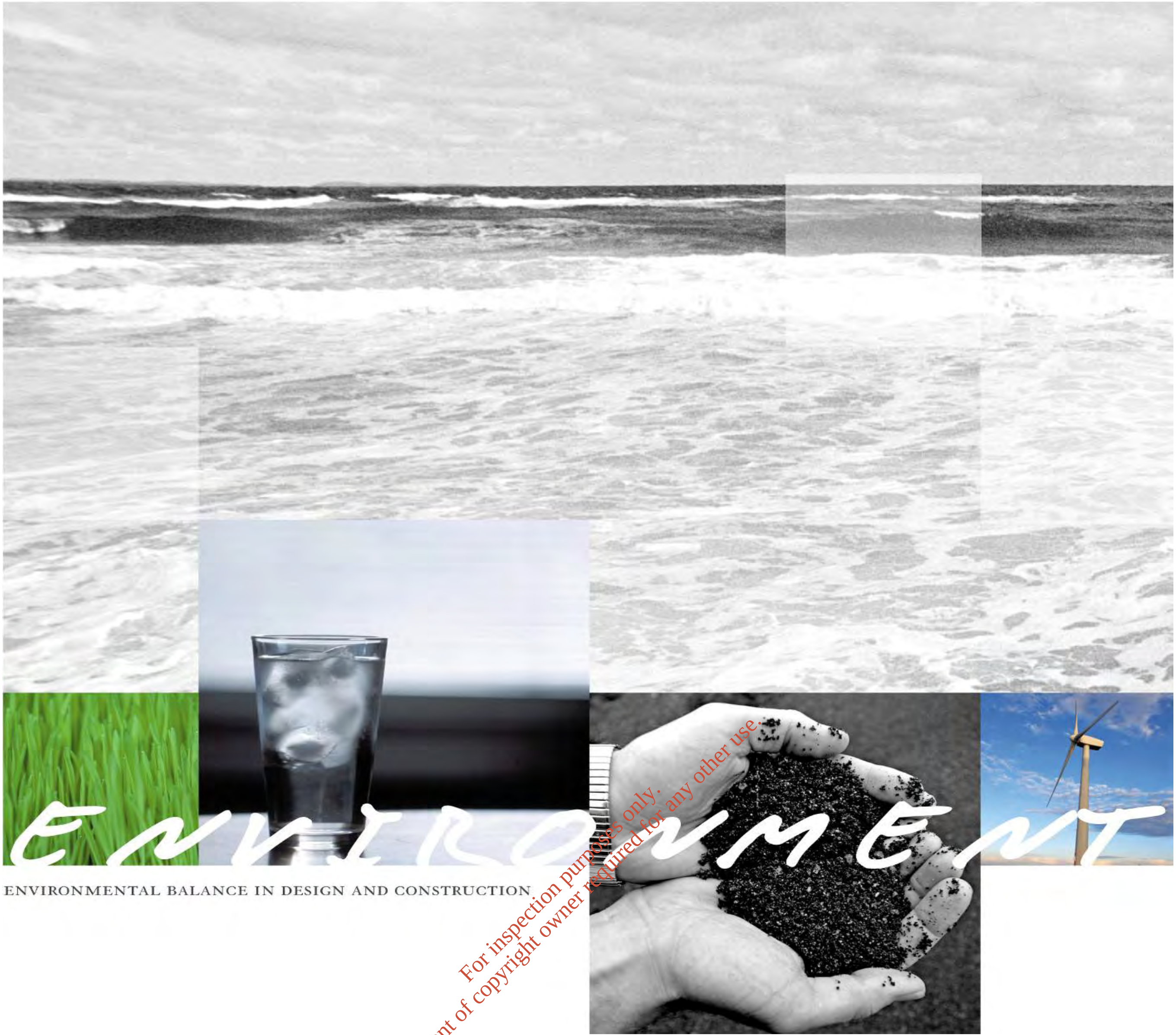

TIER 2 RISK ASSESSMENT

BALLYMULVEY HISTORIC LANDFILL SITE, BALLYMAHON, CO. LONGFORD

NOVEMBER 2018

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TIER 2 RISK ASSESSMENT

BALLYMULVEY HISTORIC LANDFILL SITE, BALLYMAHON, CO. LONGFORD

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Rev. Nr.	Description of Changes	Prepared by:	Checked by:	Approved by:	Date:
0	Issue for Comment	DH	JON	BG	07.11.2018
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Client: Longford County Council

Keywords: Site Investigation, environmental risk assessment, waste, leachate, soil sampling, groundwater sampling,

Abstract: This report represents the findings of a Tier 2 site investigation carried out at Ballymulvey Historic Landfill, Ballymahon, Co. Longford, and conducted in accordance with the EPA Code of Practice for unregulated landfill sites. The site investigation was undertaken to determine the extent of the historic landfilling at the site.

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NON-TECHNICAL SUMMARY

Fehily Timoney & Company (FT) was appointed by Longford County Council (LCC) to complete a Tier 2 environmental risk assessment (ERA) of Ballymahon Historic Landfill in accordance with the Environmental Protection Agency (EPA) Code of Practice (CoP) (2007): *Environmental Risk Assessment for Unregulated Waste Disposal Sites*.

The site is located in Ballymulvey, approximately 1.5 km north-east of Ballymahon, Co. Longford and situated 250m from the junction with the N55 road to the north-west, Toome Cross Roads. It is understood that the site began operation as a landfill sometime in the mid-1960s and ceased sometime in the mid-1990s, following a High Court Order. Despite the lack of written records, it is understood that the site accepted municipal waste/domestic refuse, but no chemical/hazardous waste; although, asbestos containing material (ACM) was accepted and deposited in a discrete area of the landfill.

A Tier 1 study conducted by AECOM determined the site to be a high-risk classification (Class A). The primary risks identified relate to the risk of leachate runoff entering surface water and the risk of leachate migration to groundwater. The completed Tier I study is included as an Appendix 1.

The Tier 2 study, presented herein, consisted of a desktop study, geophysical survey, intrusive site investigation works, environmental monitoring (surface water and groundwater sampling) and laboratory analysis. The results of these works informed the development of the CSM (conceptual site model) and risk screening model.

On the basis that the site was remediated in the early-2000's, a site investigation rationale was devised to assess the suitability of the remedial works and the existing environmental impact from the landfill. Based on the findings of the Tier 1 Risk Assessment, a detailed site walkover and review of the landfill design drawings and historical monitoring results was undertaken. The site investigation works included:

- 4 No. shallow trial pit excavations for capping permeability testing
- 1 No. trial pit to assess the capping profile
- Installation of 3 No. groundwater boreholes
- Surface and Groundwater Water Monitoring

Low infiltration results from the capping permeability testing indicate rapid vertical rainfall migration into the waste body and bedrock aquifer is being prevented by the low permeability fly ash cover. Three new groundwater boreholes (GW01 to GW03) were drilled to depths ranging between 7.50m bgl to 13.5m bgl at the site. The boreholes were drilled and installed as replacement groundwater monitoring locations.

Analysis of groundwater samples obtained from monitoring wells GW01, GW02 (upgradient) and GW03 (down gradient) reported ammonia concentrations which exceed guideline threshold values. The ammonia concentrations at both upgradient boreholes GW01 and GW02 could indicate contamination from the waste body, slurry spreading or from nearby septic tanks as the levels of coliforms detected were high. The highest ammonia concentration of 11.1 mg/l recorded at GW03 is 63-times the groundwater threshold value. At this concentration it is probable to consider that the waste body is impacting water quality and indicates a leachate plume is potentially migrating beyond the landfill boundary.

The peat strata underlying the waste body may also be influencing high levels of ammonia detected in the groundwater.

The low infiltration results from the in-situ permeability testing of the landfill capping material suggest that rapid vertical rainfall migration into the waste body is being minimised. The landfill cap is likely reducing leachate generation within the waste body. Groundwater levels measured indicate that the waste material is below the natural groundwater level at the site, therefore groundwater flow through the waste body is very likely the primary source of leachate generation.

Surface water results shows the surface water quality in the immediate vicinity of the landfill is of poor quality with respect to conductivity and sulphate. However, concentrations reduce further downstream at sampling location SW-G indicating the effect may be local in nature.

The results of the Tier 2 assessment and risk model indicate that the site is being maintained as a **High-Risk Classification (Class A)**. The principal risks identified on the site are the migration of leachate from the site to the groundwater aquifer and the risk posed to the unnamed tributary stream of the River Inny from the migration of landfill leachate from the waste material encountered at the site.

Based on the results of the initial Tier II assessment the site is classified as High Risk. The site is therefore: "considered to pose a significant risk to the environment or human health." For a high-risk site, the CoP indicates that a Tier III Environmental risk analysis be undertaken including a Detailed Quantitative Risk Assessment. Further the site be regularised/authorised in accordance with current waste management legislation.

FT recommended that further groundwater, surface water monitoring and landfill gas monitoring and analysis be undertaken at each monitoring location GW01 to GW03; BH5, BH6 and all surface water locations (where possible). The results of this analysis will be used to confirm the conclusion of this report and future Tier III report.

1 INTRODUCTION

1.1 Background

Ballymulvey Landfill is located approximately 1.5 km north-east of Ballymahon, Co. Longford and is situated approximately 250m from the junction with the N55 road to the north-west, Toome Cross Roads. The site was formerly operated as a municipal waste landfill by Longford County Council (LCC) and is registered as a historic landfill with the EPA (Section 22 register).

Under Waste Management Regulations, LCC is required to complete a tiered risk assessment of historic waste disposal sites in accordance with the Environmental Protection Agency (EPA) Code of Practice for Unregulated Waste Disposal Sites. Once the risk assessment and, if necessary, remediation plans have been prepared to the satisfaction of the EPA, an application can be made for the granting of a Certification of Authorisation to demonstrate compliance with the regulations.

A data gap analysis and Tier 1 Assessment completed by AECOM in September 2017 determined that the site had a risk classification of High (Class A) based on risk of leachate runoff entering surface waters and the risk of leachate migration to groundwater.

1.2 Scope of Works

FT's scope of work was to undertake a Tier 2 assessment of the site in accordance with the EPA Code of Practice (CoP) 2007: *Environmental Risk Assessment for Unregulated Waste Disposal Sites*. This approach required the completion of the following:

- Desk Study
- Detailed Site Walkover
- Intrusive Site Investigation
- Groundwater and Surface Water sampling
- Leachate Testing
- Environmental Risk Assessment (ERA)
- Geophysical and surveying to estimate extents and depths of waste
- Development of a conceptual site model (CSM)

As part of the initial desk study, a review of all available information was undertaken. This was followed-up with a site walkover by FT personnel. The desk study and site walkover were used to determine the locations for the intrusive site investigation.

FT appointed Priority Geotechnical (PGL) to conduct the site investigation which included; excavation of trial pits for testing existing capping permeability and the installation of three onsite groundwater monitoring boreholes.

Trial pits were excavated to provide an assessment of the suitability of the existing landfill capping. Three new groundwater monitoring boreholes were installed to assess the impact, if any, of the onsite groundwater. The existing leachate boreholes were sampled to assess the type and strength of the leachate encountered in the waste body.

Laboratory analysis of soil samples (geotechnical testing), groundwater and leachate were conducted to assess and quantify any potential or ongoing environmental impacts.

The information gathered from the desk study and intrusive site investigation were used to inform the development of both the CSM and the Environmental Risk Assessment (ERA). This report presents the findings of the assessment.

2 DESK STUDY

2.1 Introduction

The desk study included the review of the following literature sources and websites:

- Geological Survey of Ireland, Groundwater Web Mapping: www.gsi.ie
- Environmental Protection Agency Maps: www.epa.ie
- National Parks and Wildlife Service Map Viewer: www.npws.ie
- BS 5930: 1999, Code of Practice for Site Investigations
- BS 10175: 2000, Investigation of Potentially Contaminated Sites – Code of Practice

A desktop review of all available documentation for the site was conducted followed by a detailed site walkover. The documentation made available to FT for the desktop review included the data gap analysis and Tier 1 Assessment prepared by AECOM on 27th September 2017.

2.2 Desk Study

This section of the report presents the findings of the desk study.

2.2.1 Site Description & On-Site Conditions

The site is located in Ballymulvey, approximately 1.5 km north-east of Ballymahon, Co. Longford. The site is situated on the south-western side of the L1121 roadway, with access to the site through a locked gateway 250 m from its junction with the N55 road to the north-west, Toome Cross Roads.

From available maps it is estimated that the site is 4.3 ha in area, with 50% of the site occupied by the waste body which is made up of two profiled and capped landfill mounds covered in vegetation. An open water lagoon area which is overgrown with vegetation is situated along the eastern boundary of the site. Previously installed landfill monitoring infrastructure (leachate / groundwater wells) are located across the footprint of the site.

An aerial photograph of the site is shown in Figure 2.1, overleaf.

2.2.2 Previous Studies

A Datagap Analysis and Tier 1 Assessment completed by AECOM on 27th September 2017 which comprised the following:

- Interpretation of historical monitoring data provided by LCC with data for landfill gas, surface water, leachate and groundwater collated between 1992 and 2014;
- Identification of contaminant sources, pathways of contaminant migration and potential receptors which may be vulnerable if exposed to those contaminants; i.e. the identification of Source- Pathway-Receptor (SPR) linkages;
- The prioritisation of sites and SPR linkages based on their perceived risk; and,
- Development of a conceptual site model (CSM)

Based on the available information, the Tier 1 Assessment determined that the overall risk score for Ballymulvey Landfill was 70%, resulting in a risk classification of High (Class A).

A copy of this assessment is included in Appendix 1.

