Kerdiffstown Landfill Remediation Project

Annual Environmental Report 2019

IEL: P1063-01

Kildare County Council
Comhairle Contae Chill Dara

Report Title:	Annual Environmental Report 2019
Licence No.	P1063-01
Report Ref:	2020-02
Status:	Final

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Glossary of Abbreviations / Definitions

ABP	An Bord Pleanála
AER	Annual Environmental Report
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
C&D	Construction and Demolition
CSM	Conceptual Site Model
EC	Electrical Conductivity
EIAR	Environmental Impact Assessment Report
EPA	Environmental Protection Agency
GTV	Groundwater Threshold Value (as established by S.I No. 9 of 2010)
H&S	Health and Safety
IGV	Interim Groundwater Value (as established by S.I No. 9 of 2010)
KCC	Kildare County Council
KLRP	Kerdiffstown Landfill Remediation Project
LAeq	Equivalent average sound pressure level over the measuring period,
LA90	The sound pressure level exceeded for ninety percent of the monitoring period which is used to determine the general background noise of an area, and
LA10	The sound pressure level exceeded for ten percent of the monitoring period which provides an indication of the higher range of noise levels experienced in the area.
LOD	Limit of Detection
mAOD	metres Above Ordnance Datum
PAH	Polycyclic Aromatic Hydrocarbon
PGC	Palmerstown Golf Club
PSDP	Project Supervisor for the Design Stage
PRTR	Pollutant Release Transfer Register
TOC	Total Organic Carbon

SVOC	Semi-Volatile Organic Compound
VOC	Volatile Organic Compound

Executive Summary

This report summarises the results and findings of environmental monitoring undertaken in 2019 at the Kerdiffstown Landfill near Naas in County Kildare. The landfill is an in-filled sand and gravel quarry which was backfilled with wastes from the 1950s. The facility ceased accepting waste in June 2010. Since its closure the site has been managed and maintained pending restoration works.

The Kerdiffstown site occupies an area of approximately 31 hectares, with an estimated 3.1 million cubic metres of waste present. Until June 2015 the site was under the control of the Environmental Protection Agency (EPA) following the abandonment of the site by the former operators in June 2010. The site is currently managed and maintained by Kildare County Council (KCC).

In March 2019, KCC were granted an Industrial Emissions Licence (IEL) from the EPA (EPA Reg No.: P1063-01). Schedule D of the licence specifies the required content of this report and this report satisfies these requirements.

This report includes a summary of site activities, incidents and complaints, engineering works, environmental monitoring results, written procedures, summary waste and leachate records for the facility for the period January to December 2019. It also summaries proposed works at the site for 2020.

With respect to complaints, these are a rare occurrence having decreased significantly in recent years. In addition, incidents are also a rare occurrence. In 2019, a wide range of environmental monitoring was undertaken at the site including the following:

- Groundwater and surface water monitoring (measurements of water quality and groundwater levels) on a monthly basis to establish the impacts from landfill leachate on the water environment;
- Landfill gas monitoring from onsite and offsite boreholes on a routine basis to determine landfill gas quality and potential for offsite impacts;
- Monitoring of leachate collected for offsite disposal and volumes of leachate discharged offsite on a weekly basis;
- Monthly odour assessments undertaken both on and off site;
- A surface emissions volatile organic compound (VOC) survey to determine the quantities of VOCs being discharged through the landfill surface;
- Flare stack emissions testing to inform compliance with future licence conditions;
- Noise monitoring;
- Geotechnical assessments of slopes to determine slope stability and;
- Dust monitoring in to determine the dust deposition rate.

This report summarises the findings of the above monitoring and signposts the reader to documents produced for each of the monitoring activities.

The ongoing management of the landfill in its current unremediated state is maintaining a stable condition with the results of environmental monitoring within the ranges previously detected. Compliance with the Industrial Emission Licence is a

primary objective for the project team both now and during the remediation works scheduled to begin later in 2020.

1. Introduction

1.1. About this Report

This report includes a summary of all site activities, incidents and complaints, engineering works, environmental monitoring results, written procedures, summary waste and leachate records as well as detailed drawings for the Kerdiffstown Landfill facility for the period January to December 2019.

Following the commencement of an intervention at the site in February 2011 the Environmental Protection Agency (EPA) and between 2015 and 2019 Kildare County Council (KCC) has continued to take measures to manage activities at the site and to reduce the potential environmental impact of the site. In November 2018 KCC took ownership of the site and associated lands (See section 1.2.2 below for more details).

