4.1.2 Giant-rhubarb

A review of Giant-rhubarb records retrieved from Biodiversity Ireland website's online database was undertaken within the landfill site and its adjacent surroundings. Records of invasive flora within 2km and 10km grid squares (R38Y and R38, respectively), encompassing the site, were assessed. Giant-rhubarb was recorded during assessment of these records but was not recorded during survey of the site.

4.1.3 Sycamore

A review of Sycamore records retrieved from Biodiversity Ireland website's online database was undertaken within the landfill site and its adjacent surroundings. Records of invasive flora within 2km and 10km grid squares (R38Y and R38, respectively), encompassing the site, were assessed. Sycamore was recorded during assessment of these records but was not recorded during survey of the site.

4.2 Results of Field Survey and Mapping

A field survey of the site was conducted on the 3rd of May 2018. Invasive plant species on site were identified and locations of species of principle concern were logged on a GPS device. The field survey detected seven invasive species present within the site.

These are:

- Japanese Knotweed (*Fallopia japonica*)
- Winter Heliotrope (*Petasites fragrans*)
- Spanish Bluebell (*Hyacinthoides hispanica*)
- Cherry Laurel (*Prunus laurocerasus*)
- Montbretia (*Crocosmia* X *crocosmiflora*)
- Snowberry (*Symphoricarpos albus*)
- Butterfly-bush (*Buddleija davidii*)

The co-ordinates recorded for these species are included in Appendix 1. As stated in section 2.4, the wide distribution throughout the site rendered mapping of Butterfly-bush (*Buddleija davidii*) impractical.

Figures 4-1 and 4-2 below show the locations and extents of invasive species mapped.

4.3 Location and links to sensitive habitats

The site’s location within a wetland means there is potential for transport of Japanese knotweed stem fragments downstream to other locations, including Natura 2000 sites.

The wetland is not at risk from infestation of any of the invasive species recorded on-site, since the particular species in question cannot grow in wetland habitats.

The means of introduction to the landfill site for all species present is likely to have been via unregulated placement of soil.

Map Path: R:\Map Production\2017\P0563\Workspace\AA\P0563_Fig4-1_LocationAndExtentOfJapaneseKnotweed_A3.mxd

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
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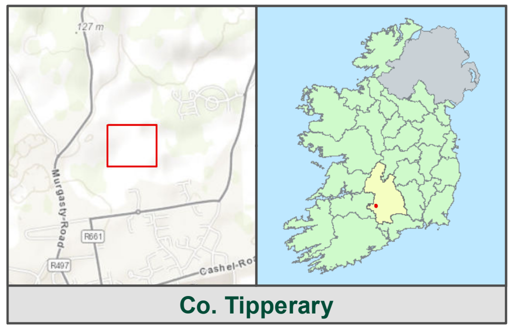

Legend

🟥	Landfill Boundary
⬚	Indicative Footprint of Remedial Works
🟧	Japanese Knotweed

Figure Title

Location & Extent of Japanese Knotweed

Figure No. 4.1

Project

Tipperary Town Historical Landfill Remediation

Client

Tipperary County Council

Scale 1:1,000 **Page Size** A3

Revision A **Date** 29/06/2018

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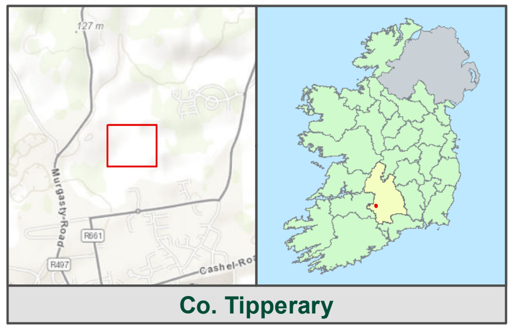
Map Path: R:\Map Production\2017\P0563\Workspace\AA\P0563_Fig4-2_LocationAndExtentOfOtherInvasiveSpecies_A3.mxd



Co. Tipperary

Legend

🟥	Landfill Boundary
▨	Indicative Footprint of Remedial Works
●	Cherry Laurel
●	Montbretia
●	Snowberry
●	Spanish Bluebell
🟨	Winter Heliotrope

Figure Title

Location & Extent of Other Invasive Species

Figure No. 4.2

Project

Tipperary Town Historical Landfill Remediation

Client

Tipperary County Council

Scale 1:1,000 **Page Size** A3

Revision A **Date** 29/06/2018

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5 PROPOSED MEASURES FOR THE MANAGEMENT OF INVASIVE SPECIES WITHIN AND ADJACENT TO THE DEVELOPMENT SITE

It is recommended that a qualified and competent specialist in the treatment of invasive plant species with appropriate experience and expertise is employed for the duration of the project to ensure that all the measures outlined in relation to the Invasive Species Management Plan are implemented.

5.1 General Measures

While it is extremely important and more efficient to contain invasive species at the point of infestation, care shall also be taken to ensure the plan shall also be adhered to ensure that the species is not spread outside the site.

According to Invasive Species Ireland (ISI) invasive non-native species are the second greatest threat (after habitat destruction) to worldwide biodiversity. Invasive species negatively impact Ireland’s native species; changing habitats and ultimately threatening ecosystems which impacts on biodiversity as well as economics as they are costly to eradicate.

Halting the spread of non-native invasive species can be achieved via prevention, containment, treatment and eradication (ISI, 2012a).

5.1.1 Prevention

Prevention of the spread of invasive species will be achieved by:

- The finalised invasive species management plan in conjunction with competent and experienced Contractor.
- Supervision of control measures and treatment works by an appropriately qualified ecologist or invasive species specialist.
- Raising awareness of site workers via tool box talks given by a suitably qualified person as part of site introduction; informing workers what to look out for and the what procedure to follow if they observe an invasive species.
- Only planting or sowing of native species within the proposed development will be allowed.
- Where invasive species have been physically removed and disturbed soil, this soil will be seeded or replanted (including 5cm deep mulch) with native plant species. This will prevent the easy colonisation of bare soil by invasive species in the area.
- Unwanted material originating from the site will be transported off site by an appropriately licensed waste contractor and disposed of properly at a suitably licenced facility.
- Signs should warn people working there that there is Japanese Knotweed and other invasive species contamination.
- Stockpiles of soil contaminated with Japanese Knotweed to be indicated clearly with appropriate signs and isolate them.
- Ensure good hygiene practices:
  - Remove the build-up of soil on equipment
  - Keep equipment clean
  - Do not move fouled equipment from one site to another.
- All vehicles exiting the site should be washed down with a pressure washer to prevent the transport of seeds, since this cannot be prevented comprehensively by any other measure.
- Waste water from washing facilities will be stored securely and treated to prevent spread outside the site.
- Footwear and clothing of operatives working near invasive species should be checked for seeds, fruits, or other viable material before exiting the site.

5.1.2 Containment

The three most common ways a site can become infected are:

1. Importation of infected soil.
2. Contamination on vehicles and equipment.
3. Illegal dumping.

Containment of invasive species will be achieved by:

- A pre-construction survey shall be undertaken during the growing season immediately prior to the construction phase to mark out the extent of invasive plant species. This survey shall inform the finalised draft of the invasive species management plan prior to the commencement of works. Prior to the construction phase, invasive species are to be treated (Section 5 for treatment methods).
- Japanese Knotweed within the site including the 7m buffer from the footprint of the development will be excavated (following herbicide treatment) prior to the construction phase. Cordoning off of Japanese Knotweed will occur if required. Japanese Knotweed's root structure rhizomes can extend up to 7 m in a lateral direction (but usually only up to 5 m), and 3m deep from the over ground parent plant.
- Cordoning off the area for other invasive species– this shall include a buffer of up to 1m surrounding the area of infection. This will prevent plants with underground rhizomes being transported to other sections of the site and it will also prevent contact with plants which could result in the transport of seed, fruit or vegetation to other parts of the site. No construction works will occur within exclusion zones prior to the eradication of invasive species.
- No machinery or personnel shall be allowed within exclusion zones. Similarly, there shall be no storage of materials within or adjacent exclusion zones.
- No soil or vegetation shall be removed from this area unless it is contained and is transported via an appropriately licensed waste contractor to a suitably licenced facility for treatment.
- Informing all site staff through toolbox talks as part of site inductions.
- Any new sightings of invasive plant species shall be relayed to construction staff and the developer. These areas shall follow the same protocol as the current infected area.

5.2 Japanese Knotweed

Two options for the treatment of Japanese Knotweed at the site have been recommended. Since the infested areas will be capped, all potentially infested soil will be required to be removed and disposed of appropriately. Either of these two options shall be used to eradicate Japanese Knotweed from the site and avoid the spread of the species. However, the following general recommendations will be adhered to as part of the plan:

- Japanese Knotweed root systems can extend up to 7m in a lateral direction (but usually only up to 5 m), and 2m deep from the over ground parent plant.
- Staff shall be made aware of this buffer zone when working within areas of infestation.
- Areas of infestation to be fenced off from other works areas including a buffering distance of up to 7m to create exclusion zones.
- Construction works will only be allowed within exclusion zones following the eradication of Japanese Knotweed.
- No treatment measures to take place in these areas without supervision and agreement by appointed appropriately experienced ecologist or Japanese Knotweed eradication specialist.
- All machinery and vehicles operating within areas of infestation to be thoroughly checked and if necessary cleaned prior to leaving the area to protect against further spreading of Japanese Knotweed.

- During vegetation clearance and the removal of rubbish and other waste materials from infested areas care must be taken to ensure that Japanese Knotweed is not carried with these materials out of the site. Japanese Knotweed plants (or other invasive species) should not be removed along with other vegetation during clearance works.
- No material shall be taken from areas of infestation (unless for disposal at a suitably licenced facility). All staff shall be made aware of nature of threat via toolbox talks as part of site inductions. Toolbox talks shall be undertaken with all personnel accessing the site to ensure that the details of the invasive species management plan are adhered to and to raise awareness of the potential treat of invasive species.
- Wheel washes shall be put in place at entry and exit points, if considered appropriate. Waste water from these facilities will be stored and treated to avoid further outbreaks.
- If operating within an area of known infestation all machinery, vehicles, equipment, foot ware and clothing will be cleaned thoroughly (if necessary using steam cleaners) in a contained area to avoid further contamination.
- It is unlikely that one treatment will kill this plant. Treatment will be required for years before eradication is achieved.

Option 1: The burial method (on-site)

This is an option that is used in situations where there is a pressing development need for the site and time constraints which would not allow for in-situ herbicide control over a longer period of time.

Pre-excavation treatment

The Japanese Knotweed infestation must be treated with herbicide before removing. When sufficient time has been allowed for the herbicide to take effect (preferably at least a fortnight) the canes should be cut and removed and contained for burial.

Herbicides can be applied using a range of suitable applicators such as a knapsack sprayer. Control is easier if dead winter stems are tidied over the winter months to assist with access before growth commences i.e. to prevent tripping on them or them interfering with your knapsack lance. It is advised to leave live canes in situ to reduce the risk of spread to other sites. Care must be taken to avoid spreading Knotweed crowns when tidying dead canes. Application in sensitive vegetation areas is best achieved by stem injection or weed wiper.

Stockpiling Japanese Knotweed infested soil prior to burial

If soil containing Japanese Knotweed is stockpiled, the material must be stored in a manner that will not harm health or the environment. The stockpile should be on an area of the site that will remain undisturbed. The area should be clearly signed and regularly treated with herbicide to avoid re-infestation.

As a precaution, the stock piled material should be laid on a root barrier membrane to avoid contaminating the site further and covered fully with the same material to avoid dispersal via wind.

Burying the material

Soil containing Japanese Knotweed material may be buried on the site where it is produced to ensure that it is completely eradicated.

It is advisable to apply a non-persistent herbicide at least once to reduce the growth of infective material. The period of time during which the herbicide is ‘active’ is described on the product label. Material cannot be buried during that period of activity.

Material must be buried on-site at least 5m deep. The Japanese Knotweed material must then be covered with a root barrier membrane layer before infilling it to 5m deep with inert fill or topsoil.

Root barrier membranes that may have been used to protect clean ground from vehicles involved in excavating Japanese Knotweed must also be buried. This method relies on the depth of burial as the main Japanese Knotweed treatment, rather than the protection from the root barrier membrane.

Where on-site burial is used, the area of deposition must be accurately mapped and the location recorded to prevent potential disturbance and re-infestation, future owners must be advised of its position. Japanese Knotweed is likely to survive for many years, depending on how effective the treatment was before it was buried. It is essential that it is not buried in a location where landscaping, installing services, building foundation are proposed or erosion from a watercourse is likely.

Where the deep burial of the dead Japanese Knotweed material is the preferred method of disposal, it is recommended to use glyphosate formulations. Other persistent herbicides are not allowed for deep burial under various waste regulations and due to a potential risk of pollution of groundwater.

Material, including contaminated soils, rhizome and the crown at the base of the stem, must be buried:

- at least 5 metres deep, (immediately cover to 1-2 metres, final depth after 2-4 weeks);
- at least 10 metres from the margins of the site or any engineering features, for example drains or bunds, of the site;

It is only acceptable to bury Japanese Knotweed material if the soil is otherwise uncontaminated.

- Moving soil off site
- Transporting soil infested with Japanese Knotweed, it is essential to carry out strict hygiene measures.

Option 2: Moving Soil and treated Japanese Knotweed off site

Material (soil, vegetation, etc.) contaminated with Japanese Knotweed can only be transported offsite under the conditions of a relevant licence from the National Parks and Wildlife Service (NPWS). The material can only be removed to a prearranged EPA licenced waste transfer facility by the licenced haulier. Excavation for off-site disposal, great care to avoid excess waste and make sure the excavated Japanese Knotweed does not contaminate surplus soil that is currently free from infestation during excavations. When transporting soil infested with Japanese Knotweed, it is essential to carry out strict hygiene measures. If proper standards are not followed, this may lead to Japanese Knotweed spreading. Japanese Knotweed is a particular problem along transport corridors, where it interferes with the line of vision and can cause accidents.

Trucks transport the material should only be filled up to a maximum of 20cm from the top. The void must be sealed with a well-secured membrane.

There must be enough membrane to let the soil be sealed into a temporary cell for transporting. It is very important that the soil is contained to prevent any material being lost when it is moved. To contain the soil in the short-term, you can use a lower specification of membrane.

The final fate of Knotweed material transported off-site would be deep burial or incineration at an appropriately licensed facility.

5.3 Winter Heliotrope

Two options for the treatment of Winter Heliotrope at the site are recommended. This option shall be used to eradicate Winter Heliotrope from the site and avoid the spread of the species. However, the following general recommendations will be adhered to as part of the plan:

- Staff shall be made aware of this buffer zone when working within areas of infestation.
- Areas of infestation to be fenced off from other works areas including a buffering distance of up to 1m to create exclusion zones.
- Construction works will not be allowed within exclusion zones until the species has been fully eradicated but may continue outside of these areas.
- No treatment measures to take place in these areas without supervision and agreement by appointed eradication specialist.