Map Path: R:\Map Production\2018\P1444\Workspace\Ballymulvey Historic Landfill\P1444_Fig2-1_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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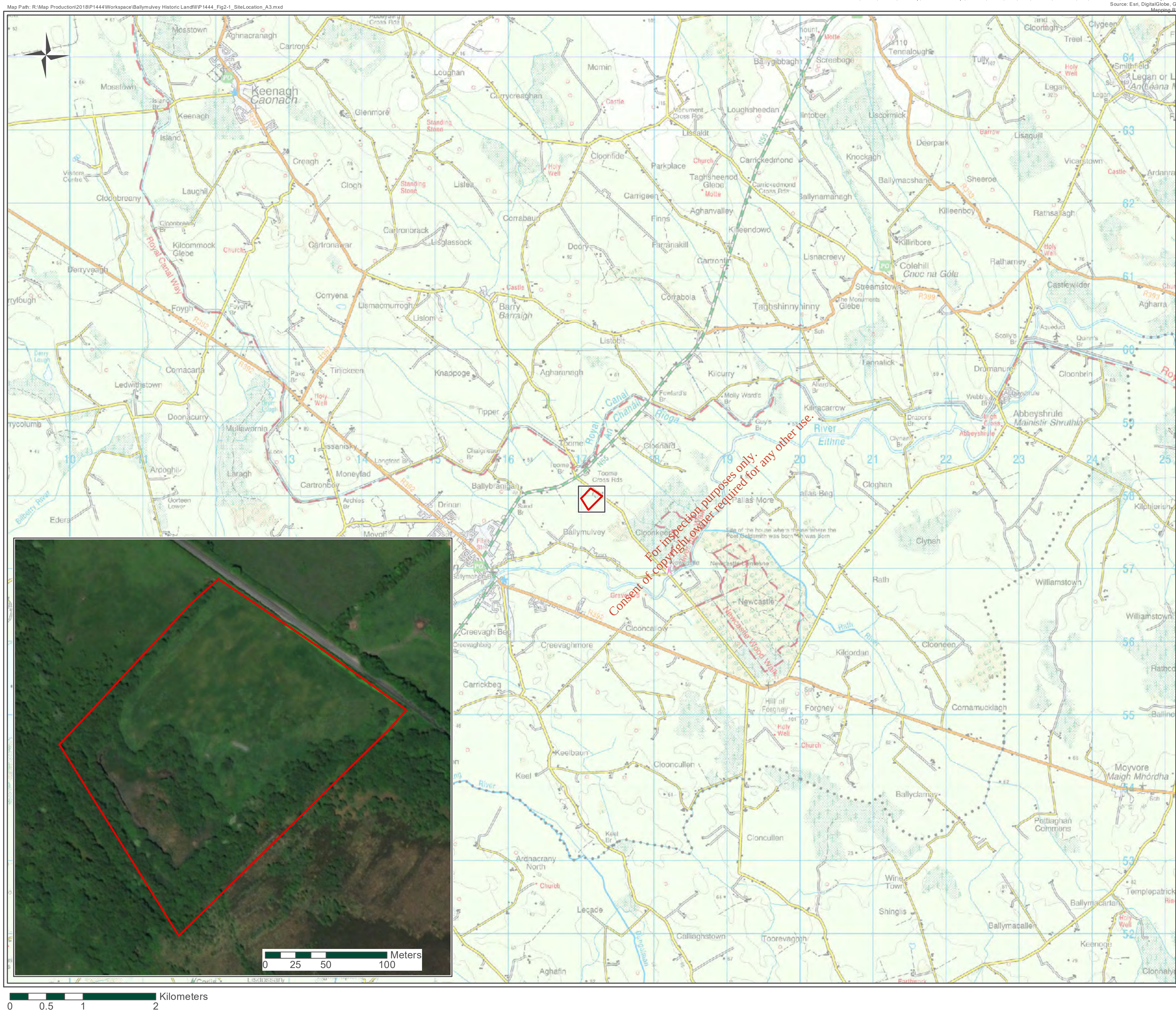

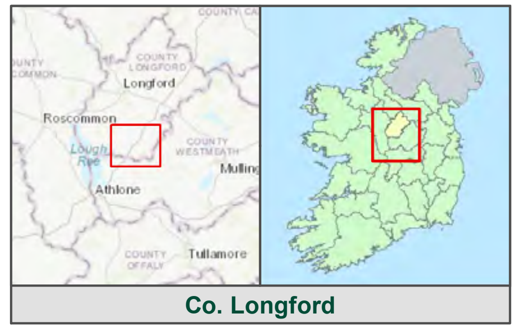

Legend

Site Boundary

Figure Title	Site Location Plan and Aerial View
Figure No.	2.1
Project	Historical Landfills: Ballymulvey
Client	Longford County Council
Scale	1:50,000
Page Size	A3
Revision	A
Date	29/08/2018

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2.2.3 Topography

The countryside surrounding the site is generally quite flat, undulating between 50 m and 60 m above Ordnance Datum (OD). There is a gentle topographic gradient from north/north-east to south/south-west, generally towards the River Inny to the south of the site.

2.2.4 Geology

Drift/Quaternary Geology

The Quaternary Map provided by GSI Online identifies the quaternary sediments at the site as cut-away raised bog, with limestone gravel to the north of the L1121 and in zones to the south of the site. To the west, overburden is comprised of glacial till derived from sandstone gravels and cherts (see Figure 2.2).

During the installation of boreholes during the site investigation, the presence of peat and gravel strata is described in the drillers logs to a depth of approximately 7.5m BGL at borehole GW03, see PGL borehole logs, Appendix 3.

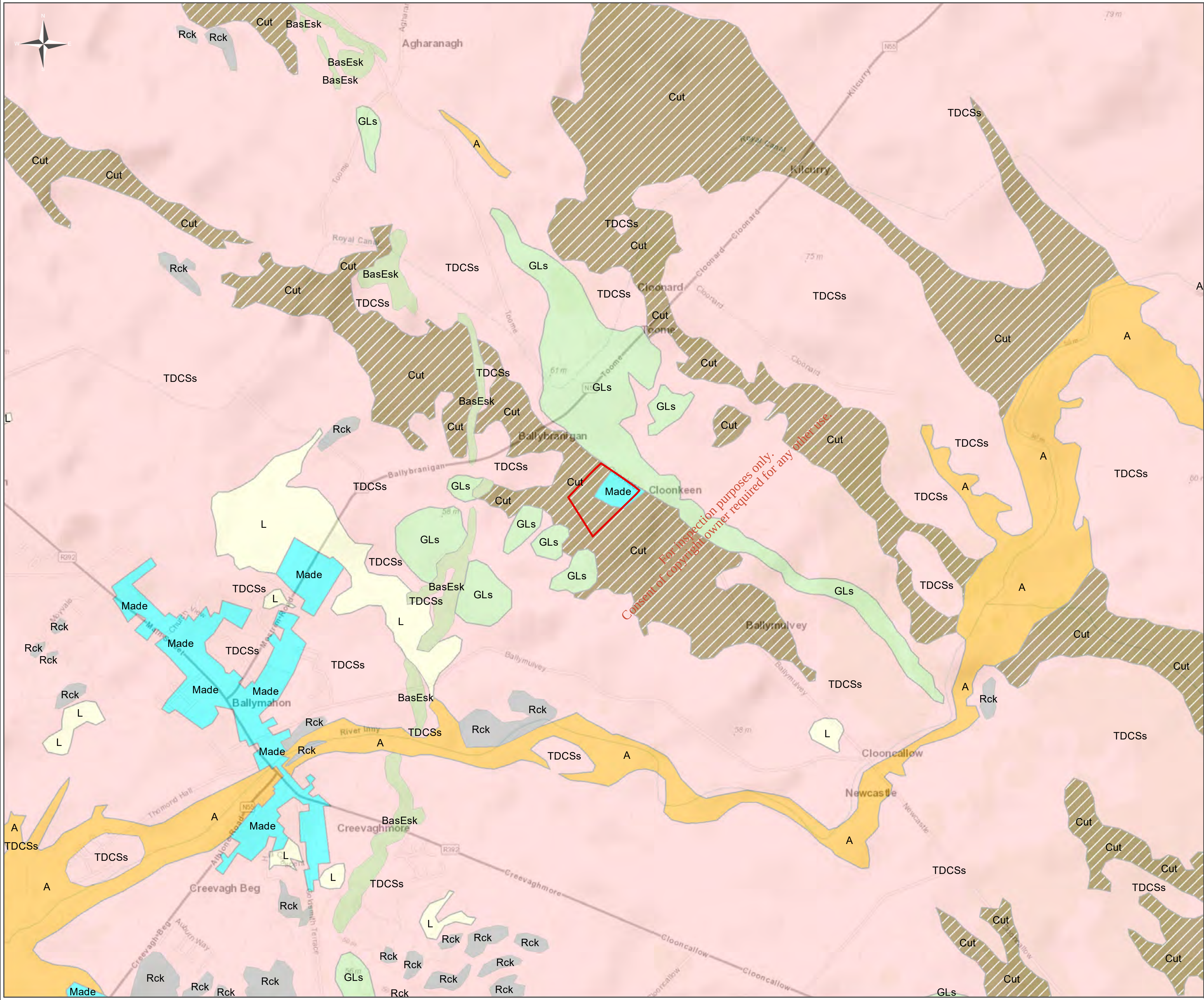
Solid or Bedrock Geology

The GSI online 1:100,000 scale bedrock geology map, shows the bedrock beneath the site is Waulsortian Limestone – massive, unbedded, pale grey limestone and mudstone of the Carboniferous era. The closest outcrop of bedrock to the site is 1 km to the west at Ballybranigan. A well record for the townland of Ballymulvey indicates that the depth to bedrock at that location was 0.6 m.

The bedrock geology is presented in Figure 2.3.

Limestone bedrock was encountered at a depth of 10.5m bgl in boreholes GW02 and GW03 during borehole installations as referenced in the PGL borehole logs, Appendix 3.

Map Path: R:\Map Production\2018\P1444\Workspace\Ballymulvey Historic Landfill\P1444_Fig2-2_QuaternaryGeology_A3.mxd



0 0.5 1 2 Kilometers

Co. Longford

Legend

Site Boundary

Subsoils Data

- A, alluvium
- BasEsk, basic esker sands and gravels
- Cut, cutover peat
- GLs, limestone sands and gravels - Carboniferous
- L, lake sediment
- Made, made ground
- Rck, bedrock at surface
- TDCSs,

Figure Title	Quaternary Geology
Figure No.	2.2
Project	Historical Landfills: Ballymulvey
Client	Longford County Council
Scale 1:15,000	**Page Size** A3
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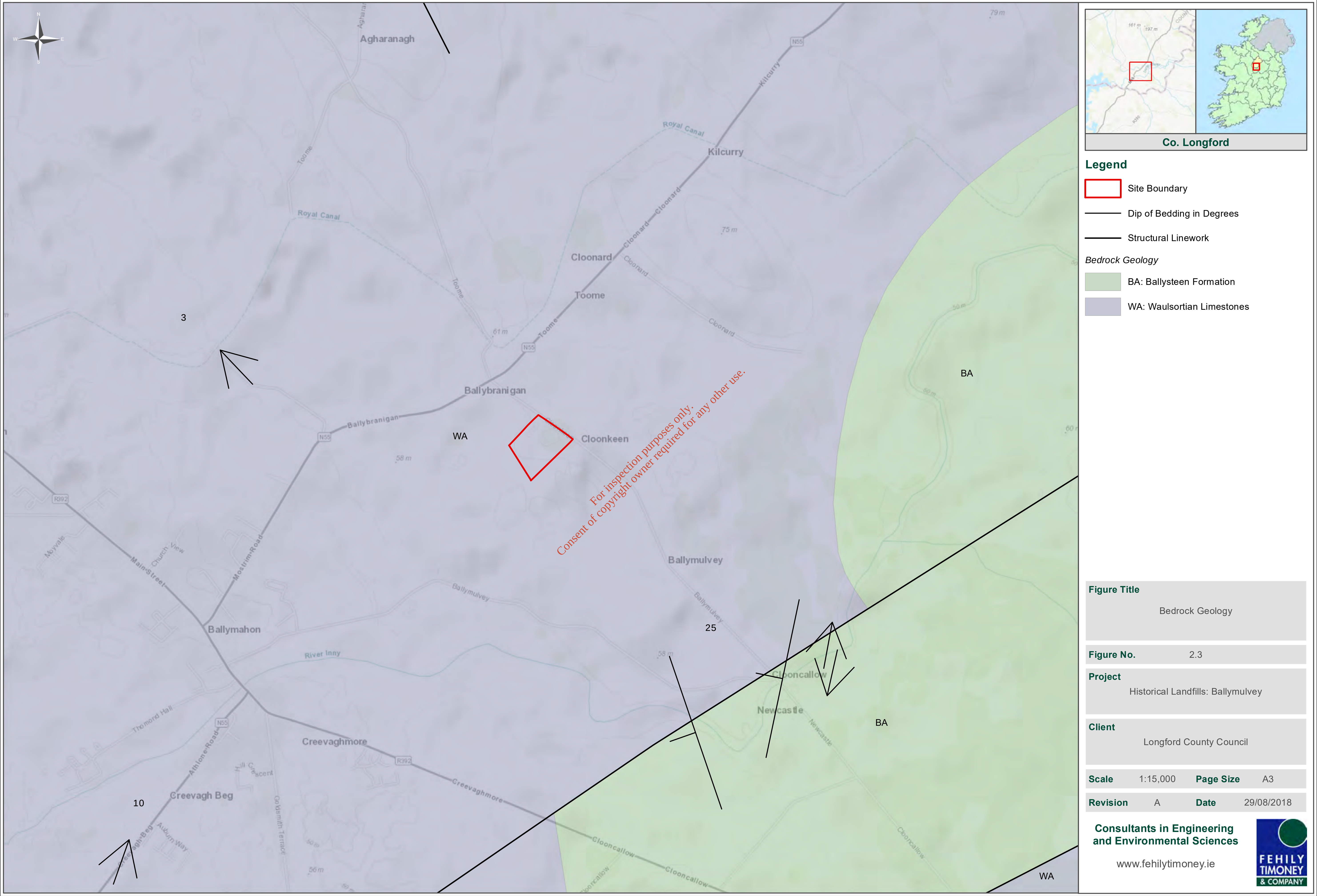
Map Path: R:\Map Production\2018\P1444\Workspace\Ballymulvey Historic Landfill\P1444_Fig2-3_BedrockGeology_A3.mxd



0 | 0.5 | 1 | 2 Kilometers

Legend

- Site Boundary
- Dip of Bedding in Degrees
- Structural Linework

Bedrock Geology

- BA: Ballysteen Formation
- WA: Waulsortian Limestones

Figure Title
Bedrock Geology

Figure No. 2.3

Project
Historical Landfills: Ballymulvey

Client
Longford County Council

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2.2.5 Hydrogeology

An examination of the national bedrock aquifer map on the GSI online mapping identified that the aquifer underlying the site is classified as a locally important aquifer which is moderately productive in local zones. The bedrock aquifer mapping is presented in Figure 2.4.

There are no wells or springs within the site boundary. According to the GSI website, one borehole of unknown use is located within 500m south-west of the site. The single well record near the site indicates that the well dates from the nineteenth century and was drilled to a depth of 19.2 m below ground level. The abstraction rate is not noted and, given its age and its location between 150 m and 1.15 km south of the site, it is considered likely that it was for domestic/agricultural use. Whether the well remains in use or not is not recorded. There are no zones of contribution for a groundwater sourced public or group water scheme within a 10 km radius of the site.