Table 1.1 Kerdiffstown Landfill - General Information

Industrial emissions register no:	P1063-01	
Name of intervening authority, name and address of facility:	Intervening Authority: Kildare County Council Áras Chill Dara, Devoy Park, Naas, Co. Kildare	Address of Facility: Kerdiffstown Landfill Johnstown Naas Co. Kildare
Site Description:	Kerdiffstown landfill is located 0.5km Northwest of Johnstown, County Kildare and 3.5 km north-east of Naas town. The landfill is an in-filled sand and gravel quarry which was backfilled with wastes from the 1950s. The facility ceased accepting waste in June 2010. Since the sites closure the site has been managed and maintained pending any restoration works. The Kerdiffstown site occupies an area of approximately 31 ha, with an estimated 3.1 million m^3 of waste present.	

1.2. Background to Kerdiffstown Landfill Remediation Project

The landfill is an in-filled sand and gravel quarry which was progressively backfilled with wastes by a variety of operators from the 1950s onwards. The former operator first occupied the site and began receiving waste material during the mid-1990s.

In June 2010, Neiphin Trading, who operated the site between 1995 and 2010, vacated the site and it was left in an unsecured condition. In January 2011, a major fire developed within a mass of mounded waste material present in the north of the site which required the intervention of several regulatory agencies (including the EPA).

The site was under the control of the Kildare Fire Service until late February 2011, when it was handed over to the care of the EPA, who took emergency measures (under powers of the Waste Management Act) to contain and limit the environmental impact. Since the fire was brought under control and extinguished in 2011 the site remained under 'emergency measures' and the EPA implemented a series of follow up works to deal with the most immediate risks. In June 2015 control of the site was handed over to Kildare County Council (KCC).

The facility at Kerdiffstown previously operated under waste licence W0047-01 issued by the EPA in 2003 (and subsequent revised licence W0047-02 issued in 2006). The site consisted of an extensive recycling facility, now dismantled, an authorised lined landfill which was partially filled with waste and a large area in which substantial quantities of waste has been deposited. The main area of waste deposition is in the unlined north-western area of the landfill. There are also smaller volumes of waste stockpiled around the site. The presence of such large quantities of waste and the lack of appropriate infrastructure to manage polluting emissions gives rise to the risk of environmental pollution.

The Kerdiffstown facility is no longer managed under the terms of the previous waste licence (W0047-02). The EPA and subsequently KCC took control and managed the site under emergency powers (Section 56 of the Waste Management Act (as amended)) until 12 November 2018 (see Section 1.2.2 below).

Although the former waste licence was no longer in effect (since September 2010) a range of environmental monitoring continued to be undertaken during between 2011 and up to March 2019. The range and frequency of monitoring was based on the requirements of the former waste licence which was subsequently modified to suit project requirements. The monitoring data gathered between 2011 and the first half of 2017 was used to support a planning application in the form of an EIAR and an Industrial Emissions Licence (IEL) application to replace the former waste licence. Subsequent monitoring conducted in the latter half of 2017, throughout 2018 and up to February 2019 was been undertaken to monitor the environmental risk profile of the site and document any changes.

1.3. Current Regulatory Regime

The site is currently under the control of KCC with responsibility for implementing the remediation and ongoing management of the site. The statutory approvals required to undertake the remediation have been put in place as set out below.

In August 2017, an application for planning approval and compulsory purchase of associated lands was made to An Bord Pleanála (ABP) to enable the remediation of the site. Approval was granted in May 2018 (ABP Ref 09.JA0041) for both the planning application and compulsory purchase order (CPO). The lands associated with the Kerdiffstown facility are now in the possession of KCC effective from 12 November 2018.

