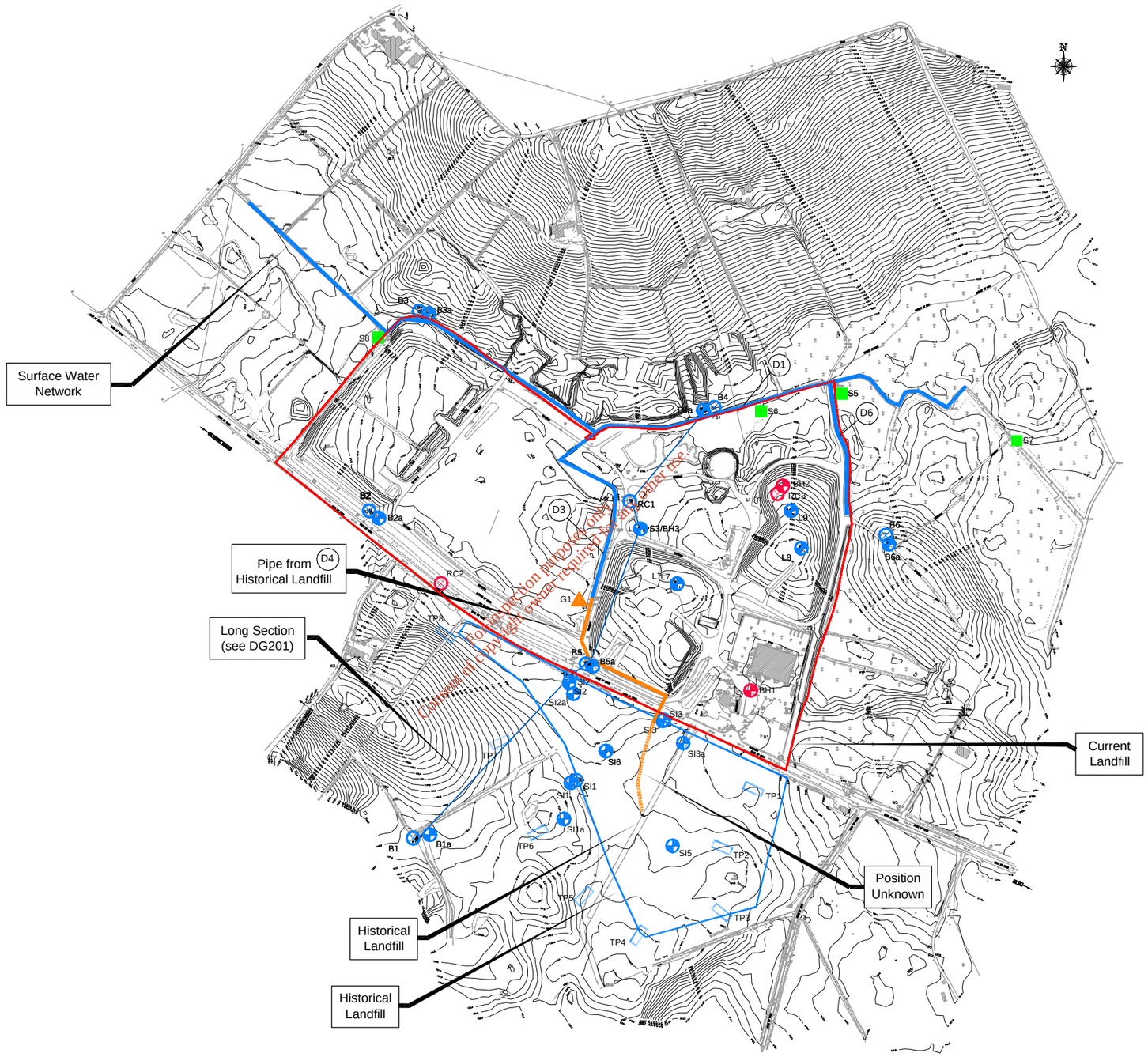
Appendix IV

Trial Pit / Borehole Locations from 2003 Site Investigation



LEGEND

for each series of Ground Investigation

- Overburden (2002)
- Bedrock (2002)
- D1 — Surface Water Stream
- S1 — Surface Water Monitoring Point
- G1 — Outfall from Historical Landfill Monitoring Point
- Overburden (Pre 1998)
- Bedrock (Pre 1998)
- Overburden (2002)
- Bedrock (2002)
- Trial Pit (2002)

Client:

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No.	Date	By / Ch	Amendment / Issue	App.
A01	Nov'03	RH / HD	ISSUE FOR APPROVAL	LO'T

Project: Scotch Corner Landfill Environment Study

Title: BOREHOLE AND TRIAL PIT LOCATIONS

Drawn by:	RH	Job No:	mde0170
Checked by:	HD	File No:	mde0170fg0001A01
Approved by:	LO'T	Drg. No:	Fig 1
Scale:	1:2500 @ A1	Rev:	F01
Date:	Nov'03		

GLOVER Site Investigations

Scotch Corner Landfill Site

Location diagram of excavated Site Investigation features.

Monaghan County Council

M.C. O'Sullivan & Co. Ltd.

Borehole Location

Trial Pit Location

SCALE	SHEET	DATE
1:5000	01 of 01	28/11/02

DRAWN	CHKD	DRAWING	REV
I.P.	R.B.	4697/SctchCmr/1102/SILoc	A

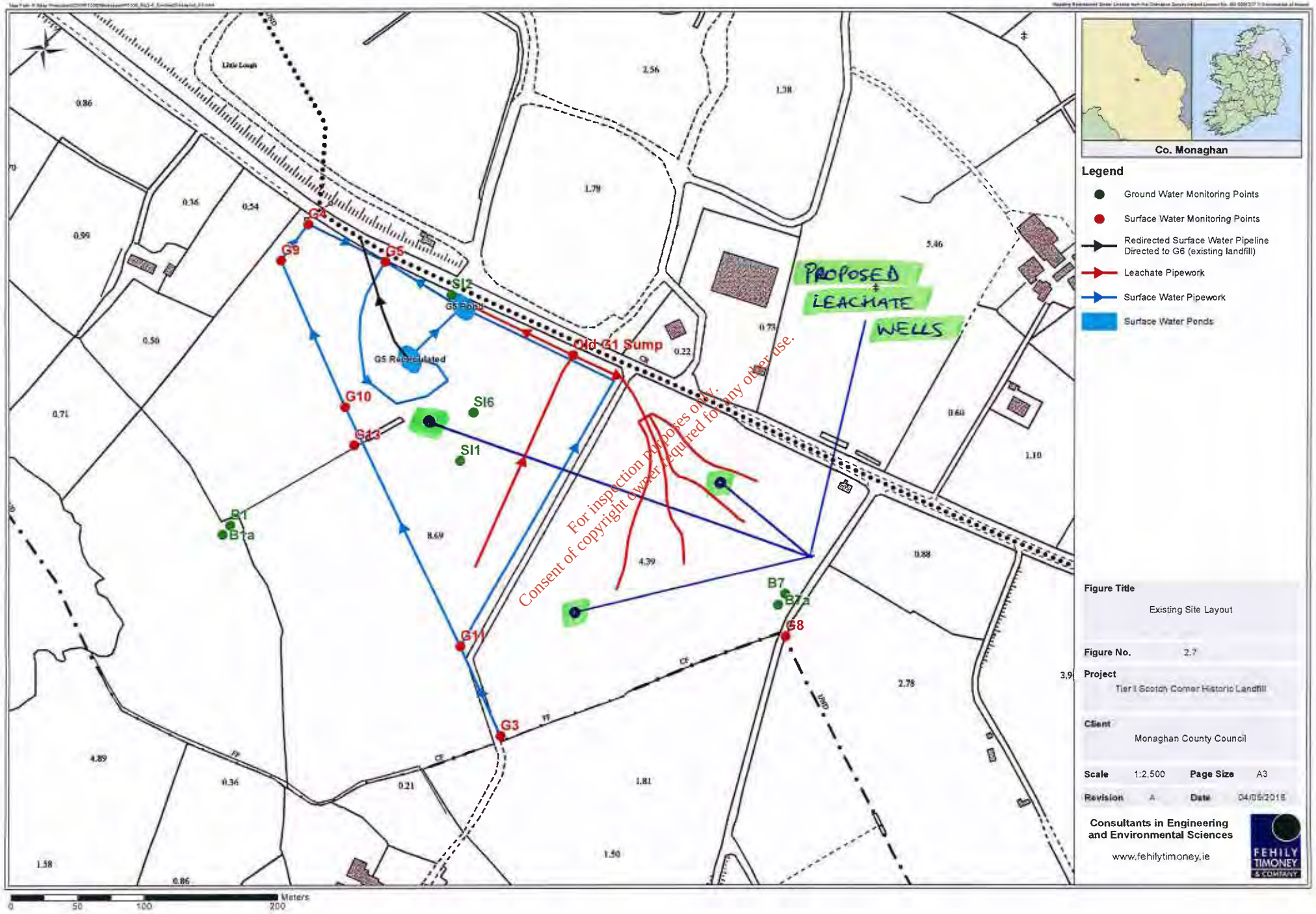

Figure Title
Existing Site Layout

Figure No. 2.7

Project
Tier I Scotch Corner Historic Landfill

Client
Monaghan County Council

Scale 1:2,500 Page Size A3

Revision A Date 04/05/2018

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TIER 2 RISK ASSESSMENT

SCOTCH CORNER HISTORIC LANDFILL SITE, LETTERBANE, CO. MONAGHAN

NOVEMBER 2018

FEHILY TIMONEY & COMPANY

TIER 2 RISK ASSESSMENT

SCOTCH CORNER HISTORIC LANDFILL SITE, CO. MONAGHAN

User is Responsible for Checking the Revision Status of this Document

Rev. Nr.	Description of Changes	Prepared by:	Checked by:	Approved by:	Date:
0	Issue to Client	DH/CF	JON	BG	28.11.18

Client: Monaghan 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 Scotch Corner Historic Landfill, Co. Monaghan, and conducted in accordance with the EPA Code of Practice for unregulated landfill sites. The site investigation was undertaken to determine the extent and impact, if any, of the historic landfilling at the site.

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EXECUTIVE SUMMARY

Fehily Timoney & Company (FT) was appointed by Monaghan County Council (MCC) to complete a Tier 2 environmental risk assessment (ERA) on Scotch Corner 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 approximately 4km south-west of Clontibret off the R184 in Co. Monaghan. The 4.5hectare historic landfill is located to the south of the licenced Scotch Conor Landfill on the opposite side of the local access road. The historic landfill accepted municipal waste throughout the late 1970s and 1980s and is reported to have ceased operation in 1991.

A Tier 1 study was conducted by FT in June 2018 and determined the site to be a moderate-risk classification (Class B). The primary risks identified related to the risk of leachate runoff entering a tributary of the River Fane downstream of the waste body. The completed Tier I study is included as Appendix 1.

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

The scope of site investigation works included:

- 18 No. trial pit excavations
- Installation and monitoring of 4 No. leachate boreholes
- 1 No. geophysical survey (2D resistivity and seismic refraction profiling)
- Environmental sampling: groundwater, surface water and leachate
- Factual reporting

The findings of the intrusive site investigation suggest the waste material is deposited in a single infill area tending north-west to south-east and between 350m in length and 225m in width. Based on this interpretation, the maximum waste footprint is calculated to be 10.14 acres or 4.1 hectares.

A volume calculation was conducted based on the results of the geophysical survey of the existing ground level and the base of waste as interpreted, with estimates indicating an interred waste volume of approximately 164,000m^3 at the site.

Analysis of waste samples from the trial pits excavated indicate that the waste material encountered within the site is typically non-hazardous waste.

Long-term monitoring at downgradient monitoring borehole B5a has consistently detected elevated ammonia above the groundwater threshold value (GTV) since March 2015. The elevated ammonia results suggest leachate from the historic landfill is being detected in the groundwater at this location. Chloride concentrations have been generally below GTVs since March 2015 except for one exceedance recorded in March 2018.

Analysis of groundwater samples obtained from perimeter monitoring wells B1a (up-gradient) and B5a (downgradient) indicate ammonia concentrations differences between upgradient and downgradient monitoring locations suggests that the landfill is contributing locally to a deterioration in groundwater quality north of the site boundary and indicates leachate is migrating northwards into the Licenced facility.

Analysis of landfill gas from the leachate wells installed across the site showed concentrations of both CO_2 and CH_4 within the waste body remain substantially high indicating that biodegradation of the interred municipal waste remains active, the landfill gas risk also remains high due to the proximity of Local Authority and Civic Amenity buildings within 50m north of the waste body. The elevated gas concentrations from perimeter borehole B8a are likely to be due to the borehole being screened within the waste body underlying the entrance forecourt to Scotch Corner licenced landfill.

Analysis of surface water samples obtained shows the downstream ammonia concentration at G5-recirculated discharge point is of relatively good quality before exiting the landfill towards sampling location G6. The ammonia concentration at G6 is 14-times greater than G5-recirculated, which suggests ingress from the surrounding waste body between the two sampling points G5-recirculated and G6.

Based on the results of the Tier 2 site assessment and risk model, the site is being maintained as a Moderate-Risk Classification (Class B). The principal risks identified on the site is the risk posed to surface waters from the migration of landfill leachate from the waste material encountered at the site. Environmental monitoring has also indicated several instances of Generic Assessment Criteria (GAC) value exceedances across surface water, groundwater and landfill gas.

It is therefore recommended by FT that a Tier 3 DQRA be undertaken for the site in conjunction with an application for a Certificate of Registration for this site. As part of the Tier 3 assessment, further groundwater, surface water monitoring and landfill gas monitoring and analysis is being recommended at each shallow and deep perimeter monitoring well B1a/B1, B5a/B5, B7a/B7, B8a/B8 and all surface water locations (G8, G3, G11, G13, G10, G9, G4, G5 (recirculated) and G6) inclusive. The results of this analysis should be used to confirm the conclusion of the Tier 3 report and inform future works.

1 INTRODUCTION

1.1 Background

Scotch Corner historic landfill is in the townland of Letterbane, approximately 4km south-west of Clontibret off the R184 road in Co. Monaghan. The 4.5-hectare historic landfill is located to the south of the licenced facility (Waste Licence No. W0020-02) on the opposite side of the local access road. The historic landfill accepted municipal waste throughout the late 1970s and 1980s and ceased operation in 1991.

Monaghan County Council (MCC) is required to complete a tiered risk assessment of unregulated waste disposal sites in accordance with the Environmental Protection Agency (EPA) Code of Practice for Environmental Risk Assessment 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 Tier 1 Environmental Risk Assessment (ERA) completed by Fehily Timoney & Co. (FT) in May 2018 determined the site had a risk classification of Moderate (Class B) based on the risk of leachate runoff entering a tributary of the River Fane 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;
- Site Walkover;
- Intrusive Site Investigation;
- Geophysical Surveying to estimate extents and depths of waste;
- Environmental Monitoring: Surface Water, Groundwater and Leachate Testing;
- Environmental Risk Assessment (ERA); and,
- Development of a conceptual site model (CSM)

As part of the initial desk study, a review of 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 Limited (PGL) to conduct the site investigation which included; excavation of trial pits, a geophysical investigation and the installation of four onsite leachate monitoring boreholes (SI6 – SI10).