Table 2.1 presents the details of the borehole within 1km of the site.

Table 2.1: Borehole Description near the Project Site

BH ID/Spring	Yield class	Yield (m^3/d)	Use	Depth (m)	Depth to Rock Confidence	Distance from site (km)	Date
2025SEW002	Moderate	98.1	Unknown	19.2	0.6	0.5	1899

There are no Groundwater Drinking Water Protection Areas within the site boundaries according to GSI. The closest groundwater protection area to the site is approximately 12.5 km to the west of the site in the Townland of Newtowncashel. The inner protection area of the water body is 2.55 km^2.

The potentiometric mapping completed as part of the Tier 2 site investigation works has determined the direction of groundwater flow is to the south/south-west, towards Ballymahon (see Section 4.2, Figure 4.1).

The Water Framework Directive Groundwater Bodies dataset from GSI shows that the groundwater body (GWB) is named Inny and has a poorly productive bedrock flow regime. Groundwater flow will be concentrated in fractured and weathered zones and near fault zones (these rocks do not exhibit intergranular permeability). Groundwater flow paths will be short, in general between 30 and 300 m, with groundwater discharging locally to rivers and streams. Most groundwater flow is likely to circulate in the upper tens of metres of bedrock, recharging and discharging in local zones. The site is within the Shannon River Basin District.

The GSI mapping showing approximate locations of known wells and springs is included in Figure 2.5.

Map Path: R:\Map Production\2018\P1444\Workspace\Ballymulvey Historic Landfill\P1444_Fig2-4_AquiferClassification_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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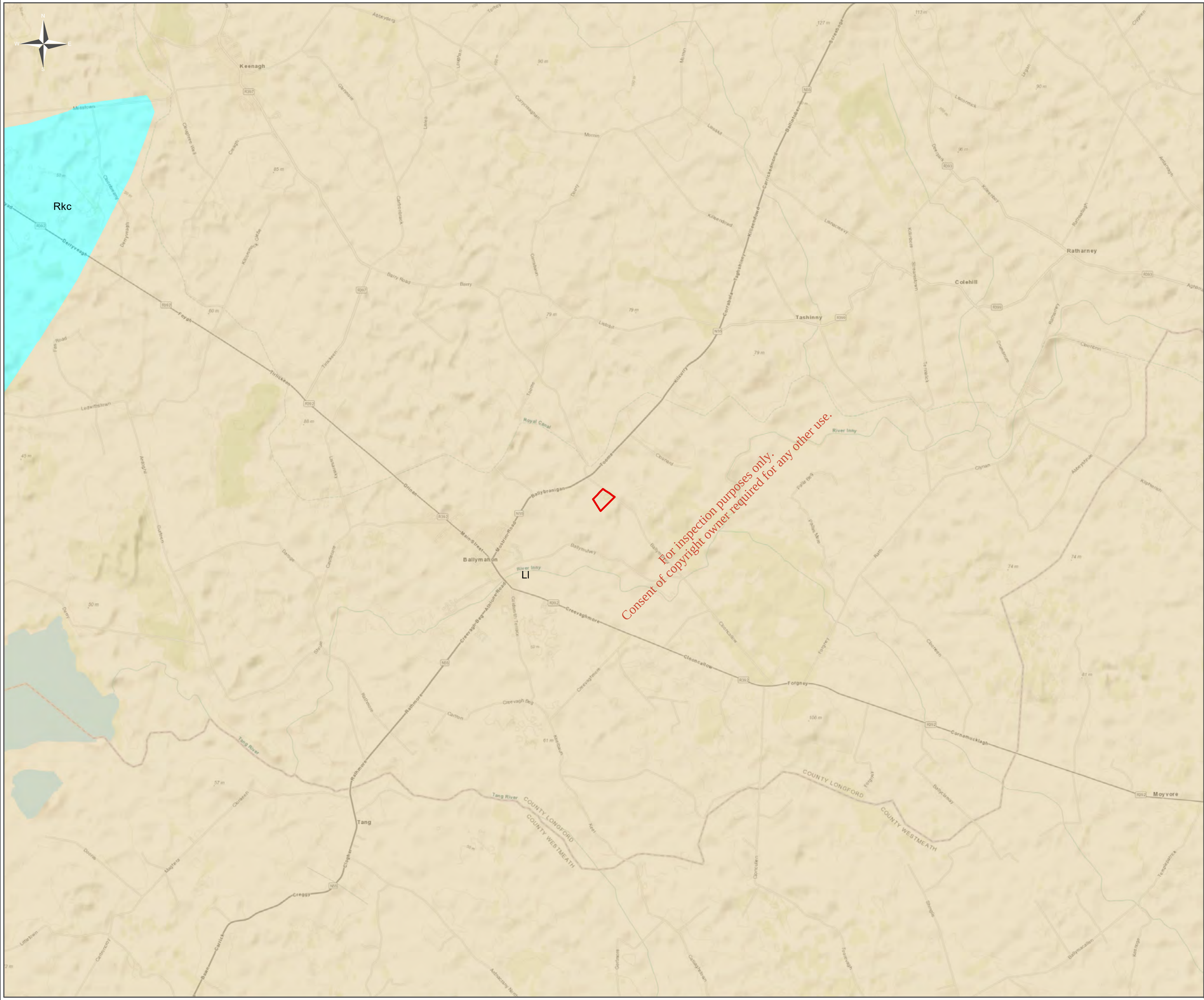

Kilometers
0 0.5 1 2

Co. Longford

Legend

- Site Boundary
- LI: Locally Important Aquifer - Bedrock Mod Productive Locally
- Rkc: Regionally Important Aquifer - Karstified (conduit)

Figure Title
Aquifer Classification

Figure No. 2.4

Project
Historical Landfills: Ballymulvey

Client
Longford County Council

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Map Path: R:\Map Production\2018\P1444\Workspace\Ballymulvey Historic Landfill\P1444_Fig2-5_WellsAndSprings_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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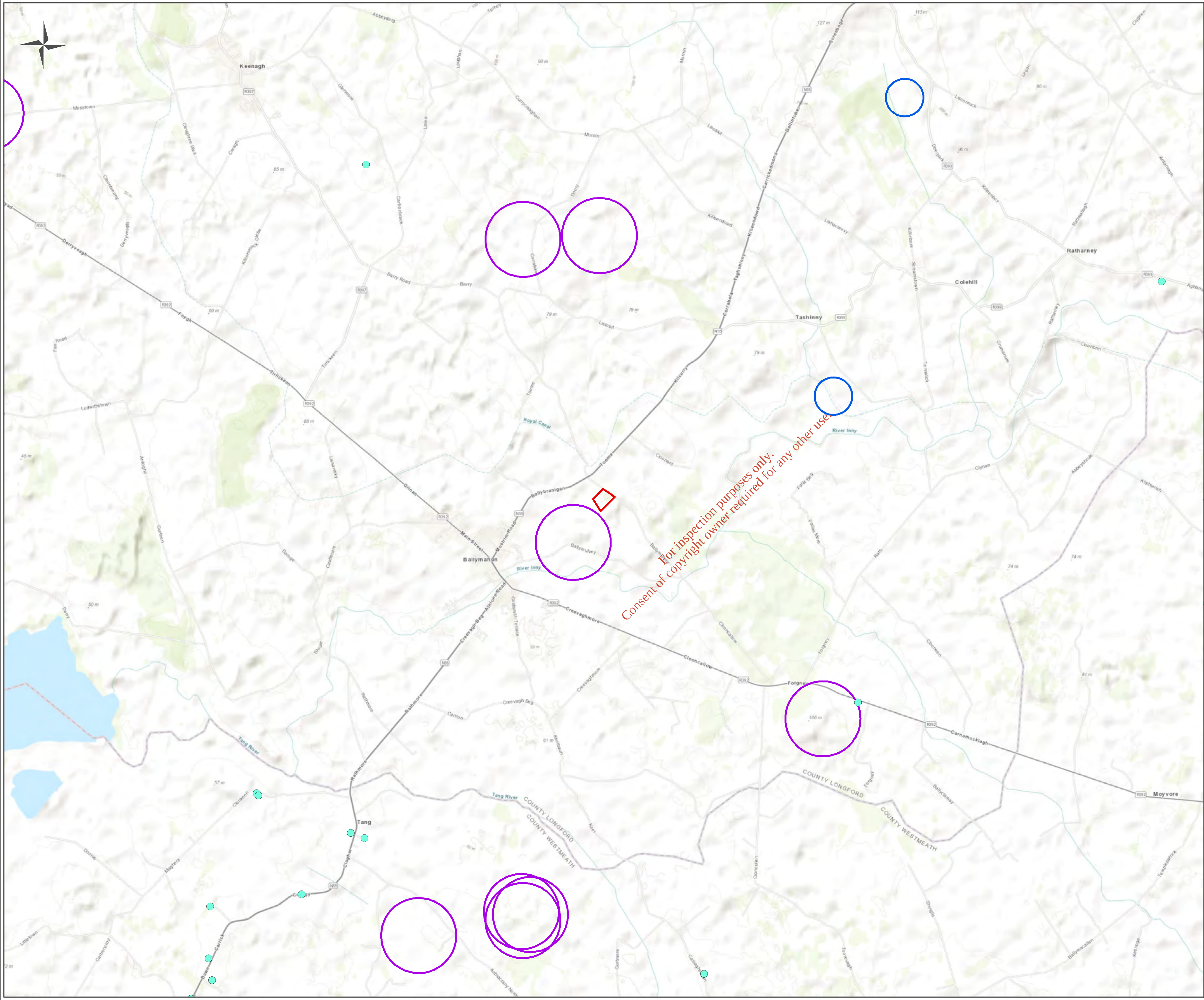

Co. Longford

Legend

- Site Boundary
- Groundwater Well (10-50m Accuracy)
- Groundwater Well (50-100m Accuracy)
- Groundwater Well (100-200m Accuracy)
- Groundwater Well (200-500m Accuracy)
- Groundwater Well (500m-1km Accuracy)

Figure Title	Wells and Springs
Figure No.	2.5
Project	Historical Landfills: Ballymulvey
Client	Longford County Council

Scale	1:50,000	**Page Size**	A3
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0 0.5 1 2 Kilometers

2.2.6 Groundwater Vulnerability

Groundwater vulnerability, as defined by the GSI, is the term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities.

The factors used in assessing groundwater vulnerability include subsoil type and thickness and recharge type as indicated in Table 2.2. The GSI procedure whereby groundwater protection is assessed is outlined in the EPA-GSI publication *Groundwater Protection Schemes* (DELG/EPA/GSI, 1999).

The GSI Online mapping data set identifies the vulnerability of groundwater to contamination is classified as moderate, given the presence of cut-away raised bog and deep glacial till overburden. The Groundwater Vulnerability mapping is presented in Figure 2.6.

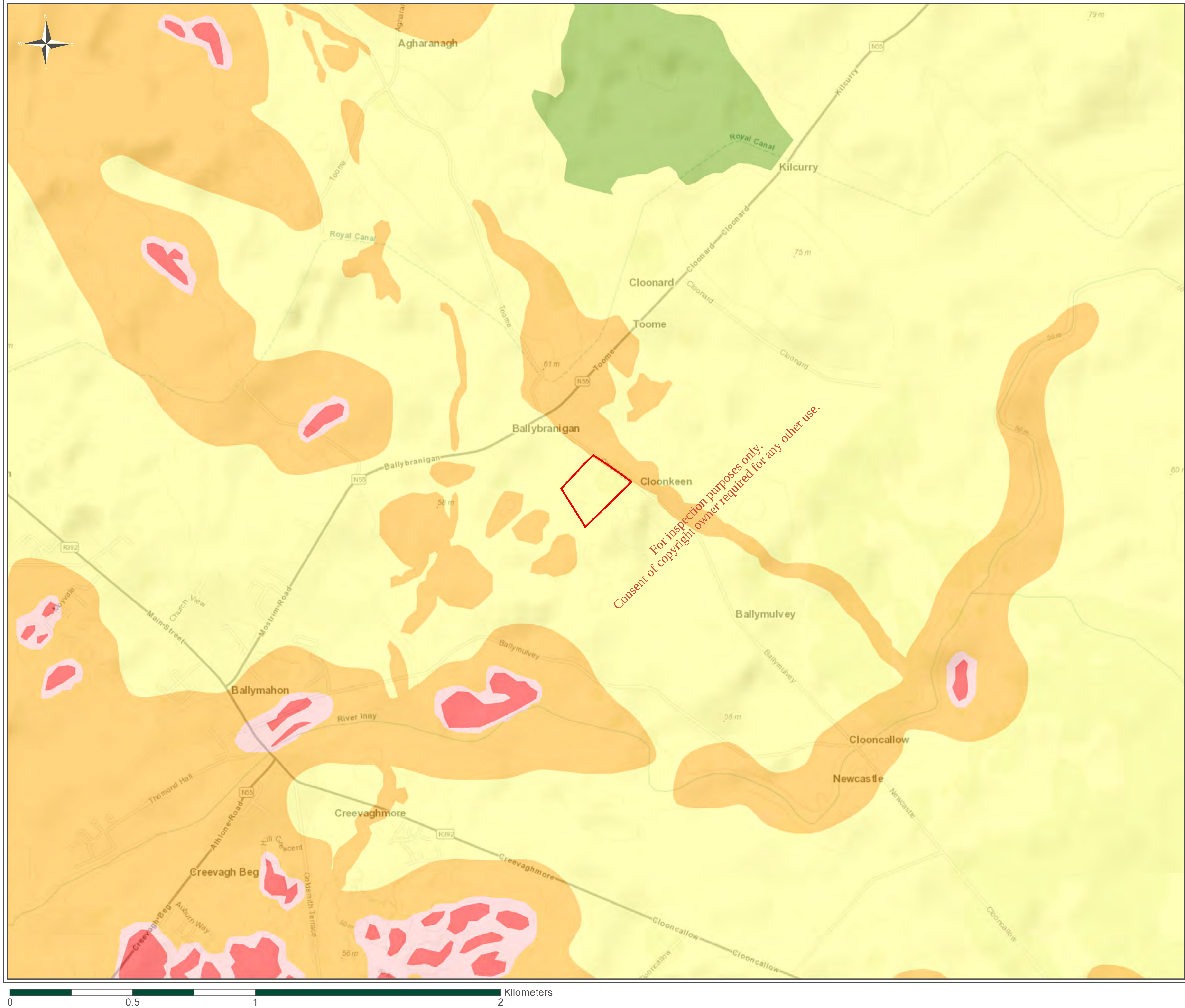
The recharge coefficient associated with the cut-away bog underlying the site is 4% and the recharge rate is 200mm/year.