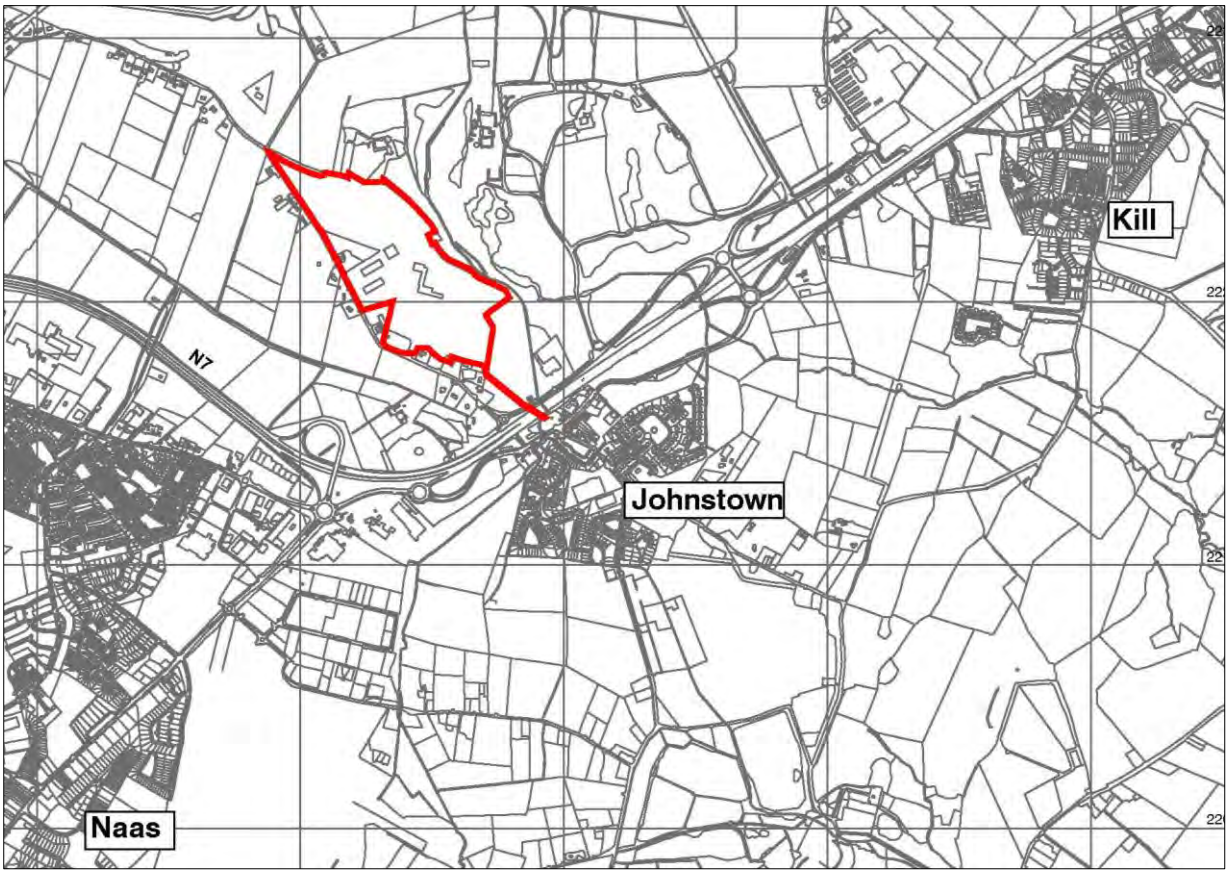
In September 2017, KCC applied for an Industrial Emissions Licence (IEL) to EPA the supported by an Environmental Impact Assessment Report (EIAR) (EPA Licence Reg Number P1063-01). This licence was granted on 07 March 2019 and the requirements of this licence have been incorporated into this report.

1.4. Site Location

The site location is provided below in Plate 1.1 and attached as Figure 1. The site layout is provided in Figure 2. The site is located c. 3.5km northeast of Naas and approximately 0.5km northwest of the N7 and Johnstown village. To the northeast is parkland associated with Kerdiffstown House, to the north is a golf course and to the south west and south east are a mixture of land uses including residential, agriculture and worked out quarries.

The L2005 County Road from Sallins to Johnstown runs next to the western and southern site boundaries, with the nearest residential property approximately 10m from the site boundary. It should be noted that the redline boundary as shown on all figures is the Industrial Emissions Licence boundary.

Plate 1.1: Site Location Plan



1.5. Current Site Layout

The current site layout is attached as Figure 2. Plate 1.2 below shows the site sub-divided into several discrete geographical areas, or zones, each of which has its own unique characteristics. The layout of the various zones with information on the key characteristics of the materials within each zone is summarised in Table 1.2.