The purpose of the geophysical study was to attempt to define the vertical and lateral extents of the waste body. Trial pits were excavated to provide a preliminary assessment of the volume, extent and type of waste infilled at the site. The leachate boreholes were installed to assess the type and strength of the leachate encountered in the waste body. Previously installed perimeter groundwater monitoring boreholes were used to assess the impact, if any, to the local groundwater quality beyond the site boundary.

Laboratory analysis of waste samples, groundwater and leachate were conducted to assess and quantify any potential for ongoing environmental impacts.

The information gathered from the desk study, intrusive site investigation and geophysical survey were used to inform the development of 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 available documentation for the site was conducted followed by a site walkover. The documentation made available to FT for the desktop review included groundwater, surface water and gas monitoring data gathered for the Scotch Corner Licenced site located north of the historic landfill.

2.2 Desk Study

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

2.2.1 Site Description and On-Site Conditions

The landfill is located approximately 4km south-west of Clontibret off the R184 in Co. Monaghan. The 4.5hectare historic landfill is located to the south of the licenced site on the opposite side of the local access road.

The land use in the area is primarily agricultural with the land used for pasture. The site is bounded to the north by a local access road with the Scotch Corner licenced landfill facility and McElaney's Recycling and Civic Amenity opposite the site, to the west by bog land to the east by agricultural fields and to the south by agricultural land and bogs.

The location of the site is shown in Error! Reference source not found., overleaf.

2.2.2 Topography

The historic landfill site is located in a primarily rural setting in an area of rolling topography dominated by drumlins. Areas between the drumlins are often boggy at elevations between 110 - 125m above ordnance datum (OD), while more free-draining ground is found on the drumlins themselves which rise to between 140mOD and 150mOD. There is a hill located to the north of the site with a peak elevation of 157mOD.

Map Path: R:\Map Production\2018\P1679\Workspace\P1679_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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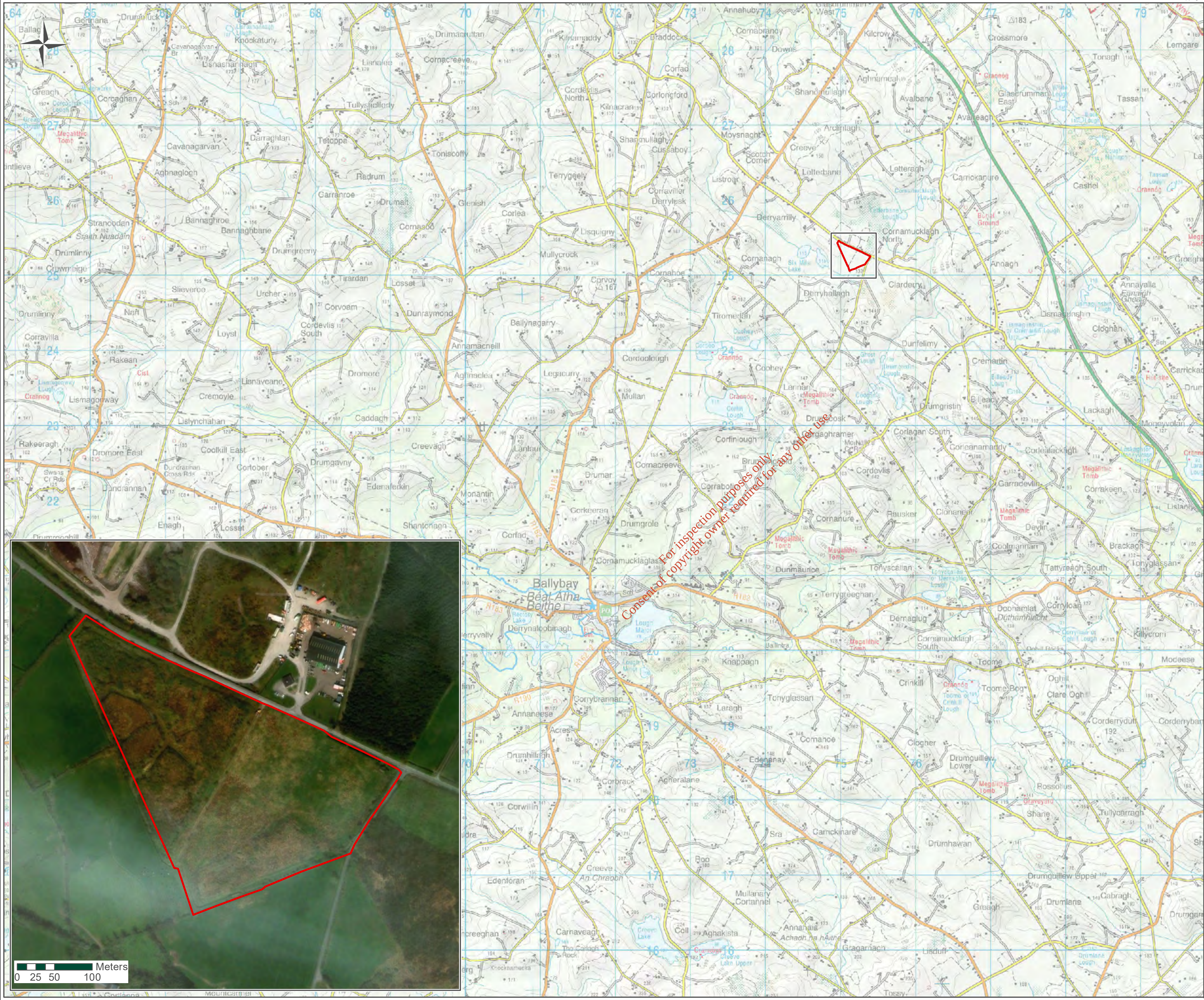

Kilometers
0 0.5 1 2

Co. Monaghan

Legend

Site Boundary

Figure Title	Site Location
Figure No.	2.1
Project	Scotch Corner Historic Landfill Tier 2
Client	Monaghan County Council
Scale 1:50,000	**Page Size** A3
Revision A	**Date** 12/11/2018

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2.2.3 Geology

Drift/Quaternary Geology

The landfill site is underlain by relatively thin subsoil overlying a poorly productive bedrock aquifer. The subsoils are typically glacial till comprising sandy gravelly clay. According to the GSI, the glacial overburden is mapped as '*Till derived from Low Palaeozoic Sandstone and shales'* (TLPSS), as shown in Figure 2.2. The north-eastern portion of the site and surrounding area is underlain by cutaway blanket peat.

Both blanket peat and glacial till were encountered during the trial pitting stage of the site investigation as referenced in the PGL logs, Appendix 2.

Solid or Bedrock Geology

The GSI online 1:100,000 scale bedrock geology map, the site is underlain by the Silurian Lough Avaghon formation (LA) which is generally made up of '*grey, fine to coarse grained, massive greywacke sandstones, micro-conglomerates and amalgamated beds'*.

Bedrock outcrop has been mapped approximately 290m north-east of the site boundary, close to the River Fane tributary stream adjacent to the Scotch Corner licenced site. The bedrock geology is presented in Figure 2-3.

Bedrock was encountered during borehole installations as referenced in the PGL borehole logs, Appendix 2.

Map Path: R:\Map Production\2018\P1679\Workspace\P1679_Fig2-2_QuaternaryGeology_A3.mxd

Legend

- Site Boundary

Subsoils Data

- A, alluvium
- Cut, cutover peat
- GLPSsS, sandstone & shale sands and gravels
- L, lake sediment
- Made, made ground
- Rck, bedrock at surface
- TLPSsS, sanstone and shales till - Lower Paleozoic
- Water, water

0 0.5 1 2 Kilometers

Figure Title
Quaternary Geology

Figure No. 2.2

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Scotch Corner Historic Landfill Tier 2

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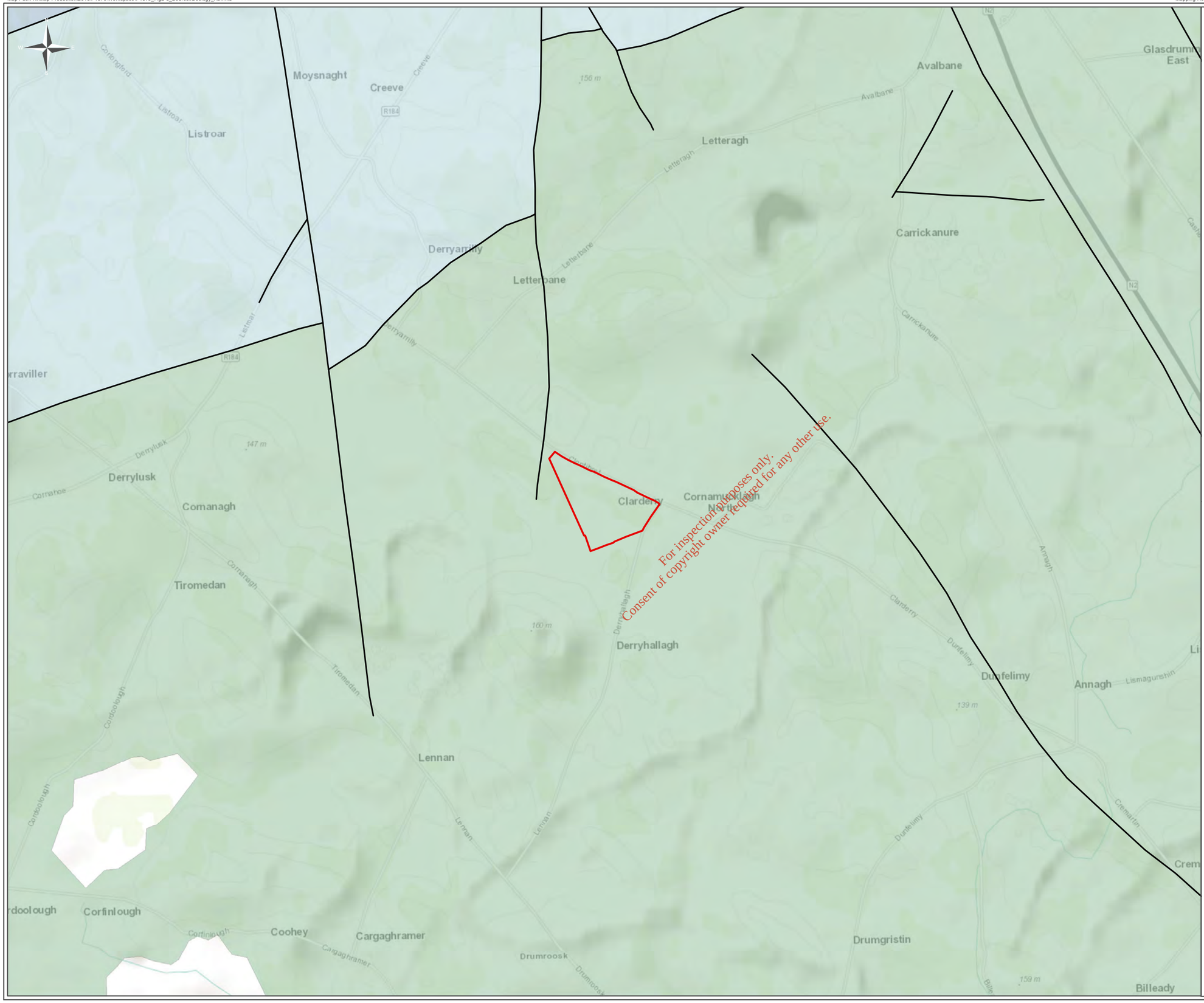
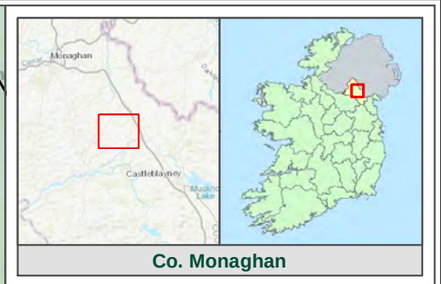
Map Path: R:\Map Production\2018\P1679\Workspace\P1679_Fig2-3_BedrockGeology_A3.mxd





Legend

- Site Boundary
- Structural Linework

Bedrock Geology

- LA: Lough Avaghon
- RI: Red Island Formation
- SG: Slieve Glah Formation

Kilometers
0 0.5 1 2

Figure Title
Bedrock Geology

Figure No. 2.3

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2.2.4 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 Poor Aquifer (Pl) - bedrock which is generally unproductive except for local zones. The bedrock aquifer mapping is presented in Figure 2-4.

The site lies within the Clarderry Groundwater Body (GWB No. IENBG026) which is a small groundwater body defined around the area of the landfill and surrounding lands and is defined as being at *Good Status* under the Water Framework Directive.

There are no Groundwater Drinking Water Protection Areas within the site boundaries, according to GSI. The closest groundwater protection area to the sites is the Monaghan Town outer protection areas, approximately 10km north-west of the site boundary. The outer protection area is 3.76km^2.

There are no karst landforms within the site boundary. The nearest karst landform is a spring named St. Catherine's Well, approximately 1.1km north of the site boundary. The spring lithology is muddy limestone.

The GSI national recharge map defined the annual recharge as 100mm/yr. The effective rainfall for the area is 683mm/yr., indicating the recharge coefficient is 22.5%, which implies the majority of available recharge runs off due to a shallow water table in the subsoil that results from the low permeability of the bedrock aquifer. This will result in flashy streams with reduced baseflow.

Historical mapping for the area shows several springs in the surrounding area. Some of these springs are located at the base of the drumlins and may represent groundwater discharging from the drumlin sediments where these spread out at the base of the drumlins. Other springs are mapped along the edge of the Six Mile Lakes and may represent local groundwater discharges to the lake.