- All machinery and vehicles operating within areas of infestation to be thoroughly checked and if necessary cleaned prior to leaving the area to protect against further spreading of Winter Heliotrope.
- No material shall be taken from areas of infestation; unless for disposal. All material will be either deep buried (2m) or transported by an appropriately licensed waste contractor and received by an appropriately licensed facility.
- All staff shall be made aware of nature of threat via toolbox talks as part of site inductions. Toolbox talks shall be undertaken with all personnel accessing the site to ensure that the details of the invasive species management plan are adhered to and to raise awareness of the potential treat of invasive species.
- Wheel washes shall be put in place at entry and exit points, if considered appropriate. Waste water from these facilities will need to be stored and treated to avoid further outbreaks.
- If operating within an area of known infestation all machinery, vehicles, equipment, foot ware and clothing will need to be cleaned thoroughly (if necessary using steam cleaners) in a contained area to avoid further contamination.

Option 1 – Removal and follow up herbicide spraying

As this species spreads vegetatively via rhizomes, treatment is comprised of a physical and chemical combined approach. First, rhizomes are removed and secondly the areas are re visited and any potential growth is sprayed using glyphosate-based herbicide after flowering in February to March or midsummer or later but before the foliage begins to die back (NRA, 2010).

Remaining plant matter from this process should be either buried, under the above conditions, or transported, using an appropriate licenced vehicle to a licenced waste processing facility.

It should be noted that a number of winter heliotrope growths are intermingled with Winter Heliotrope. Therefore, it follows that these areas should be excavated and buried along with the soil from these areas as outlined above.

Option 2 – In-situ Burial

If areas of Winter Heliotrope separate from knotweed infestations at an elevation which would allow material from outside the site of a sufficient depth (min 1m) to be deposited on top during the re-grading process without disturbance to the Winter Heliotrope, this, and subsequent capping would kill off the plant and prevent re-growth. This method would only work if no interaction with winter heliotrope occurred, precluding the transport of viable material on plant equipment.

5.4 Spanish Bluebell

Three options for the treatment of Spanish Bluebell at the site have been proposed. It will be necessary to ensure that soil containing bulbs, seeds or other viable material is not transported within or outside the site; therefore, excavation and appropriate disposal, or in-situ burial are the means by which this can be achieved. As such, any one or a combination of these options shall be used to eradicate Spanish Bluebell from the site and avoid the spread of the species. However, the following general recommendations will be adhered to as part of the plan:

- Spanish Bluebell is spread both by seed and vegetatively. A buffer area of 1m will be left to prevent damage to the plants, seedpods and bulbs, which can result in the production of new individuals, thus making the plant more difficult to treat.
- Staff shall be made aware of this buffer zone when working within areas of infestation.
- Areas of infestation to be fenced off from other works areas including a buffering distance of up to 1m to create exclusion zones.
- Construction works will not be allowed within exclusion zones until the species has been fully eradicated but may continue outside of these areas.

- No treatment measures to take place in these areas without supervision and agreement by appointed eradication specialist.
- All machinery and vehicles operating within areas of infestation to be thoroughly checked and if necessary cleaned prior to leaving the area to protect against spread of seeds or other material.
- No material shall be taken from areas of infestation; unless for disposal. All material will be either deep buried (2m) or transported by an appropriately licensed waste contractor and received by an appropriately licensed facility.
- All staff shall be made aware of nature of threat via toolbox talks as part of site inductions. Toolbox talks shall be undertaken with all personnel accessing the site to ensure that the details of the invasive species management plan are adhered to and to raise awareness of the potential treat of invasive species.
- Wheel washes shall be put in place at entry and exit points, if considered appropriate. Waste water from these facilities will need to be stored and treated to avoid further outbreaks.
- If operating within an area of known infestation all machinery, vehicles, equipment, foot ware and clothing will need to be cleaned thoroughly (if necessary using steam cleaners) in a contained area to avoid further contamination.

Mechanical excavation and removal

Bulbs, roots and tissue can be mechanically removed from the ground. Care should be taken when completing this method as a missing bulb may be able to grow a new colony of bluebell. The best time to complete mechanical removal of Spanish bluebell is early spring, before the plant starts to flower. Waste materials, including soil, containing the Spanish bluebells are to be considered as ‘controlled’ waste and must be disposed of appropriately, through properly licenced processes.

Option 1: Excavation and Burial On-site

Excavate soil up to 1m from the plant/growth. Excavated material will be buried to a depth of 2m. Wash down all equipment into the transportation vehicle to ensure all material and seeds are transported to the burial site. Wash out transportation vehicle into burial site.

Option 2: Excavation and Disposal at Licensed Facility

Excavate soil up to 1m from the plant/growth. Wash down all equipment into the transportation vehicle to ensure all material and seeds are transported to the disposal site.

Trucks transporting the material should only be filled up to a maximum of 20cm from the top. The void must be sealed with a well-secured membrane.

There must be enough membrane to let the soil be sealed into a temporary cell for transporting. It is very important that the soil is contained to prevent any material being lost when it is moved. To contain the soil in the short-term, you can use a lower specification of membrane.

Option 3 – In-situ Burial

Similarly, to winter heliotrope above, infestations at an elevation which would allow material from outside the site of a sufficient depth (min 1m) to be deposited on top of the plants during the re-grading process without disturbance to Spanish Bluebell plants could be treated this way. This, and subsequent capping would kill off the plant and prevent re-growth. No direct interaction with plant material should occur during this process. Washing down of plant equipment and checking of clothing and footwear of operatives working in the area would also be required to ensure no seeds were transported during the process.

5.5 Cherry Laurel

Four options for the treatment of Cherry Laurel has been proposed. Any one or a combination of these four options shall be used to eradicate Cherry Laurel from the site and avoid the spread of the species. However, the following general recommendations will be adhered to as part of the plan:

- Construction works will only be allowed within exclusion zones once the species has been fully eradicated.
- No treatment measures to take place in these areas without supervision and agreement by appointed Cherry Laurel eradication specialist.
- The Cherry Laurel plant contains cyanide and as per good practice should only be handled with gloves. This plant will be disposed of via an appropriately licensed waste facility.
- Equipment, clothing and footwear should be checked following treatment operations and cleared of fruits/seeds as necessary

Option 1 – Cut to stump and dig out stump; bury during re-grading

This method involves cutting the main stem of the plant down near ground level, and digging out the stump and any visible roots. This option is not usually practical in areas where there are other invasive plants present as the disturbed soil can allow for the setting of seeds or the spread of rhizomes od adjacent species (ISI, 2012b).

Montbretia is present adjacent to the Cherry Laurel plant in this instance.

If the stump and Montbretia are at an elevation which would allow burial (min 1m) following treatment, this would be sufficient to prevent re-growth.

If they are required to be buried at a lower level, this could be carried out provided it takes place in an adjacent area, within a quarantine zone overlapping both the extraction and burial sites, to ensure no viable material from either species exits the quarantine zone.

Option 2 – Cut to stump and treat stump with herbicide

This method involves cutting the main stem of the plant down near ground level, and applying glyphosate (20% solution), tryclopyr (8% solution) or ammonium sulphate (40% solution) to the freshly cut wound.

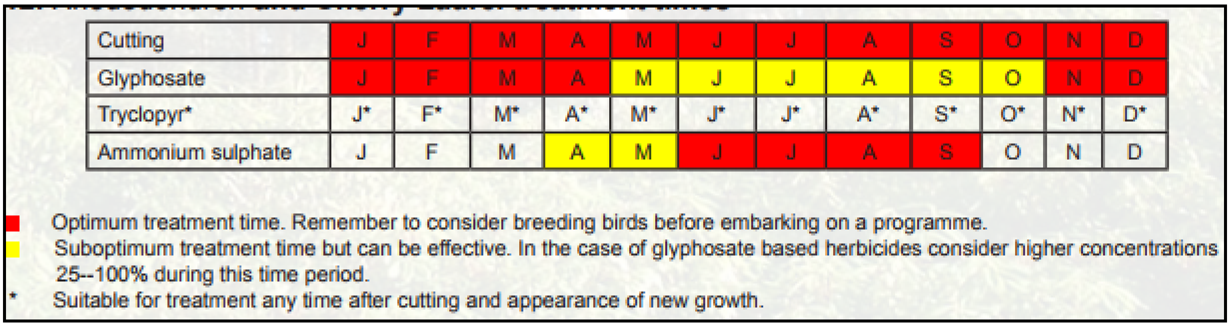
The herbicide concentrations used and timings of applications vary according to which chemical is used. When treating many stems, vegetable dye added to herbicide is useful for highlighting the stems that have and haven’t been treated. The use of a brush or other such applicator will provide an accurate application and prevent damaging adjacent non-target plants via spray drift. Please see table below for best treatment time (ISI, 2012b).

Option 3 – Cut to main stem and inject stem with glyphosate

This method involves the ‘drill and drop’ method where the main stem is cut and a hole drilled into the cut. This provides a targeted application of glyphosate (25% solution). The main drawback to this technique is that the plant is left in place to rot away; which can take a decade or more. Please see table below for best treatment time (ISI, 2012b).

Option 4 - Cut back to stump and spray regrowth with chemicals

This application involves cutting a main stem down near ground level and then treating the new stems with herbicide. This method is the least effective as some stems may be missed and not treated. Also, the application of herbicide is generally via spraying which can result in adjacent non-target plants being killed off. Please see table below for best treatment time (ISI, 2012b).



Cutting	J	F	M	A	M	J	J	A	S	O	N	D
Glyphosate	J	F	M	A	M	J	J	A	S	O	N	D
Tryclopyr*	J*	F*	M*	A*	M*	J*	J*	A*	S*	O*	N*	D*
Ammonium sulphate	J	F	M	A	M	J	J	A	S	O	N	D

🟥 Optimum treatment time. Remember to consider breeding birds before embarking on a programme.

🟨 Suboptimum treatment time but can be effective. In the case of glyphosate based herbicides consider higher concentrations 25--100% during this time period.

* Suitable for treatment any time after cutting and appearance of new growth.

Figure 5-1: Best time for the treatment of Cherry Laurel (ISI, 2012b)

5.6 Montbretia

Four options for the treatment of Montbretia at the site have been proposed. Any one or a combination of these options shall be used to eradicate Montbretia from the site and avoid the spread of the species. However, the following general recommendations will be adhered to as part of the plan:

- Montbretia is spread vegetatively and a buffer of 1m will be left to prevent damage to the plant, or its corms, which can result in the production of new stems which can make the plant more difficult to treat.
- Staff shall be made aware of this buffer zone when working within areas of infestation.
- Areas of infestation to be fenced off from other works areas including a buffering distance of up to 1m to create exclusion zones.
- Construction works will not be allowed within exclusion zones until the species has been fully eradicated but may continue outside of these areas.
- No treatment measures to take place in these areas without supervision and agreement by appointed eradication specialist.
- All machinery and vehicles operating within areas of infestation to be thoroughly checked and if necessary cleaned prior to leaving the area to protect against further spreading of Winter Heliotrope.
- No material shall be taken from areas of infestation; unless for disposal. All material will be either deep buried (2m) or transported by an appropriately licensed waste contractor and received by an appropriately licensed facility.
- All staff shall be made aware of nature of threat via toolbox talks as part of site inductions. Toolbox talks shall be undertaken with all personnel accessing the site to ensure that the details of the invasive species management plan are adhered to and to raise awareness of the potential treat of invasive species.
- Wheel washes shall be put in place at entry and exit points, if considered appropriate. Waste water from these facilities will need to be stored and treated to avoid further outbreaks.
- If operating within an area of known infestation all machinery, vehicles, equipment, foot ware and clothing will need to be cleaned thoroughly (if necessary using steam cleaners) in a contained area to avoid further contamination.

Option 1 – In-situ burial

If the growth of Montbretia is at an elevation which would allow material from outside the site of a sufficient depth (min 1m) to be deposited on top during the re-grading process without disturbance to the Montbretia (and adjacent cur cherry laurel stump), this, and subsequent capping would kill off the plant and prevent re-growth. This method would only work if no interaction with the Montbretia occurred, precluding the transport of viable material on plant equipment.

Option 2 – Digging

Digging can be used in order to extract corms and additional root system from the site. This should be completed before seeds are produced, pre July. If corms are damaged lost during excavation it is likely that new growth would form from these. Excavation machinery, tools and PPE must be cleaned before exit from the site. Subsequent excavated materials should be removed from the site, using appropriately licenced transport, to an appropriately licenced facility equipped to deal with such volumes (IWS, 2018).

Option 3 – Spray chemical treatment

Infestations of Montbretia can also be treated with herbicide whilst the plants are actively growing, this is estimated to be from April to July, after the plants have sprouted, full leaf stage. A glyphosate based herbicide can be sprayed upon Montbretia during this time. It is recommended for post-treated areas that an appropriate grass-forb seed mix is sown in order to prevent recolonization (IWS, 2018).

Option 4 – Sweep chemical treatment

A weak glyphosate mix should be used during the full leaf stage, when the leaves are green, in order to kill off above ground growth of the plants (IWS, 2018).

5.7 Snowberry

One option for the treatment of Snowberry at the site has been proposed. Any one or a combination of these options shall be used to eradicate Snowberry from the site and avoid the spread of the species. However, the following general recommendations will be adhered to as part of the plan:

- Snowberry is spread both by seed, a buffer area of 1m will be left to prevent further contact with plants, possibly causing seeds to fall or become attached upon machinery or person. Disturbed seeds may result in the propagation of a new snowberry population else ware.
- Staff shall be made aware of this buffer zone when working within areas of infestation.
- Areas of infestation to be fenced off from other works areas including a buffering distance of up to 1m to create exclusion zones.
- Construction works will not be allowed within exclusion zones until the species has been fully eradicated but may continue outside of these areas.
- No treatment measures to take place in these areas without supervision and agreement by appointed eradication specialist.
- All machinery and vehicles operating within areas of infestation to be thoroughly checked and if necessary cleaned prior to leaving the area to protect against further spreading of Winter Heliotrope.
- No material shall be taken from areas of infestation; unless for disposal. All material will be either deep buried (2m) or transported by an appropriately licensed waste contractor and received by an appropriately licensed facility.
- All staff shall be made aware of nature of threat via toolbox talks as part of site inductions. Toolbox talks shall be undertaken with all personnel accessing the site to ensure that the details of the invasive species management plan are adhered to and to raise awareness of the potential treat of invasive species.
- Wheel washes shall be put in place at entry and exit points, if considered appropriate. Waste water from these facilities will need to be stored and treated to avoid further outbreaks.
- If operating within an area of known infestation all machinery, vehicles, equipment, foot ware and clothing will need to be cleaned thoroughly (if necessary using steam cleaners) in a contained area to avoid further contamination.

Option 1- Excavation

Since the snowberry growth falls within the area of soil required to be excavated and disposed of around Japanese knotweed growth 5, the Snowberry will be required to be disposed of in the same manner and at the same time as this Japanese knotweed growth.

Excavation of the entire root system is thought to be a very effective method of Snowberry control. This must be done before the plants seeds ripen in autumn. Plant matter from this process can be disposed of using a licenced landfill site or may be buried to a depth of over 2m.

5.8 Butterfly Bush

Since the primary mode of spread for this species is via the transport of seeds in wind, the potential for spread due to human activities is considered relatively less important than for the other invasive species present; Butterfly Bush would continue to disperse and spread on its own in the absence of human intervention, while for the other species present, transport by humans is a more important mechanism of spread.

Control measures should focus on preventing the transport of seed outside the site during re-grading works, and minimising disturbance of ripe seed-heads if clearance works are required to be carried out while ripe seed is present.