Table 2.2: GSI Guidelines – Aquifer Vulnerability Mapping

Vulnerability Rating	Hydrogeological Conditions		
	Subsoil Permeability (Type) and Thickness		
	High Permeability (Shallow Bedrock)	Moderate Permeability (e.g. Sandy soil)	Low Permeability (e.g. Clayey subsoil, clay, peat)
Extreme (E)	0 - 3.0 m	0 - 3.0 m	0 - 3.0 m
High (H)	>3.0 m	3.0 -10.0 m	3.0 - 5.0 m
Moderate (M)	N/A	>10.0 m	5.0 - 10.0 m
Low (L)	N/A	N/A	>10 m

Notes:
N/A = Not Applicable
Precise permeability values cannot be given at present

Map Path: R:\Map Production\2018\P1444\Workspace\Ballymulvey Historic Landfill\P1444_Fig2-6_GroundwaterVulnerability_A3.mxd



Co. Longford

Legend

Site Boundary

Groundwater Vulnerability

- E - Extreme
- H - High
- M - Moderate
- L - Low
- Water
- X (Rock Near Surface or Karst)

Figure Title Groundwater Vulnerability

Figure No. 2.6

Project Historical Landfills: Ballymulvey

Client Longford County Council

Scale 1:15,000 **Page Size** A3

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2.2.7 Hydrology

At its closest point the River Inny is 900 m south of the site. The River Inny flows from north-east to south-west along the south-eastern boundary of Cloonkeen Woods. Approximately 1.5 km south-east of the site the flow direction of the River Inny changes course to a more westerly direction, and the river passes through Ballymahon 1.6 km southwest of the site. Approximately 350 m north-west of the site is the Royal Canal at Toome Bridge.

The EPA has classified the River Inny as being of Good Status (Q4) at the following monitoring locations:

- Newcastle Bridge, RS261011200 1.5 km south-east of the site, based on data from 2004 to 2016
- Ballymahon Bridge, RS26101300 1.6 km south-west of the site, based on date prior to 2004
- Shrule Bridge, RS261011350 4 km south-west of the site, based on data from 2004 to 2016

The River Inny is not used for public water supply purposes down-gradient of the site. An unnamed tributary of the River Inny, flowing from north to south, is mapped along the N55 approximately 700 m west of the site. Several land drains are also mapped between the site and this tributary which appear to feed into the Inny.

There is no record of a flood event within 1.5 km of the site. However, stretches of the River Inny to the south-west of Ballymahon have been known to flood. In 2009 Longford, including areas around Ballymahon, suffered a one in 50-year flood which caused considerable damage to residential and commercial properties, but this did not affect the site.

2.2.8 Ecology

There are no Special Areas of Conservation or Special Protection Areas within a 5 km radius of the site.

The Royal Canal proposed National Heritage Area (pNHA) flows east-west approximately 500m north of the site. The Royal Canal is a man-made waterway linking the River Liffey at Dublin to the River Shannon near Tarmonbarry. There is a branch line from Kilashee to Longford Town. The canal pNHA comprises the central channel and the banks on either side of it. The main water supply is from Lough Owel (also an NHA) via a feeder channel into the canal at Mullingar.

The ecology protected areas mapping is presented in Figure 2.7.

2.2.9 Site Development History

The 25'' historical mapping (1888-1913) indicates that the site was boggy, and several land drains appear to have been installed, particularly across bogland to the east/south-east of the site which may be relics of peat cutting activity. A gravel pit is evident approximately 150 m north-east of the site. The thick hedgerow was still present along the roadside boundary. A spring is mapped to the north-west of Toome Cross Roads, approximately 400 m north west of the site.

The OSI Historical 25'' Mapping is presented in Figure 2.8.

The site began operating as a landfill in the mid-1960s and ceased in the mid-1990s, following a High Court Order. The site had operated as the primary county landfill following the closure of the Cartron Big Historic Landfill in the late 1980's, prior to this the landfill has served the local needs of Ballymulvey and surrounding areas. Despite the lack of written records, it is understood that the site accepted household waste, but no chemical/hazardous waste; although, asbestos containing material (ACM) was accepted and deposited in a discrete area of the landfill (see Appendix 2 – Site Drawings and Plans).

From the limited records that are available, it appears that the ACM waste originated from Lanesborough Power Station, located 20 km north-west of the site. The ACM waste was accepted on site between 22 and 27 July 1987 and was brought to site double-bagged and marked as 'Danger Asbestos' and 'Do Not Inhale'. A discrete hole was excavated 75 m in from the roadside boundary and 10 m from the north-western boundary fence. The excavation was 19 m in length (parallel to the L1121) and 4 m in width (parallel to the boundary fence).

Records indicate that approximately 1.8 m of double-bagged ACM waste was buried beneath of 0.6m to 1.0m of sand, with an additional 1.2m layer of refuse above this. The final cover on the ACM is estimated to be between 3 m to 3.7 m in thickness.

An aerial photograph of the site from 1995 shows the site with ongoing works. Most activity appears to be in the eastern quadrant of the site. There does not appear to be any structures or buildings present.

Two site maps dating from May 1997 (Ref: F061-01_A and F061-02_B) are included in Appendix 2 and indicate that waste disposal activities continued within three separate cells. The second drawing (F061-02_B) illustrates how the waste body was to be capped and the top profiled to form two separate mounds, one either side of the entrance gate running north-east to south-west.

The site was remediated to its current standard in two phases, first the site was capped and profiled to its current profile using ash from the local peat burning power plant in the late 1990's, the second stage works comprised the importation and placement of a topsoil cover atop this fly ash capping in 2003.

2.2.9.1 Site Remediation Works

Aerial photograph from 2000 (see Plate-1 and Plate-2) shows the site is in the process of being capped and profiled, remediation works at the site are likely to have commenced sometime between 1998 and 2000.

Plate 1-1: OSi Aerial 1995 **Plate 1-2: OSi Aerial 2000**

A site plan included in Appendix 2 (Drawing Ref: BLS-01), dates from 2001 and illustrates the "as built" condition of the site following reinstatement. It is broadly consistent with the proposed drawing from 1997. The crest heights are slightly higher than those proposed; Bund 1 is completed at 61 m above OD while Bund 2 is 63 m above OD. A network of stone filled gas trenches are illustrated with six passive vents (1 to 6) and four gas monitoring points (G4 to G7). However, no stone filled leachate drains or toe-drain are illustrated. Two leachate monitoring points within the waste body are present, BH5 and BH6.

The 2005 aerial photograph shows the profiled cap to be covered in vegetation. In this aerial photograph no open water is visible in the lagoon area, it appears to be vegetated. In none of the aerial photographs are structures or buildings apparent.

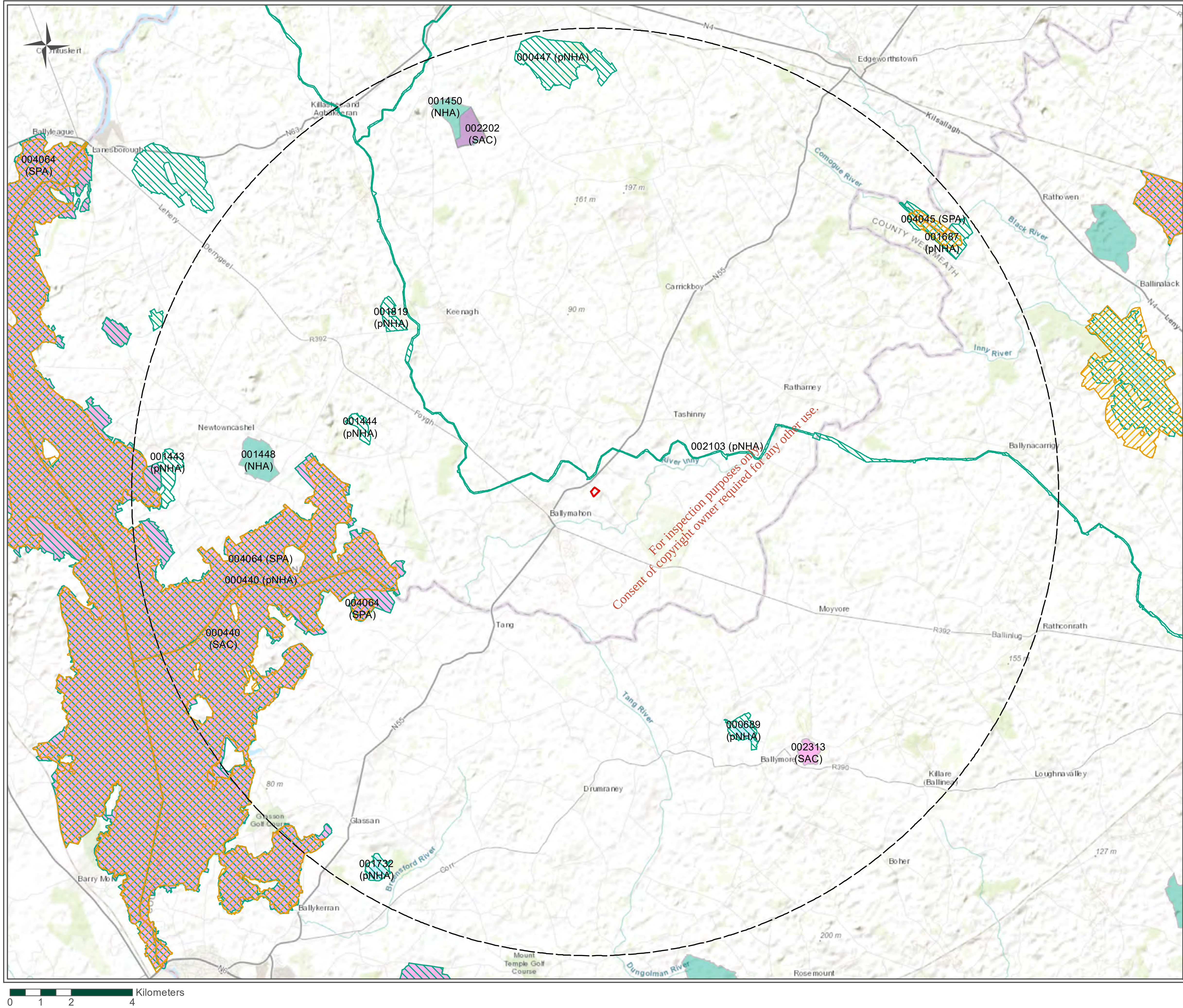
2.2.10 Existing Geological Heritage

There are no Geological Heritage sites within the site boundary according to the GSI Geological Heritage map layer. The nearest recorded area of Geological Heritage held by the GSI is the Ballymahon Esker located approximately 2.0 km south of the project site. It comprises good examples of a beaded esker with geological features showing '*an elongated ridge of sands and gravels deposited under the ice sheet at the end of the Ice Age'*. The geological heritage mapping is presented in Figure 2.9.

2.2.11 Archaeological Heritage

There are no Archaeological Heritage sites with the site boundary according to the Heritage Ireland GSI Geological Heritage map layer.

Map Path: R:\Map Production\2018\P1444\Workspace\Ballymulvey Historic Landfill\P1444_Fig2-7_EcologyProtectedSites_A3.mxd



Co. Longford

Legend

- Site Boundary
- 15km Distance from Site Boundary

Special Protection Area (SPA)

- Closest Site: 6.8km

Proposed Natural Heritage Area (pNHA)

- Closest Site: 0.4km

Special Area of Conservation (SAC)

- Closest Site: 6.5km

Natural Heritage Area (NHA)

- Closest Site: 10.2km

Figure Title

Ecology: Protected Sites

Figure No. 2.7

Project

Historical Landfills: Ballymulvey

Client

Longford County Council

Scale 1:120,000 **Page Size** A3

Revision A **Date** 29/08/2018

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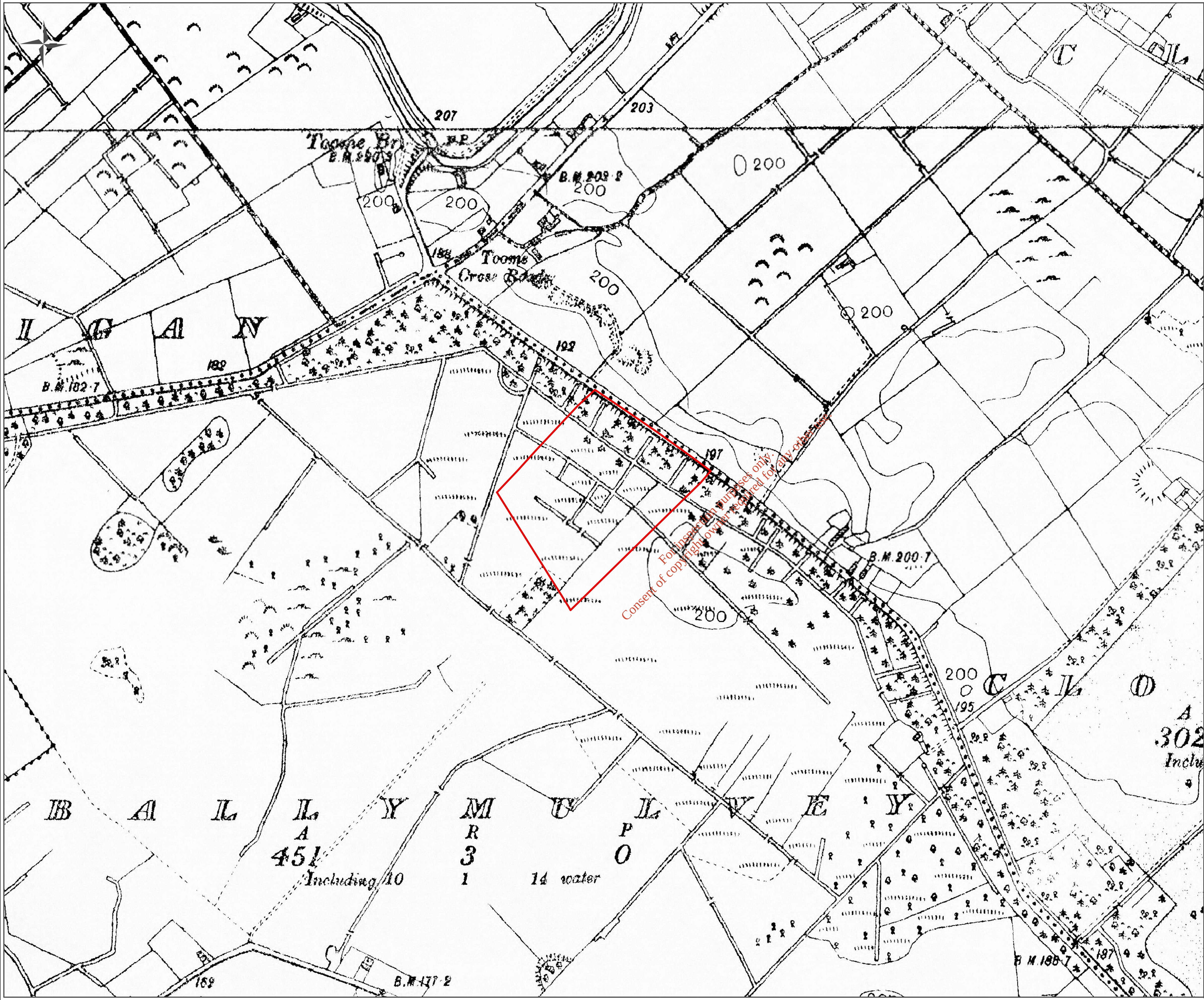
Map Path: R:\Map Production\2018\P1444\Workspace\Ballymulvey Historic Landfill\P1444_Fig2-8_OSiHistoricalMapping_A3.mxd