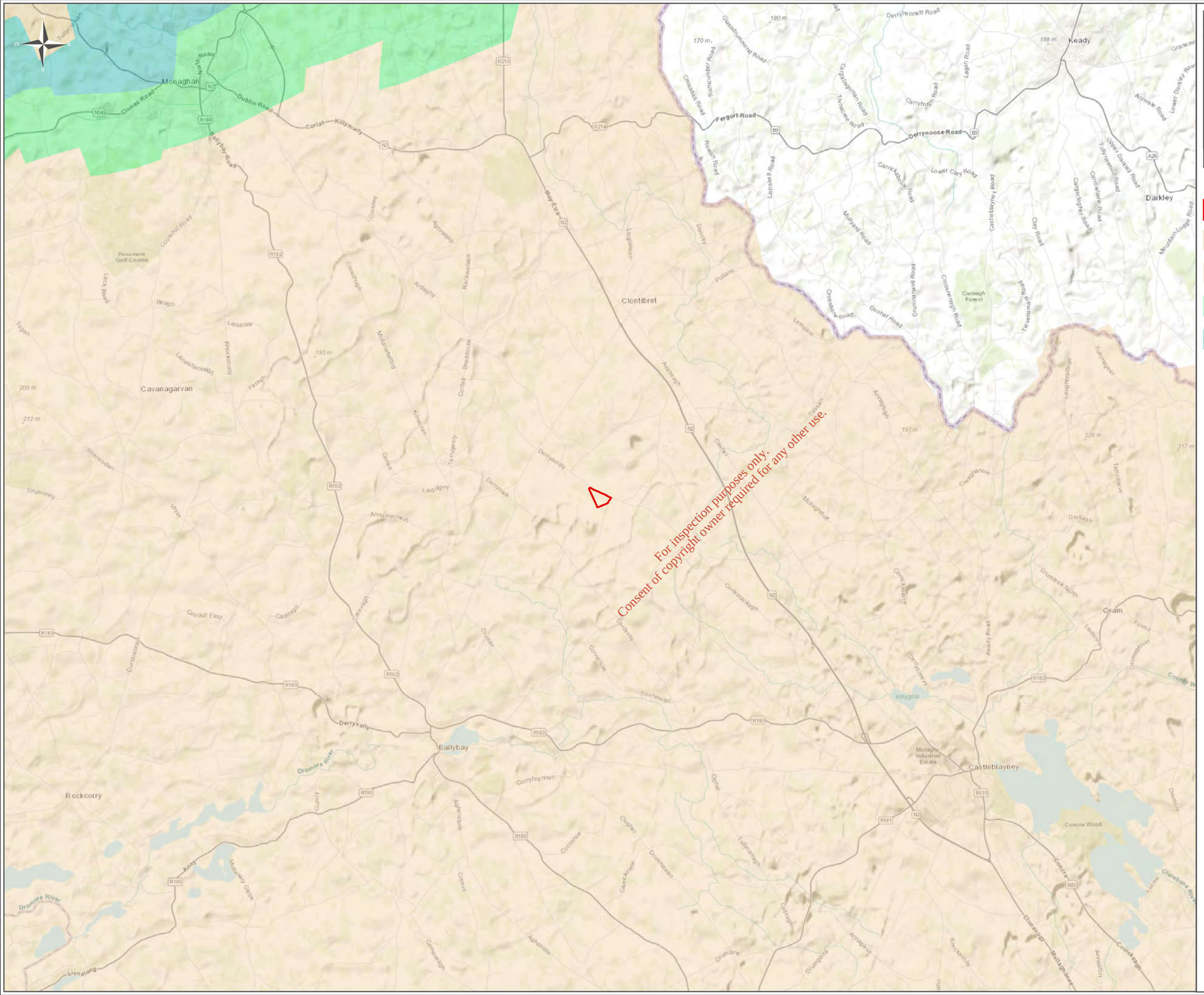
There are no public groundwater supplies and no groundwater dependent ecosystems in the area. Private groundwater supplies within 250m north of the site have been monitored and only one of these now remain active (W7), the other sites have become inactive.

Table 2-1: Distance of wells and springs from the Site

BH/Spring	Yield class	Yield	Use	Depth (m)	Depth to Rock confidence (m)	Distance from site (km)	Date
2631NEW016	Poor	15.3	--	3.1	0.9	0.35	1971
2631NWW097	Poor	10.9	--	4.0	1.2	0.5	1965
2631NWW117	Poor	17.5	--	4.9	1.2	0.5	1971
2631NWW054	Poor	13.1	--	3.1	--	0.7	1971
2631NEW012	Poor	10.9	--	21.3	4.9	0.6	1968
2631NEW010	Poor	26.2	--	45.7	--	0.85	1972

The GSI mapping showing approximate locations of known wells and springs is included in Figure 2-5.

Map Path: R:\Map Production\2018\P1679\Workspace\P1679_Fig2-4_AquiferClassification_A3.mxd



Legend

- Site Boundary
- LI: Locally Important Aquifer - Bedrock Mod Productive Locally
- Pl: Poor Aquifer Bedrock Generally Unproductive Except Locally
- Rf: Regionally Important Aquifer - Fissured Bedrock
- Rk: Regionally Important Aquifer - Karstified

Kilometers
0 0.5 1 2

Figure Title
Aquifer Classification

Figure No. 2.4

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Scotch Corner Historic Landfill Tier 2

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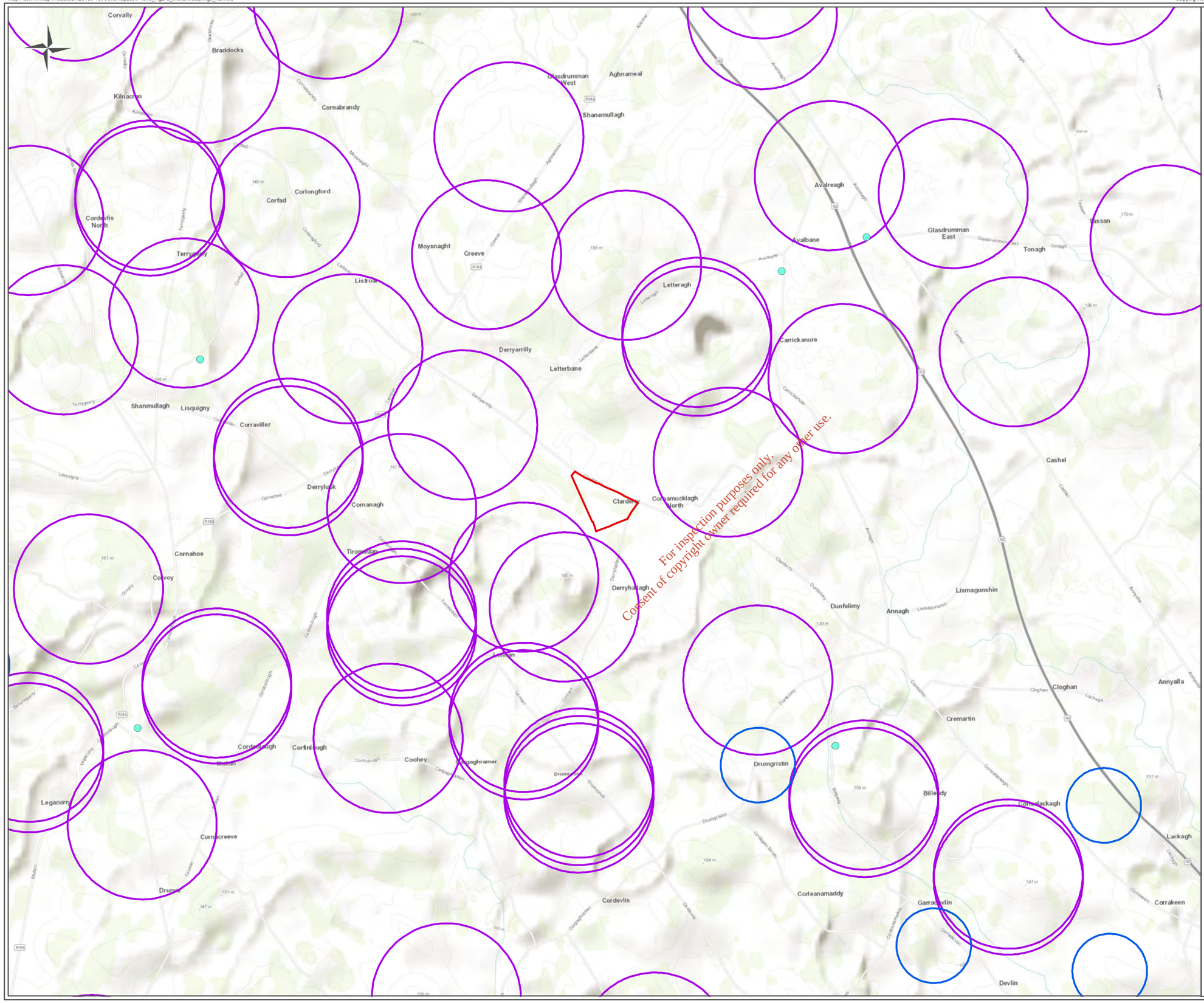
Map Path: R:\Map Production\2018\P1679\Workspace\P1679_Fig2-5_WellsAndSprings_A3.mxd



Co. Monaghan

Legend

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

Figure Title	Wells and Springs
Figure No.	2.5
Project	Scotch Corner Historic Landfill Tier 2
Client	Monaghan County Council
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Page Size	A3
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2.2.5 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 could be contaminated by human activities.

The vulnerability of an aquifer to contamination is influenced by the leaching characteristics of the topsoil, the permeability and thickness of the subsoil, the presence of an unsaturated zone, the type of aquifer, and the amount and form of recharge (the hydrologic process where water moves downward from surface water to groundwater).

Groundwater vulnerability is determined mainly according to the thickness and permeability of the subsoil that underlies the topsoil, as both properties strongly influence the travel times and attenuation processes of contaminants that could be released into the subsurface from below the topsoil.

The Lough Avaghon formation is classified as a Poor Aquifer (Pl) that is generally unproductive except in local zones. The aquifer vulnerability is mainly extreme in the inter-drumlin areas where Scotch Corner historic landfill is founded. The vulnerability at the drumlins themselves is lower due to the thicker subsoils comprising the drumlins.

The groundwater vulnerability for the site is presented in Table 2.2. This table outlines the standard ratings of vulnerability used by the GSI, with the existing site conditions highlighted based on the findings of the site investigations.

Table 2-2: Groundwater Vulnerability

Vulnerability Rating	Hydrogeological Conditions		
	Subsoil Permeability (Type) and Thickness		
	High Permeability (sand/gravel)	Moderate Permeability (sandy soil)	Low Permeability (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\P1679\Workspace\P1679_Fig2-6_GroundwaterVulnerability_A3.mxd

Legend

- Site Boundary

Groundwater Vulnerability

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

Kilometers
0 0.5 1 2

Figure Title
Groundwater Vulnerability

Figure No. 2.6

Project
Scotch Corner Historic Landfill Tier 2

Client
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2.2.6 Hydrology

The site is located within the catchment of the River Fane which flows towards the southeast. The streams flowing along the northern boundary of the Scotch Corner licenced site are tributaries to the River Fane. There is a catchment boundary to the south of the site defined by a low rise in topography to the south of the historic landfill. This catchment drains to the north west to the Six Mile Lake stream, which is a tributary of the River Cor.

There are several small lakes located in the vicinity of the site. Two small lakes to the south of the historic landfill termed Six Mile Lakes drain towards the north west. Letterbane Lough lies along the course of the River Fane to the north east of the site.

Historical Mapping for the area illustrates a small lake called Little Lough which was positioned in the central area of the site. This lake was drained during the expansion of the site.

2.2.7 Ecology

There are no Special Areas of Conservation or Special Protection Areas within a 10 km radius of the site. The nearest pNHA is Coordoo Lough located approximately 1.9km south-west of the site. The ecology protected areas mapping is presented in
Figure 2-7.

2.2.8 Site History

OSI Historic Map (1888-1913 and 1837-1842) identifies that the land within the site boundary and the surrounding area was previously arable land. The dominant land cover is referenced as blanket peat bog.

The OSI Historical Mapping is presented in
Figure 2-8.

According to the OSI aerial imagery mapping, since 1995 the landfill site has been covered with a soil capping and managed as agricultural land.

The current aerial imagery of the site indicates that the topography in the western portion of the site has been altered with several earthen mounds. Through discussion with MCC it was established that the mounds are made up of excavated clay overburden material deposited at the historic landfill during the construction of Phase 2 and Phase 3 engineered landfill cells at the licenced facility.

2.2.9 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 Tassan Lead Mine located approximately 4.0 km east of the project site. Tassan was the largest and most productive of the Monaghan District lead mines, from c. 1840-1866. It comprises good examples of extant mine features, including mine buildings and solid waste.

The Rockcorry-Cootehill Ribbed Moraines are located approximately 8km south-west of the site. This area includes the largest individual ribbed moraines found anywhere in the world. The largest individual feature contains approximately 400 million tonnes of sediment.

The geological heritage mapping is presented in
Figure 2-9.

2.2.10 Existing Geotechnical Stability

GSI landslides database has no record of geotechnical instability within the site boundary or within a 15km radius of the site. The site is located within an area of low landslide susceptibility.

GSI online mapping indicates the presence of cutaway peat within the site boundary and to the north of the site.

Based on the existing database and topography it is considered that the landfill will have a negligible risk of geotechnical instability and there will be no perceived impact on any existing known geohazards.

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.

2.2.12 Previous Studies and Site Investigations

There have been a series of site investigations conducted since the closure of the historic site. A drilling programme was completed in 1998 to support the preparation of an Environmental Impact Assessment for the licenced landfill. Drilling was completed at this time within the historic landfill, boreholes SI1 to SI6 were drilled through overburden and fill into the underlying waste and bedrock. Only three of these boreholes are still present on site (SI1, SI6 and SI2) but are not included in Scotch Corner's waste licence monitoring programme.

A second set of boreholes were drilled in 2002 that comprised six nested boreholes. These included six deep boreholes drilled and screened in bedrock (B1 to B6) and six adjacent shallow boreholes (B1a to B6a) that were drilled and screened only in the overburden. The resulting report notes the fractures were generally tight indicating more fractured bedrock than that noted in outcrops. The depth to bedrock was found to vary between 2m and 5mbgl.

Groundwater monitoring wells B1a/B1, B5a/B5, B7a/B7 and B8a/B8 are the perimeter boreholes which surround the historic landfill.

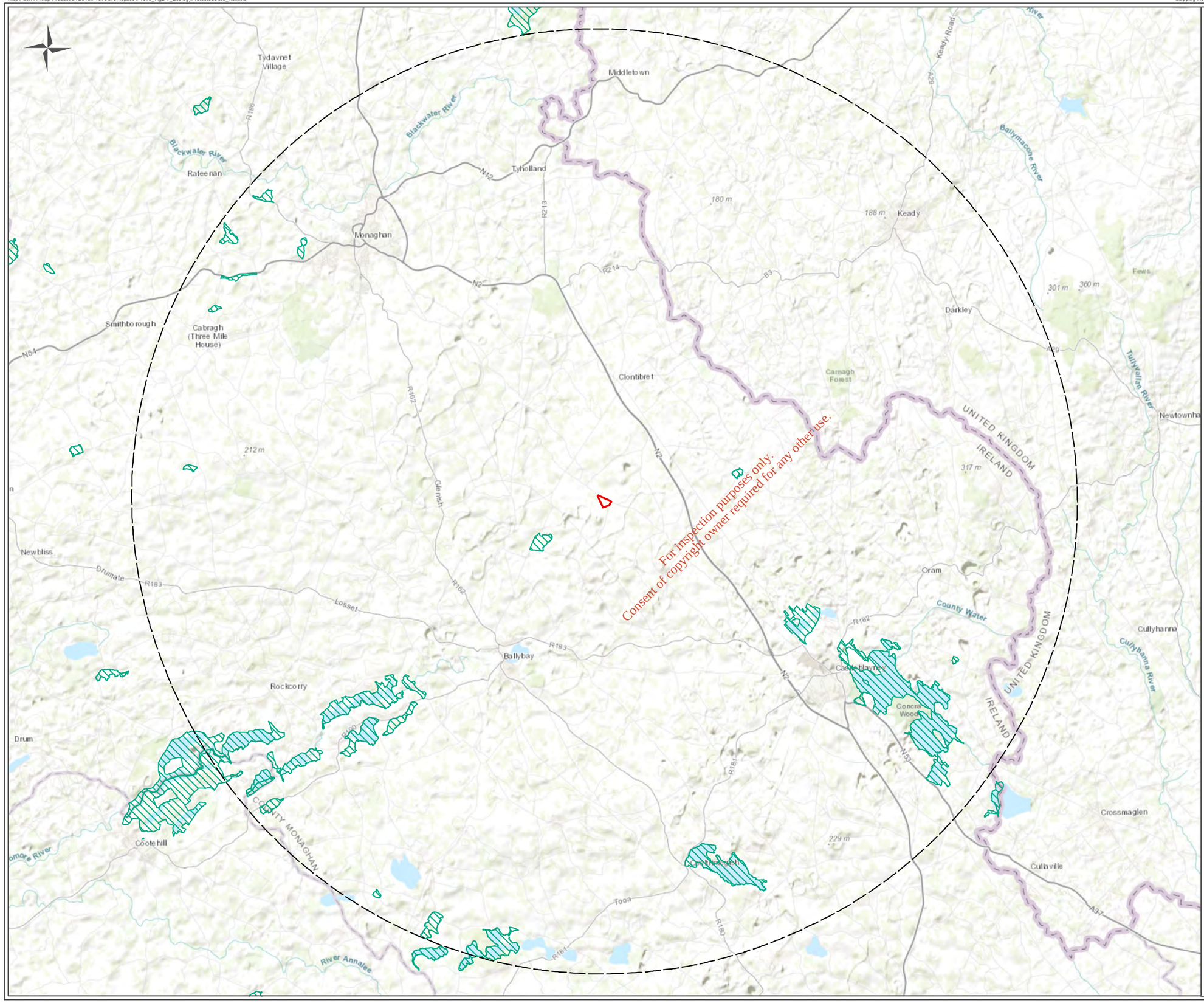
Leachate within the historic landfill is collected via a concrete pipe system and directed to a holding sump (Old G1) and recirculated back to the eastern portion of the historic landfill via a manifolded system (see Figure 4.2).