Due to the widespread presence of butterfly bush throughout the site, exclusion zones surrounding plants are unlikely to be impractical. As such, measures to prevent the accidental transport of seed outside the site should be focused on washing down of machinery exiting the site, and checking of clothing and footwear of operatives.

Since it is likely that vegetation clearance will be required prior to works, measures should be taken to minimise the potential for disturbance of seed.

These measures should focus on the removal of flower spikes from all plants present within the site.

If treatment can be undertaken while plants are in flower, all flower-spikes should be removed and buried on-site.

If treatment must be undertaken after flowers have been fertilised, each flower spike should first have a bag placed over it before cutting to prevent seeds being dislodged and spread during the process. The bags containing seed-heads should then be retained onsite and buried during re-grading works.

Following removal of reproductive material, plants should be cut to the stump, and cut material either retained on-site and buried during re-grading works, or transported off site and monitored until the following growing season to ensure no re-growth occurs prior to disposal.

6 MANAGEMENT PLAN

The management of any invasive species is achieved by the assessment and mapping of the invasive species, containment once found, continual monitoring and record keeping as well as the safe disposal of invasive species material.

6.1 Containment

For the efficient use of resources namely, financial and physical effort, it is important to prevent the further spread of invasive species containment. Containment will be achieved via:

- Cordoning off the area of infestation to prevent further spread of seed by people or machinery;
- Mark the cordoned off area with an information/warning sign (see appendix 3);
- Tool box talks to be carried out for all maintenance workers working within the site;
- Landholder to be informed of location of the invasive species and the management plan;
- To help with monitoring of the infestation the area is to be outlined where practical with spray paint;
- Ensure anyone treating the infestation is a suitably qualified trained professional who follows the management plan.
- The site will be re-surveyed prior to treatment/ remedial works to confirm the findings of the original survey.
- Follow up surveys will be carried out post-construction to determine effectiveness of treatment and trigger further treatment if required.

6.2 Schedule

As remediation works are required to be initiated during the second half of 2018, any control/eradication measures based on long- term chemical treatment is not feasible.

As such, the proposed measures are focused on off-site burial using appropriate methodologies.
Periodic re-survey for Japanese knotweed would be advisable, to ensure that treatment measures were effective, and to trigger further treatment if necessary. There is no potential for any of the other species present to re-grow once buried under the landfill cap.

The potentially contaminated runoff and other materials generated during quarantine procedures will be required to be treated to prevent growth of any invasive species, and stored in a secure location and monitored for up to 18 months following final use.

Any plant material transported off site should be stored securely and monitored until the end of following growing season to ensure no viable material is disposed of in uncontrolled circumstances.

Please note that the schedule and treatment method may require amendment following any given site visit.

Table 6-1: Treatment and Monitoring Schedule

Year	Details of measures
1	• A pre-construction survey shall be undertaken during the growing season to mark out the extent of invasive species within the site prior to any works commencing on-site. • Invasive species material which is to be retained onsite will be buried in advance of other regrading works, and no further excavation or disturbance of these areas will take place. • Japanese Knotweed within the site including the 7m buffer from the footprint of the development will be excavated (following herbicide treatment) prior to the construction phase. • Cordoning off the area of infestation (exclusion zone) – this shall include a buffer of up to 7m surrounding the area of infection for Japanese Knotweed to ensure that underground rhizomes shall not be transported to other sections of the site. These root structures rhizomes can extend up to 7 m in a lateral direction (but usually only up to 5 m), and 2m deep from the over ground parent plant. No construction works, storage or access allowable within these exclusion zones until Japanese Knotweed has been fully eradicated. • Invasive species material which is to be retained onsite will be buried in advance of other regrading works, and no further excavation or disturbance of these areas will take place. • Winter Heliotrope, Cherry Laurel, Montbretia, Spanish Bluebell and Snowberry shall include a buffer of up to 1m surrounding the area of infestation. This will prevent plants with underground rhizomes being transported to other sections of the site and it will also prevent contact with plants which could result in the transport of seed, fruit or vegetation. • Treatment of invasive species using one or more of the treatment options(i) proposed in Section 5. • Only once treatment has been completed and invasive species have been eradicated from within the area of works/buried securely will re-grading works commence. • Toolbox talk shall be given to all personnel accessing the site. • Site to be monitored continually for signs of regrowth of all invasive species during re-grading and capping works; Japanese Knotweed is of primary concern. • Disposal of ALL cut and excavated plant matter, if chosen to be processed off-site, should be done so through a licenced waste processor. Adequate licences may also need to be obtained for the transportation of such matter.
2 - 5	• Following capping, site to be monitored annually for signs of regrowth of invasive Japanese Knotweed. • Monitoring of plant material transported off site for signs of growth during following growing season. Monitoring of material collected during equipment washing for signs of growth during following growing season.

6.3 Mapping, Evaluating and Record Keeping

During each treatment the following will take place before control treatments:

1. Check that the area of infestation is still cordoned off and a warning/information sign is still in place;
2. Photographs of the area(s) of invasive species infestation;
3. Map the extent via recording gps coordinates and measure the length and width of infestation and plot on map;
4. Evaluate the status/condition of the infestation;
5. If the infestation has spread spray paint the extent of the new area (for comparison on next visit);
6. Make sure step 1-5 are recorded;

At the end of each site visit the recorded data should be compared with the findings of this report and where required the management plan should be updated. Tipperary Co. Council will receive a short report on the progress of treatment following treatment works, and any subsequent monitoring.

6.4 Appropriate disposal

6.4.1 Storage

As outlined in section 5 above, all cut and excavated plant matter should be stored securely in line with the relevant treatment methodology.

6.4.2 Disposal

6.4.2.1 Deep burial

Burial of plant matter and possible contaminated soil should be completed as per the species-specific conditions discussed in section 5. It is recommended that Japanese knotweed be buried to depths of 5m or greater beneath the surface. Contaminated soil from the excavation of the invasive species present on site, (see section 5) depending on the species, and where required by treatment methodology, may be buried alongside such Japanese knotweed plant matter.

Disposal of plant matter and soil off-site if required, should be completed through an appropriately licenced haulier and waste facility.

6.4.2.2 Incineration

If no deep burial sites are available, transport to a licensed facility capable of incinerating soil containing Japanese knotweed rhizomes is an alternative treatment option.

7 CONCLUSION

There is a legal obligation not to spread plants listed on the third schedule of Regulations 49 and 50 of the European Communities (Birds and Natural Habitats) Regulations 2011; the relevant species at Tipperary Town landfill, and therefore those of principal concern, are Japanese Knotweed (*Fallopia japonica*) and Spanish Bluebell (*Hyacinthoides hispanica*). Environmental best practice, and the need to prevent the spread of the other invasive species present on-site to Natura 2000 sites, dictates the need to take measures to prevent the spread of these species.

Various treatment measures are advocated for the invasive species present on-site, with several options available in most cases.

It is recommended that a competent and experienced invasive species management Contractor is appointed to eradicate invasive species from the site.

A dedicated invasive species survey is recommended to be undertake by the appointed Contractor to confirm the findings of the previous survey.

All invasive species present on-site will be required to be cordoned off prior to any treatment works, with exclusion zones in place as specified in section 5.

A quarantine zone where equipment washing and inspection of clothing and footwear can be carried out should be established at the site entrance prior to treatment works, and remain in operation until all vegetation has been removed or buried.

The growths of Japanese knotweed present must be treated, excavated and disposed of or buried according to relevant legislation and under licence before any works can take place in infested areas.

For the remainder of species, in-situ burial (or burial of cut material in the case of shrubs/trees) incorporated into re-grading works is advocated as the most efficient and cost-effective means of treatment; this would only be feasible where the plants are at an elevation which would allow sufficient soil to be deposited on top. Where this is not feasible, other options for treatment should be followed. Following burial, areas should remain cordoned off, with appropriate methodologies in place to ensure no disturbance occurs during subsequent works.

Treatment works should be supervised by an appropriately qualified ecologist or invasive species specialist.

Yearly monitoring for re-growth of Japanese knotweed is recommended for up to 5 years following capping. A specialist would not be required for this activity; however, any survey should ensure comprehensive coverage of the capped landfill.

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Appendix 1

Co-ordinates recorded for invasive plant species

Japanese Knotweed

Growth	Lat	Lon	Notes
1	52.48202	-8.15570704	N/A
	52.48203	-8.155556	N/A
	52.48209	-8.15562598	N/A
	52.4821	-8.155658	N/A
	52.48209	-8.15573302	N/A
	52.48208	-8.15574098	N/A
	52.48215	-8.15569899	N/A
	52.48214	-8.15572204	N/A
	52.4821	-8.15566102	N/A
	52.48209	-8.15553898	N/A
	52.48215	-8.155542	N/A
	52.48218	-8.15557603	N/A
	52.48217	-8.15563302	N/A
2	52.48264	-8.15614499	Sparse
	52.48266	-8.15619201	Sparse
	52.48263	-8.15627701	Sparse
	52.4826	-8.15631003	Sparse
	52.4826	-8.15625597	Sparse
	52.48263	-8.156218	Sparse
	52.48264	-8.15619302	Sparse
3	52.48249	-8.15656199	New shoots on spoil heaps
	52.4825	-8.15654003	New shoots on spoil heaps
	52.48252	-8.15647901	New shoots on spoil heaps
4	52.48346	-8.15627499	Patchy, many small shoots spread out
	52.4834	-8.15623702	Patchy, many small shoots spread out
	52.48341	-8.15622303	Patchy, many small shoots spread out
	52.48342	-8.15619797	Patchy, many small shoots spread out
	52.48345	-8.15619302	Patchy, many small shoots spread out
	52.48344	-8.15622697	Patchy, many small shoots spread out
	52.48347	-8.15621104	Patchy, many small shoots spread

Growth	Lat	Lon	Notes
			out
	52.48349	-8.15625303	Patchy, many small shoots spread out
	52.48349	-8.15627499	Patchy, many small shoots spread out
	52.48357	-8.15635999	Patchy, many small shoots spread out
	52.48357	-8.15635001	Patchy, many small shoots spread out
	52.48357	-8.15641698	Patchy, many small shoots spread out
	52.48356	-8.15639603	Patchy, many small shoots spread out
	52.48339	-8.15652402	N/A
	52.48339	-8.15654296	N/A
	52.48338	-8.15654003	N/A
	52.48337	-8.15655897	N/A
	52.48336	-8.15652704	N/A
	52.48337	-8.15648597	N/A
	52.48339	-8.15646702	N/A
5	52.48343	-8.15745701	0.5m down bank, c. 1m wide
	52.48341	-8.15750596	0.5m down bank, c. 1m wide
6	52.48328	-8.15739197	Sparse new stems
	52.48327	-8.15739498	Sparse new stems
	52.48323	-8.15738099	Sparse new stems
	52.48322	-8.15740697	Sparse new stems
	52.48323	-8.15744402	Sparse new stems
	52.48324	-8.15741904	Sparse new stems
	52.48328	-8.15739901	Sparse new stems
	52.4833	-8.15738702	Sparse new stems
	52.48329	-8.15736397	Sparse new stems
7	52.48317	-8.157384	Lone Stem
8	52.48277	-8.15720203	N/A
	52.48277	-8.15716297	N/A
	52.48279	-8.15719298	N/A
	52.4828	-8.15720798	N/A

Growth	Lat	Lon	Notes
9	52.48272	-8.15705996	Sparse
	52.48273	-8.15708804	Sparse
	52.48273	-8.15706499	Sparse
	52.48271	-8.15703699	Sparse
	52.4827	-8.15701998	Sparse
	52.48272	-8.15701101	Sparse
	52.48273	-8.15701202	Sparse
	52.48274	-8.15702702	Sparse
9	52.48273	-8.15701302	N/A
	52.48274	-8.15699098	N/A
	52.48275	-8.15698	N/A
	52.48276	-8.15700204	N/A
10	52.48237	-8.15756698	N/A
	52.48234	-8.15754703	N/A
11	52.48193	-8.15668998	N/A
	52.4819	-8.15667397	N/A
	52.48188	-8.15666702	N/A
	52.48189	-8.15662502	N/A
	52.48189	-8.156606	N/A
	52.48189	-8.15655302	N/A
	52.4819	-8.15653601	N/A
	52.48193	-8.156578	N/A
	52.48194	-8.15662201	N/A
	52.48194	-8.15665604	N/A
	52.48193	-8.15671404	N/A
	52.48191	-8.15670499	N/A
12	52.4818	-8.15656601	c. 5m down bank
	52.48176	-8.15657197	c. 5m down bank
	52.48175	-8.15657498	c. 5m down bank
13	52.48206	-8.15664397	1 stem
14	52.48176	-8.15666903	N/A

Growth	Lat	Lon	Notes
	52.48179	-8.15665897	N/A
	52.48179	-8.15662603	N/A
15	52.48183	-8.15663399	1.5m strip, also P. frag under, extends to 792-799
	52.48181	-8.15670499	1.5m strip, also P. frag under, extends to 792-799

Winter Heliotrope

Growth	Lat	Lon	Notes
1	52.48317104	-8.157214019	N/A
	52.48315503	-8.157236986	N/A
	52.48312301	-8.157241009	N/A
	52.483121	-8.157240003	N/A
	52.483136	-8.157248972	N/A
	52.48314698	-8.157264981	N/A
	52.48316802	-8.157281997	N/A
2	52.48304104	-8.156866003	Mixed with b. bur
	52.48303399	-8.156830966	Mixed with b. bur
	52.48300801	-8.156815041	Mixed with b. bur
	52.48298404	-8.156815963	Mixed with b. bur
	52.482977	-8.156855023	Mixed with b. bur
	52.48299804	-8.156854017	Mixed with b. bur
	52.483006	-8.15686902	Mixed with b. bur
3	52.48306802	-8.15707203	N/A
	52.48307297	-8.157013021	N/A
	52.48308898	-8.157005981	N/A

Growth	Lat	Lon	Notes
	52.48311404	-8.157030037	N/A
	52.48310801	-8.157068007	N/A
	52.48309803	-8.157090973	N/A
	52.48308697	-8.157122992	N/A
	52.48307498	-8.157117041	N/A
4	52.48189297	-8.156729965	Not all ground carpeted, but outer extent overlaps Knotweed
	52.48186497	-8.156736	Not all carpeted, but outer extent overlaps Knotweed
	52.48186799	-8.156696018	Not all carpeted, but outer extent overlaps Knotweed
	52.48187603	-8.156670034	Not all carpeted, but outer extent overlaps Knotweed
	52.48185902	-8.156586969	Not all carpeted, but outer extent overlaps Knotweed
	52.48193203	-8.156639021	Not all carpeted, but outer extent overlaps Knotweed
	52.48195399	-8.15671999	Not all carpeted, but outer extent overlaps Knotweed
	52.48195298	-8.15674304	Not all carpeted, but outer extent overlaps Knotweed
5	52.48166699	-8.156470964	up to knotweed
	52.48161703	-8.156470042	up to knotweed
	52.48154998	-8.156460989	up to knotweed
	52.48154998	-8.156470042	up to knotweed
	52.48155501	-8.156521004	up to knotweed
	52.48157303	-8.156575989	up to knotweed
	52.48162902	-8.156590993	up to knotweed
	52.48168199	-8.15660499	up to knotweed
6	52.481813	-8.156704986	N/A
	52.48181099	-8.156686965	N/A
	52.48181099	-8.156724013	N/A
	52.48183203	-8.156765001	N/A
	52.481856	-8.156788973	N/A
	52.48186396	-8.156751003	N/A
	52.48185701	-8.156732982	N/A
	52.481855	-8.156724013	N/A