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



0 100 200 400 Meters

Co. Longford

Legend

Site Boundary

Figure Title	OSi Historical Mapping
Figure No.	2.8
Project	Historical Landfills: Ballymulvey
Client	Longford County Council
Scale 1:5,000	**Page Size** A3
Revision A	**Date** 29/08/2018

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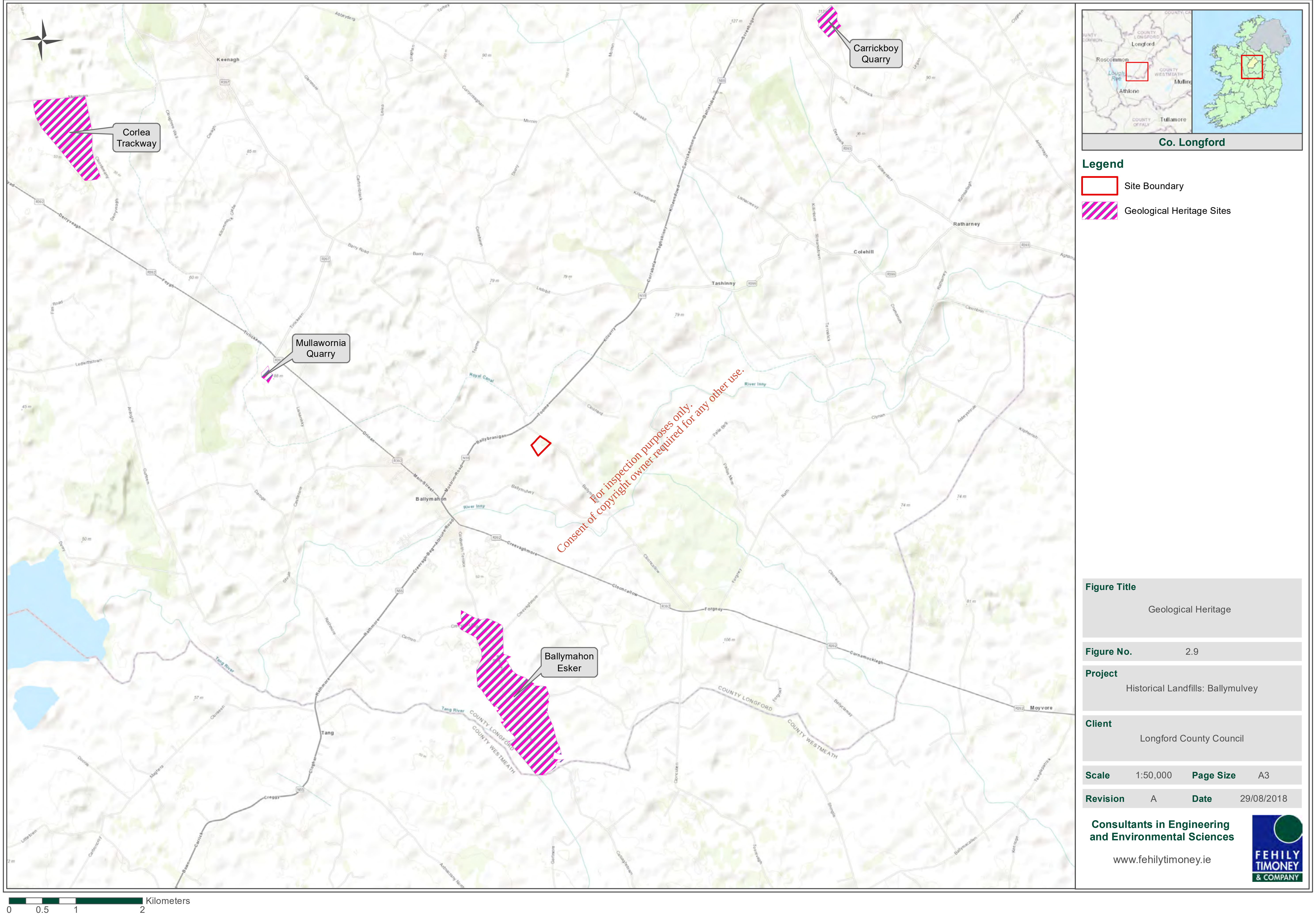

Figure Title	Geological Heritage
Figure No.	2.9
Project	Historical Landfills: Ballymulvey
Client	Longford County Council
Scale	1:50,000
Page Size	A3
Revision	A
Date	29/08/2018

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3 TIER 2 SITE INVESTIGATION

3.1 Site Investigation Works

On the basis that the site was remediated in the early-2000's, a site investigation rationale was devised to assess the suitability of the remedial works and the existing environmental impact from the landfill. Based on the findings of the Tier 1 Risk Assessment, a detailed site walkover and review of the landfill design drawings and historical monitoring results, the scope of the site investigation works included:

- 4 No. shallow trial pit excavations for capping permeability testing
- 1 No. trial pit to assess capping profile
- Installation of 3 No. groundwater boreholes
- Surface and Groundwater Water Monitoring
- Factual reporting

The site investigation included the review of the following literature sources and websites:

- EPA 2003, Landfill Manuals: Landfill Monitoring (2nd Edition)
- EPA 1999, Landfill Manuals: Site Investigations
- CLR Report No. 4 1994 – Sampling Strategies for Contaminated Land, DoE, Contaminated Land Research (CLR) Report
- BS 5930: 1999, Code of Practice for Site Investigations
- BS 10175: 2000, Investigation of Potentially Contaminated Sites – Code of Practice
- BS 6068 Water Quality: Sampling (parts 6.1-6.6 and 6.11-6.12, 6.14)
- BS 8855 Soil analysis (all parts)
- CLM: Ready Reference 2002, Section 3.1 Soil sampling strategies
- CLM: Ready Reference 2002, Section 3.2 Groundwater sampling/monitoring strategies
- CLM: Ready Reference 2002, Section 3.3 Gas sampling/monitoring strategies

3.1.1 Site Walkover

A site walkover was conducted on the 26th June 2018 prior to site investigation works by LCC and an FT representative. During the site walkover the scope of the investigative works were evaluated based on the findings in the Tier I assessment and additional information provided by LCC. A site walkover checklist and photolog are provided in Appendix 5.

The scope was agreed based on the site walkover assessment, "as built" drawings and other information received by LCC. The locations of the intrusive works at the site are presented in Figure 3.1.

A site walkover checklist and photographic log are provided in Appendix 5.

Map Path: R:\Map Production\2018\P1444\Workspace\Ballymulvey Historic Landfill\P1444_Fig3-1_SiteInvestigationLocationPlan_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

- Groundwater Well
- Leachate Well
- Site Boundary

Figure Title	Site Investigation Location Plan
Figure No.	3.1
Project	Historical Landfills: Ballymulvey
Client	Longford County Council
Scale 1:2,000	**Page Size** A3
Revision A	**Date** 09/10/2018

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3.1.2 Trial Pitting

An intrusive investigation involving trial pitting was undertaken by PGL on the 2nd August 2018 under the supervision of PGLs Engineering Geologist.

A total of 5 No. shallow trial pits (SA01 to SA04 and TP01) were excavated to a maximum depth of 1.6m below existing ground level (bgl) using a 13-tonne tracked excavator. The purpose of the exploratory holes was to assess the permeability of the existing capping material.

A summary of the landfill capping profile is presented in Table 3.1 below with photographs and exploratory hole logs provided in the PGL site investigation report, Appendix 3.

Table 3.1: Summary of Landfill Capping Profile

Strata	Trial Pit	Depth to Top of Strata	Strata Thickness	Description
TOPSOIL	TP01	0 - 0.18mBGL	0.2m	Brown, sandy SILT. Sand is fine to coarse.
FLY ASH	TP01	0.18 – 1.10mBGL	0.9m	Dark Grey black, well compacted fly ash.
SAND	TP01	1.10 – 1.60mBGL	0.5m	Grey sandy gravelly CLAY with frequent cobbles and boulders.
WASTE	TP01	n/a	n/a	Landfill Waste Material

The landfill capping profile description as described by PGLs Engineering Geologist has been confirmed to a depth of 1.60m BGL. Based on the above profile, capping thickness generally confirms with what has been reported by LCC:

- 150 mm of top soil seeded with grass
- 600 mm of subsoil
- 700 mm of impermeable material

3.1.3 Capping Infiltration Tests

Four soakaway test pits (SA01 to SA04) were excavated to depths ranging between 0.45m bgl to 1.0m bgl using a 13t tracked excavator. The exploratory logs are presented in the PGL site investigation report, Appendix 3. The locations of the soakaway tests at the site are presented in Figure 3.2.

Four infiltration tests were carried out in general accordance with the BRE Digest 365, 2007 Soakaway Design Standards. Single cycles of infiltration / drainage were undertaken. The soakaway pits failed to drain in full over the test durations of 180 minutes. The calculated infiltration values (f) for each test are presented in Table 3.2.

Table 3.2: Soakaway Infiltration Rate Results

Test No.	Test Depth (m BGL)	Capping Material	Test Time (min)	Infiltration Rate (f)
SA01	0.85	Fly Ash	180	1.30×10^{-5} m/s
SA02	0.45	Fly Ash	180	1.03×10^{-5} m/s
SA03	1.0	Fly Ash	180	4.88×10^{-6} m/s
SA04	0.45	Fly Ash	180	3.98×10^{-6} m/s

The low infiltration results presented in Table 3.2 suggest that rapid vertical leachate migration into the waste body and bedrock aquifer is being prevented by the low permeability of the fly ash cover. Therefore, the low permeability capping on the waste body is suitable to minimise leachate generation within the waste body.

Figure 3.2: Capping Infiltration Testing Locations

3.1.4 Borehole Installation & Groundwater / Leachate Sampling

Groundwater monitoring was previously undertaken by LCC from 3 No. monitoring wells: BH1, BH2 and BH3; between 2002 and 2014. During the site walkover, the existing wells were found to be installed to shallow depths ranging from 2.29m – 2.75m.

The volume of water in each well was also found to be minimal, particularly following purging. It was also evident that well casing was not installed, and no gas bungs or suitable well covers were present.

Following approval from LCC, three new groundwater boreholes (GW01 to GW03) were drilled to depths ranging between 7.50m bgl to 13.5m bgl at the site. The boreholes were drilled and installed as replacement groundwater monitoring locations.

Groundwater boreholes were advanced near the boundary of the deposited waste as identified during the desk study and site walkover. The purpose of these wells was to intercept and define the groundwater flow direction upstream and downstream of the identified waste body.

Previously installed leachate boreholes BH5 and BH6 were incorporated into the site investigation to assess the type and strength of leachate within the waste body at these locations.

Groundwater and leachate monitoring was undertaken in boreholes GW01 – GW03, BH5 and BH6 on 26th September and 8th October 2018. Prior to sampling the groundwater locations, the standpipe wells were purged and developed with Waterra groundwater sampling pipework / foot valves and gas caps installed by PGL on the 20th September 2018 in preparation for groundwater monitoring to be undertaken by FT.

All samples were appropriately bottled (using prepared laboratory bottle ware) and packaged for submission to the laboratory. The samples were submitted for laboratory testing.

The analysis results are presented in Appendix 5 and are further discussed in the proceeding sections.

4 ENVIRONMENTAL ASSESSMENT

4.1 Chemical Assessment Criteria

- European Communities, Environmental Objectives (Groundwater)(Amendment) Regulations, 2016 (S.I. No. 366 of 2016)
- European Communities Environmental Objectives (Surface Waters) (Amendment) Regulations, 2012 (S.I. No. 327 of 2012)
- European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (S.I No. 272 of 2009)
- European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989 (S.I. No. 294/1989).
- Interim Guideline Values (IGV) set out in the EPAs Groundwater *Towards Setting the Guideline Values for the Protection of Groundwater in Ireland*.

The results of the environmental assessment at the Ballymulvey Landfill site are presented in the following sections.

4.2 Groundwater & Leachate Analysis

Two rounds of groundwater and leachate quality monitoring were undertaken at the site on the 26th September and 8th October 2018. The findings from the monitoring and an interpretation of the results are presented in the following sections.

4.2.1 Groundwater Depth Analysis

Groundwater depth analysis was undertaken on two occasions following the installation of the monitoring locations. Static groundwater levels from the 8th October 2018 are calculated in Table 4.1.

Table 4.1: Groundwater Depth Analysis

Borehole ID	Top of Casing (mAOD)	Dip (m) 8/10/18	Groundwater Level (mAOD)	Location Gradient
GW01	56.80	2.42	54.38	Upgradient
GW02	57.32	2.87	54.45	Cross-gradient
GW03	53.91	1.11	52.80	Down-gradient
BH5	62.43	6.08	56.35	Centre of waste body
BH6	61.44	5.51	55.93	Western portion of waste body

*Note: Location gradient is in reference to the identified waste deposition area

Based on the above field survey measurements, the groundwater flow direction is assumed to be due south / south-west. The measured leachate levels within BH5 and BH6 appear to be higher than the anticipated potentiometric groundwater level at this location of the site. The raised levels in this portion of the site suggest leachate perching may be occurring. A potentiometric map illustrating the hydraulic gradient and the direction of groundwater flow is presented in Figure 4.1.

4.2.2 Groundwater Borehole Position

The location of the groundwater boreholes (GW01 to GW03) installed at the site where based on the anticipated groundwater flow direction. A desktop analysis of the site in tandem with a site walkover estimated that the likely groundwater flow direction is South to South-West.