The Tier 1 Assessment completed by FT in June 2018 comprised the following:

- Development of a conceptual site model (CSM);
- 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; and
- The prioritisation of sites and SPR linkages based on their perceived risk.

Based on available information, the Tier 1 Assessment determined that the overall risk score for Scotch Corner Landfill was 46%, resulting in a risk classification of Moderate (Class B).

A copy of this assessment is included in Appendix 1.



Co. Monaghan

Legend

- Site Boundary
- 15km Distance from Site Boundary

Proposed Natural Heritage Area (pNHA)

- Closest Site: 1.9km

0 1 2 4 Kilometers

Figure Title
Ecology: Protected Sites

Figure No. 2.7

Project
Scotch Corner Historic Landfill Tier 2

Client
Monaghan County Council

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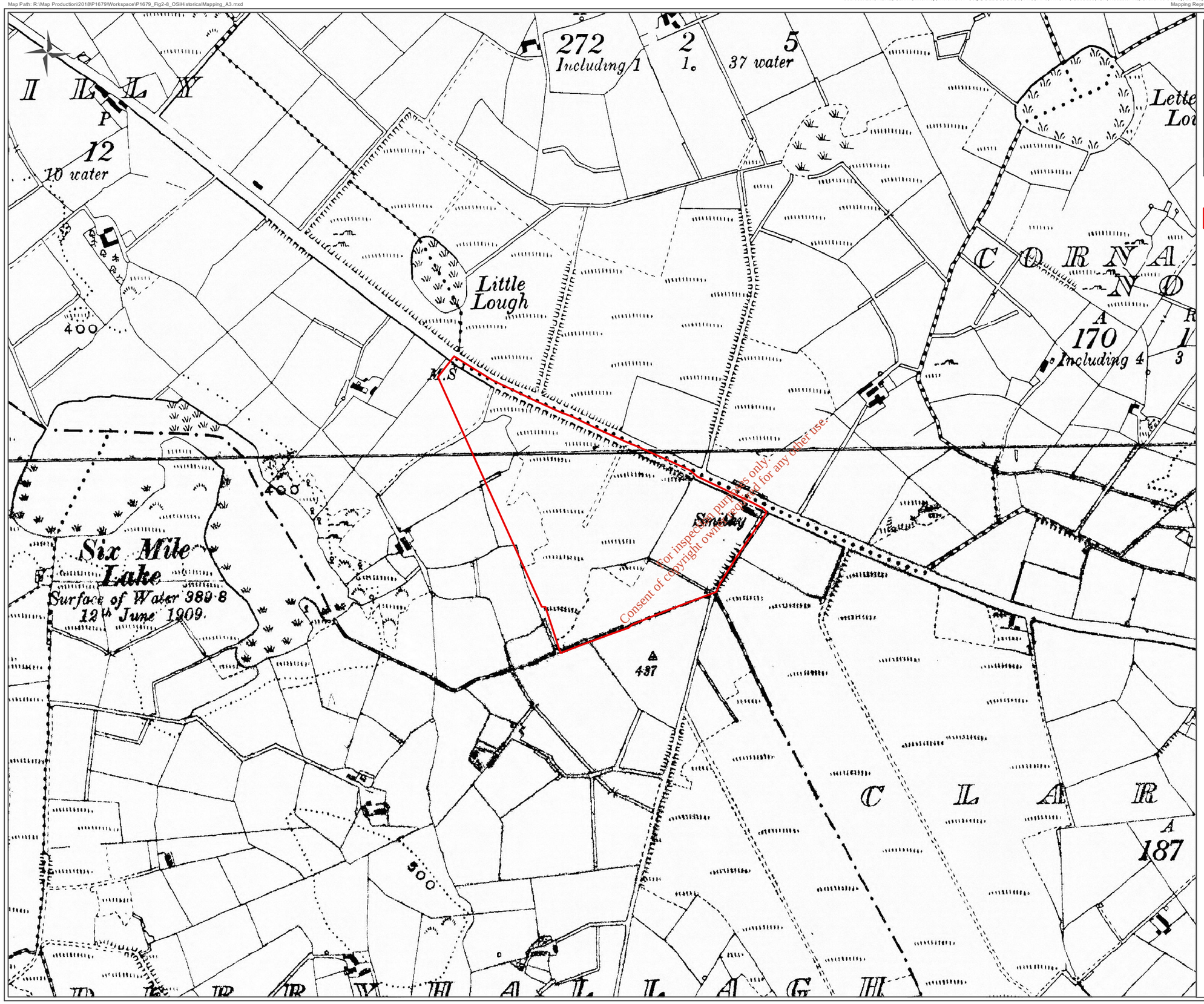

Co. Monaghan

Legend

Site Boundary

Figure Title	OSi Historical Mapping
Figure No.	2.8
Project	Scotch Corner Historic Landfill Tier 2
Client	Monaghan County Council
Scale	1:5,000
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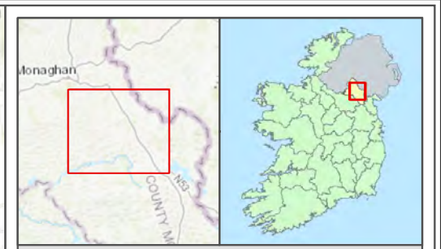
Meters
0 50 100 200

Clontibret Stream

Lemgare

Tassan

Rockcorry-Cootehill Ribbed Moraines



Co. Monaghan

Legend

- Site Boundary
- Geological Heritage Sites

0 1 2 4 Kilometers

Figure Title
Geological Heritage

Figure No. 2.9

Project
Scotch Corner Historic Landfill Tier 2

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3 TIER 2 SITE INVESTIGATION

3.1 Site Investigation Works

The site investigation rationale was devised based on findings of the Tier 1 Site, a site walkover and historical aerial photography.

The scope of site investigation works included:

- 18 No. trial pit excavations
- Installation and monitoring of 4 No. leachate boreholes
- 1 No. geophysical survey (2D resistivity and seismic refraction profiling)
- Environmental sampling: groundwater, surface water and leachate
- 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
- BS 5930: 1999, Code of Practice for Site Investigations
- BS 6068 Water Quality: Sampling (parts 6.1-6.6 and 6.11-6.12, 6.14)
- BS 8855 Soil analysis (all parts)
- BRE (1991) Soakaway design, Digest 365, Buildings Research Establishment, London.
- 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 prior to site investigation works by an FT Engineer. The FT Project Engineer noted that the site is currently very overgrown, particularly at the western end of the site, and that the ground level is undulating. The walkover focused on the surface water drainage network surrounding the site along the southern and western landfill perimeter where surface water sampling locations G3, G4, G5, G8, G9, G10, G11, G13 are located and the leachate collection system at Old G1 Sump.

The perimeter drainage is installed to direct all surface water runoff towards the G5 sump along the northern boundary as illustrated in Figure 2.7. Surface water is pumped from the G5 sump back to a central location in the western portion of the site to percolate down through stockpiled fill material. The infiltrated surface water is then collected at sump 'G5 recirculated' at the foot of an embankment and directed north towards G6 and ultimately the River Fane tributary stream within the licenced facility.

Since September 2017, MCC have altered the leachate collection at the historic site which previously was directed to the leachate lagoon within the licenced facility. Any leachate collected at the site is pumped from the Old G1 sump and directed to a manifold system consisting of 4 no. distribution valves and recirculated across the surface in the eastern portion of the historic site (see Figure 4.2).

During the site walkover the scope of the investigative works were evaluated based on the findings in the Tier I assessment. The locations of the intrusive works undertaken at the site are presented in Figure 3-1.

A site walkover checklist and photographic log are provided in Appendix 6.

Legend

- Leachate Well Locations
- Trial Pit Locations
- Site Boundary

Figure Title
Site Investigation Location Plan

Figure No. 3.1

Project
Scotch Corner Historic Landfill Tier 2

Client
Monaghan County Council

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Meters
0 50 100 200

3.1.2 Trial Pitting

An intrusive investigation involving trial pitting was undertaken by PGL on 20th and 21st September 2018 under the supervision of PGLs Engineering Geologist.

A total of 18 No. trial pits (TP01 to TP18) were excavated to a maximum depth of 4.70m below existing ground level (bgl) using a 13-tonne tracked excavator.

A summary of the ground conditions is presented in Table 3.1 below with photographs and exploratory hole logs provided in the PGL site investigation report, Appendix 2.

Table 3-1: Summary of Ground Condition

Trial Pit ID	Depth of cover material (m BGL)	Depth to base of made ground/waste (m BGL)	Profile Description
TP01	0.30 (Topsoil) 0.30 – 3.80 (Made Ground) 3.80 – 4.30 (Peat)	4.3 (base of excavation)	MADE GROUND: Landfill material mixed with peat and sandy gravelly CLAY – plastic, glass, metal, paper, fabric. Waste material encountered from 3.0m BGL. Cut-over blanket PEAT.
TP02	0.30 (Topsoil) 0.30 – 4.70 (Made Ground)	4.7 (base of excavation)	MADE GROUND: Landfill material mixed with peat and sandy gravelly CLAY – plastic, glass, cables. Waste material encountered from 3.8m BGL.
TP03	0.0 – 1.10 (Gravel)	1.10 (base of excavation – terminated at assumed bedrock)	MADE GROUND: Blue grey clayey sandy GRAVEL.
TP04	0.10 (Topsoil) 0.10 – 4.3 (Made Ground) 4.3 – 4.5 (Peat)	4.5 (base of excavation)	MADE GROUND: Landfill material mixed with sandy gravelly CLAY – plastic, glass, metal, cables. Strong odour noted. Waste material encountered from 1.1m – 4.3m BGL. Cut-over blanket PEAT.
TP05	3.10 (Made Ground)	3.1 (base of excavation - terminated at assumed bedrock obstruction)	MADE GROUND: Landfill material mixed with GRAVEL and sandy gravelly CLAY – cement blocks, glass, cables, plastic.
TP06	0.10 (Topsoil) 0.1 – 1.9 (Made Ground) 1.9 – 2.5 (Clay)	2.5 (base of excavation - terminated at natural ground)	MADE GROUND: Landfill material mixed with sandy GRAVEL – plastic, rubber, glass, foam, pipes, steel straps, planks of wood. Grey slightly sandy gravelly CLAY.
TP07	0.10 (Made Ground) 0.1 – 0.35 (Cobbles and Boulders)	0.35 (base of excavation – terminated at bedrock)	MADE GROUND: Bituminous surfacing with gravel. COBBLES and BOULDERS.
TP08	2.10 (Made Ground) 2.10 – 3.0 (Peat)	3.0 (base of excavation)	MADE GROUND: Landfill material mixed with grey CLAY – plastic, metal, wood, wire, foam, shoes, clothes, coal bags.

Trial Pit ID	Depth of cover material (m BGL)	Depth to base of made ground/waste (m BGL)	Profile Description
			Cut-over blanket PEAT.
TP09	2.50 (Made Ground) 2.5 – 3.0 (Clay)	3.0 (base of excavation – terminated at natural ground)	MADE GROUND: Landfill material mixed with grey CLAY – plastic, metal, timber, textile, glass. Grey slightly sandy gravelly CLAY.
TP10	3.30 (Peat) 3.3 – 3.8 (Clay)	3.8 (base of excavation)	Brown PEAT with rootlets. Grey slightly sandy slightly gravelly CLAY.
TP11	0.20 (Topsoil) 0.2 – 0.8 (Gravel) 0.8 – 3.0 (Clay)	3.0 (base of excavation – terminated due to natural ground)	Grey sandy GRAVEL. Blue grey sandy gravelly CLAY.
TP12	0.20 (Topsoil) 0.2 – 1.4 (Made Ground) 1.4 – 1.8 (Clay)	1.8 (base of excavation – terminated due to natural ground)	MADE GROUND: Landfill material mixed with grey CLAY – plastic, metal, wood.
TP13	0.10 (Topsoil) 0.1 – 4.0 (Made Ground) 4.0 – 4.5 (Peat)	4.5 (base of excavation)	MADE GROUND: Landfill material mixed with grey CLAY – plastic, metal, wood.
TP14	0.30 (Topsoil) 0.3 – 0.65 (Clay)	0.65 (base of excavation – terminated due to assumed bedrock)	Brown slightly sandy gravelly CLAY.
TP15	0.10 (Topsoil) 0.1 – 3.9 (Made Ground) 3.9 – 4.2 (Peat)	4.2 (base of excavation - terminated at natural ground)	MADE GROUND: Landfill material mixed with grey CLAY – plastic, metal, timber, textile, glass. Cut-over blanket PEAT.
TP16	0.15 (Topsoil) 0.15 – 2.3 (Made Ground) 2.3 – 3.0 (Clay)	3.0 (base of excavation)	MADE GROUND: Landfill material mixed with grey CLAY – plastic, metal, timber, textile, glass. Strong odour noted. Grey slightly sandy gravelly CLAY.
TP17	0.20 (Topsoil) 0.2 – 1.8 (Clay)	1.8 (base of excavation – terminated on bedrock obstruction)	Brown grey slightly sandy gravelly CLAY.
TP18	0.50 (Topsoil) 0.5 – 1.2 (Grey Clay) 1.2 – 2.8 (Blue Clay)	2.8 (base of excavation – terminated due to presence of natural ground)	Grey brown slightly sandy gravelly CLAY. Blue grey slightly sandy slightly gravelly CLAY.