Cherry Laurel

Lat	Lon	Notes
52.48278	-8.15656	Small Plant

Montbretia

Lat	Lon	Notes
52.48278	-8.15656	Limited growth (<2x2m) beside cherry laurel

Spanish Bluebell

Growth	Lat	Lon
1	52.48265698	-8.155717012
2	52.48307901	-8.156057987
3	52.48316199	-8.156013982
4	52.48316702	-8.155989004
5	52.48320004	-8.156033009
6	52.48319099	-8.15605497
7	52.48358502	-8.156480016
8	52.48357999	-8.156504994
9	52.48354898	-8.156502983
10	52.483552	-8.15654397
11	52.48307398	-8.157393979
12	52.48191702	-8.157004975

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APPENDIX 6

Water Quality Monitoring
2010 - 2015

Sample Date	21/09/15				01/10/14		
Sample Location	MW1	MW2	SW1	SW2	MW2	MW3	SW1
Cond. (µs/cm)	3000	2930	759	806	3240	4680	801
BOD (mg/L)	<6	36	5.6	3.1	8.4	22	6.5
COD (mg/L)	116	145	41	44	128	181	51
Ammonical Nitrogen (mg/L)	160	77	1.4	1.7	81	250	0.69
Chloride (mg/L)	157	534	69	84	626	349	56
Iron (µg/L)							
Manganese (µg/L)							
Ortho-Phosphate PO4 (mg/L)	<0.010	0.41	0.14	0.15	0.5	0.014	0.26
pH	6.9	9	6.5	7	8.9	7.1	7.7
Suspended Solids (mg/L)			<20	<8			49
Total Suspended Solids (mg/L)							
Dissolved Oxygen % Saturation							
Cyanide (mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05
Temperature (°C)	12.8	12	11.7	12.5	12.3	12.6	12.9
DO (% saturation)	nm	nm	33	23	nm	nm	58
Nitrite (mg/ L N)					<0.004	<0.004	0.005
Total Oxidised Nitrogen (mg/L N)	<0.20	<0.20	0.2	<0.20	<0.20	<0.20	<0.20
Alkalinity-Total (mg/L CaCO3)	1360	553	273	286			325
Total Organic Carbon (mg/L C)							
1,1,1,2-Tetrachloroethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,1-Trichloroethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2,2-Tetrachloroethane (µg/L)	<1	<1	<1	<1	<1	<1	<1
1,1,2-Trichloroethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-Dichloropropene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Sample Date	21/09/15				01/10/14		
1,2,3-Trichlorobenzene (µg/L)	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
1,2,3-Trichloropropane (µg/L)	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
1,2,4-Trichlorobenzene (µg/L)	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
1,2,4-Trimethylbenzene (µg/L)	4.3	2.2	<0.5	<0.5	4	3.5	<0.5
1,2-Dibromo-3-Chloropropane (µg/L)	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
1,2-Dibromoethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dichlorobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dichloroethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dichloropropane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3,5-Trimethylbenzene (µg/L)	<0.5	0.8	<0.5	<0.5	1	<0.5	<0.5
1,3-Dichlorobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3-Dichloropropane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,4-Dichlorobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,2-Dichloropropane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Chlorotoluene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chlorotoluene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Isopropyltoluene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzene (µg/L)	1.3	2.8	<0.5	<0.5	1.5	<0.5	<0.5
Bromobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromochloromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromodichloromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromoform (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Sample Date	21/09/15				01/10/14		
Bromomethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
c-1,2-Dichloroethene (µg/L)	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
c-1,3-Dichloropropene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Carbon Tetrachloride (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorobenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chloroform (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibromochloromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibromomethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dichlorodifluoromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dichloromethane (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene (µg/L)	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobutadiene (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Isopropylbenzene (µg/L)	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
m,p-Xylene (µg/L)	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene (µg/L)	0.6	0.5	<0.5	<0.5	0.5	<0.5	<0.5
n-Butylbenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
n-Propylbenzene (µg/L)	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
o-Xylene (µg/L)	1.1	<0.5	<0.5	<0.5	<0.5	0.8	<0.5
sec-Butylbenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Styrene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
t-1,2-Dichloroethene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
t-1,3-Dichloropropene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
tert-Butylbenzene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Tetrachloroethene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene (µg/L)	1.3	2.4	<0.5	0.8	1.8	<0.5	<0.5
Trichloroethene (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Sample Date	21/09/15				01/10/14		
Trichlorofluoromethane (µg/L)	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Vinyl Chloride (µg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoride (mg/L)	<1	<1	<0.20	0.2			
Sulphate (mg/L)	17	87	12	4			
Aluminium (µg/L)	42	140	16	<10			
Arsenic (µg/L)	<1.0	3.8	<1.0	<1			
Barium (µg/L)	110	110	91	95			
Beryllium (µg/L)	<1.0	<1.0	<1.0	<1			
Boron (µg/L)	420	1700	92	97			
Cadmium (µg/L)	<0.020	0.1	<0.020	<0.02			
Calcium (mg/L)	200	31	110	110			
Cobalt (µg/L)	4.1	1.6	<1.0	<1.0			
Iron (µg/L)	4300	440	660	700			
Lead (µg/L)	<0.1	3.2	<1.0	<1.0			
Magnesium (mg/L)	50	22	9.2	10			
Manganese (µg/L)	780	170	330	330			
Nickel (µg/L)	<1.0	5.6	<1.0	<1.0			
Potassium (mg/L)	98	130	8.2	9.9			
Selenium (µg/L)	1.5	1.5	1.2	<1.0			
Sodium (mg/L)	61	380	40	52			
Strontium (µg/L)	870	510	190	200			
Thallium (µg/L)	<1.0	<1.0	<1.0	<1.0			
Uranium (µg/L)	<1.0	<1.0	<1.0	<1.0			
Vanadium (µg/L)	<1.0	<1.0	<1.0	<1.0			
Mercury (µg/L)	<0.50	0.6	<0.50	<0.5			
Antimony (µg/L)	<1.0	<1.0	<1.0	<1.0			
Chromium (µg/L)	1.1	1.1	<1.0	<1.0			
Copper (µg/L)	1	5.1	<1.0	<1.0			
Molybdenum (µg/L)	<1.0	23	<0.1	<1.0			
Zinc (µg/L)	10	17	9	8.8			

Sample Date	14/05/14		22/01/14		12/12/13		
Sample Location	SW1	SW2	SW1	SW2	SW1	SW2	SW3
Cond. (µs/cm)			482	636	782	782	781
BOD (mg/L)		1.13	0.21	0.79	1.04	0.84	5.03
COD (mg/L)	28	25	25	18			
Ammonical Nitrogen (mg/L)			0.18	0.86	3.7	3.65	0
Chloride (mg/L)			94	65	45	48	21
Iron (µg/L)			720	320	3700	2950	1165
Manganese (µg/L)			214	112	770	655	385
Ortho-Phosphate PO4 (mg/L)					0.655	0.655	0.371
pH	7.752	7.772	7.85	7.85			
Suspended Solids (mg/L)					22	18	100
Total Suspended Solids (mg/L)		2	20	2			

Sample Date	26/09/13			08/05/13			24/01/13		
Sample Location	SW1	SW2	SW3	SW1	SW2	SW3	SW1	SW2	SW3
Cond. (µs/cm)		747	510	324	461	312	648	639	657
BOD (mg/L)		7.49	1.29	1.5	0.1	1.9	0.82	0.74	0.78
COD (mg/L)		66	34	18	24	21	21.9	21.2	18.8
Ammonical Nitrogen (mg/L)		0.37	0.2	0.32	0.5	0	1.4394	1.6485	0.0635
Chloride (mg/L)		74.9	17.65	31	50	14.3	18.13	19.56	28.63
Iron (µg/L)		640	1030	400	410	900	220	130	340
Manganese (µg/L)		785	348	225	294	155	149	134	261
Ortho-Phosphate PO4 (mg/L)									
pH	7.3	7.52	7.82	7.384	7.498	7.657	7.388	7.273	7.995
Suspended Solids (mg/L)									
Total Suspended Solids (mg/L)		16	13	7	6	29	0	0	6
Dissolved Oxygen % Saturation		1.8	4.7						

Sample Date	11/12/12			19/09/12			04/04/12		
Sample Location	SW1	SW2	SW3	SW1	SW2	SW3	SW1	SW2	SW3
Cond. (µs/cm)	688	676	684	642	745	749	803	888	954
BOD (mg/L)	0.26	0.06	0.42	0	0	0	3	1.04	6.07
COD (mg/L)	24.7	17.1	22.3	42	36	39			
Ammonical Nitrogen (mg/L)	0.089	1.83	1.36	1.4056	2.73	2.94	3.23	4.52	
Chloride (mg/L)	43.9	33.88	30.5	11.93	40.56	25.29			
Iron (µg/L)	1020	80	720	4750	410	1250	570	40	16300
Manganese (µg/L)	312	144	176	289	313	398	12	22	1510
Ortho-Phosphate PO4 (mg/L)							0.15	0.15	0.21
pH	7.902	7.206	7.175	7.68	7.253	7.331			
Suspended Solids (mg/L)							12	6	216
Total Suspended Solids (mg/L)	29	2	17						
Dissolved Oxygen % Saturation									

Sample Date	18/01/12			09/12/11			17/08/10		
Sample Location	**SW1**	**SW2**	**SW3**	**SW1**	**SW2**	**SW3**	**MW2**	**MW3**	**SW1**
Cond. (µs/cm)	728	721	472	606	581	498			
BOD (mg/L)	4.87	6.42	31.2	2.85	1.23	44.1			
COD (mg/L)	6.5	14.5	191	27.6	27.3	310.2			
Ammonical Nitrogen (mg/L)	1.2127	1.25	0.76	1.16	1.53	0.82			
Chloride (mg/L)	24	28	5				966	1269.6	57.5
Iron (µg/L)	260	240	9150	270	250	780			
Manganese (µg/L)	154	149	257	147	144	499			
Ortho-Phosphate PO4 (mg/L)				0.04	0.02	0.03			
pH	7.51	7.48	6.83						
Suspended Solids (mg/L)				5	8	260			
Total Suspended Solids (mg/L)	2	1	50						
Dissolved Oxygen % Saturation									

TIPPERARY TOWN HISTORC LANDFILL INVASIVE SPECIES TREATMENT MONITORING REPORT - INSPECTION # 1 (OCTOBER 2018)

NOVEMBER 2018

Comhairle Contae Thiobraid Árann
Tipperary County Council

FEHILY TIMONEY & COMPANY

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1 INTRODUCTION

Fehily Timoney and Co. were commissioned by Tipperary County Council to provide consultancy services in respect of the proposed Tipperary Town historical landfill remediation; following on from initial surveys an Appropriate Assessment screening report and outline Invasive Species Management Plan (oISMP) were produced for the site and proposed remediation works. Following the adoption of a treatment strategy proposed in the oISMP and appointment of an invasive species management contractor (Invasive Plant Solutions), Fehily Timoney and Co. were commissioned to carry out monitoring of the invasive species treatment programme.

The invasive species recorded at the site were:

- Japanese Knotweed (*Fallopia japonica*)
- Spanish bluebell (*Hyacinthoides hispanica*)
- Winter heliotrope (*Petasites fragrans*)
- Cherry laurel (*Prunus lauroceracus*)
- Montbretia (*Crocusmia x crocusmiflora*)
- Snowberry (*Symphoricarpos albus*)
- Butterfly-bush (*Buddleija davidii*)

Two of these species (Japanese Knotweed and Spanish bluebell) are listed in schedule III under Regulations 49 & 50 in the European Communities (Birds and Natural Habitats) Regulations 2011, which makes it an offence to cause their spread.

The strategy for treatment of invasive species selected was in-situ herbicide treatment, projected to take place over a period of two years with the option to continue the treatment for a further two years if required. The actual treatment period will be defined depending on the effectiveness of treatment measures and vigour and extent of Japanese Knotweed growths at the landfill site.

The treatment of the invasive species other than Japanese Knotweed at the site over two years should be sufficient to ensure regeneration from the seed bank does not occur.

The monitoring schedule entails inspection of the invasive plant species at the site twice per year; once prior to treatment, and once after. For year one (2018), a pre-treatment survey of all invasive species other than Japanese knotweed (Japanese knotweed had already been treated prior to this visit) and site walkover to mark Spanish bluebell locations was undertaken on the 9th of October 2018. The post-treatment visit was undertaken on the 13th of October 2018, during which treated Japanese knotweed growths were examined in detail.

The first comprehensive pre-treatment inspection will take place in spring 2019; at this stage, the extent of each growth will be mapped to allow comparison to its previous size following initial treatment and to determine the effectiveness of treatment undertaken in 2019. These inspections will be repeated until the invasive species selected for treatment have been eradicated from the site.

Treatment of Japanese Knotweed only was undertaken in 2018 and the treatment of the remainder of species will commence in 2019. Therefore, this first monitoring report deals primarily with Japanese Knotweed treatment.

1.1 Methodology

1.1.1 Pre-treatment Visit

A site walkover was undertaken with an IPS operative to mark the locations of Spanish bluebell within the landfill site; a GPS enabled tablet loaded with the invasive species map for the site was used to locate each area, which were then marked for treatment during spring 2019.

Areas of invasive species other than Japanese knotweed and Spanish bluebell (winter heliotrope, montbretia, cherry laurel and snowberry) were also visited to confirm their location for IPS. The GPS enabled tablet was used to locate these areas, which had visible above-ground plant material at this point. Any other relevant observations such as previously un-recorded areas of invasive species were also recorded.

1.1.2 Post-treatment Visit

All growths of Japanese Knotweed identified during initial surveys were inspected and examined for signs of herbicide treatment. Dead brown canes (stems) are indicative of herbicide treatment, this condition could also arise from natural die-off. Since stem injection was used to deliver herbicide to individual stems, needle marks and surrounding dark green discolouration/dye was visible on most of canes examined. In some instances, needle marks were visible, but not accompanied by the dark green colour. These signs, in conjunction with stem condition, were used to determine if stands had been treated. The condition of stems was recorded to assess the effectiveness of treatment.

Areas of other invasive species which were extant (winter heliotrope, montbretia, cherry laurel and snowberry) were also inspected to determine whether herbicide treatment was carried out.

Spanish bluebell locations were not inspected since there are no visible signs of this species during Autumn, and IPS had indicated that no treatment would be undertaken until spring 2018.

Any other relevant observations such as previously un-recorded areas of invasive species were also recorded.

1.2 Survey Details

Table 1: Survey details and weather conditions

Date	Weather	Surveyor
09/10/2018	precipitation: dry; visibility: very good	BOD
13/11/2018	precipitation: dry; visibility: very good	BOD

2 RESULTS – PRE-TREATMENT SURVEY

Snowberry, montbretia, and cherry laurel were visible during the pre-treatment visit, and the invasive species contractor was made familiar with their location, extent and condition.

Three previously un-mapped growths of winter heliotrope were observed during the pre-treatment visit.

3 RESULTS – POST-TREATMENT SURVEY

For monitoring purposes, Japanese Knotweed and winter heliotrope growths were numbered as shown in Figure 1 below.

Previously un-detected areas of Japanese Knotweed and winter heliotrope (two and three respectively) were also recorded; these are dealt with under the relevant heading below.