GW03 was therefore located south-west of the waste mass to act as a downgradient monitoring location.

GW01 and GW02 were positioned north of the waste body along the north-eastern site boundary to act as up-gradient or cross-gradient monitoring boreholes.

4.2.3 Leachate Monitoring

There are two leachate monitoring wells previously installed within the waste body: BH5 and BH6. Monitoring data was available from 2002 through to 2014. These results are presented in Table 1 of the Tier 1 Report, Appendix 1.

The monitoring suite varied over time but generally included: chemical and biological oxygen demand (COD and BOD), ammonia, total organic carbon, chloride, potassium, sodium and selected metals.

Map Path: R:\Map Production\2018\P1444\Workspace\Ballymulvey Historic Landfill\P1444_Fig4-1_GroundwaterFlow_A3.mxd

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Legend

- Dipped Water Level (mAOD)
- Groundwater Flow Direction
- Site Boundary

Interpolated Dipped Water Level (mAOD)

- 52.5 - 53
- 53.1 - 53.5
- 53.6 - 54
- 54.1 - 54.5

Figure Title	Groundwater Flow
Figure No.	4.1
Project	Historical Landfills: Ballymulvey
Client	Longford County Council
Scale 1:2,000	**Page Size** A3
Revision A	**Date** 17/10/2018

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4.2.4 Groundwater Quality Monitoring

The results of groundwater samples analysed from the 3 No. boreholes (GW01 – GW03) at the site have been assessed against the EPAs Interim Guideline Values (IGVs) and the European Groundwater Regulations (2016) assessment criteria. A summary of the maximum results reported from the two monitoring rounds is outlined in Table 4.2, full laboratory reports are presented in Appendix 4.

Table 4.2: Groundwater Sampling Results

Parameter	Units	EPA IGV Standards [1]	S.I. No. 366 of 2016 Standards [2]	GW01	GW02	GW03
pH	pH units	**6.5 - 9.5**	**--**	7.15	7.11	7.04
Conductivity	mS/cm	**1**	**1.875**	0.96	0.783	1.25
Alkalinity as CaCO3	mg/l	**200**	**--**	**653**	**414**	**695**
Ammoniacal Nitrogen as N	mg/l	**0.15**	**0.175**	**3.99**	**3.55**	**11.1**
Sodium	mg/l	**150**	**150**	16.4	13.2	76.8
Sulphate as SO4	mg/l	**200**	**250**	6.83	10.1	3.9
Total Oxidised Nitrogen	mg/l	**--**	**--**	1.17	<0.1	<0.1
Total Organic Carbon	mg/l	**--**	**--**	15.1	15.8	29.1
Arsenic	mg/l	**0.01**	**0.0075**	0.00472	**0.0523**	**0.0204**
Boron	mg/l	**1.0**	**0.75**	0.0571	0.0328	0.0604
Cadmium	mg/l	**0.005**	**0.005**	0.00018	<0.0008	<0.0008
Calcium	mg/l	**200**	**--**	**201**	188	189
Chloride	mg/l	**30**	**187.5**	25.6	35.5	140
Chromium	mg/l	**0.03**	**0.05**	<0.001	0.0013	<0.001
Copper	mg/l	**0.2**	**2**	0.00354	0.00135	0.00098
Cyanide	mg/l	**0.01**	**0.0375**	<0.05	<0.05	<0.05
Fluoride	mg/l	**1.0**	**0.8**	<0.5	<0.5	<0.5
Iron	mg/l	**0.2**	**--**	**9.08**	**7.97**	**2.36**
Lead	mg/l	**0.01**	**0.025**	0.00506	0.00214	0.00032
Magnesium	mg/l	**50**	**--**	15.9	7.88	23.6
Manganese	mg/l	**0.05**	**--**	**1.5**	**1.26**	**0.617**
Mercury	mg/l	**0.001**	**0.001**	<0.0001	<0.0001	<0.0001
Nickel	mg/l	**0.02**	**0.02**	0.00807	0.00756	0.00441
Phosphorus	mg/l	**0.03**	**0.035**	**0.254**	0.0695	**0.13**
Potassium	mg/l	**5**	**--**	**7.45**	4.06	**22.1**
Zinc	mg/l	**0.1**	**--**	0.0151	0.0103	0.00652
Dissolved Oxygen	mg/l	**no abnormal change**	**--**	8.56	8.68	**4.92**
Total Coliforms	cfu/100 ml	**0**	**--**	**6050**	**141000**	**13000000**

[1] EPA - Towards Setting Guideline Values for the Protection of Groundwater in Ireland (2003) – Interim Guideline Values
[2] European Communities Environmental Objectives (Groundwater)(Amendment) Regulations (2016) – SI No. 366 of 2016
* Items shaded in **bold** are in exceedance of both EPA IGV Standards
* Items shaded in **orange** are in exceedance of the Drinking Water Regulations

4.2.5 Groundwater Analysis Discussion

The results of the groundwater monitoring from GW01 – GW03 have reported a number of exceedances of the IGVs and European Groundwater limit values.

Samples recovered from monitoring wells GW01, GW02 and GW03 reported ammonia concentrations of 3.99 mg/l, 3.55 mg/l and 11.1 mg/l respectively, which exceed guideline threshold values. The ammonia concentrations at both upgradient boreholes GW01 and GW02 could indicate contamination from the waste body, slurry spreading or from nearby septic tanks as the levels of coliforms detected are high. The highest ammonia concentration of 11.1 mg/l recorded at GW03 is 63-times the groundwater threshold value. At this concentration it is probable to consider that the waste body is impacting water quality and indicates a leachate plume is potentially migrating beyond the landfill boundary.

The peat strata underlying the waste body may also be influencing high levels of ammonia detected in the groundwater.

Elevated alkalinity (CaCO3) is consistent across all three sampling locations. The alkaline groundwater quality in the range 414 mg/l to 695 mg/l is over 2-3 times the IGV threshold value. The alkaline groundwater quality detected at each monitoring borehole is considered to be a factor of the local bedrock hydrochemistry.

Elevated arsenic concentrations exceeding the 2016 groundwater quality standard are reported at monitoring wells GW02 and GW03. The detected concentrations of 0.0204 mg/l and 0.0523 mg/l at downgradient boreholes GW03 and upgradient borehole GW02 are considered to be an indication of impact from the waste body.

Significantly elevated iron and manganese concentrations exceeding the IGV threshold limit value of 0.2 mg/l and 0.05 mg/l respectively are reported at all monitoring wells GW01 to GW03. Iron concentrations were detected within the range 2.36 mg/l to 9.08 mg/l and show a reducing concentration trend between upgradient boreholes GW01 & GW02 and downgradient borehole GW03. A similar reduction trend between upgradient and downgradient boreholes can be seen with the results reported for manganese. Manganese concentrations range from 0.617 mg/l to 1.50 mg/l across all monitoring wells with the highest concentration reported in upgradient borehole GW01. Review of the Tier 1 report (see Appendix 1) shows similar concentrations and trends are reported for iron and manganese which suggest that these are background levels within the local bedrock hydrochemistry.

Samples collected from upgradient monitoring well GW01 and downgradient monitoring well GW03 reported phosphorus concentrations of 0.245 mg/l and 0.13 mg/l which exceeds both IGV and European Groundwater threshold values. Phosphorus concentrations detected up to 7-times the guideline levels are considered to be representative of impact from the waste body.

Elevated potassium concentrations of 7.45 mg/l and 22.1 mg/l were also detected in samples collected from monitoring wells GW01 and GW03 respectively. The potassium concentrations exceed the IGV standard of 5 mg/l and are considered to be representative of impact from the waste body.

The significantly reduced dissolved oxygen (DO) concentration of 4.92 mg/l at GW03 represents a 56% reduction in available DO compared with upgradient levels and provides an indicator of the contamination being detected downgradient of the waste body.

4.2.6 Groundwater Comparison with Historical Monitoring Data

Groundwater monitoring was undertaken from the old network of monitoring wells: BH1, BH2 and BH3; between 2002 and 2014. The monitoring suite varied over time but generally included: ammonia, total organic carbon, chloride, potassium, sodium, dissolved oxygen, nitrate and selected metals.

The average results from the 2002 - 2014 monitoring period are tabulated in Table 4.3. Selected results from this study, some of which exceeded the groundwater guideline values, have also been tabulated for comparison.

Table 4.3: Historical and Tier 2 Groundwater Data Comparison

	Conductivity	Ammonia as N	TOC	Dissolved Oxygen	Iron	Manganese	Potassium
2002 - 2014	mS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
BH1 Average	1.54	33	23	2.0	9.1	1.6	20
BH2 Average	1.01	12	17	1.8	13.2	1.7	10
BH3 Average	1.14	15	21	2.1	1.7	0.6	30
2018							
GW01 *	0.96	3.99	15.1	8.56	9.08	1.5	7.45
GW02 *	0.783	3.55	15.8	8.68	7.97	1.26	4.06
GW03 *	1.25	11.1	29.1	4.92	2.36	0.617	22.1

* maximum results from the Tier 2 monitoring rounds

The results of the 2018 monitoring are presented in Table 4.3 and generally shows that groundwater quality has improved when compared against the historical quality. Results for ammonia and dissolved oxygen show an improvement across all monitoring locations when compared against previous levels. The selected metals iron, manganese and potassium seem to be within a similar range as previously recorded.

4.2.7 Leachate Quality Monitoring

The results of leachate samples analysed from the 2 No. boreholes (BH5 and BH6) at the site have been assessed against both the methanogenic and acetogenic constituents contained within Table 7.2 of the EPA Landfill Manual (2003). A summary of the results is outlined in Table 4.4 and Table 4.5, while the laboratory reports are presented in Appendix 4.

Table 4.4: Summary of Methanogenic Leachate Composition at BH5 and BH6

	Overall Range		Overall Values		Ballymulvey Leachate Quality	
	Minimum	**Maximum**	**Median**	**Mean**	**BH5**	**BH6**
pH-value	6.8	8.2	7.35	7.52	7.29	7.13
Conductivity (µS/cm)	5,990	19,300	10,000	11,502	8,180	1,840
Alkalinity (as CaCO3)	3,000	9,130	5,000	5,376	3,630	684
COD	622	8,000	1,770	2,307	677	45
BOD5	97	1,770	253	374	28.2	6.15
TOC	184	2,270	555	733	87.7	13.7
Fatty Acids (as C)	<5	146	5	18	<5	<5
Ammoniacal-N	283	2,040	902	889	469	66.2
Nitrite-N	<0.01	1.3	0.09	0.17	<0.0152	<0.0152
Sulphate (as SO4)	<5	322	35	67	<2	<2
Phosphate (as P)	0.3	18.4	2.7	4.3	<0.05	<0.05

	Overall Range		Overall Values		Ballymulvey Leachate Quality	
	Minimum	Maximum	Median	Mean	BH5	BH6
Chloride	570	4,710	1,950	2,074	1180	90.1
Sodium	474	3,650	1,400	1,480	698	92.8
Magnesium	40	1,580	166	250	220	46.5
Potassium	100	1,580	791	854	160	51.1
Calcium	23	501	117	151	222	177
Chromium	<0.03	0.56	0.07	0.09	<0.03	<0.03
Manganese	0.04	3.59	0.3	0.46	0.348	0.444
Iron	1.6	160	15.3	27.4	17.0	12.4
Nickel	<0.03	0.6	0.14	0.17	<0.03	<0.03
Copper	<0.02	0.62	0.07	0.13	<0.02	<0.02

* Results in reported in mg/l except pH-value and conductivity (µS/cm).
* Source: UK Department of the Environment (1995)

Table 4.5: Summary of Acetogenic Leachate Composition at BH5 and BH6

	Overall Range		Overall Values		Ballymulvey Leachate Quality	
	Minimum	Maximum	Median	Mean	BH5	BH6
pH-value	5.12	7.8	6.0	6.73	7.29	7.13
Conductivity (µS/cm)	5,800	52,000	13,195	16,921	8,180	1,840
Alkalinity (as CaCO3)	2,720	15,870	5,155	7,251	3,630	684
COD	2,740	152,000	23,600	36,817	677	45
BOD5	2,000	68,000	14,600	18,632	28.2	6.15
TOC	1,010	29,000	7,800	12,217	87.7	13.7
Fatty Acids (as C)	963	22,414	5,144	8,197	<5	<5
Ammoniacal-N	194	3,610	582	922	469	66.2
Nitrite-N	0.01	1.4	0.1	0.2	<0.0152	<0.0152
Sulphate (as SO4)	<5	1,560	608	676	<2	<2
Phosphate (as P)	0.6	22.6	3.3	5.0	<0.05	<0.05
Chloride	659	4,670	1,490	1,850	1180	90.1
Sodium	474	2,400	1,270	1,371	698	92.8
Magnesium	25	820	400	384	220	46.5
Potassium	350	3,100	900	1,143	160	51.1
Calcium	270	6,240	1,600	2,241	222	177
Chromium	0.03	0.3	0.12	0.13	<0.03	<0.03
Manganese	1.4	164.0	22.95	32.94	0.348	0.444

	Overall Range		Overall Values		Ballymulvey Leachate Quality	
	Minimum	Maximum	Median	Mean	BH5	BH6
Iron	48.3	2,300	475	653.8	17.0	12.4
Nickel	<0.03	1.87	0.23	0.42	<0.03	<0.03
Copper	0.02	1.1	0.075	0.13	<0.02	<0.02

4.2.8 Leachate Analysis Discussion

As can be seen from Table 4.4 the sampled leachate strength in well BH5 is greater than in well BH6. When leachate concentrations are assessed against typical landfill leachate parameters during the methanogenic and acetogenic stages, the leachate composition at the Ballymulvey landfill appears to be representative of the minimum to mean concentrations of the methanogenic phase when compared to the typical concentrations reported in the EPA Landfill Manual (2003).

4.2.9 Leachate Comparison with Historical Monitoring Data

Monitoring data is available from 2002 to 2014 for leachate monitoring wells BH5 and BH6. The monitoring suite varied over time but generally included: chemical and biological oxygen demand (COD and BOD), ammonia, total organic carbon, chloride, potassium, sodium and selected metals.

The average results from the 2002 - 2014 monitoring period are tabulated in Table 4.5. Selected results from current monitoring at BH5 and BH6 have also been tabulated for comparison.