Natural ground comprising of PEAT and sandy gravelly CLAY was encountered in 13 No. trial pits TP01, TP04, TP06, TP07, TP08 to TP11 and TP14 to TP18.

Within areas where deposited waste was encountered the ground conditions generally comprised of *MADE GROUND: landfill material mixed with grey CLAY comprising of plastic, metal, timber, textiles, glass.* Waste material was generally encountered to depths ranging between 4.0m and 4.7m BGL at 11 No. trial pits (TP01, TP02, TP04 – TP06, TP08, TP09, TP12, TP13, TP15 and TP16). Leachate was encountered in all these trial pits during the intrusive site investigation.

The waste material as described by PGLs Engineering Geologist is very typical of municipal solid waste (MSW) material, see Appendix 2. Trial pitting did not show specific evidence of industrial waste being encountered.

As noted most of the waste encountered contained evidence of waste typical of MSW material. Visual and olfactory evidence of putrescible / biodegradable waste odours were noted by PGLs supervising Geologist during the site investigation.

Groundwater was encountered in 13 No. trial pits as detailed in Table 3.2.

Table 3-2: Groundwater strikes encountered during trial pitting

Trial Pit ID	Water Level (mBGL)	Flow Rate
TP01	3.80	Fast Flow
TP02	3.60	Steady Flow
TP03	0.70	Fast Flow
TP04	3.50	Fast Flow
TP05	2.60	Steady Flow
TP06	1.00	Fast Flow
TP08	2.10	Fast Flow
TP09	2.10	Fast Flow
TP11	0.80	Fast Flow
TP13	2.70	Fast Flow
TP15	3.10	Steady Flow
TP16	2.30	Slow Flow
TP18	0.60	Slow Flow

3.1.3 Waste Sampling

3 No. samples of the made ground/waste material were collected from trial pits TP01, TP08 and TP13 across the landfill site.

Samples were submitted for Waste Acceptance Criteria (WAC) to ALS Environmental Ltd, a UKAS/MCERTS approved laboratory.

The results are provided in Appendix 3.

3.1.4 Borehole Installations and Groundwater / Leachate Sampling

Four leachate boreholes (SI07, SI08, SI09 and SI10) were drilled to depths ranging between 2.60m bgl to 5.80m bgl within the anticipated waste body at the site. The boreholes were drilled and installed as leachate monitoring locations.

The leachate monitoring boreholes were advanced near the centre of the site following interpretation of desk study and anecdotal information provided by MCC. The primary purpose of these wells was to assess the type and strength of leachate within the waste body at these locations.

The boreholes were also used to confirm the depth to bedrock at these locations for the calibration of the geophysical survey ERT profiles as discussed in Section 3.1.5.

Since 2002, MCC as part Scotch Corner's waste licence compliance (W0020-02) undertake groundwater level and quality monitoring at the shallow (B1a and B5a) and deep perimeter boreholes (B1 and B5). Since 2015, shallow (B7a and B8a) and deep (B7 and B8) boreholes have been monitored by MCC along with the other accessible historic landfill borehole SI6. The locations of the leachate and groundwater monitoring standpipes are illustrated in Figure 3.2. The borehole logs for these wells are provided in Appendix 5.

The shallow boreholes have been drilled and screened only in the overburden. The results of groundwater monitoring from June and September 2018 is presented as part of the Tier 2 assessment in Section 4.3.

Leachate and gas monitoring was undertaken by FT in boreholes SI06 – SI10 on 1st October and 10th October 2018.

Prior to sampling being undertaken, the groundwater well standpipes were purged and developed with a Wasp P-5 submersible pump by Monaghan County Council and leachate wells purged using a hand bailer. Gas caps were installed by PGL on the leachate wells for gas 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 4 and are further discussed in the proceeding sections.

Legend

- Groundwater Well Locations
- Leachate Well Locations
- Site Boundary

Figure Title
Leachate and Groundwater Monitoring Wells

Figure No. 3.2

Project
Scotch Corner Historic Landfill Tier 2

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Meters
0 50 100 200

3.1.5 Geophysical Investigation

Priority Geotechnical Ltd. were instructed by FT to undertake a geophysical investigation of the site. The survey was carried out on the 15th and 18th October 2018.

The geophysical survey comprised of 2D electrical resistivity and seismic refraction profiling along 4 no. designated profiles in the survey area. A total of 1,450m of electrical resistivity profiles were collected.

The geophysical survey, calibrated against the findings of the trial pitting and borehole installations was used to estimate a general profile of the buried waste above the in-situ bedrock.

Seismic Refraction Profiling and Electrical Resistivity Tomography (ERT)

PGL recorded 4 no. ERT profiles data along four designated profiles. ERT profiles are named R1 through R4. The location of these profiles is given in Drawing No's P18175_GP_D01 to P18175_GP_D02 and an interpretation of the results are included below in Figure 3.3 and in the PGL Geophysics Report, Appendix 2.

Figure 3-3: Scotch Corner ERT Profiles R1 to R4

Results

The geophysical survey succeeded in validating the general location of the waste material. The ERT profiles mapped the lateral extent of the landfill material with an increase in resistivity close to the surface outside areas of landfill material. ERT profile R2 does not indicate the presence of waste close to the surface in the first 230m, therefore the extent of the landfill material at these locations should be interpreted in conjunction with trial pit information (TP01, TP02, TP04 an TP05). No evidence of landfill material was seen on ERT profile R4.

The geophysical results confirm the findings of the desk study and anecdotal information gathered, indicating that the site was backfilled with municipal solid waste directly atop the underlying Peat or Clay glacial till strata. The geophysical profiles indicate the bulk of the waste has been deposited in the western portion of the site towards the main R184 road and the depth appears to taper to a shallower depth in the southern area of the site.

The modelled profiles and geophysical interpretations are presented in Figure 3.4 to Figure 3.7.

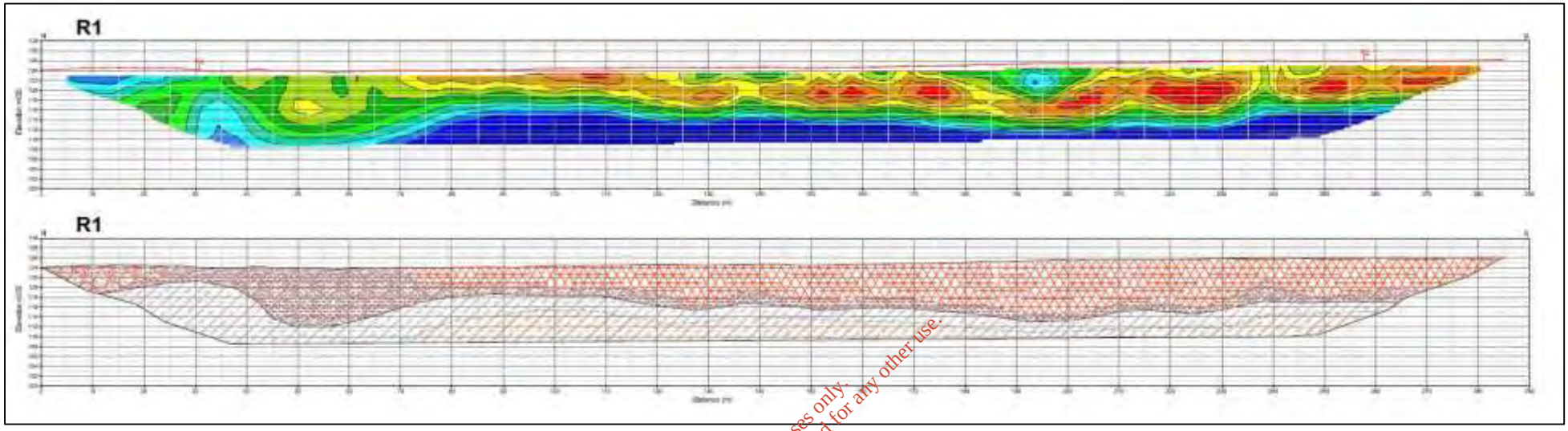

Figure 3-4: ERT Profile R1 Interpreted Cross Section

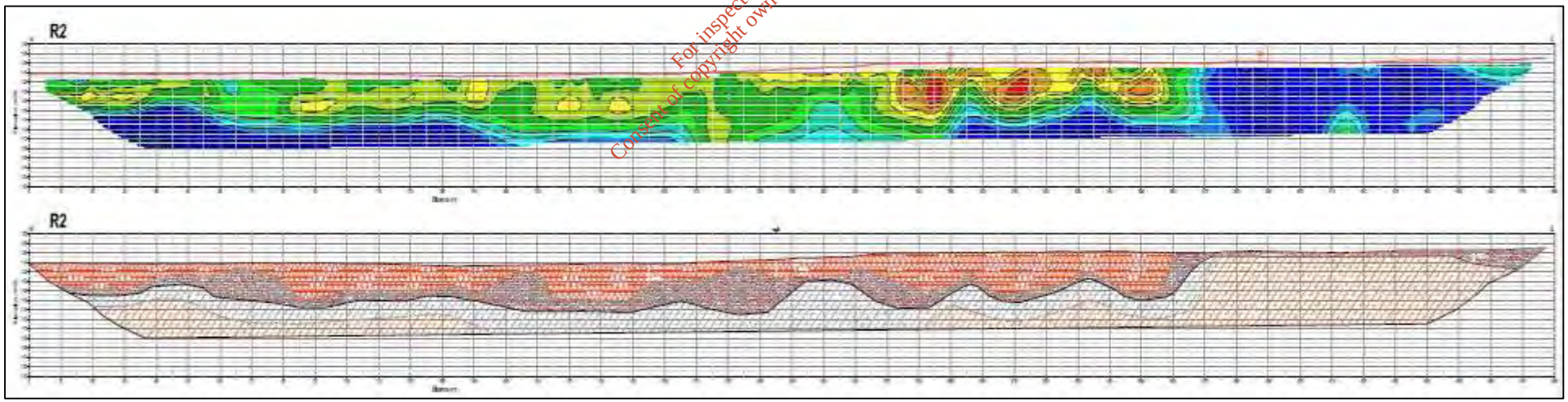

Figure 3-5: ERT Profile R2 Interpreted Cross Section

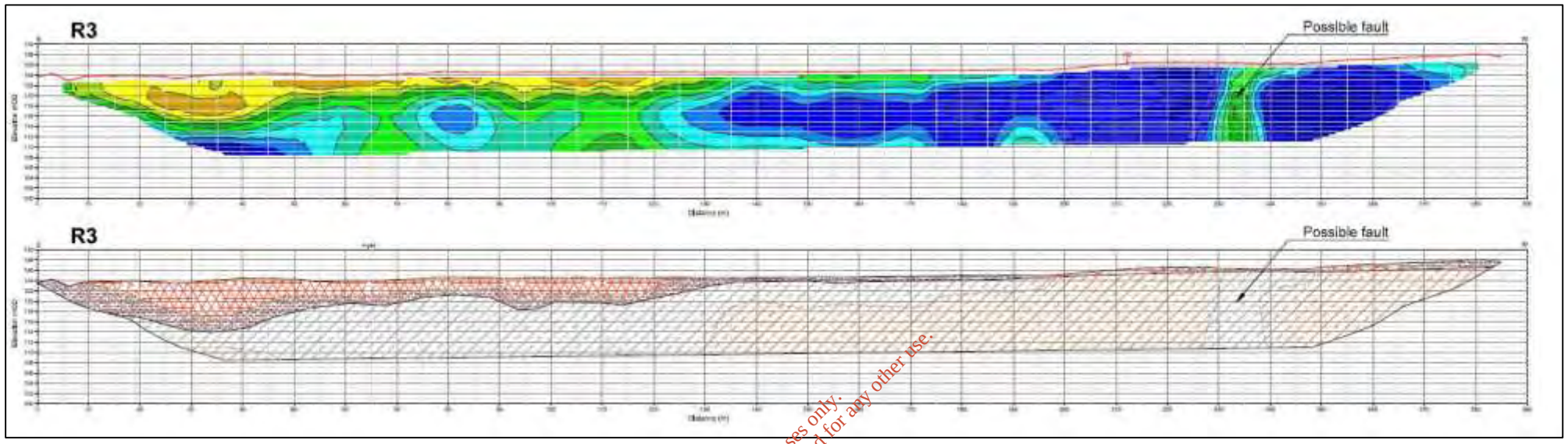

Figure 3-6: ERT Profile R3 Interpreted Cross Section

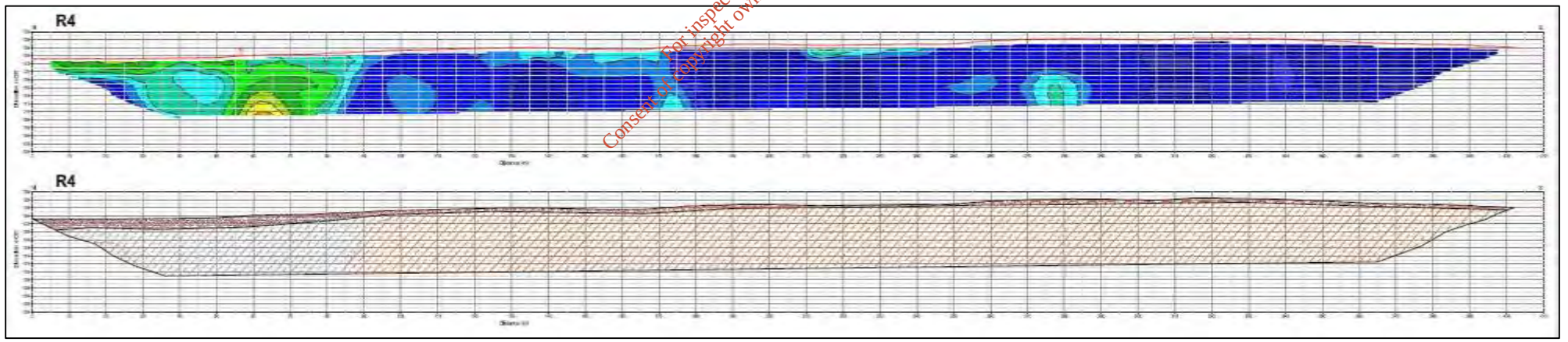

Figure 3-7: ERT Profile R4 Interpreted Cross Section

3.1.6 Waste Delineation

The combined findings of the geophysical survey and intrusive site investigation were used to interpret the aerial extent of the waste mass. The geophysical survey comprised of 2D electrical resistivity tomography (ERT) to measure the ground resistivity distribution across the landfill area.

The extent of the waste deposit has been interpreted by the presence of undisturbed ground encountered in 13 No. trial pits TP01, TP04, TP06, TP07, TP08 to TP11 and TP14 to TP18.

PGL described the 3 No. areas of anomalous resistivity picked up on ERT profiles R1, R2 and R3 are the areas of waste material. Landfill material was seen to extend to a maximum depth of 10m bgl as imaged on ERT profile R1. The ERT profiles mapped the lateral extent of the landfill material with an increase in resistivity close to the surface outside areas of landfill material.

The findings of the site investigation work suggest the waste material is deposited in a single infill area tending north-west to south-east and between 350m in length and 225m in width. Based on this interpretation, the maximum waste footprint is calculated to be approximately 10.14 acres or 4.1 hectares.