One previously un-recorded non-native invasive plant species – Himalayan honeysuckle *Leycesteria formosa* was also recorded, as detailed below in 2.3.

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
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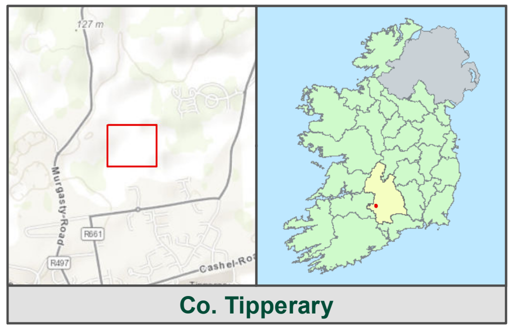
Map Path: R:\Map Production\2017\P0563\Workspace\P0563_Fig1_InvasiveSpecies_A3.mxd



Co. Tipperary

Legend

▭ Landfill Boundary

Invasive Species

- ● Cherry Laurel
- ● Himalayan Honeysuckle
- ● Montbretia
- ● Snowberry
- ● Spanish Bluebell

Japanese Knotweed

- ▨ Previously Mapped
- ▨ Newly Mapped

Winter Heliotrope

- ▨ Previously Mapped
- ▨ Newly Mapped

Figure Title

Invasive Species

Figure No. 1

Project

Tipperary Town Historical Landfill Remediation

Client

Tipperary County Council

Scale 1:1,000 **Page Size** A3

Revision A **Date** 22/11/2018

Consultants in Engineering and Environmental Sciences

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3.1 Japanese Knotweed

Each area is described below in terms of scale and treatment status and any other relevant information is also included.

Updated mapping including numbering of Japanese Knotweed growths is provided in Figure 1.

3.1.1 Area 1

Japanese Knotweed area 1 consists of two large dense stands at the south-eastern corner of the landfill. This area is bisected by a horse trail leading from an adjoining field up onto the landfill mound.

All canes were dead, brown and dry when inspected; needle marks and stem staining were observed on most stems examined.

As such, treatment is confirmed and appears to have been completely effective.

Plate 1: Japanese Knotweed Area 1

3.1.2 Area 2

Japanese Knotweed area 2 consists of several small stems growing from a mound of vegetated spoil within the landfill site.

All canes were dead, brown and dry when inspected, and needle marks and stem staining were observed, confirming treatment was carried out, and was completely effective.

Plate 2: Japanese Knotweed Area 2

3.1.3 Area 3

Area 3 is a small to medium sized stand growing from vegetated spoil within the landfill site. It is not particularly dense or well-established, although some larger canes are present.

Most canes were dead, brown and dry when inspected, with needle marks and stem staining confirming treatment was carried out. Several of the larger central canes were still showed signs of life, despite having been injected. As such, while treatment was confirmed to have been carried out, it does not appear to have been as effective as other areas. This may be due to a more resilient central growth. This also illustrates the resilience of Japanese Knotweed and the need for repeated treatment.

Also, of note in this area was disturbance to the growth. Several stems and an underlying clump of rhizome had been dislodged from the upper section of the bank where the growth is located and rolled down the hill but remained within the growth. As such, while disturbed, the Knotweed did not spread. This appears to have been caused by horses, which roam freely through the site, grazing in parts of the landfill.

Plate 3: Japanese Knotweed Area 3

Plate 4: treated stem showing discolouration/dye and resistance to herbicide (centre) and dislodged rhizomes/stems (bottom centre and left) at Japanese Knotweed Area 3

3.1.4 Area 4

Area 4 is a small to medium sized stand growing from vegetated spoil within the landfill site. The area is dense and well-established with larger canes common in central areas.

Most canes were dead, brown and dry when inspected, with needle marks and stem staining confirming treatment was carried out. Several of the larger central canes still showed signs of life at their bases. Similarly, to area 3, this demonstrates resistance to herbicide treatment. However, treatment was more effective in this area compared to area 3.

Plate 5: Japanese Knotweed Area 4

Plate 6: Needle marks and associated discolouration at Japanese Knotweed Area 4

3.1.5 Area 5

This is a medium-sized crescent shaped growth, which is more sparse than larger, dense, established growths at the site.

All canes were dead, brown and dry when inspected, and needle marks and stem staining were observed, confirming treatment was carried out, and was completely effective.

A dislodged group of older dead stems (natural die-off from the previous year) and attached rhizome were present in the middle of the growth. This may have come loose from the unstable substrate after dying off or been dislodged by horses; the cause is not clear. In any case, no re-growth occurred from the rhizome.

Plate 7: Japanese Knotweed Area 5

3.1.6 Area 6

Area 6 is a small sparse growth of Japanese Knotweed. All canes were dead, brown and dry when inspected, and needle marks and stem staining were observed, confirming treatment was carried out, and was completely effective.

Plate 8: Japanese Knotweed Area 6

3.1.7 Area 7

Area 7 is a small and relatively sparse growth at the base of the landfill mound, fringing the surrounding swamp. The growth is established, but not dense.

All canes were dead, brown and dry when inspected, and needle marks and stem staining were observed, confirming treatment was carried out, and was completely effective.

Plate 9: Japanese Knotweed Area 7

3.1.8 Area 8

This area consists of a sparse but established small main growth and an associated linear growth of small (20-30 cm height) of recently spread stems.

Most of the larger canes were dead, brown and dry when inspected, and needle marks and stem staining were observed. All the smaller canes were also dead, brown and dry, with some retaining dead leaves. No needle marks were observed on smaller stems, indicating herbicide was applied by spraying.

Three large canes showed signs of resistance with the lower parts of stems retaining some green colouring.

As such, treatment was carried out and was largely effective; however, some older and more vigorous growth was resistant to treatment.

Plate 10: large stems showing needle marks and herbicide resistance (Japanese Knotweed Area 8)

Plate 11: Small stems showing symptoms of herbicide treatment at Japanese Knotweed Area 8

3.1.9 Area 9

Area 9 is a medium sized growth of Japanese Knotweed at the base of the landfill mound, situated along the western edge of the landfill, at the base of a steep bank, bordering the surrounding swamp. It is partly overgrown with brambles which extend into the crown of the growth. The brambles and some willow shrubs partly obscure the growth.

These conditions resulted in this growth not being detected during the initial survey on the 3rd of May 2018.

As such, it was not injected during the initial round of herbicide treatment.

The canes of this growth had died off at the time of survey, however they showed no signs of herbicide treatment, and appeared to have died off naturally. The growth also showed signs of having been affected by damp.

Plate 12: Newly discovered Japanese Knotweed growth (Area 9) (upper centre)

3.1.10 Area 10

This is a small, sparse growth near the centre of the landfill mound. All canes were dead, brown and dry when inspected, and needle marks and stem staining were observed, confirming treatment was carried out and was effective.

Plate 13: Japanese Knotweed Area 10

3.1.11 Area 11

Area 11 is a large, dense and well-established growth near the centre of the landfill mound. Part of the growth is difficult to access due to the presence of a pile of severed tree branches, which the Knotweed has grown through and around.

Most of canes are brown and have needle marks indicating that treatment was carried out and was largely effective. Several canes at the eastern side were not brown, again demonstrating the challenge posed by treating a large, well-established and vigorous growth.

Plate 14: Japanese Knotweed Area 11

3.1.12 Area 12

Area 12 consists of a small, sparse growth of limited extent. Only one cane reaches waist height, while the remainder are at the level of the ground vegetation layer.

Brown dead canes lacking injection marks were observed here; following consultation with IPS (Invasive Plant Solutions), it was determined that this area has not been treated to date since it could not be relocated by treatment operatives but will be included in the next treatment round.

Plate 15: Waist-height cane at Japanese Knotweed Area 12

3.1.13 Area 13

Area 13 is a medium-sized, well established, but not extremely dense linear growth along the side of an embankment to the east of the corrugated shed. It is partially overgrown by brambles at its northern end, and access is difficult due to the steepness of the bank and thick growths of bramble at ground level.

This growth was not detected during the initial survey but was assumed to be area 12 by IPS operatives and stem-injected during the first round of treatment. Most of the canes were injected and had died off, However, several stems in a difficult to access area appeared not to have been treated.

3.1.14 Area 14

This growth consisted of several small stems when observed during the initial survey on 3rd May 2018. The area has since been disturbed by the movement of adjacent soil in the intervening period however, and currently only one stem is visible.

It was not possible to confirm through observation whether or not this had been treated, due to the stem being partially obscured by soil, and the fact that natural die-off may have occurred; IPS have indicated that this growth was treated however.

Plate 16: Japanese Knotweed Area 14, May 2018

Plate 17: Japanese Knotweed Area 14, November 2018 – note spoil has been dug out from behind the growth

3.1.15 Area 15

Area 15 is a large, extremely dense, and well-established growth which starts at the southern edge of the landfill site and extends southwards along a bank, and into an adjacent field.

Most of the canes were brown and had needle marks indicating that treatment was carried out and was largely effective. A small number of canes showed signs of resistance, remaining green; however, this is normal for large vigorous growths and the high percentage treated successfully indicates that the treatment carried out was as effective as possible.

Plate 18: Japanese Knotweed Area 15

3.2 Winter Heliotrope

Three previously undetected growths of winter heliotrope *Petasites fragrans* were recorded during the post-treatment survey carried out on 13th November 2018.

These consisted of two growths which carpet the landfill surface, one c. 20m^2 and one c. 10m^2, and a smaller growth less than 1m^2 in extent.

Updated mapping including numbering of winter heliotrope growths is provided in Figure 1.

IPS indicated that winter heliotrope at the landfill was treated on 22nd November 2018, and that follow up inspections and treatments will take place in December 2018 and January 2019. Since this treatment was undertaken after FT's post-treatment inspection, it's effectiveness will be assessed during the pre-treatment inspection in 2019.

3.3 Himalayan Honeysuckle

The non-native invasive plant species Himalayan honeysuckle *Leycesteria Formosa* was recorded during the post-treatment survey carried out on 13th November 2018. This had not been recorded during the previous survey. The record consists of one multiple-stemmed bush (see Figure 1 and plate 20 below).

This species has not been assessed as posing a *risk* of becoming a medium impact invasive; it's limited extent within the site and susceptibility to herbicide treatment means it can be easily incorporated into the treatment schedule.

Plate 19: Himalayan Honeysuckle within the landfill site

3.4 Other Invasive Plant Species

The other invasive plant species on site will be treated during 2019 at the appropriate times of year, when the plants present above ground and are receptive to herbicide and/or physical treatment.

Of particular importance is Spanish bluebell *Hyacinthoides hispanica*; the optimum treatment period for this species is when the plant is visible above ground and before seed has been produced during spring and early summer; ideally, treatment should be undertaken as early as possible before flowers are produced.

4 DISCUSSION & RECOMMENDATIONS

In all Japanese Knotweed areas where treatment was undertaken, the treatment was observed to have been effective, with die-back occurring in most instances. A small number of recalcitrant stems demonstrates the vigorousness of this species, and the need for repeated treatments. ISP have indicated that the first stem injection could be expected to successfully treat 75% of emergent stems for large dense stands, and 90-100% of smaller stands. This is broadly in line with observations of treated growths, with the success rate for large established growths actually appearing to be higher (80-90%).

Since the ultimate target of stem injection is the underground rhizome, with the stem providing a pathway for the herbicide, success cannot be gauged immediately following the first treatment. A better indication of effectiveness will be the amount of re-growth next season. As such, at this stage, the physical evidence that a high percentage of stems were injected at all growths located by IPS is sufficient to confirm treatment was carried out proficiently.

The two growths which were not treated (areas 9 & 12) were omitted due to not being detected during the initial survey and not being identify by the Contractor due to the minuteness of the growth. These areas will be included in the next round of treatment. In terms of timing, the delay in initiating treatment at these areas is not envisaged to result in delays in the treatment schedule, since the size of the growths (medium-sized and minute) means these areas are likely to be eradicated before the larger well-established growths such as 1, 10 & 15, despite treatment beginning later.

The disturbance of spoil near area 14 (see plates 17 & 18) is cause for concern, since this could potentially result in the spread of Japanese Knotweed to other areas and interfere with the treatment programme at the landfill. In this instance interference with the rhizome does not appear to have occurred, but rather the canes were destabilised and partly buried when soil was scraped from the mound behind the growth. It is understood that Tipperary Co Co are taking measures to prevent further disturbance in future.

The presence of horses on the site could potentially spread the Japanese Knotweed. It maybe unfeasible to secure the entire landfill boundary from horses therefore a more practical approach would be to install fencing in strategic areas which would prevent horses from entering.
While fencing a portion of Knotweed growths would be effective in preventing interference from horses, demarcation of all growths to highlight their presence to any operatives is recommended, to ensure interference to not occur inadvertently.

Careful vegetation clearance around Japanese Knotweed growths is also recommended; this would allow better of access and safer conditions for treatment works and surveying, and also to erect fencing and cordoning. Any such clearance should only be undertaken under strict supervision by an ecologist or invasive plant specialist however, to ensure Japanese Knotweed is not spread.

MEMORANDUM

To:	Kieran McKenna	**From:**	Jonathon Dunn Aoife Byrne Bernadette Guinan
Company:	Tipperary County Council	**Date:**	16 August 2019

Subject: **Ecological Surveillance – Pre-Treatment Site Inspection Spring/Summer 2019**

Background

Fehily Timoney and Company (FT) were commissioned by Tipperary County Council to carry out ecological surveillance of the invasive species treatment programme at the Tipperary Town Historic Landfill, which is being undertaken by Invasive Plant Solutions Ltd.

The ecological surveillance being carried out by FT consists of:

- A site survey following treatment at the end of each year of the treatment programme;
- A site inspection prior to the first treatment application in each year of the programme to monitor the extent of the Japanese knotweed infestation.

This memo provides a summary of the site inspection prior to the 2019 spring/summer treatment of Japanese Knotweed.

Area numbers referenced below are consistent with those referenced in the FT report *"Tipperary Town Historic Landfill Invasive Species Treatment Monitoring Report - Inspection # 1 (October 2018)"*.

Summary of Pre-Treatment Site Inspection

The Pre-Treatment Site Inspection was undertaken by FT Ecologist Jonathon Dunn on the 07/05/2019, in the presence of Kyran Colgan from Invasive Plant Solutions Ltd.

Areas 2, 4, 10 and 13 had no new growth of Japanese Knotweed following the Autumn/Winter 2018 treatment. Most of these areas were in locations that were sheltered from disturbance.

Areas 1, 3, 5, 6, 7, 8, 11, 14 and 15 had small patches of new growth, between 2-10% of the original cluster sizes. It was noted that the new growths were small and near the margins, suggesting that disturbance (possibly by horses) played a role in spreading new vegetative fragments. However, the extent of the regrowth is well within the margins of what is to be expected following successful treatment by injection and spot spraying. Area 12 had a regrowth of 40% of original cluster size – however area 12 is a small patch.

MEMORANDUM

To:	Kieran McKenna	**From:**	Luke Myers Aoife Byrne Bernadette Guinan
Company:	Tipperary County Council	**Date:**	27 November 2019

Subject: **Ecological Surveillance – Post-Treatment Site Inspection 2019**

Background

Fehily Timoney and Company (FT) were commissioned by Tipperary County Council to carry out ecological surveillance of the invasive species treatment programme at the Tipperary Town Historic Landfill, which is being undertaken by Invasive Plant Solutions Ltd.