Table 4.6: Historical and Tier 2 Leachate Data Comparison

	Conductivity	Ammonia as N	TOC	Chloride	Sodium	Potassium
2002 - 2014	mS/cm	mg/l	mg/l	mg/l	mg/l	mg/l
BH5	11.59	373	55	2.0	9.1	159
BH6	8.54	1022	411	1.8	13.2	734
2018						
BH5 *	8.18	469	87.7	1180	698	160
BH6 *	1.84	66.2	13.7	90.1	92.8	51.1

* maximum results from the Tier 2 monitoring rounds

The results of the 2018 monitoring are presented in Table 4.5 generally shows concentrations are variable across each monitoring location when comparing against the historical average concentrations. The current results for BH5 are generally consistent with the long-term average results with the exception of the spikes in chloride (1,180 mg/l) and sodium (698 mg/l) concentrations.

Selected parameters at BH6 show current concentrations appear to be an order of magnitude lower than the historical average, again with the exception of increased chloride (90.1 mg/l) and sodium (92.8 mg/l) concentrations which are higher than average.

It should be noted that the latest results presented in Table 4.5 are the maximum concentrations recorded over 2 No. monitoring rounds. Further monitoring rounds are recommended to provide a more robust comparison against the historical long-term trends.

4.3 Landfill Gas Monitoring

Landfill gas (LFG) was monitored at borehole location (GW01 – GW03; BH5 and BH6) as indicated on Figure 3.1. In accordance with the EPA CoP, methane, carbon dioxide, oxygen and atmospheric pressure were using a geotechnical instrument GEM5000 Landfill Gas analyser.

4.3.1 Monitoring Results

As reported within the CoP, the trigger level for methane outside the waste body is 1% v/v and for carbon dioxide is 1.5% v/v. The monitoring results for methane, carbon dioxide and oxygen levels for the perimeter boreholes GW01 to GW03 are summarised in Table 4.6, with onsite leachate boreholes BH5 and BH6 summarised in Table 4.7.

Table 4.7: Perimeter Well Monitoring Results September & October 2018

Date: 25-9-2018						
Sample Station	**CH_4**	**CO_2**	**O_2**	**Atmospheric Pressure**	**Staff Member**	**Weather**
	(% v/v)	**(% v/v)**	**(% v/v)**	**(mbar)**		
GW01	0.1	0.2	22.2	1032	Daniel Hayden	Cloudy with light wind S-SE, 12°C - 14°C
GW02	0.1	**1.6**	19.7	1032		
GW03	0.1	0.4	21.9	1032		

Date: 8-10-2018						
Sample Station	**CH_4**	**CO_2**	**O_2**	**Atmospheric Pressure**	**Staff Member**	**Weather**
	(% v/v)	**(% v/v)**	**(% v/v)**	**(mbar)**		
GW01	0.1	0.2	23.6	1012	Daniel Hayden	Cloudy with light rain and wind NW-W, 13°C - 15°C
GW02	0.2	**1.8**	18.5	1012		
GW03	0.1	0.4	23.6	1012		

As shown in Table 4.6, concentrations carbon dioxide (CO_2) at upgradient borehole GW02 slightly exceed the threshold values set by the CoP during both monitoring rounds. The CO_2 concentrations of 1.6% and 1.8% recorded on the 25th September and 8th October may be due to the proximity of borehole GW02 to the waste body. It is considered that the proximity of the waste body to borehole GW02 would also be leading to the elevated traces of ground gases at this location.

Concentrations of both CO_2 and CH_4 at boreholes GW01 and GW03 were below the threshold values set by the CoP during both monitoring rounds.

Table 4.8: Onsite Leachate Well Monitoring Results September & October 2018

Date: 25-09-2018						
Sample Station	**CH_4 (% v/v)**	**CO_2 (% v/v)**	**O_2 (% v/v)**	**Atmospheric Pressure (mbar)**	**Staff Member**	**Weather**
BH5	0.1	0.1	22.3	1032	Daniel Hayden	Cloudy with light wind S-SE, 12°C - 14°C
BH6	0.1	0.2	22.2	1032		
Date: 8-10-2018						
Sample Station	**CH_4 (% v/v)**	**CO_2 (% v/v)**	**O_2 (% v/v)**	**Atmospheric Pressure (mbar)**	**Staff Member**	**Weather**
BH5	0.1	0.2	21.7	1012	Daniel Hayden	Cloudy with light rain and wind NW-W, 13°C - 15°C
BH6	0.1	0.2	21.8	1012		

As shown Table 4.7, concentrations of both CO_2 and CH_4 at boreholes BH5 and BH6 were below the threshold values set by the CoP during both monitoring rounds.

It is noted that both leachate boreholes BH5 and BH6 are not fitted with gas bungs with sampling valves (see Figure 4.2). Therefore, gas monitoring results at these locations may not be representative of landfill gas concentrations within the waste body.

Figure 4.2: Leachate Monitoring Boreholes BH5 and BH6

4.4 Surface Water Monitoring

4.4.1 Previous Monitoring Locations

Longford County Council (LCC) identified a series of on-site and off-site surface water monitoring locations as part of on-going monitoring post-closure, as detailed below.

On-Site Locations:
Surface water monitoring was undertaken by LCC between 2002 and 2014 at five on-site monitoring points (SS1 to SS5). The frequency of monitoring varied but this was due to some monitoring locations being periodically dry.

Off-Site Locations:
There is an extensive network of off-site surface water monitoring points referenced A to P. The frequency of monitoring was also variable due to some monitoring locations being periodically dry.

Sampling locations A, B, C, M and L were on drains in close vicinity of the site. Sample location K was on a drain/stream to the south-east of the site. Sample locations D, E, F, and G are on drains/stream to the west of the site that feed into the River Inny. Sample locations H and J are on the River Inny to the south-west of the site, up-stream and downstream of its confluence with the tributary. It is not known where monitoring points N, O and P were in relation to the site (see Figure 4.2).

4.4.2 Tier 2 Monitoring Locations

Two surface water monitoring rounds were carried out on the 6th September and 26th September 2018.

Some of the sampling locations were found to be dry during the 3-week monitoring period in September 2018. As a result, none of the on-site monitoring locations SS1 to SS5 could be sampled.

Many of the previously identified off-site monitoring locations also remained dry during the monitoring period, therefore only 2 No. viable locations (SW-C and SW-G) were sampled, as shown on Figure 4.2.

4.4.3 Monitoring Parameters

The results of surface water sampling analysed from the 2 No. sampling locations (C & G) at the site have been assessed against the Maximum Admissible Concentration (MAC) Regulations (1989) and the Environmental Quality Standard (EQS) for Surface Waters Regulations (2009) assessment criteria.

A summary of the maximum values reported for each parameter from the two monitoring rounds is outlined in Table 4.8, while the laboratory reports are presented in Appendix 4.

Table 4.9: Surface Water Sampling Results

Parameter	Units	MAC [1] / EQS [2]	6th - 26th September 2018	
			SW-C	SW-G
pH (Laboratory)	pH Units	6.0<pH<9.0 [2]	7.55	8.06
Dissolved Oxygen	mg/l	<9 – 6 [1]	11.2	13.0
Conductivity	mS/cm	1 [1]	**2.08**	0.648
BOD, unfiltered	mg/l	≤2.6 (95%ile) [2]	<1	<1
Sulphate	mg/l	200 [1]	**652**	43.5
Chloride	mg/l	250 [1]	249	22.9
Ammoniacal Nitrogen as N	mg/l	≤0.140(95%ile) [2]	<0.2	<0.2
Potassium	mg/l	--	14.1	3.59
Sodium	mg/l	200 [1]	136	12.6

Notes:

1 Maximum Admissible Concentration (MAC), as classified by European Communities (Quality of Surface Water intended for abstraction of drinking water) Regulations 1989 (S.I No. 294 of 1989)

2 Environmental Quality Standard (EQS), European Communities Environmental Objectives (Surface Waters) Regulations 2009 (S.I No. 272 of 2009)

* Items shaded in **orange** are in exceedance of the MAC Regulations (1989)

4.4.4 Surface Water Analysis Discussion

The results of the surface water monitoring from locations SW-C & SW-G show 2 No. exceedances of the MAC (1989) Regulation limit values for conductivity and sulphate. Results from sampling location SW-C detected a sulphate concentration of 652 mg/l and indicates to the presence of a pathway from the landfill to a nearby drainage channel flowing south-west.

The electrical conductivity value of 2.08 mS/cm recorded at monitoring location SW-C appears to reflect the elevated sulphate concentrations detected. The chloride concentration of 249 mg/l, at 1 mg/l below the MAC limit value of 250 mg/l, is also considered to be influencing the elevated conductivity at this location.

The results reported at downstream monitoring location SW-G are seen to be considerably lower than the hydrologically connected upstream location SW-C. The results of all monitoring parameters at location SW-G were reported below both guideline threshold limit values.

It is noted in the Tier 1 report (See Pg. 14, Appendix 1) that during the site walkover the standing water level in the perimeter cut-off drain and lagoon was observed to be very high (at ground level) with potential for overflow/seepage from lagoon to cut-off drain. Seepage southwards/south-westwards from cut-off drain to boggy woodland south of the site was observed.

Based on the above statement, the detection of elevated sulphate at SW-C indicates the possible presence of a hydrological pathway from the landfill to the nearby land drain.

Overall the limited surface water results show the surface water quality in the immediate vicinity of the landfill is of poor quality with respect to conductivity and sulphate. The concentrations of these elevated parameters are seen to reduce in strength further downstream as identified at sampling location SW-G.

The remaining results of the surface water laboratory analysis as presented in Table 4.8, when assessed against the MAC (1989) and EQS (2009) quality standards were found to be below the guideline values in all assessments.

4.4.5 Surface Water Comparison with Historical Monitoring Data

The average results from the 2002 - 2014 monitoring period are tabulated in Table 4.9. Selected results from the current monitoring rounds at locations SW-C and SW-G have also been tabulated for comparison.

Table 4.10: Historical and Tier 2 Surface Water Data Comparison

	Conductivity	Dissolved Oxygen	BOD	Ammonia as N	Chloride
2002 - 2014	mS/cm	mg/l		mg/l	mg/l
SW-C	1.20	3.9	16	18	152
SW-G	0.68	11	1	0.14	25
2018					
SW-C *	2.08	11.2	<1	<0.2	249
SW-G *	0.648	13.0	<1	<0.2	22.9

* maximum results from the Tier 2 monitoring rounds

The results of the 2018 monitoring presented in Table 4.9 generally show water quality has improved at both monitoring locations when comparing against the historical average concentrations. The long-term historical data for monitoring location SW-C was consistently exceeding the surface water regulations for selected parameters. The current results for SW-C show a reduction of BOD and ammonia levels to below the laboratory limit of detection. Results for chloride (249 mg/l) show concentrations to be within the average range for this location.

Water quality results from SW-G indicate there is a general improvement with distance from the site with results for electrical conductivity and chloride broadly in line with historical average concentrations.

Co. Longford

Legend

Rivers

Site Boundary

Surface Water Monitoring Locations

Dry

Not Sampled

Sampled

Figure Title

Surface Water Monitoring

Figure No. 4.3

Project

Historical Landfills: Ballymulvey

Client

Longford County Council

Scale	1:5,250	**Page Size**	A3
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5 RISK ASSESSMENT

5.1 Introduction

Risk assessment considers the likelihood of occurrence and the consequence of occurrence of an event (Royal Society, 1992[1]). ERA (Environmental Risk Assessment) is based on the development of a Conceptual Site Model (CSM) which is used to determine the potential exposure of a vulnerable receptor to a contaminant. The CSM is used as the basis for the risk assessment. It is used to identify all possible sources (S), pathways (P) and receptors (R) as well as the processes that are likely to occur along each of the source-pathway-receptor (S-P-R) linkages and uncertainties.

Based on the desktop investigation and completed site investigation, this CSM assumes the source to be the made ground containing waste deposit, the pathway to involve the migration of landfill gas, surface water and groundwater and the ultimate receptors to be the surface water features, groundwater, groundwater abstraction well and all human presence near the waste material.

5.2 Potential Pathways and Receptors

A pathway is a mechanism or route by which a contaminant encounters, or otherwise affects, a receptor. Contaminants associated with deposited waste may include leachate generated from groundwater/rainwater infiltration into the waste material and/or the generation of landfill gas from the degradation of the biodegradable fraction of deposited waste.

The potential pathways associated with the Ballymulvey site are:

- Groundwater migration; and,
- Surface water infiltration.

5.2.1 Groundwater/Leachate Migration

According to the EPA CoP, there are three main pathways for leachate migration. These are:

- Vertically to the water table or top of an aquifer, where groundwater is the receptor
- Vertically to an aquifer and then horizontally in the aquifer to a receptor such as a well, spring, stream or in this case, the adjacent coastline
- Horizontally at the ground surface or at shallow depth to a surface receptor

The migration and attenuation of leachate from the site depends on the permeability and thickness of subsoil and on both the bedrock permeability value and type. These elements are encompassed in groundwater vulnerability, groundwater flow regime and surface water drainage. The main receptors to leachate migration from this site are:

- Aquifer;
- Surface water features; and
- Human presence nearby the site

5.2.2 Landfill Gas Migration

According to the EPA CoP, there are two main pathways for landfill gas migration. These are:

- Lateral migration via subsoil
- Vertical migration via subsoil

[1] Royal Society 1992, Risk: Analysis, Perception and Management. The Royal Society, London (ISBN 0-85403-467-6).