The maximum estimated waste footprint based on the site investigations completed to date is presented in Figure 3-8.

A volume calculation was conducted based on the surveyed surface profiles for the existing ground level and the base of waste as interpreted, preliminary estimates indicate an interred waste volume of approximately 164,000 m^3 at the site.

Legend

- Site Boundary
- Maximum Anticipated Waste Footprint (c.4.2ha)

Meters
0 50 100 200

Figure Title	Maximum Anticipated Waste Footprint
Figure No.	3.7
Project	Scotch Corner Historic Landfill Tier 2
Client	Monaghan County Council
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4 ENVIRONMENTAL ASSESSMENT

4.1 Chemical Assessment Criteria

- Council Decision 2003/33/EC – Waste Acceptance Criteria
- European Communities, Environmental Objectives (Groundwater)(Amendment) Regulations, 2016 (S.I. No. 366 of 2016)
- Interim Guideline Values (IGV) set out in the EPAs Groundwater *Towards Setting the Guideline Values for the Protection of Groundwater in Ireland*.
- 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).

The results of the environmental assessment at Scotch Corner Historic Landfill site is presented in the following sections.

4.2 Waste Classification Assessment

Waste samples collected during this assessment have been compared against Waste Acceptance Criteria (WAC) to determine the appropriate waste classification rating associated with the interred waste. WAC screening is used to categorise the interred waste as inert, non-hazardous or hazardous material.

4.2.1 Chemical Results for Waste Samples

The waste samples analysed from the site investigations were assessed against the Waste Classification Assessment Criteria to determine the broad classification of waste landfilled. A summary of the results for Scotch Corner Historic Landfill is outlined in Table 4.1 below, while the laboratory reports are presented in Appendix 3.

Table 4-1: Waste Sampling Results – WAC Analysis

Parameter	Units	Inert Waste Acceptance Criteria	Non-Hazardous Waste Acceptance Criteria	Hazardous Waste Acceptance Criteria	Sampling Results - Sample ID		
					TP01 (3.5m)	TP08 (1.5m)	TP13 (3.0m)
Asbestos in soil	--	Detected	Detected	Detected	ND	ND	ND
Arsenic	$mg.kg^{-1}$	0.5	2	25	<0.050	<0.050	<0.050
Barium	$mg.kg^{-1}$	20	100	300	<0.50	<0.50	<0.50
Cadmium	$mg.kg^{-1}$	0.04	1	5	<0.010	<0.010	<0.010
Chromium	$mg.kg^{-1}$	0.5	10	70	<0.050	<0.050	<0.050
Copper	$mg.kg^{-1}$	2	50	100	<0.050	<0.050	<0.050
Mercury Dissolved	$mg.kg^{-1}$	0.01	0.2	2	<0.005	<0.005	<0.005
Molybdenum	$mg.kg^{-1}$	0.5	10	30	<0.050	<0.050	<0.050
Nickel	$mg.kg^{-1}$	0.4	10	40	<0.050	<0.050	<0.050
Lead	$mg.kg^{-1}$	0.5	10	50	<0.010	<0.010	<0.010
Antimony	$mg.kg^{-1}$	0.06	0.7	5	<0.010	<0.010	<0.010
Selenium	$mg.kg^{-1}$	0.1	0.5	7	<0.010	<0.010	<0.010
Zinc	$mg.kg^{-1}$	4	50	200	<0.50	<0.50	<0.50
Chloride	$mg.kg^{-1}$	800	15000	25000	14	51	26
Fluoride	$mg.kg^{-1}$	10	150	500	1.1	28	1.4
Sulphate	$mg.kg^{-1}$	1000	20000	50000	210	240	390
Total Dissolved Solids	$mg.kg^{-1}$	4000	60000	100000	810	1100	990
Total Monohydric Phenols	$mg.kg^{-1}$	1	--	--	<0.30	<0.30	<0.30
Dissolved Organic Carbon	$mg.kg^{-1}$	500	800	1000	150	110	150
Sum of BTEX	$mg.kg^{-1}$	6	--	--	<0.010	0.066	2.6
Total Organic Carbon *	%	3	5	6	7.3	7.2	11
Moisture Content ratio	%	--	--	--	47	28	48
Mineral Oil	$mg.kg^{-1}$	500	--	--	<10	930	<10

Parameter	Units	Inert Waste Acceptance Criteria	Non-Hazardous Waste Acceptance Criteria	Hazardous Waste Acceptance Criteria	Sampling Results - Sample ID		
					TP01 (3.5m)	TP08 (1.5m)	TP13 (3.0m)
PCBs (Sum of 7)	$mg.kg^{-1}$	1	--	--	<0.10	<0.10	<0.10
PAH (Sum of 17)	$mg.kg^{-1}$	100	--	--	<2.0	<2.0	<2.0
pH	pH units	>6 or <9	>6	--	7.6	8.0	8.1
Loss on ignition	%	--	--	10	12	14	38

* ND – non-detected
* Hazardous Waste Landfill Criteria: >6% TOC

4.2.2 Waste Classification

Based on the 3 No. soil samples submitted for laboratory waste acceptance criteria (WAC) testing and the representative spread across the site, analysis of waste samples from the trial pits excavated indicate that the waste material encountered within the site is typical of non-hazardous municipal waste with a high organic load content.

4.3 Groundwater and Leachate Analysis

The shallow perimeter boreholes B1a, B5a, B7a and B8a have been monitored quarterly by MCC since March 2015 along with the other accessible historic landfill boreholes (SI1, SI2 and SI6).

Data from two rounds of groundwater quality monitoring undertaken by MCC on the 6th June and 5th September 2018 have been used for this assessment. Two rounds of leachate quality monitoring were undertaken by FT on the 2nd October and 10th October 2018. The findings from the monitoring and an interpretation of the results are presented in the following sections.

4.3.1 Groundwater Depth Analysis

Groundwater depth analysis was undertaken on two occasions following the installation of the rotary core standpipes. Static groundwater levels from the 5th September (Groundwater) and 10th October 2018 (Leachate) are calculated in Table 4.2.

Table 4-2: Groundwater Depth Analysis

Borehole ID	Top of Casing (mAOD)	Dip (m)	Groundwater Level (mAOD)	Location Gradient
SI06	125.41	2.37	122.49	Central
SI07	126.40	0.68	125.25	Down-gradient
SI08	124.60	1.06	123.05	Upgradient
SI09	125.85	2.49	122.95	Central
SI10	124.83	2.86	121.59	Down-gradient
B1a	128.58	1.28	126.97	Upgradient
B5a	123.92	2.36	121.14	Down-gradient
B7a	127.31	1.19	125.65	Cross-gradient
B8a	128.94	2.32	126.13	Down-gradient

*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 north-north-east. A potentiometric map illustrating the hydraulic gradient and the direction of groundwater flow is presented in Figure 4-1.

4.3.2 Leachate Borehole Position

In addition to the previously installed leachate wells SI1, SI6 and SI2, four leachate monitoring boreholes (SI7 to SI10) were installed near the centre of the site based on the anticipated waste footprint across the site following the desktop analysis and discussions between FT and MCC. The purpose of these boreholes was to assess the strength and type of leachate within the waste body.

4.3.3 Groundwater Borehole Position

Previously installed groundwater monitoring boreholes (B1a, B5a, B7a and B8a) were selected for this assessment as suitable perimeter monitoring wells based on their proximity to the landfill. The purpose of these boreholes was to assess the potential for leachate migration beyond the landfill boundary.

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Legend

- Borehole Locations
- Groundwater Contours
- Site Boundary

Figure Title	Groundwater Flow Direction
Figure No.	4.1
Project	Scotch Corner Historic Landfill Tier 2
Client	Monaghan County Council
Scale	1:3,500
Page Size	A3
Revision	A
Date	13/11/2018

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4.3.4 Groundwater Quality Monitoring

Results from the June and September 2018 groundwater monitoring from the 4 No. perimeter boreholes (B1a, B5a, B7a and B8a) 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 for each parameter over two monitoring rounds is outlined in Table 4.3.

Table 4-3: Groundwater Sampling Results – June and September 2018

Parameter	Units	EPA IGV Standards [1]	S.I. No. 9 of 2016 Standards [2]	B1a	B5a	B7a	B8a
June 2018							
pH	pH units	6.5 - 9.5	--	6.9	6.7	6.8	6.4
Conductivity	mS/cm	1	1.875	0.589	1.22	0.622	1.82
Ammoniacal Nitrogen as N	mg/l	0.15	0.175	0.22	27.45	2.20	47.69
Total Oxidised Nitrogen	mg/l	--	--	<0.50	<0.50	<0.50	<0.50
Total Organic Carbon	mg/l	--	--	5.2	8.1	9.4	13.1
Chloride	mg/l	30	187.5	12.54	56.04	15.93	189.94
Dissolved Oxygen	mg/l	no abnormal change	--	1.51	1.56	1.51	1.06
September 2018							
pH	pH units	6.5 - 9.5	--	7.0	6.7	6.8	6.3
Conductivity	mS/cm	1	1.875	0.538	1.46	0.619	1.58
Ammoniacal Nitrogen as N	mg/l	0.15	0.175	0.42	31.5	2.54	46.91
Total Oxidised Nitrogen	mg/l	--	--	<0.50	<0.50	<0.50	<0.50
Total Organic Carbon	mg/l	--	--	5.4	15.0	10.6	11.0
Chloride	mg/l	30	187.5	11.03	74.09	15.08	106.17
Dissolved Oxygen	mg/l	no abnormal change	--	1.93	2.04	1.94	1.31

[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

4.3.5 Groundwater Analysis Discussion

The results of the groundwater monitoring from perimeter wells B1a, B5a, B7a and B8a have reported several exceedances of the IGVs and European Groundwater limit values.

The results from two monitoring rounds for each perimeter well B1a, B5a, B7a and B8a reported ammonia concentrations which exceed guideline threshold values. The ammonia concentrations detected at upgradient borehole B1a is representative of background levels possibly due to agricultural land spreading. Ammonia concentrations within the range 46.91 mg/l to 47.69 mg/l recorded at downgradient borehole B8a is over 100-times greater than upgradient levels. Downgradient borehole B5a is installed along the southern boundary of the -licensed facility. The elevated ammonia results ranging from 27 mg/l to 31.5 mg/l indicate the presence of a leachate plume from the waste body which is migrating northwards into the Licenced facility.

Elevated chloride concentrations of 76.04 mg/l and 189.94 mg/l detected in downgradient boreholes B5a and B8a are another indicator of possible leachate plume migrating north from the historic landfill.

The elevated hydraulic conductivity concentrations detected at B5a and B8a are an indicator of the elevated chloride concentrations detected downgradient of the historic landfill.

Despite the elevated concentrations observed at downgradient borehole B8a, it is noted that B8a is screened in an unlined waste body and elevated concentrations are considered attributable to the waste body underlying the Scotch Corner Licenced site entrance forecourt.

4.3.6 Historic Trends – Ammonia and Chloride

Groundwater quality monitoring at the site has been completed by MCC at boreholes B1a, B5a, B7a and B8a since March 2015. Groundwater quality results at the site have previously been compared to the drinking water maximum admissible concentration (MAC) (e.g. for ammonia - 0.23mg/l). It is important to note that the threshold values in the Groundwater Regulations (GTVs) are considerably lower than the MAC. This review assesses available data against the Groundwater Regulations (2016) (SI No. 366 of 2015) groundwater threshold values (GTVs).

Based on a review of the long-term monitoring data from the four perimeter boreholes, ammonia (Figure 4.2) and chloride (Figure 4.3) has been selected to illustrate the trends being observed since March 2015 for these parameters within localised groundwater quality at the site.