The ecological surveillance being carried out by FT consists of:

- A site survey following treatment at the end of each year of the treatment programme;
- A site inspection prior to the first treatment application in each year of the programme;
- to monitor the extent of the Japanese knotweed infestation.

This memo provides a summary of the post-treatment in 2019 of Japanese Knotweed.

Area numbers referenced below are consistent with those referenced in the FT report *"Tipperary Town Historic Landfill Invasive Species Treatment Monitoring Report - Inspection # 1 (October 2018)"*.

Summary of Site Inspections 2019

In May 2019 the Pre-Treatment Site Inspection was undertaken by an FT Ecologist in the presence of Kyran Colgan from Invasive Plant Solutions Ltd. During the 2019 Pre-Treatment Site Inspection, areas 2, 4, 10 and 13 had no new growth of Japanese Knotweed following the Autumn/Winter 2018 treatment. Areas 1, 3, 5, 6, 7, 8, 11, 14 and 15 had small patches of new growth, between 2-10% of the original cluster sizes. During the pre-treatment site inspection in 2019, area 12 had a regrowth of 40% of original cluster size.

The 2019 Summer/Autumn Treatment Site Inspection was undertaken by an FT Ecologist on the 31/10/2019. As detailed by Kyran Colgan from Invasive Plant Solutions Ltd., control of invasive species within the historical Tipperary Town Landfill site included stem injection and spot spraying.

During the 2019 Summer/Autumn Treatment Site Inspection, areas 2, 4, 5, 6, 7, 9, 10, 12 and 14 had no new growth of Japanese Knotweed, following Summer/Autumn 2019 treatment. This is an increase of five areas of no new growth compared to the pre-treatment site inspection five months prior. Areas 3, 8, 11 and 13 had small patches of growth.

All growths within these Japanese Knotweed areas were small shoots dying back as a result of treatment and were located within the existing mapped areas with no expansion observed. Some growth was identified in areas 1 and 15; both of these areas were subjected to spot spraying and stem injection during the Summer/Autumn 2019 treatment period. No expansion was identified in areas 1 or 15 outside of the existing mapped areas.

Additional invasive species were assessed, and points of interest noted:

- All previously identified areas containing Montbretia were visited during this assessment. New areas of Montbretia were identified along the site boundary. A small area of the invasive plant Montbretia was identified at the main access gate within an area used for dumping garden vegetation.
- All previously identified areas containing Winter Heliotrope were visited during this assessment. New growths of Winter Heliotrope were identified on site.
- Areas identified to be containing Snowberry were visited. A second Snowberry plant was newly identified during this survey period.
- Clematis (Old mans beard) was newly identified on site.

MEMORANDUM

To:	Kieran McKenna	**From:**	Jonathon Dunn Aoife Byrne Bernadette Guinan
Company:	Tipperary County Council	**Date:**	28 July 2020

Subject: **Ecological Surveillance – Invasive Species Treatment Site Inspection 2020**

Background

Fehily Timoney and Company (FT) were commissioned by Tipperary County Council to carry out ecological surveillance of the invasive species treatment programme at the Tipperary Town Historic Landfill, which is being undertaken by Invasive Plant Solutions Ltd.

The ecological surveillance being carried out by FT consists of:

- A site inspection following the first treatment application in each year of the programme to monitor the extent of the Japanese knotweed infestation.
- A site survey following treatment at the end of each year of the treatment programme;

This memo provides a summary of the site inspection of the treatment in 2020 of Japanese Knotweed.

Area numbers referenced below are consistent with those referenced in the FT report *"Tipperary Town Historic Landfill Invasive Species Treatment Monitoring Report - Inspection # 1 (October 2018)"*.

Summary of Invasive Species Treatment Site Inspection 2020

On 2nd July 2020 the Invasive Species Treatment Site Inspection was undertaken by FT Ecologist Jonathon Dunn.

Areas 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13 and 14 had no new growth of Japanese knotweed following the Autumn/winter treatment in 2019.

Areas 8, 9 and 15 had small patches of new growth between <1 to 2% of the original cluster sizes. New growth for areas 8 and 15 were small (around 10 cm in height) and generally near the margins of the clusters. Area 9 had a small patch of new growth around 2 m tall, located slightly away from the original cluster in thick brambles. However, this new growth represented <1% of the original cluster size. The extent of regrowth recorded is well within the margins of what is expected following successful treatment by injection and spot spraying.

FEHILY
TIMONEY

CONSULTANTS IN ENGINEERING,
ENVIRONMENTAL SCIENCE
& PLANNING

APPENDIX 7

European Site Synopses

SITE SYNOPSIS

Site Name: Moanour Mountain SAC

Site Code: 002257

Situated approximately 7 km south-west of Tipperary town, this site lies on the north-western slope of Moanour Mountain, an outlying ridge of the Galtee Mountains. It lies entirely above the 220 m contour line, with a maximum height of 335 m. The site represents probably the only part of this mountainous ridge that retains semi-natural vegetation, the remainder having been afforested.

The site is a Special Area of Conservation (SAC) selected for the following habitats and/or species listed on Annex I / II of the E.U. Habitats Directive (* = priority; numbers in brackets are Natura 2000 codes):

[4010] Wet Heath
[4030] Dry Heath

The lower western part of this site is dominated by acid grassland on mineral soil, characterised by the presence of Heath Bedstraw (*Galium saxatile*), Sheep's-fescue (*Festuca ovina*), Tormentil (*Potentilla erecta*) and Mat-grass (*Nardus stricta*), as well as species such as Common Bent (*Agrostis capillaris*), Green-ribbed Sedge (*Carex binervis*) and Pill Sedge (*C. pilulifera*).

The grassland merges in places with dry heath, with such species as Bell Heather (*Erica cinerea*), Heather (*Calluna vulgaris*) and gorse (*Ulex europaeus* and *U. gallii*). As one moves upslope, the heath gets wetter and wet heath dominates the eastern part of the site. Species present include Purple Moor-grass (*Molinia caerulea*), Deergrass (*Trichophorum cespitosum*), Common Cottongrass (*Eriophorum angustifolium*), Cross-leaved Heath (*Erica tetralix*), Heath Rush (*Juncus squarrosus*), Lousewort (*Pedicularis sylvatica*) and Round-leaved Sundew (*Drosera rotundfolia*). Bryophytes are well represented, with a range of bog mosses (*Sphagnum capillifolium*, *S. cuspidatum* and *S. compactum*), as well as *Campylopus introflexus, Odontischisma sphagni* and *Gymnocolea inflata*. The lichen *Cladonia portentosa* occurs. At the summit of Moanour Mountain, the wet heath habitat grades in places to shallow blanket bog.

Land use at the site consists of grazing by sheep.

While a relatively small site, it is of particular conservation importance for the presence of wet heath and dry heath, both good examples of E.U. Habitats Directive Annex I habitats.

SITE SYNOPSIS

Site Name: Lower River Shannon SAC

Site Code: 002165

This very large site stretches along the Shannon valley from Killaloe in Co. Clare to Loop Head/ Kerry Head, a distance of some 120 km. The site thus encompasses the Shannon, Feale, Mulkear and Fergus estuaries, the freshwater lower reaches of the River Shannon (between Killaloe and Limerick), the freshwater stretches of much of the Feale and Mulkear catchments and the marine area between Loop Head and Kerry Head. Rivers within the sub-catchment of the Feale include the Galey, Smearlagh, Oolagh, Allaughaun, Owveg, Clydagh, Caher, Breanagh and Glenacarney. Rivers within the sub-catchment of the Mulkear include the Killeenagarriff, Annagh, Newport, the Dead River, the Bilboa, Glashacloonaraveela, Gortnageragh and Cahernahallia.

The site is a Special Area of Conservation (SAC) selected for the following habitats and/or species listed on Annex I / II of the E.U. Habitats Directive (* = priority; numbers in brackets are Natura 2000 codes):

[1110] Sandbanks
[1130] Estuaries
[1140] Tidal Mudflats and Sandflats
[1150] Coastal Lagoons*
[1160] Large Shallow Inlets and Bays
[1170] Reefs
[1220] Perennial Vegetation of Stony Banks
[1230] Vegetated Sea Cliffs
[1310] *Salicornia* Mud
[1330] Atlantic Salt Meadows
[1410] Mediterranean Salt Meadows
[3260] Floating River Vegetation
[6410] *Molinia* Meadows
[91E0] Alluvial Forests*
[1029] Freshwater Pearl Mussel (*Margaritifera margaritifera*)
[1095] Sea Lamprey (*Petromyzon marinus*)
[1096] Brook Lamprey (*Lampetra planeri*)
[1099] River Lamprey (*Lampetra fluviatilis*)
[1106] Atlantic Salmon (*Salmo salar*)
[1349] Bottle-nosed Dolphin (*Tursiops truncatus*)
[1355] Otter (*Lutra lutra*)

The Shannon and Fergus Rivers flow through Carboniferous limestone as far as Foynes, but west of Foynes Namurian shales and flagstones predominate (except at Kerry Head, which is formed from Old Red Sandstone). The eastern sections of the Feale catchment flow through Namurian rocks and the western stretches through Carboniferous limestone. The Mulkear flows through Lower Palaeozoic rocks in the upper reaches before passing through Namurian rocks, followed by Lower Carboniferous shales and Carboniferous limestone. The Mulkear River itself, immediately north of Pallas Green, passes through an area of Rhyolites, Tuffs and Agglomerates.

The Shannon and Fergus Estuaries form the largest estuarine complex in Ireland. They form a unit stretching from the upper tidal limits of the Shannon and Fergus Rivers to the mouth of the Shannon Estuary (considered to be a line across the narrow strait between Kilcredaun Point and Kilconly Point). Within this main unit there are several tributaries with their own 'sub-estuaries' e.g. the Deel River, Mulkear River, and Maigue River. To the west of Foynes, a number of small estuaries form indentations in the predominantly hard coastline, namely Poulnasherry Bay, Ballylongford Bay, Clonderalaw Bay and the Feale or Cashen River estuary.

Both the Fergus and inner Shannon Estuaries feature vast expanses of intertidal mudflats, often fringed with saltmarsh vegetation. The smaller estuaries also feature mudflats, but have their own unique characteristics, e.g. Poulnasherry Bay is stony and unusually rich in species and biotopes. Plant species are typically scarce on the mudflats, although there are some eelgrass (*Zostera* spp.) beds and patches of green algae (e.g. *Ulva* sp. and *Enteromorpha* sp.). The main macro-invertebrate community which has been noted from the inner Shannon and Fergus estuaries is a *Macoma-Scrobicularia-Nereis* community.

In the transition zone between mudflats and saltmarsh, specialised colonisers of mud predominate. For example, swards of Common Cord-grass (*Spartina anglica*) frequently occur in the upper parts of the estuaries. Less common are swards of Glasswort (*Salicornia europaea* agg.). In the innermost parts of the estuaries, the tidal channels or creeks are fringed with species such as Common Reed (*Phragmites australis*) and club-rushes (*Scirpus maritimus, S. tabernaemontani* and *S. triquetrus*). In addition to the nationally rare Triangular Club-rush (*Scirpus triqueter*), two scarce species are found in some of these creeks (e.g. Ballinacurra Creek): Lesser Bulrush (*Typha angustifolia*) and Summer Snowflake (*Leucojum aestivum*).

Saltmarsh vegetation frequently fringes the mudflats. Over twenty areas of estuarine saltmarsh have been identified within the site, the most important of which are around the Fergus estuary and at Ringmoylan Quay. The dominant type of saltmarsh present is Atlantic salt meadow occurring over mud. Characteristic species occurring include Common Saltmarsh-grass (*Puccinellia maritima*), Sea Aster (*Aster tripolium*), Thrift (*Armeria maritima*), Sea-milkwort (*Glaux maritima*), Sea Plantain (*Plantago maritima*), Red Fescue (*Festuca rubra*), Creeping Bent (*Agrostis stolonifera*), Saltmarsh Rush (*Juncus gerardi*), Long-bracted Sedge (*Carex extensa*), Lesser Sea-spurrey

(*Spergularia marina*) and Sea Arrowgrass (*Triglochin maritima*). Areas of Mediterranean salt meadows, characterised by clumps of Sea Rush (*Juncus maritimus*) occur occasionally. Two scarce species are found on saltmarshes in the vicinity of the Fergus estuary: a type of robust saltmarsh-grass (*Puccinellia foucaudii*), sometimes placed within the species Common Saltmarsh-grass (*P. maritima*) and Hard-grass (*Parapholis strigosa*).

Saltmarsh vegetation also occurs around a number of lagoons within the site, two of which have been surveyed as part of a National Inventory of Lagoons. Clooncooneen Pool (4-5 ha) is a natural sedimentary lagoon impounded by a low cobble barrier. Seawater enters by percolation through the barrier and by overwash. This lagoon represents a type which may be unique to Ireland since the substrate is composed almost entirely of peat. The adjacent shore features one of the best examples of a drowned forest in Ireland. Aquatic vegetation in the lagoon includes typical species such as Beaked Tasselweed (*Ruppia maritima*) and green algae (*Cladophora* sp.). The fauna is not diverse, but is typical of a high salinity lagoon and includes six lagoon specialists (*Hydrobia ventrosa, Cerastoderma glaucum, Lekanesphaera hookeri, Palaemonetes varians, Sigara stagnalis* and *Enochrus bicolor*). In contrast, Shannon Airport Lagoon (2 ha) is an artificial saline lake with an artificial barrier and sluiced outlet. However, it supports two Red Data Book species of stonewort (*Chara canescens* and *Chara cf. connivens*).

Most of the site west of Kilcredaun Point/Kilconly Point is bounded by high rocky sea cliffs. The cliffs in the outer part of the site are sparsely vegetated with lichens, Red Fescue, Sea Beet (*Beta vulgaris* subsp. *maritima*), Sea Campion (*Silene vulgaris* subsp. *maritima*), Thrift and plantains (*Plantago* spp.). A rare endemic type of sea-lavender, *Limonium recurvum* subsp. *pseudotranswallianum,* occurs on cliffs near Loop Head. Cliff-top vegetation usually consists of either grassland or maritime heath. The boulder clay cliffs further up the estuary tend to be more densely vegetated, with swards of Red Fescue and species such as Kidney Vetch (*Anthyllis vulneraria*) and Common Bird's-foot-trefoil (*Lotus corniculatus*).

The site supports an excellent example of a large shallow inlet and bay. Littoral sediment communities in the mouth of the Shannon Estuary occur in areas that are exposed to wave action and also in areas extremely sheltered from wave action. Characteristically, exposed sediment communities are composed of coarse sand and have a sparse fauna. Species richness increases as conditions become more sheltered. All shores in the site have a zone of sand hoppers at the top, and below this each of the shores has different characteristic species giving a range of different shore types.

The intertidal reefs in the Shannon Estuary are exposed or moderately exposed to wave action and subject to moderate tidal streams. Known sites are steeply sloping and show a good zonation down the shore. Well developed lichen zones and littoral reef communities offering a high species richness in the sublittoral fringe and strong populations of the Purple Sea Urchin *Paracentrotus lividus* are found. The communities found are tolerant to sand scour and tidal streams. The infralittoral reefs range from sloping platforms with some vertical steps, to ridged bedrock with gullies of sand between the ridges, to ridged bedrock with boulders or a mixture of cobbles, gravel and sand. Kelp is very common to about 18 m. Below this it becomes rare and the community is characterised by coralline crusts and red foliose algae.