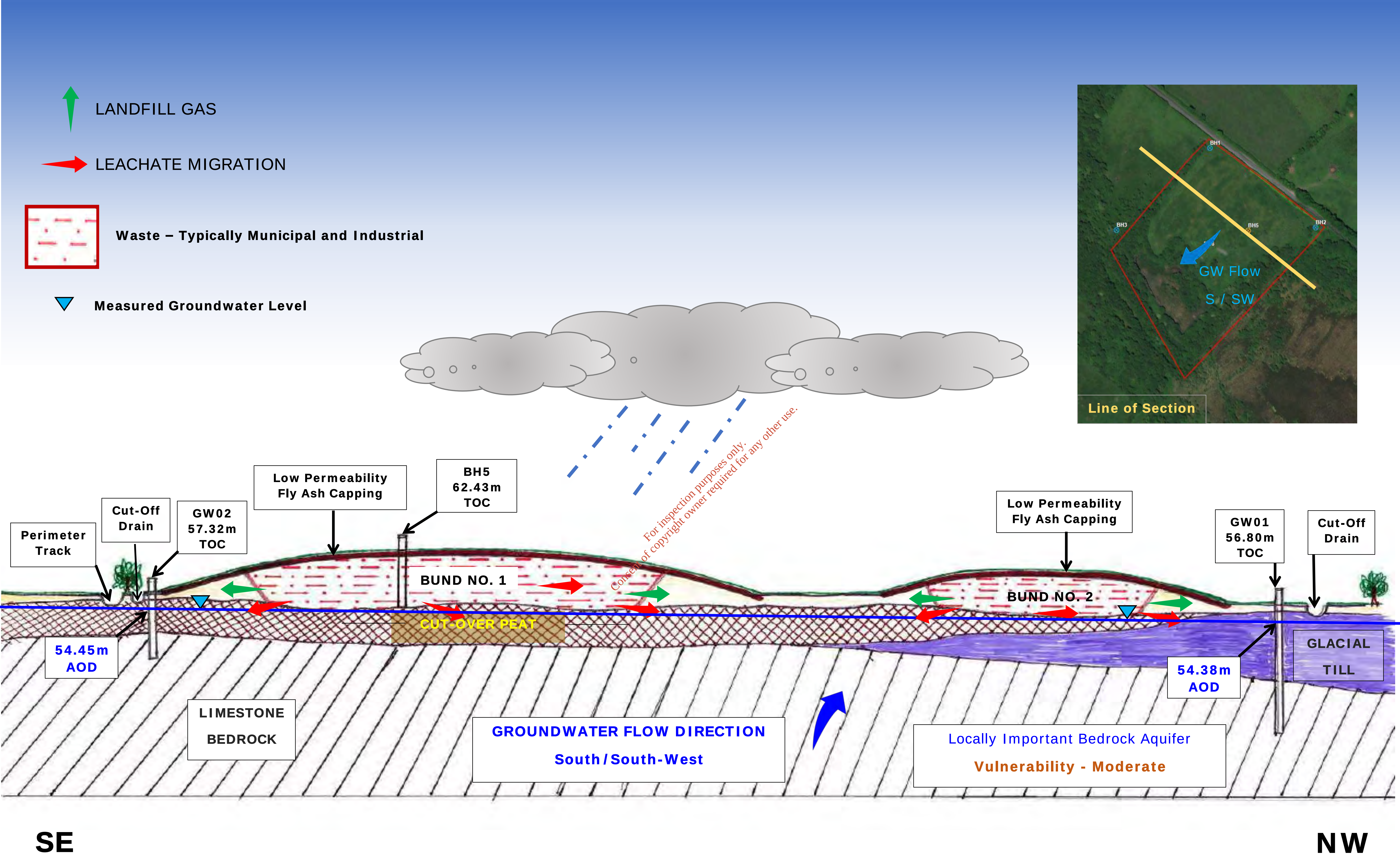
The migration of landfill gas from the site depends on the nature of the material deposited and the nature, permeability and thickness of the surrounding subsoil or bedrock.

The main receptors to potential landfill gas migration from this site are:

- Human Presence/Buildings nearby the waste body

5.3 Conceptual Site Model

Based on the desktop investigation and site investigation works undertaken for Ballymulvey Historic Landfill, an assessment of the risk is made to confirm the source – pathway – receptor (S-P-R) linkages identified in the preliminary investigation. The results and analysis of the investigation has enabled a basic conceptual model to be produced for the site, which is presented in Figure 5.1, overleaf.



CROSS SECTION SOUTH-EAST / NORTH-WEST

FIGURE 5.1 BALLYMULVEY HISTORIC LANDFILL
CONCEPTUAL SITE MODEL

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5.4 Risk Prioritisation

Risk prioritisation enables resources to be prioritised on the highest risk facilities and on the highest source – pathway – receptor linkage potential.

The risk prioritisation process assigns a score to each linkage and the overall score is the maximum of the individual linkages for the site. The higher the score a site/linkage receives the higher the risk.

To classify the risk, scores will be applied to the information obtained during the site investigation of Ballymulvey Historic Landfill. Where there is insufficient information available (i.e. where there is a high degree of uncertainty) the highest score is assumed.

In accordance with the EPA CoP (2007) the scoring matrices are as follows:

- Leachate: Source/hazard scoring matrix, based on waste footprint
- Landfill gas: Source/hazard scoring matrix based on waste footprint
- Leachate migration: Pathway (Vertical)
- Leachate migration: Pathway (Horizontal)
- Leachate migration: Pathway (Surface water drainage)
- Landfill gas: Pathway (Lateral migration potential)
- Landfill gas: Pathway (Upwards migration potential)
- Leachate migration: Receptor (Surface water drainage)
- Leachate migration: Receptor (Human presence)
- Leachate migration: Receptor (Protected areas – SWDTE or GWDTE) (Surface water/groundwater dependent terrestrial ecosystems)
- Leachate migration: Receptor (Aquifer category – Resource potential)
- Leachate migration: Receptor (Public water supplies – other than private wells)
- Leachate migration: Receptor (Surface water bodies)
- Landfill gas: Receptor (Human presence)

Table 5.1 calculates the points awarded to each of the headings listed above.

Table 5.1: Risk Classification Calculation – Ballymulvey Landfill

EPA Ref	Risk	Points	Rationale
1a	Leachate; source/hazard scoring matrix, based on waste footprint.	7	Based on the assumption that the waste body occupies ~50% of the 4.3 ha site. Predominantly municipal waste accepted but also some ACM containing C&D waste. Waste was accepted between 1960s and early/mid-1990s.
1b	Landfill gas; source/hazard scoring matrix, based on waste footprint.	7	Based on the assumption that the waste body occupies ~50% of the 4.3 ha site. Predominantly municipal waste accepted between 1960s and early/mid-1990s. Score of 7 is being maintained due to the inadequate gas monitoring infrastructure (i.e. gas bungs / valves) at the site.
2a	Leachate migration: Pathway (Vertical)	1	GSI describes the groundwater vulnerability as Moderate across the site.
2b	Leachate migration: Pathway (Horizontal)	1	The bedrock is classified as a locally important aquifer which is moderately productive only in local zones (LI).

EPA Ref	Risk	Points	Rationale
2c	Leachate migration: Pathway (Surface water drainage)	2	The cut-off drains around the perimeter of the site links into land drains to the south, east and west that in turn feed into a tributary of the River Inny. The lagoon immediately south of the waste mounds can potentially overflow into the cut-off drain to the south.
2d	Landfill gas: Pathway (Lateral migration potential)	1.5	Soil in the area is a combination of cut-away peat and glacial tills.
2e	Landfill gas: Pathway (Upwards migration potential)	0	There are no buildings or enclosed spaces above waste body.
3a	Leachate migration: Receptor (Human presence)	2	Nearest dwelling is 150 m from the site, and several residences are present within 1 km of the site.
3b	Leachate migration: Receptor (Protected areas – SWDTE or GWDTE) (Surface water/ groundwater dependent terrestrial ecosystems)	1	There is no designated area within a 1 km radius of the site. The lagoon immediately south of the waste body and boggy woodland further south, have abundant vegetation and are likely home to a variety of fauna; evidence of deer was noted during the site walkover across the waste body.
3c	Leachate migration: Receptor (Aquifer category – Resource potential)	3	Bedrock beneath the site is classified as a locally important aquifer which is moderately productive only in local zones (LI).
3d	Leachate migration: Receptor (Public water supplies – other than private wells)	0	There is no groundwater sourced public water supplies within a 10 km radius of the site. The bedrock aquifer is not karstified.
3e	Leachate migration: Receptor (Surface water bodies)	3	The cut-off drain around the perimeter of the site discharges to land drains which in turn discharge to an unnamed tributary of the River Inny.
3f	Landfill Gas: Receptor (Human presence)	1	Nearest dwelling is 150 m from the site.

Table 5.2: 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 (1+1+2) x 3 = **84**	300	Leachate => surface water	28%
SPR2	1a x (2a + 2b + 2c) x 3b	7 x (1+1+2) x 1 = **28**	300	Leachate => SWDTE	9.3%
Leachate migration through groundwater pathway					
SPR3	1a x (2a + 2b) x 3a	7 x (1+1) x 2 = **28**	240	Leachate => human presence	11.6%
SPR4	1a x (2a + 2b) x 3b	7 x (1+1) x 1 = **14**	240	Leachate => GWDTE	5.8%

Calculator		S-P-R Values	Maximum Score	Linkage	Normalised Score
SPR5	1a x (2a + 2b) x 3c	7 x (1+1) x 3 = **42**	400	Leachate => Aquifer	10.5%
SPR6	1a x (2a + 2b) x 3d	7 x (1+1) x 0 = **0**	560	Leachate => Surface Water	0%
SPR7	1a x (2a + 2b) x 3e	7 x (1+1) x 3 = **42**	240	Leachate => SWDTE	17.5%
Calculator	**S-P-R Values**		**Maximum Score**	**Linkage**	**Normalised Score**
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	23%
Landfill gas migration pathway (lateral & vertical)					
SPR10	1b x 2d x 3f	7 x 1.5 x 1 = **10.5**	150	Landfill Gas => Human Presence	7%
SPR11	1b x 2e x 3f	7 x 0 x 1 = **0**	250	Landfill Gas => Human Presence	0%
Site maximum S-P-R Score					**70%**
Risk Classification					**A – High Risk**

Table 5.2 shows the maximum S-P-R scoring for the site is **35%.**

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)**. The principal risks identified on the site are the migration of leachate from the site to the groundwater aquifer and the risk posed to the unnamed tributary stream of the River Inny from the migration of landfill leachate from the waste material encountered at the site.

6 CONCLUSIONS & RECOMMENDATIONS

A Tier 2 study was conducted by FT in accordance with the EPA CoP for Ballymulvey Historic Landfill. The study consisted of a desktop study, intrusive site investigation works and environmental monitoring. These works informed the development of the CSM and risk screening model.

Analysis of groundwater samples obtained from monitoring wells GW01, GW02 (upgradient) and GW03 (down gradient) reported ammonia concentrations which exceed guideline threshold values. The ammonia concentrations at both upgradient boreholes GW01 and GW02 could indicate contamination from the waste body, slurry spreading or from nearby septic tanks as the levels of coliforms detected were high. The highest ammonia concentration of 11.1 mg/l recorded at GW03 is 63-times the groundwater threshold value. At this concentration it is probable to consider that the waste body is impacting water quality and indicates a leachate plume is potentially migrating beyond the landfill boundary.

The peat strata underlying the waste body may also be influencing high levels of ammonia detected in the groundwater.

The low infiltration results from the in-situ permeability testing of the landfill capping material suggest that rapid vertical rainfall migration into the waste body is being minimised. The landfill cap is likely reducing leachate generation within the waste body. Groundwater levels indicate that the waste material is below the natural groundwater level at the site, therefore groundwater flow through the waste body is likely the primary source of leachate generation.

Overall the limited surface water results show the surface water quality in the immediate vicinity of the landfill is of poor quality with respect to conductivity and sulphate. The concentrations of these elevated parameters are seen to dissipate in strength further downstream as identified at sampling location SW-G.

The results of the surface water monitoring from SW-C show 2 No. exceedances of the MAC (1989) guideline limit values for sulphate and conductivity. The detection of elevated sulphate at SW-C indicates the possible presence of a hydrological pathway from the landfill to the nearby land drain.

The results of the Tier 2 assessment and risk model indicate that the site is being maintained as a **High-Risk Classification (Class A)**. The principal risks identified on the site are the migration of leachate from the site to the groundwater aquifer and the risk posed to the unnamed tributary stream of the River Inny from the migration of landfill leachate from the waste material encountered at the site.

6.1 Recommendations

Based on the results of the initial Tier II assessment the site is classified as High Risk. The site is therefore: "considered to pose a significant risk to the environment or human health." For a high-risk site, the CoP indicates that a Tier III Environmental risk analysis be undertaken including a Detailed Quantitative Risk Assessment. Further the site be regularised/authorised in accordance with current waste management legislation.

It is therefore recommended by FTC that a Tier III DQRA be undertaken for the site in conjunction with an application for a Certificate of Registration for this site.

FT further recommended that further groundwater, leachate surface water monitoring and landfill gas monitoring and analysis be undertaken at each monitoring location GW01 to GW03; BH5, BH6 and all surface water locations (where possible) inclusive. Monitoring should be undertaken on a quarterly basis, subject to any future recommendations of the Tier III report or Certificate of Authorisation. Landfill gas monitoring points should be fully capped in advance of monitoring works to prevent venting.

The results of this analysis should be used to confirm the conclusion of this report and future Tier III reports.

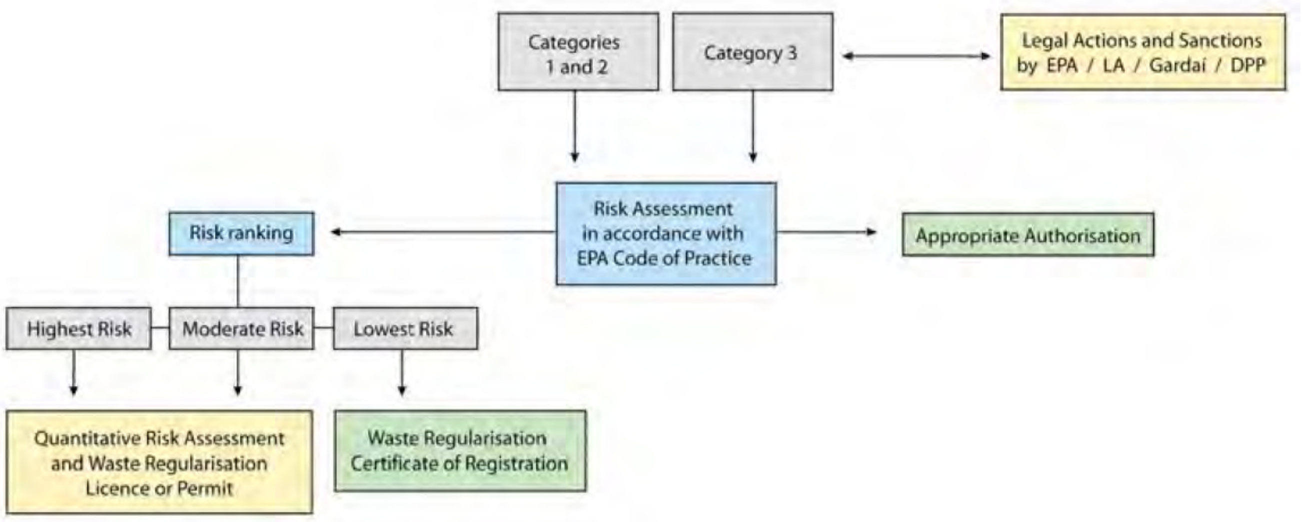

Figure 6.1: Extract from Section 1.3 of the EPA Code of Practice