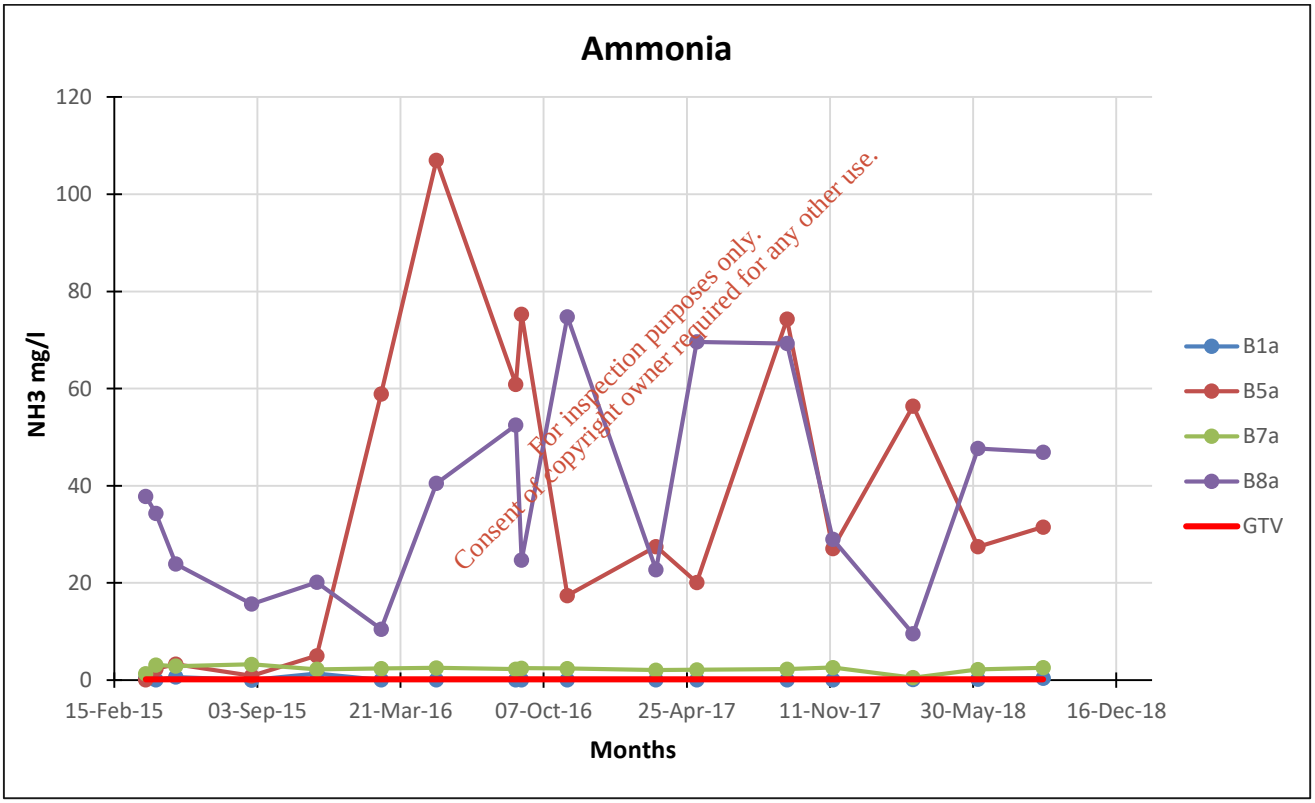

Figure 4-2: Ammonia Trend Assessment

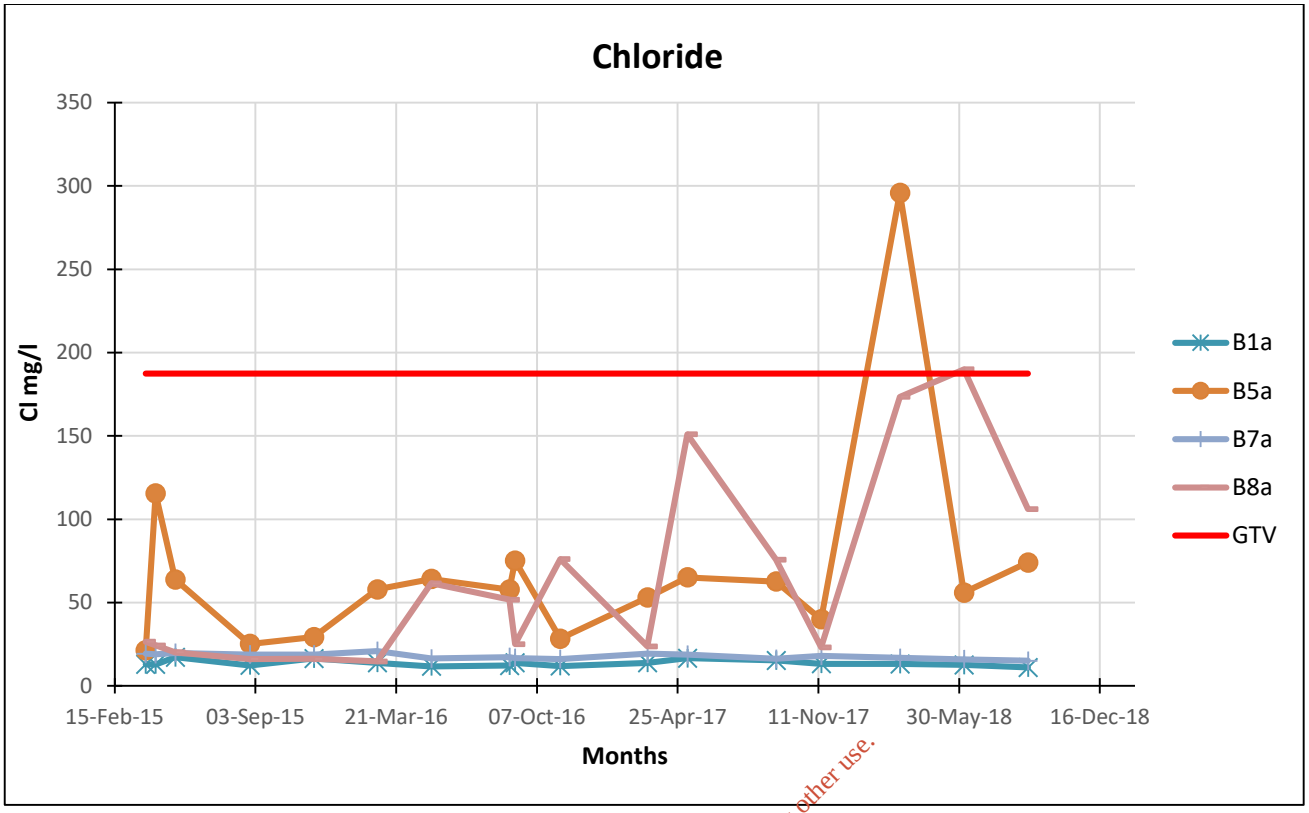

Figure 4-3: Chloride Trend Assessment

Borehole B1a is located approximately 50m south west of the historic landfill boundary. Analytical results from February 2015 to September 2018 from this location consistently indicate levels of ammonia slightly above trigger levels in both the overburden and bedrock. These elevations are not considered attributable to the landfill due to the upgradient topographical position of borehole and its location within the River Blackwater catchment.

Analytical results for borehole B7a up to September 2018 indicate levels of ammonia are over ten times above trigger levels in the shallow groundwater. Concentrations of chloride are consistently reported below the GTV in the shallow overburden at this location. The elevated ammonia is considered attributable to leachate migration from the historic landfill waste body.

The latest groundwater results for B8a show significantly elevated ammonia above GTVs in the overburden groundwater. Chloride concentrations have been generally below GTVs since March 2015 except for one exceedance recorded in June 2018. Given that borehole B8a is screened in an unlined waste body, the elevated ammonia and chloride concentrations are considered attributable to the waste body underlying the site entrance forecourt.

Monitoring at boreholes B5a installed directly downgradient of the historic landfill has detected consistent ammonia exceedances of the GTV since March 2015. The elevated ammonia results indicate leachate from the historic landfill is being detected in the groundwater at this location. Chloride concentrations have been generally below GTVs since March 2015 except for one exceedance recorded in March 2018.

4.3.7 Leachate Quality Monitoring

The results of leachate samples analysed from the 5 No. boreholes (SI6 to SI10) 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 analytical reports are presented in Appendix 4.

Table 4-4: Summary of Methanogenic Leachate Composition at Scotch Corner

	Overall Range		Overall Values		Scotch Corner Leachate Quality				
	Minimum	Maximum	Median	Mean	SI6	SI7	SI8	SI9	SI10
pH-value	6.8	8.2	7.35	7.52	7.04	7.16	7.24	7.03	7.07
Conductivity (µS/cm)	5,990	19,300	10,000	11,502	2,110	1,320	3,180	659	2,900
Alkalinity (as CaCO3)	3,000	9,130	5,000	5,376	1,060	467	1,750	338	1,470
COD	622	8,000	1,770	2,307	126	82.8	420	595	508
BOD5	97	1,770	253	374	23.8	<1.5	17.3	13.8	34
Total Organic Carbon	184	2,270	555	733	32.8	21.3	115	28.4	54.6
Fatty Acids (as C)	<5	146	5	18	0.238	<0.1	0.425	6.43	0.898
Ammoniacal-N	283	2,040	902	889	180	47.4	268	6.54	237
Nitrite-N	<0.01	1.3	0.09	0.17	<0.01	0.491	<0.01	<0.01	<0.01
Sulphate (as SO4)	<5	322	35	67	17.1	6.47	<1	26.7	18.1
Phosphate (as P)	0.3	18.4	2.7	4.3	<0.05	<0.05	<0.05	<0.05	<0.05
Chloride	570	4,710	1,950	2,074	36.8	60.1	102	13.9	136
Sodium	474	3,650	1,400	1,480	26.1	39.4	68.8	28.7	85.3
Magnesium	40	1,580	166	250	22.9	23.9	40.6	24.3	41
Potassium	100	1,580	791	854	20.7	22.5	54.3	67.8	75
Calcium	23	501	117	151	159	150	235	146	198
Chromium	<0.03	0.56	0.07	0.09	3.65	1.98	6.78	<1	9.96
Manganese	0.04	3.59	0.3	0.46	2.45	1.17	2.56	2.18	2.10
Iron	1.6	160	15.3	27.4	34.8	0.271	27.1	23.5	48.8
Nickel	<0.03	0.6	0.14	0.17	0.007	0.043	0.020	0.005	0.016
Copper	<0.02	0.62	0.07	0.13	<0.0003	0.0095	0.0014	0.0004	<0.0003

* 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 Scotch Corner

	Overall Range		Overall Values		Scotch Corner Leachate Quality				
	Minimum	Maximum	Median	Mean	SI6	SI7	SI8	SI9	SI10
pH-value	5.12	7.8	6.0	6.73	7.04	7.16	7.24	7.03	7.07
Conductivity (µS/cm)	5,800	52,000	13,195	16,921	2,110	1,320	3,180	659	2,900
Alkalinity (as CaCO3)	2,720	15,870	5,155	7,251	1,060	467	1,750	338	1,470
COD	2,740	152,000	23,600	36,817	126	82.8	420	595	508
BOD5	2,000	68,000	14,600	18,632	23.8	<1.5	17.3	13.8	34
Total Organic Carbon	1,010	29,000	7,800	12,217	32.8	21.3	115	28.4	54.6

	Overall Range		Overall Values		Scotch Corner Leachate Quality				
	Minimum	Maximum	Median	Mean	SI6	SI7	SI8	SI9	SI10
Fatty Acids (as C)	963	22,414	5,144	8,197	0.238	<0.1	0.425	6.43	0.898
Ammoniacal-N	194	3,610	582	922	180	47.4	268	6.54	237
Sulphate (as SO4)	<5	1,560	608	676	17.1	6.47	<1	26.7	18.1
Phosphate (as P)	0.6	22.6	3.3	5.0	<0.05	<0.05	<0.05	<0.05	<0.05
Chloride	659	4,670	1,490	1,850	36.8	60.1	102	13.9	136
Sodium	474	2,400	1,270	1,371	26.1	39.4	68.8	28.7	85.3
Magnesium	25	820	400	384	22.9	23.9	40.6	24.3	41
Potassium	350	3,100	900	1,143	20.7	22.5	54.3	67.8	75
Calcium	270	6,240	1,600	2,241	159	150	235	146	198
Chromium	0.03	0.3	0.12	0.13	3.65	1.98	6.78	<1	9.96
Manganese	1.4	164.0	22.95	32.94	2.45	1.17	2.56	2.18	2.10
Iron	48.3	2,300	475	653.8	34.8	0.271	27.1	23.5	48.8
Nickel	<0.03	1.87	0.23	0.42	0.007	0.043	0.020	0.005	0.016
Copper	0.02	1.1	0.075	0.13	<0.0003	0.0095	0.0014	0.0004	<0.0003

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

4.3.8 Leachate Analysis Discussion

As can be seen from Table 4.4 and Table 4.5 the overall leachate strength in the monitoring wells screened within waste material LG02 is greater than LG01. When assessed against typical landfill leachate parameters reported in the EPA Landfill Manual (2003), the leachate composition at the Scotch Corner Historic Landfill appears to be representative of the minimum to mean concentrations of the methanogenic phase.

According to the Landfill Manual, during the methanogenic stage the heavy metals are rendered insoluble and levels of dissolved metals tend to be low. Leachate concentrations for dissolved metals magnesium, potassium, calcium, chromium, manganese, iron, nickel, and copper at Scotch Corner are found to be within the typical minimum to mean reported ranges for these parameters.

The results show concentrations for typical indicator parameters ammonia, chloride, BOD and conductivity are within the minimum range for methanogenic landfills.

Methanogenic leachate generally contains low sulphate concentrations with a median of 35mg/l. The recorded sulphate concentrations from Scotch Corner are generally below the median range with the exception of sampling locations SI9 and SI10.

The reported concentrations for the parameters tested would indicate that biodegradation is beginning to stabilise.

4.4 Landfill Gas Monitoring

FT carried out monitoring of landfill gas (LFG) parameters at each leachate well monitoring location (SI6 to SI10) as indicated on Figure 3.1. Monthly gas monitoring data obtained from MCC has been interpreted for the 4 No. perimeter boreholes B1a, B5a, B7a and B8a.

In accordance with the EPA COP, methane, carbon dioxide, oxygen and atmospheric pressure were analysed at the 3 No. groundwater monitoring wells located outside the waste body and the 5 No. leachate wells located within the waste body using a geotechnical instrument GEM5000 Landfill Gas analyser.

4.4.1 Monitoring Results

In accordance with 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 borehole are summarised in Table 4.5 and with onsite leachate boreholes summarised in Table 4.6.

Table 4-6: Perimeter Well Monitoring Results August and September 2018

Date: 28-8-2018						
Sample Station	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	Atmospheric Pressure (mbar)	Staff Member	Weather
B1a	0.0	0.0	20.7	997	Daniel Hayden	Sunny with light wind S-SE, 16°C - 18°C
B5a	0.0	0.2	20.3	997		
B7a	0.0	0.0	20.5	997		
B8a	65.3	34.2	0.4	997		

Date: 27-09-2018						
Sample Station	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	Atmospheric Pressure (mbar)	Staff Member	Weather
B1a	0.0	0.0	20.5	1007	Daniel Hayden	Cloudy with light rain and wind NW-W, 13°C - 15°C
B5a	0.0	0.0	20.7	1007		
B7a	0.0	0.2	20.6	1007		
B8a	58.1	31.3	1.7	1007		

As can be seen in Table 4.5, carbon dioxide (CO_2) and methane (CH_4) levels were detected at downgradient groundwater monitoring well B8a during the monitoring rounds. Concentrations of both CO_2 and CH_4 at downgradient borehole B8a exceed the threshold values set by the CoP during both monthly monitoring rounds. The elevated gas concentrations from borehole B8a are likely to be due to the borehole being screened within the waste body underlying the entrance forecourt to Scotch Corner licenced landfill.

Concentrations of both CO_2 and CH_4 at the remaining perimeter boreholes B1a, B5a and B7a were below the threshold values set by the CoP during both monitoring rounds.

Table 4-7: Onsite Leachate Well Monitoring Results October 2018

Date: 1-10-2018						
Sample Station	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	Atmospheric Pressure (mbar)	Staff Member	Weather
SI6	68.1	31.4	0.5	1028	Daniel Hayden	Sunny with light wind S-SE, 14°C - 16°C
SI7	0.2	3.9	18.9	1028		
SI8	0.7	0.6	22.1	1028		
SI9	10.8	7.0	8.3	1028		
SI10	64.2	32.6	0.3	1028		

Date: 10-10-2018						
Sample Station	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	Atmospheric Pressure (mbar)	Staff Member	Weather
SI6	66.8	28.6	1.3	1002	Daniel Hayden	Sunny and wind SE-S, 15°C - 20°C
SI7	0.3	2.8	18.4	1002		
SI8	0.6	0.8	22.6	1002		
SI9	12.8	8.7	6.5	1002		
SI10	67.6	35.6	0.2	1002		

As can be seen in Table 4.6, carbon dioxide (CO_2) and methane (CH_4) were detected at three leachate monitoring wells SI6, SI9 and SI10 during the monitoring rounds. Elevated CO_2 levels were detected at monitoring location SI7.

Concentrations of both CO_2 and CH_4 within the waste body remain substantially high indicating that biodegradation of the interred municipal waste remains highly active.

4.5 Surface Water Monitoring

4.5.1 Monitoring Locations

The surface water monitoring locations were selected upstream and downstream of the landfill footprint, as shown on Figure 4-4. All monitoring locations (G8, G3, G11, G13, G10, G9, G4, G5 (recirculated) and G6) are positioned at locations around the perimeter of the historic landfill. G8 is the furthest upstream monitoring location and G6 is the furthest downstream location.

The following sampling locations were dry during the monitoring period: G11, G13, G10, G9, G4 and downstream G5 (recirculated) and G6. Therefore, previous monitoring data obtained from MCC from September 2018 for G5 (recirculated) and G6 are used for this assessment to interpret the water quality downstream of the landfill.

FT were able to recover samples from upstream monitoring location G8 and G3, both of which are located adjacent to the landfill's south-eastern boundary.

Two surface water monitoring rounds were carried out on the 2nd and 10th October 2018.

4.5.2 Monitoring Parameters

The results of surface water sampling analysed from the 2 No. sampling locations (G8 and G3) 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 4.7, while the laboratory reports are presented in Appendix 4.