Plate 1.2: Site Zones

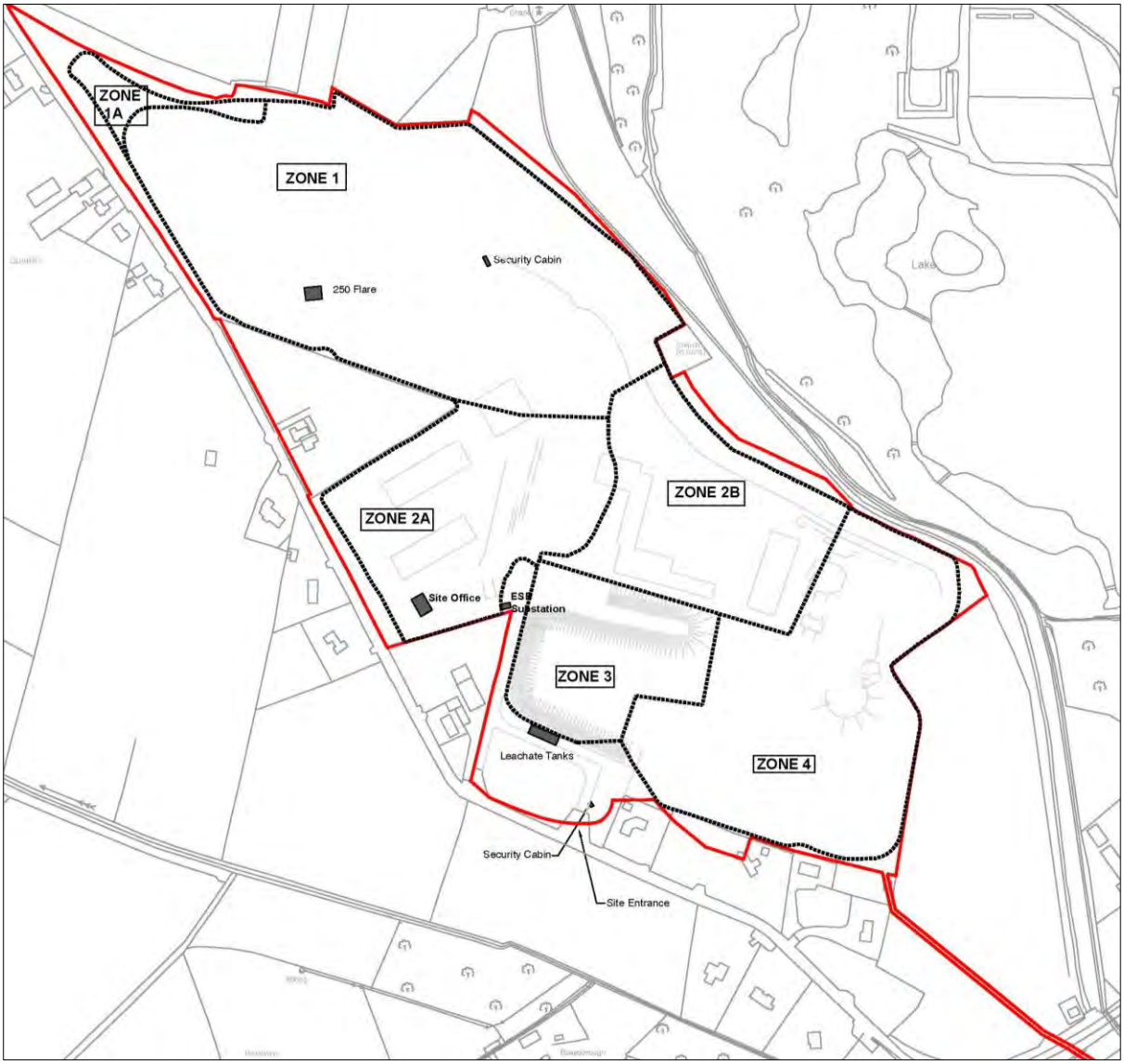


Table 1.2 Key Characteristics of the Landfill Zones

Zone Number	Zone Key Characteristics
Zone 1 (comprising sub Zones 1 & 1A) 	Estimated Area: 100,000m^2 Estimated Waste Volume: 2,023,000m^3 Wastes deposited in Zone 1 located to the north-west area of the site accounts for approximately 65% of the entire estimated volume of waste on site. The wastes in this area are typically unprocessed, highly odorous and principally comprise non-hazardous mixed construction and demolition (C&D) wastes and household / Municipal Solid Wastes (MSW). C&D wastes are noted to contain varying amounts of clay, gravel, concrete, brick, wood, textile, plastic, rubber and metal. The MSW within this zone is described as having plastic, textiles, wood, ash paper, cables and steel in varying proportions. The MSW wastes are found over most of the zone, although there appears to be more C&D waste in the north-west corner of the zone (e.g. borehole EMW12 and BH18). This area has therefore been designated as Zone 1A to reflect this reduced risk profile. To the southern end of Zone 1, wastes are observed to be more silty (e.g. BH11, BH12) with C&D and MSW waste within the silt. Throughout Zone 1, where waste is encountered, it is considered that there is sufficient putrescible material (material that contains organic material which capable of decomposing) within the waste to class the wastes as non-hazardous biodegradable waste. Zone 1 is unlined and uncapped, with no means of limiting leachate generation or management. There are a series of landfill gas wells present across Zone 1, extracting gas to a flare. The average overall quality of gas from Zone 1, based on values recorded in the landfill gas extraction wells, is methane 23% v/v carbon dioxide 25% v/v and <1% v/v oxygen. The gas wells cover selected areas of the zone based on targeting areas of odour generation.