Other coastal habitats that occur within the site include stony beaches and bedrock shores (these support a typical zonation of seaweeds such as *Fucus* spp., *Ascophyllum nodosum* and kelps), shingle beaches (with species such as Sea Beet, Sea Mayweed - *Matricaria maritima*, Sea Campion and Curled Dock - *Rumex crispus*), sandbanks which are slightly covered by sea water at all times (e.g. in the area from Kerry Head to Beal Head) and sand dunes (a small area occurs at Beal Point, where Marram – *Ammophila arenaria* is the dominant species).

Freshwater rivers have been included in the site, most notably the Feale and Mulkear catchments, the Shannon from Killaloe to Limerick (along with some of its tributaries, including a short stretch of the Kilmastulla River), the Fergus up as far as Ennis, and the Cloon River. These systems are very different in character: the Shannon is broad, generally slow flowing and naturally eutrophic; the Fergus is smaller and alkaline; while the narrow, fast flowing Cloon is acid in nature. The Feale and Mulkear catchments exhibit all the aspects of a river from source to mouth. Semi-natural habitats, such as wet grassland, wet woodland and marsh occur by the rivers, but improved grassland is the most common habitat type. One grassland type of particular conservation significance, *Molinia* meadows, occurs in several parts of the site and the examples at Worldsend on the River Shannon are especially noteworthy. Here are found areas of wet meadow dominated by rushes (*Juncus* spp.) and sedges (*Carex* spp.), and supporting a diverse and species-rich vegetation, including such uncommon species as Blue-eyed Grass (*Sisyrinchium bermudiana*) and Pale Sedge (*C. pallescens*).

Floating river vegetation characterised by species of water-crowfoot (*Ranunculus* spp.), pondweeds (*Potamogeton* spp.) and the moss *Fontinalius antipyretica* are present throughout the major river systems within the site. The rivers contain an interesting bryoflora with *Schistidium alpicola* var. *alpicola* recorded from in-stream boulders on the Bilboa, new to Co. Limerick.

Alluvial woodland occurs on the banks of the Shannon and on islands in the vicinity of the University of Limerick. The woodland is up to 50 m wide on the banks and somewhat wider on the largest island. The most prominent woodland type is gallery woodland where White Willow (*Salix alba*) dominates the tree layer with occasional Alder (*Alnus glutinosa*). The shrub layer consists of various willow species with Rusty Willow (*Salix cinerea* ssp. *oleifolia*) and what appear to be hybrids of *S. alba* x *S. viminalis.* The herbaceous layer consists of tall perennial herbs. A fringe of bulrush (*Typha* sp.) occurs on the river side of the woodland. On slightly higher ground above the wet woodland and on the raised embankment remnants of mixed oak-ash-alder woodland occur. These are poorly developed and contain numerous exotic species but locally there are signs that it is invading open grassland. Alder is the principal tree species, with occasional Pedunculate Oak (*Quercus robur*), elm (*Ulmus glabra* and *U. procera*), Hazel (*Corylus avellana*), Hawthorn (*Crataegus monogyna*) and the shrubs Guelder-rose (*Viburnum opulus*) and willows. The ground flora is species-rich.

While woodland is infrequent within the site, however Cahiracon Wood contains a strip of old oak woodland. Sessile Oak (*Q. petraea*) forms the canopy, with an understorey of Hazel and Holly (*Ilex aquifolium*). Great Wood-rush (*Luzula sylvatica*) dominates the ground flora. Less common species present include Great Horsetail (*Equisetum telmeteia*) and Pendulous Sedge (*Carex pendula*).

In the low hills to the south of the Slievefelim Mountains, the Cahernahallia River cuts a valley through the Upper Silurian rocks. For approximately 2 km south of Cappagh Bridge at Knockanavar, the valley sides are wooded. The woodland consists of birch (*Betula* spp.), Hazel, oak, Rowan (*Sorbus aucuparia*), some Ash (*Fraxinus excelsior*) and willow (*Salix* spp.). Most of the valley is not grazed by stock, and as a result the trees are regenerating well. The ground flora features prominent Great wood-rush and Bilberry (*Vaccinium myrtillus*), along with a typical range of woodland herbs. Bracken (*Pteridium aquilinum*) is a feature in areas where there is more light available.

The valley sides of the Bilboa and Gortnageragh Rivers, on higher ground north-east of Cappamore, support patches of semi-natural broadleaf woodland dominated by Ash, Hazel, oak and birch. There is a good scrub layer with Hawthorn, willow, Holly and Blackthorn (*Prunus spinosa*) common. The herb layer in these woodlands is often open, with a typically rich mixture of woodland herbs and ferns. Moss species diversity is high. The woodlands are ungrazed. The Hazel is actively coppiced in places.

There is a small area of actively regenerating cut-away raised bog at Ballyrorheen. It is situated approximately 5 km north-west of Cappamore in Co. Limerick. The bog contains some wet areas with good cover of bog mosses (*Sphagnum* spp.). Species of particular interest include Cranberry (*Vaccinium oxycoccos*) and White Sedge (*Carex curta*), along with two regionally rare mosses, including the bog moss *S. fimbriatum*. The site is being invaded by Downy Birch (*Betula pubescens*) scrub woodland. Both commercial forestry and the spread of Rhododendron (*Rhododendron ponticum*) has greatly reduced the overall value of the site.

A number of plant species that are listed in the Irish Red Data Book occur within the site, and several of these are protected under the Flora (Protection) Order, 1999. These include Triangular Club-rush (*Scirpus triquetrus*), a species which is only found in Ireland only in the Shannon Estuary, where it borders creeks in the inner estuary. Opposite-leaved Pondweed (*Groenlandia densa*) is found in the Shannon where it passes through Limerick City, while Meadow Barley (*Hordeum secalinum*) is abundant in saltmarshes at Ringmoylan and Mantlehill. Hairy Violet (*Viola hirta*) occurs in the Askeaton/Foynes area. Golden Dock (*Rumex maritimus*) is noted as occurring in the River Fergus estuary. Finally, Bearded Stonewort (*Chara canescens*), a brackish water specialist, and Convergent Stonewort (*Chara connivens*) are both found in Shannon Airport Lagoon.

Overall, the Shannon and Fergus Estuaries support the largest numbers of wintering waterfowl in Ireland. The highest count in 1995-96 was 51,423 while in 1994-95 it was 62,701. Species listed on Annex I of the E.U. Birds Directive which contributed to these totals include: Great Northern Diver (3; 1994/95), Whooper Swan (201; 1995/96), Pale-bellied Brent Goose (246; 1995/96), Golden Plover (11,067; 1994/95) and Bar-tailed Godwit (476; 1995/96). In the past, three separate flocks of Greenland White-fronted Goose were regularly found, but none were seen in 1993/94.

Other wintering waders and wildfowl present include Greylag Goose (216; 1995/96), Shelduck (1,060; 1995/96), Wigeon (5,976; 1995/96), Teal (2,319; 1995-96), Mallard (528; 1995/96), Pintail (45; 1995/96), Shoveler (84; 1995/96), Tufted Duck (272; 1995/96), Scaup (121; 1995/96), Ringed Plover (240; 1995/96), Grey Plover (750; 1995/96), Lapwing (24,581; 1995/96), Knot (800; 1995/96), Dunlin (20,100; 1995/96), Snipe (719, 1995/96), Black-tailed Godwit (1,062; 1995/96), Curlew (1,504; 1995/96), Redshank (3,228; 1995/96), Greenshank (36; 1995/96) and Turnstone (107; 1995/96). A number of wintering gulls are also present, including Black-headed Gull (2,216; 1995/96), Common Gull (366; 1995/96) and Lesser Black-backed Gull (100; 1994/95). This is the most important coastal site in Ireland for a number of the waders including Lapwing, Dunlin, Snipe and Redshank. It also provides an important staging ground for species such as Black-tailed Godwit and Greenshank.

A number of species listed on Annex I of the E.U. Birds Directive breed within the site. These include Peregine Falcon (2-3 pairs), Sandwich Tern (34 pairs on Rat Island, 1995), Common Tern (15 pairs: 2 on Sturamus Island and 13 on Rat Island, 1995), Chough (14-41 pairs, 1992) and Kingfisher. Other breeding birds of note include Kittiwake (690 pairs at Loop Head, 1987) and Guillemot (4,010 individuals at Loop Head, 1987).

There is a resident population of Bottle-nosed Dolphin in the Shannon Estuary. This is the only known resident population of this E.U. Habitats Directive Annex II species in Ireland. The population is estimated (in 2006) to be 140 ± 12 individuals. Otter, a species also listed on Annex II of this Directive, is commonly found on the site.

Five species of fish listed on Annex II of the E.U. Habitats Directive are found within the site. These are Sea Lamprey (*Petromyzon marinus*), Brook Lamprey (*Lampetra planeri*), River Lamprey (*Lampetra fluviatilis*), Twaite Shad (*Allosa fallax fallax*) and Salmon (*Salmo salar*). The three lampreys and Salmon have all been observed spawning in the lower Shannon or its tributaries. The Fergus is important in its lower reaches for spring salmon, while the Mulkear catchment excels as a grilse fishery, though spring fish are caught on the actual Mulkear River. The Feale is important for both types. Twaite Shad is not thought to spawn within the site. There are few other river systems in Ireland which contain all three species of lamprey.

Two additional fish species of note, listed in the Irish Red Data Book, also occur, namely Smelt (*Osmerus eperlanus*) and Pollan (*Coregonus autumnalis pollan*). Only the former has been observed spawning in the Shannon.

Freshwater Pearl Mussel (*Margaritifera margaritifera*), a species listed on Annex II of the E.U. Habitats Directive, occurs abundantly in parts of the Cloon River.

There is a wide range of land uses within the site. The most common use of the terrestrial parts is grazing by cattle, and some areas have been damaged through over-grazing and poaching. Much of the land adjacent to the rivers and estuaries has been improved or reclaimed and is protected by embankments (especially along the Fergus estuary). Further, reclamation continues to pose a threat, as do flood relief works (e.g. dredging of rivers). Gravel extraction poses a major threat on the Feale.

In the past, cord-grass (*Spartina* sp.) was planted to assist in land reclamation. This has spread widely, and may oust less vigorous colonisers of mud and may also reduce the area of mudflat available to feeding birds.

Domestic and industrial wastes are discharged into the Shannon, but water quality is generally satisfactory, except in the upper estuary where it reflects the sewage load from Limerick City. Analyses for trace metals suggest a relatively clean estuary with no influences of industrial discharges apparent. Further industrial development along the Shannon and water polluting operations are potential threats.

Fishing is a main tourist attraction on the Shannon and there are a large number of angler associations, some with a number of beats. Fishing stands and styles have been erected in places. The River Feale is a designated Salmonid Water under the E.U. Freshwater Fish Directive. Other uses of the site include commercial angling, oyster farming, boating (including dolphin-watching trips) and shooting. Some of these may pose threats to the birds and dolphins through disturbance. Specific threats to the dolphins include underwater acoustic disturbance, entanglement in fishing gear and collisions with fast moving craft.

This site is of great ecological interest as it contains a high number of habitats and species listed on Annexes I and II of the E.U. Habitats Directive, including the priority habitats lagoon and alluvial woodland, the only known resident population of Bottle-nosed Dolphin in Ireland and all three Irish lamprey species. A good number of Red Data Book species are also present, perhaps most notably the thriving populations of Triangular Club-rush. A number of species listed on Annex I of the E.U. Birds Directive are also present, either wintering or breeding. Indeed, the Shannon and Fergus Estuaries form the largest estuarine complex in Ireland and support more wintering wildfowl and waders than any other site in the country. Most of the estuarine part of the site has been designated a Special Protection Area (SPA), under the E.U. Birds Directive, primarily to protect the large numbers of migratory birds present in winter.

Site Name: Lower River Suir SAC

Site Code: 002137

Lower River 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 Suir and its tributaries flow through the counties of Tipperary, Kilkenny and Waterford.

Upstream of Waterford city, the swinging meanders of the Suir criss-cross the Devonian sandstone rim of hard rocks no less than three times as they leave the limestone-floored downfold below Carrick-on-Suir. 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 Special Area of Conservation (SAC) selected for the following habitats and/or species listed on Annex I / II of the E.U. Habitats Directive (* = priority; numbers in brackets are Natura 2000 codes):

[1330] Atlantic Salt Meadows
[1410] Mediterranean Salt Meadows
[3260] Floating River Vegetation
[6430] Hydrophilous Tall Herb Communities
[91A0] Old Oak Woodlands
[91E0] Alluvial Forests*
[91J0] Yew Woodlands*

[1029] Freshwater Pearl Mussel (*Margaritifera margaritifera*)
[1092] White-clawed Crayfish (*Austropotamobius pallipes*)
[1095] Sea Lamprey (*Petromyzon marinus*)
[1096] Brook Lamprey (*Lampetra planeri*)
[1099] River Lamprey (*Lampetra fluviatilis*)

[1103] Twaite Shad (*Alosa fallax*)
[1106] Atlantic Salmon (*Salmo salar*)
[1355] Otter (*Lutra lutra*)

Alluvial wet woodland is a declining habitat type 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*), Rusty Willow (*S. cinerea* subsp. *oleifolia*), Osier (*S. viminalis*), with Yellow Iris (*Iris pseudacorus*), Hemlock Water-dropwort (*Oenanthe crocata*), Wild Angelica (*Angelica sylvestris*), Pendulous Sedge (*Carex pendula*), Meadowsweet (*Filipendula ulmaria*) and Common 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. A small plot is currently being coppiced and managed by the National Parks and Wildlife Service. In the drier areas species such as Ash (*Fraxinus excelsior*), Hazel (*Corylus avellana*), Hawthorn (*Crataegus monogyna*) and Blackthorn (*Prunus spinosa*) occur.

Eutrophic tall herb vegetation occurs in association with the various areas of alluvial forest and elsewhere where the floodplain of the river is intact. Characteristic species of the habitat include Meadowsweet, 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 Pedunculate Oak, *Quercus robur*) are well grown and spreading. Ivy (*Hedera helix*) and Bramble (*Rubus fruticosus* agg.) 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. The site is quite species-rich throughout, including an abundance of mosses, liverworts and lichens. The rare lichen *Lobaria pulmonaria,* an indicator of ancient woodlands, is found here.

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-scripta*), 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. Here the influence of the drift is more marked, with the occurrence of Wood Anemone (*Anemone nemorosa*) amongst the ground flora.

Two stands of Yew (*Taxus baccata*) woods, a rare habitat in Ireland and the E.U., occur within the site. These are on limestone ridges at Shanbally and Cahir Park. Both are in woods planted with non-native species, including conifers. However, the area at Cahir Park is fairly substantial in size and includes some relatively undisturbed patches of wood and some very old trees. Regeneration of the Yew trees is mostly poor, due to competition from species such as Sycamore (*Acer pseudoplatanus*) and, at Shanbally, due to heavy grazing by goats. Other native species which occur with the Yew trees include Ash, Pedunculate Oak, Hazel and Spindle (*Euonymus europaeus*). Future prospects for these Yew woods are good as the sites are proposed for restoration under a Coillte E.U. LIFE programme.