Table 4-8: Surface Water Sampling Results

Parameter	Units	MAC [1]/EQS [2]	2nd - 10th October		MCC Monitoring Data September 2018	
			G8	G3	G5 Recirc	G6
			US	US	DS	DS
pH (Laboratory)	pH Units	6.0<pH<9.0[2]	7.26	8.01	7.1	7.5
Dissolved Oxygen	mg/l	<9 – 6 [1]	6.99	7.98	6.08	6.54
Conductivity	µS/cm	1 [1]	0.218	0.927	0.761	1.072
BOD, unfiltered	mg/l	≤2.6 (95%ile)[2]	6.05	<2.5	--	--
COD, unfiltered	mg/l	40 [1]	148	97.9	46	42
Sulphate	mg/l	200 [1]	36.4	15.6	--	--
Chloride	mg/l	250 [1]	22.4	46.2	--	--
Ammoniacal Nitrogen as N	mg/l	≤0.140(95%ile) [2]	<0.140	46.9	0.47	5.84
Potassium	mg/l	--	1.22	15.5	--	--
Sodium	mg/l	200 [1]	17.3	26.1	--	--

Notes:

Items in bold are in exceedance of the 1989 MAC Regulations [1]
Items shaded in orange are in exceedance of the 2009 EQS Regulations [2]
'--' denotes: not measured by MCC
US/DS: upstream / downstream

4.5.3 Surface Water Analysis Discussion

The results of the surface water monitoring from 4 No. perimeter sampling locations G8, G3, G5 recirculated and G6 have returned several exceedances of the EQS (2009) and MAC (1989) guideline limit values.

Results from upstream sampling location G3 and downstream locations G5 (recirculated) and G6 detected ammonia concentrations of 46.9 mg/l, 0.47 mg/l and 5.84 mg/l respectively. The detection of elevated ammonia at upstream surface water location G3 indicates to the presence of a potential pathway from the waste body located north of this sampling location. The current practice of leachate recirculation from the Old-G1 Sump via the manifolded network may also be contributing to elevated ammonia at G3 and further investigation of this may be necessary to assess this potential pollutant pathway.

Ammonia concentrations of 0.42 mg/l and 5.84 mg/l at downstream locations G5-recirculated and G6 exceed the EQS guideline threshold, however the results indicate a decrease in ammonia levels discharging from the landfill compared to the level detected at G3. The ammonia concentration at G5-recirculated discharge appears to be of relatively good quality before exiting the landfill towards sampling location G6. The ammonia concentration at G6 is 14-times greater than G5-recirculated, which suggests ingress from the surrounding waste body between the two sampling points G5-recirculated and G6.

The furthest upstream monitoring location G8 has returned BOD and COD concentrations of 6.05 mg/l and 148 mg/l respectively. The presence of elevated ammonia and COD concentrations at this location could be a result of localised slurry spreading in the adjacent agricultural field.

Elevated COD concentrations above MAC guideline levels are consistent across all monitoring locations sampled. COD concentrations in upstream samples (G8 and G3) are over twice the levels than the levels detected in downstream samples G5-recirculated and G6 which recorded only slight exceedances of the MAC threshold value.

The remaining results of the surface water laboratory analysis at G3 and G8 as presented in Table 4.5, when assessed against the MAC (1989) and EQS (2009) quality standards were found to be below the guideline values in all assessments.

Legend

- Surface Water Monitoring Locations
- Dry Sampling Locations
- Leachate Pipework
- Redirected Surface Water Pipeline Directed to G6 (existing landfill)
- Surface Water Pipework
- Surface Water Ponds
- Site Boundary

Figure Title
Surface Water Monitoring Locations

Figure No. 4.2

Project
Scotch Corner Historic Landfill Tier 2

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Scale	1:2,500	**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 wells 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 Scotch Corner site are:

- Groundwater migration;
- Surface water infiltration; and
- Landfill gas migration.

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/Occupied Residential dwellings within 250m of the waste body

It is noted that 2 No. disused derelict structures exist within the site boundary.

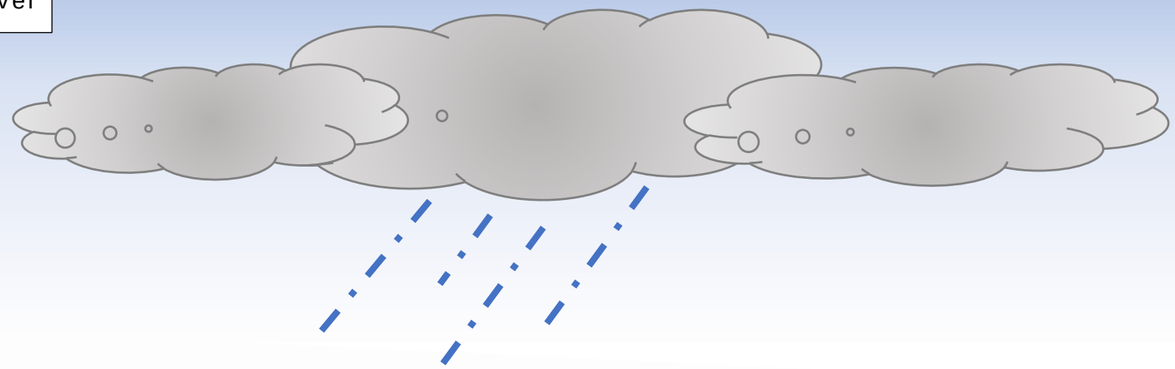
5.3 Conceptual Site Model

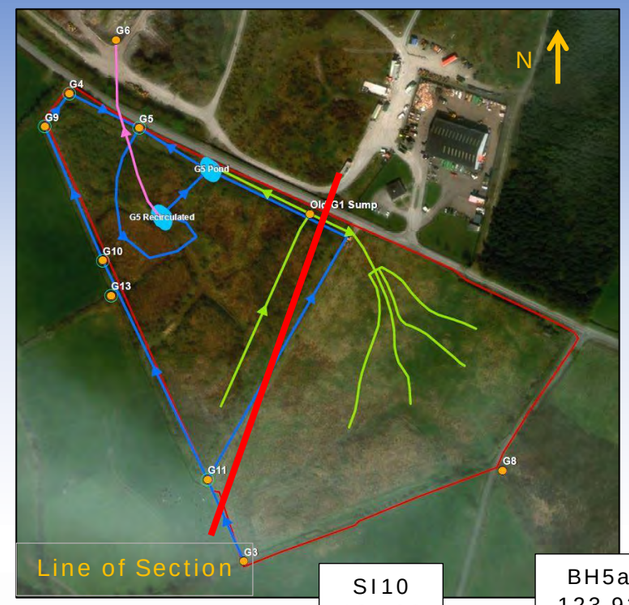
Based on the desktop investigation and site investigation works undertaken for Scotch Corner Historic Landfill, an assessment of the risk is made to confirm the source – pathway – receptor (S-P-R) linkages identified in the preliminary investigation. The results and analysis of the investigation has enabled a basic conceptual model to be produced for the site, which is presented in Figure 5-1, overleaf.

Landfill Gas Migration

Leachate Migration

Measured Groundwater Level





SI8
124.6mOD

SI10
124.83
mOD

BH5a
123.92
mOD

123.05mOD

121.59mOD

SANDY CLAY
GLACIAL
TILL

BEDROCK:
MUDSTONE

BEDROCK:
SANDSTONE

WASTE
BODY

Depth of waste ~5.0m BGL

Surface
Water
Drainage

Poor Aquifer: Bedrock which is generally unproductive

Vulnerability - Extreme

GW FLOW
DIRECTION

North – North-East

CROSS SECTION NORTH-EAST / SOUTH-WEST

FIGURE 5.1 SCOTCH CORNER 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 Scotch Corner 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 – Scotch Corner Historic Landfill

EPA Ref	Risk	Points	Rationale
1a	Leachate; source/hazard scoring matrix, based on waste footprint.	7	Based on a waste footprint of >1 and ≤5 ha and a site that operated as a municipal waste landfill between 1980 to 1991.
1b	Landfill gas; source/hazard scoring matrix, based on waste footprint.	7	Based on a municipal waste footprint of >1 and ≤5 ha and the detection of gas concentrations indicating biodegradation of the MSW remains highly active and Local Authority offices and Civic Amenity Site are within 50m from the northern site boundary.
2a	Leachate migration: Pathway (Vertical)	3	GSI describes the groundwater vulnerability as Extreme and trial pitting has confirmed waste has been placed on top of bedrock.
2b	Leachate migration: Pathway (Horizontal)	1	The bedrock is classified by the GSI as a Poorly Productive Aquifer (Pl) – bedrock which is unproductive except in Local Zones.

EPA Ref	Risk	Points	Rationale
2c	Leachate migration: Pathway (Surface water drainage)	2	Connection between the waste body and a tributary stream of the River Fane downstream of the landfill.
2d	Landfill gas: Pathway (Lateral migration potential)	1	Based on the intrusive works confirming the presence of Peat and Clay glacial tills underlying the site.
2e	Landfill gas: Pathway (Upwards migration potential)	1	Based on no buildings or enclosed spaces above waste body and the presence of a Clay / Peat subsoil covering the majority of the identified waste body in the western portion of the landfill.
3a	Leachate migration: Receptor (Human presence)	1	Private groundwater supplies within 1km north of the historic site is currently monitored by MCC at borehole W7.
3b	Leachate migration: Receptor (Protected areas – SWDTE or GWDTE) (Surface water/ groundwater dependent terrestrial ecosystems)	0	The nearest SAC/pNHA is located greater than 1 km from the waste body
3c	Leachate migration: Receptor (Aquifer category – Resource potential)	1	The bedrock is classified by the GSI as a Poorly Productive Aquifer (Pl) – bedrock which is unproductive except in Local Zones.
3d	Leachate migration: Receptor (Public water supplies – other than private wells)	0	No known public water supply within 1 km. Bedrock not karstic.
3e	Leachate migration: Receptor (Surface water bodies)	2	Tributary stream of the River Fane located within 250m downstream of landfill site boundary.
3f	Landfill Gas: Receptor (Human presence)	5	Local Authority offices and Civic Amenity Site are within 50m from the northern site boundary.

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 (3+1+2) x 2 = 84	300	Leachate => surface water	28%
SPR2	1a x (2a + 2b + 2c) x 3b	7 x (3+1+2) x 0 = 0	300	Leachate => SWDTE	0%
Leachate migration through groundwater pathway					
SPR3	1a x (2a + 2b) x 3a	7 x (3+1) x 1 = 28	240	Leachate => human presence	11.6%

Calculator		S-P-R Values	Maximum Score	Linkage	Normalised Score
SPR4	1a x (2a + 2b) x 3b	7 x (3+1) x 0 = 0	240	Leachate => GWDTE	0%
SPR5	1a x (2a + 2b) x 3c	7 x (3+1) x 1 = 28	400	Leachate => Aquifer	7%
SPR6	1a x (2a + 2b) x 3d	7 x (3+1) x 0 = 0	560	Leachate => Surface Water	0%
SPR7	1a x (2a + 2b) x 3e	7 x (3+1) x 2 = 56	240	Leachate => SWDTE	23%
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 2 = 28	60	Leachate => Surface Water	46%
SPR9	1a x 2c x 3b	7 x 2 x 0 = 0	60	Leachate => SWDTE	0%
Landfill gas migration pathway (lateral & vertical)					
SPR10	1b x 2d x 3f	7 x 1 x 5 = 35	150	Landfill Gas => Human Presence	23%
SPR11	1b x 2e x 3f	7 x 1 x 5 = 35	250	Landfill Gas => Human Presence	14%
Site maximum S-P-R Score					46%
Risk Classification					B – Moderate

Table 5.2 shows the maximum S-P-R scoring for the site is 46%.

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 Moderate Risk Classification (Class B). The principal risks identified on the site is the risk posed to surface waters from the migration of landfill leachate from the waste material encountered at the site.

6 CONCLUSIONS AND RECOMMENDATIONS

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

The findings of the intrusive works suggest the waste material is deposited in a single infill area tending north-west to south-east and between 350m in length and 225m in width. Based on this interpretation, the maximum waste footprint is calculated to be 10.14 acres or 4.1 hectares.

A volume calculation was conducted based on the results of the geophysical survey of the existing ground level and the base of waste as interpreted, with estimates indicating an interred waste volume of approximately 164,000 m^3 at the site.

Analysis of waste samples from the trial pits excavated indicate that the waste material encountered within the site is typically non-hazardous. Based on the 3 No. waste acceptance criteria (WAC) tests completed and the representative spread across the Scotch Corner site, the site investigation suggests that the interred waste material tested may be classified as non-hazardous.

Long-term monitoring at downgradient monitoring borehole B5a has consistently detected elevated ammonia above the GTV since March 2015. The elevated ammonia results suggest leachate from the historic landfill is being detected in the groundwater at this location. Chloride concentrations have been generally below GTVs since March 2015 except for one exceedance recorded in March 2018.

Analysis of groundwater samples obtained from perimeter monitoring wells B1a (up-gradient) and B5a (downgradient) indicate concentration differences between upgradient and downgradient monitoring locations suggests that the landfill is contributing locally to a deterioration in groundwater quality north of the site boundary.

Analysis of landfill gas from the leachate wells installed across the site showed concentrations of both CO_2 and CH_4 within the waste body remain substantially high indicating that biodegradation of the interred municipal waste remains active, the landfill gas risk also remains high due to the proximity of Local Authority and Civic Amenity buildings within 50m north of the waste body. The elevated gas concentrations from perimeter borehole B8a are likely to be due to the borehole being screened within the waste body underlying the entrance forecourt to Scotch Corner licenced landfill.

Analysis of surface water samples obtained shows the downstream ammonia concentration at G5-recirculated discharge point is of relatively good quality before exiting the landfill towards sampling location G6. The ammonia concentration at G6 is 14-times greater than G5-recirculated, which suggests ingress from the surrounding waste body between the two sampling points G5-recirculated and G6. Elevated COD concentrations above MAC guideline levels are consistent across all monitoring locations sampled. COD concentrations in upstream samples (G8 and G3) are over twice the levels than the levels detected in downstream samples G5-recirculated and G6 which recorded only slight exceedances of the MAC threshold value.

The results of the Tier 2 assessment and risk model indicate that the site is being maintained as a Moderate-Risk Classification (Class B). The principal risks identified on the site is the risk posed to surface waters from the migration of landfill leachate from the waste material encountered at the site. Environmental monitoring has also indicated several instances of Generic Assessment Criteria (GAC) value exceedances across surface water, groundwater and landfill gas.

6.1 Recommendations

Based on the results of the initial Tier II assessment the site is classified as Moderate Risk. For a moderate-risk site, the CoP indicates that a Tier III Environmental risk analysis be undertaken including a Detailed Quantitative Risk Assessment (DQRA).

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.

As part of the Tier 3 assessment, continued groundwater, surface water monitoring and landfill gas monitoring and analysis is recommended at each shallow and deep perimeter monitoring well B1a/B1, B5a/B5, B7a/B7, B8a/B8 and all surface water locations (G8, G3, G11, G13, G10, G9, G4, G5 (recirculated) and G6) inclusive.

The results of this analysis should be used to confirm the conclusion of the Tier 3 report and inform future works.

Figure 6-1: Extract from Section 1.3 of the EPA Code of Practice