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*), water-milfoils (*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 (*R. 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 (*Nasturtium officinale*) 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 (*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, reedswamp, 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 Iris, Meadowsweet, rushes (*Juncus* spp.), Meadow Buttercup (*Ranunculus acris*) and Cuckooflower (*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 5 km 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 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 (both *Margaritifera margaritifera* and *M. margaritifera* subsp. *durrovensis* occur), White-clawed Crayfish, Salmon, Twaite Shad (*Alosa fallax fallax*), three species of Lampreys - Sea Lamprey, Brook

Lamprey and River Lamprey, and Otter. 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, Natterer's Bat, Pipistrelle Bat, Pine Marten, Badger, Irish Hare, Smelt and Common Frog. 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. As the site is therefore unusual in this regard, it may also support interesting invertebrate populations.

Parts of the site have also been identified as of ornithological importance for a number of Annex I (E.U. Birds Directive) bird species, including Greenland White-fronted Goose (10), Golden Plover (1,490), Whooper Swan (7) and Kingfisher. Figures given in brackets are the average maximum counts from four count areas within the site for the three winters 1994-1997. 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 Goose on a regular basis, with numbers between 600 and 700 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 (2,750) were recorded at Faithlegg in the winter of 1996/97. In Cabragh marshes there is abundant food for surface feeding wildfowl which total approximately 1,000 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 E.U. Birds Directive, occurs along some of the many tributaries throughout the site.

Land use 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 E.U. 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 habitats alluvial forest and Yew woodland. The site also supports populations of several important animals species, some listed on Annex II of the Habitats Directive or listed in the Irish Red Data Book. The presence of two legally protected plants (Flora (Protection) Order, 1999) and the ornithological importance of the site adds further to the ecological interest and importance.

SITE SYNOPSIS

Site Name: Philipston Marsh SAC

Site Code: 001847

Philipston Marsh is a small wetland near Philipston House, south of Cappagh White in Co. Tipperary. It represents one of only two examples of calcareous fen and mire vegetation in the Mulkear River catchment and is thus a rare habitat type in this locality.

The site is a Special Area of Conservation (SAC) selected for the following habitats and/or species listed on Annex I / II of the E.U. Habitats Directive (* = priority; numbers in brackets are Natura 2000 codes):

[7140] Transition Mires

The marsh supports a dense reedbed of Common Reed (*Phragmites australis*) and patches of Rusty Willow (*Salix cinerea* subsp. *oleifolia*) scrub on its northern margins. The southern part is flushed with calcareous groundwater issuing from the base of a gentle slope. This area supports a very species-rich mosaic of fen and transition mire plant communities, amongst which are found several uncommon species, including Broad-leaved Cottongrass (*Eriophorum latifolium*), Marsh Helleborine (*Epipactis palustris*), Fen Bedstraw (*Galium uliginosum*), Lesser Tussock-sedge (*Carex diandra*) and Long-stalked Yellow-sedge (*C. lepidocarpa*). Typical rich fen bryophytes, such as *Campylium stellatum*, *Drepanocladus revolvens*, *Ctenidium molluscum*, *Fissidens adianthoides*, *Philonotis calcarea* and *Palustriella commutate,* are largely confined to Philipston Marsh within the Mulkear River catchment.

This undisturbed fen and mire system supports an unusual and diverse assemblage of plant communities and is particularly important for its transition mire, a habitat listed on Annex I of the E.U. Habitats Directive.

Site Name: Galtee Mountains SAC

Site Code: 000646

Situated in east Limerick and south Tipperary, the Galtee Mountains are Ireland's highest range of inland mountains. Galtymore has an elevation of 920 m and the main ridge, mostly above 700 m, extends approximately 10 km from east to west. The mountains are derived from folding of Old Red Sandstone and Silurian rocks. Heath is the main vegetation type within the site, with significant amounts of humid grassland and blanket bog occurring also. There is a series of small corrie lakes on the northern side of the mountain range, and the site encompasses the headstreams of numerous tributaries of the river Suir. The cliffs above the corries support arctic-alpine vegetation and the site as a whole supports several notable Irish rarities.

The site is a Special Area of Conservation (SAC) selected for the following habitats and/or species listed on Annex I / II of the E.U. Habitats Directive (* = priority; numbers in brackets are Natura 2000 codes):

[4010] Wet Heath
[4030] Dry Heath
[4060] Alpine and Subalpine Heaths
[6230] Species-rich *Nardus* Grassland*
[7130] Blanket Bogs (Active)*
[8110] Siliceous Scree
[8210] Calcareous Rocky Slopes
[8220] Siliceous Rocky Slopes

In areas of dry heath Heather (*Calluna vulgaris*) dominates the vegetation, with Bilberry (*Vaccinium myrtillus*) also common. This habitat type often grades into wet heath and alpine/subalpine heath. It is probably best developed on the steeper slopes. Additional species recorded from the areas of alpine/subalpine heath include Dwarf Willow (*Salix herbacea*), Heath Bedstraw (*Galium saxatile*), Hare's-tail Cottongrass (*Eriophorum vaginatum*), Great Wood-rush (*Luzula sylvatica*) and Starry Saxifrage (*Saxifraga stellaris*), amongst others.

Species-rich upland grassland occurs on steep slopes, particularly in the west of the site, and often in mosaic with humid grassland and heath. The rare species Small-white Orchid (*Pseudorchis albida*) has been recorded from within this habitat. The main grass species present include Common Bent (*Agrostis capillaris*), Mat-grass (*Nardus stricta*), Sweet Vernal-grass (*Anthoxanthum odoratum*) and Sheep's-fescue (*Festuca ovina*), while the main sedges are Green-ribbed Sedge (*Carex binervis*), Carnation Sedge (*C. panicea*) and Pill Sedge (*C. pilulifera*). Herb species include Heath

Bedstraw, Tormentil (*Potentilla erecta*), Lousewort (*Pedicularis sylvatica*), Heath Milkwort (*Polygala serpyllifolia*) and Common Milkwort (*P. vulgaris*). Heath species such as Heather and Heath-grass (*Danthonia decumbens*) are also found.

Blanket bog is localised at the site and occurs mainly at high altitudes, largely confined to flatter areas along and beside ridge tops. There is often good cover of bog mosses (*Sphagnum* spp.), along with Common Cottongrass (*E. angustifolium*) and Heather. Erosion is severe on many ridges and cols where deep peat deposits (up to 2 m) have accumulated. The uncommon species Stiff Sedge (*Carex bigelowii*) is found in this habitat at the site.

The north-facing cliffs within the site are of botanical importance as they support arctic-alpine communities with some rare plant species. These areas are linked to the habitats 'calcareous rocky slopes', 'siliceous rocky slopes' and 'siliceous scree'. Uncommon species include Northern Rock-cress (*Cardaminopsis petraea*), Mountain Sorrel (*Oxyria digyna*), Roseroot (*Rhodiola rosea*), Alpine Saw-wort (*Saussurea alpina*), Irish Saxifrage (*Saxifraga rosacea*) and the Red Listed bryophytes *Bartramia ithyphylla* and *Pohlia elongata* var. *greenii*. Other specialised mountain plants found on the site include Viviparous Fescue (*Festuca vivipara*), Fir Clubmoss (*Huperzia selago*) and Crowberry (*Empetrum nigrum*). The cliffs also support patches of Great Wood-rush, Bilberry, birch (*Betula* sp.), Rowan (*Sorbus aucuparia*) and Eared Willow (*Salix aurita*). There are several fern species recorded, most notably Brittle Bladder-fern (*Cystopteris fragilis*), Wilson's Filmy-fern (*Hymenophyllum wilsonii*), Tonbridge Filmy-fern (*H. tunbrigense*) and Green Spleenwort (*Asplenium viride*).

The rare species Small-white Orchid, Northern Rock-cress and Alpine Saw-wort have been recorded from the site. These species are included in the Red Data Book and the first two are legally protected under the Flora (Protection) Order, 2015.

The site supports breeding Peregrine, a species listed on Annex I of the E.U. Birds Directive.

Over-grazing by sheep and frequent burning are causing potentially serious damage to some areas of heath and grassland. Afforestation threatens the lower slopes and valleys. Hill walking takes place at the site and may result in trampling damage in places.

This site is of high conservation value due to the fact that it contains a range of important upland habitats in a relatively isolated inland mountain site. Eight of these habitats are listed in Annex I of the E.U. Habitats Directive, and two of those have priority status. The presence of a number of rare, scarce and uncommon plant species adds greatly to the significance of the SAC.

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APPENDIX 8

Finding of No Significant Effects Report

Finding of No Significant Effects Report	
Name and location of the Natura 2000 sites	- Lower River Suir SAC (site code 002137) approximately 6.5 km from the historical landfill site; this European site lies to the northeast, east & south of the landfill site. 18.2 km downstream. - Moanour Mountain SAC (Site Code 002257) approximately 8.3 km southwest. - Philipston Marsh SAC (Site Code 001847) approximately 9.2 km north. - Galtee Mountains SAC (Site Code 000646) approximately 9.3 km south. - Lower River Shannon SAC (Site Code 002165) approximately 12.1 km northwest. Hydrological connection 18.2 km instream distance. Via surrounding wetland, Spital-land channel, River Ara (the Ara/Aherlow confluence is within Lower River Suir SAC).
Description of the project or plan	The proposed works comprise of the following elements: - Site Compound - Invasive Species Management - Demolition of Existing Structures - Grading/Profiling of Existing Side Slopes - Profiling of Existing Site Area - Installation of Engineered Landfill Capping System - Anchor trench/Gas Barrier and Access Track at Toe of side slopes. - Installation of Passive Landfill Gas Venting System - Installation of Leachate Management Infrastructure - Landscaping Following remediation works the site will be covered in grassland.
Is the Project or Plan directly connected with or necessary to the management of the site (provide details)?	No.
Are there other projects or plans that together with the project of plan being assessed could affect the site (provide details)?	Yes. A planning search limited to applications submitted within the previous 5 years was carried out on 17th August 2020 for the townlands overlapping the proposed development site and those abutting the same. No other projects of a scale or type that could act cumulatively with the proposed remediation works at the historic landfill site are permitted in the townlands overlapping and surrounding the site. If authorised, the proposed residential development in the townland of Brodeen would have the potential contribute to cumulative effects due to ingress of suspended solids into the drainage network at construction stage.

Other Historic Landfills

In the absence of risk assessments for the other 4 historical landfill sites identified within the Suir catchment (Brittas Road and Moneanearla in Thurles, Convent Cross near Dundrum, and Coole to the west of Clonmel) and assuming a worst-case scenario where sediment was generated during remedial works at these sites and entered the river network, some potential for cumulative effects could exist. This could occur even if works were separated by a long period since the build-up of silt in gravel beds is a persistent problem. It is noted the same areas of the Lower River Suir SAC would not be affected due to the distance between the sites, but that effects on the SAC as a whole could occur.

Other Land Uses

There are mature forestry plantations on the Galtees and Moanour mountain with connectivity to the Lower River Suir SAC (streams draining these slopes feed into the Aherlow River which is within the SAC). These are upstream of the Ara/Aherlow confluence and harvesting activities could potentially generate sediment inputs which could contribute to cumulative effects.

Agricultural activities within the catchment have the potential to contribute to cumulative effects.

There is potential for the quarry upstream of the historic landfill to generate sediment which could act cumulatively with sediment generated by the proposed remediation works.

Dairy Industry

Although the activities of Tipperary Co-Operative Creamery are governed by an IPC licence (P0801-01), evidence of ineffective compliance with licence conditions has been recorded. As such it is not possible to rule out potential cumulative impacts in conjunction with this operation.

Assessment of Effects

Describe how the project or plan (alone or in combination) is likely to affect the Natura 2000 site

During Remediation Works

As the historic landfill is not located within any European sites, no direct effects via emissions will occur.

During remediation emissions in the following categories will be produced:

- soil sediment will be produced during:
    - reprofiling and capping of the site
    - the installation of the barrier system which will require vertical cut-offs on all boundaries (outside the area of the interred waste body).
    - during the installation of landfill gas management elements located on the surface of the cap (will not disturb the interred waste body).

Finding of No Significant Effects Report	
	• Invasive species material - Six invasive plant species are present within the historic landfill site; Japanese Knotweed, winter heliotrope, snowberry, Himalayan honeysuckle, butterfly bush and old man's beard. There is potential for reproductive material from Japanese knotweed to be transported downstream via the wetland and associated drainage channel. This could result in establishment of Japanese knotweed downstream resulting in bank destabilisation and associated risk of siltation. At present leachate is likely to escape from the site and enter groundwater and surface waters. During remediation works leachate will continue to be produced. Leachate monitoring results showed multiple parameters exceeded the EPA Interim Guideline Values (IGVs) for Groundwater. Elevated levels of ammonia, iron, manganese and chromium were recorded in the surface water monitoring results. The potential for indirect effects due to the transport of emissions in the form of hydrocarbons and/or suspended solids along the hydrological corridor identified (via the Spital-Land, Ara, and Aherlow) to the Lower River Suir SAC requires consideration. There is also potential for invasive species to be transported via the river network to Lower River Suir SAC (002137). The in-stream distance between the landfill site and the Lower River Suir SAC (18.2 km) and the slow flow rate and low capacity of the Spital-land watercourse means such effects are unlikely but cannot be ruled out. *After Remediation Works* Following remediation works, leachate will continue to be produced and enter groundwater for a time. However, remediation works will prevent rainwater from infiltrating the interred waste body therefore reducing the potential for leachate to be produced. During the establishment of the grass layer (will take several weeks) on the newly engineered cap, there will be soil runoff and suspended solids will be produced. However, suspended solids will be far less than that produced during remediation works and as such will not have the potential to result in effects on any European site. Occasional mowing of the low-flow drain running around the perimeter road may be required to maintain preferential flow paths. If grass clippings were left in situ nutrient inputs to the adjacent wetland could occur, with unknown effects downstream.
Explain why these effects are not considered significant	Significant effects on the Lower River Suir SAC arising from sediment or pollutant inputs, and the spread of Japanese knotweed cannot be ruled out. The following sites (1-4) are not in close proximity to, and not linked hydrologically to the proposed development site; in addition, sites 1-3 are designated only for habitats which occur within their boundaries.

Finding of No Significant Effects Report	
	The fact that the Lower River Shannon SAC (002165) lies within a different catchment, combined with its distance from the landfill site precludes impacts to the mobile species for which it is designated. As such, no impacts to these sites in terms of their qualifying interests are likely to occur. 1. Philipston Marsh SAC (001847) 2. Galtee Mountains SAC (000646) 3. Moanour Mountain SAC (002257) 4. Lower River Shannon SAC (002165)

Data Collected to Carry out the Assessment			
Who carried out the assessment	*Sources of Data*	*Level of assessment completed*	*Where can the full results of the assessment be accessed and viewed*
This evaluation was completed by Fehily Timoney and Company	• Information on the designated nature conservation sites within 15 km and whist hydrological link outside the 15 km of the study area was obtained from the NPWS website and metadata available online from the NPWS mapping system (http://webgis.npws.ie/npwsviewer/). • Information on the waterbody catchments in the development area was obtained from the Water Framework Directive Water Mapping Information System http://gis.epa.ie/Envision • OSI Aerial photography and 1:50000 mapping. • Information on the historic landfill site was obtained from the Tier 3 Risk Assessment report located in Appendix 2.	Appropriate Assessment Screening (Stage One)	An Bord Pleanála

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