Zone Number	Zone Key Characteristics
Zone 2 (comprising sub Zones 2A & 2B) 	Estimated Area: 83,000m^2 Estimated Waste Volume: 660,000m^3 Zone 2 comprises largely flat areas with thick reinforced concrete hardstanding covering an area of approximately 58,000m^2 which form an impermeable layer over the wastes and prevent direct rainwater ingress. Walls from the former buildings of the waste processing facility also remain. Wastes in this zone were observed to be unprocessed non-hazardous mixed C&D waste with varying amounts of clay, gravel, brick, concrete, wood, textile, paper, plastic, rubber and metal. Domestic waste (MSW) is also present in this area at varying depths mixed in with C&D materials. This area was originally assessed as one zone, however, review of ground investigations and subsequent monitoring data confirms that wastes in Zone 2A comprise more MSW than that in Zone 2B. Initial readings of gas shown on borehole logs show that relatively high concentrations of methane and carbon dioxide have been present in Zone 2A and 2B with two locations exceeding 20% methane. Monitoring undertaken in May and June 2017 shows a variable picture in Zone 2A with the average methane concentration ranging between 1.4% and 30 % v/v. Zone 2B shows very low concentrations of methane between 0.0% v/v and 0.9% v/v. The majority of waste in Zone 2B is reported in the borehole logs to comprise unprocessed non-hazardous mixed C&D waste with varying amounts of clay, gravel, brick, concrete, wood, textile, paper, plastic, rubber (including tyres) and metal but with MSW also present at varying depths mixed in within the C&D materials. The wastes are generally described as being dry, although damp or wet wastes are identified closer to the groundwater table with saturated wastes shown in the boreholes where waste is at the lowest elevation in Zone 2B (e.g. in BH9 and BH50). No saturated wastes have been identified in Zone 2A. The areas beyond the hardstanding are uncapped in Zones 2A and 2B. Like Zone 1, there is no means of managing leachate generated in the waste although the presence of hardstanding will limit leachate generation through infiltration.

Zone Number	Zone Key Characteristics
Zone 3 	Estimated Area: 24,000m^2 Estimated Waste Volume: 193,000m^3 Zone 3 comprises a cell with engineered basal and side slopes lining system and is referred to as the 'Lined Cell'. The wastes in Zone 3 comprise a mixture of waste similar to the wastes elsewhere on site including processed non-hazardous waste derived from composting tunnels, C&D materials and unprocessed domestic waste mixed through. Substantial quantities of woodchip were used as daily cover for the waste in the cell. C&D wastes contain varying amounts of clay, gravel, concrete, brick, wood, textile, plastic, rubber and metal. Non-hazardous waste excavated from the location of the fire at the site in 2011 was also deposited in the lined cell; volume approximately 35,000m^3. Following demolition of the site buildings in 2016, non-hazardous wastes that had been stockpiled in and around the buildings was removed and deposited to the lined cell; approximate volume 14,000m^3. Zone 3 has a temporary cap applied over the existing waste mass. Landfill gas wells extract gas to a flare. The average overall quality of gas from Zone 3, based on values recorded in the landfill gas extraction wells, is methane 25% v/v, carbon dioxide 25 %v/v and <1%v/v oxygen. Pumps located within inclined risers extending to the base of the cell extract leachate for transfer to tankers and removal from the site.

Zone Number	Zone Key Characteristics
Zone 4 	Estimated Area: 45,000m^2 Estimated Waste Volume: 227,000m^3 Zone 4 contains large waste stockpiles, redundant infrastructure and concrete tanks/bays/walls in the lower yard area, with thick reinforced concrete hardstandings covering an area of approximately 12,000m^2. The area also contains a surface water soakaway lagoon which is cut into waste deposits and into which leachate from the adjacent waste stockpiles currently drains. Stockpiles comprise both processed and unprocessed non-hazardous mixed C&D waste and household waste. The majority of waste in Zone 4 is reported in borehole and trial pit logs to comprise C&D waste with a high proportion of inert material (predominantly reported as gravelly clay) with varying amounts of plastic, timber, textiles, steel, concrete, brick, PVC pipes. The logs (30 No.) do not generally report any MSW to be present (although the logs for BH4 to BH6 do describe the wastes as MSW. However, based on the actual description of the materials and proportion of these the materials are indicative of C&D waste rather than MSW). Where gas readings have been taken and reported in the borehole logs, it is reported that methane and carbon dioxide concentrations are largely absent from the wastes or less than 1%v/v within this zone. The bottom 1 to 2m of wastes is below the water table in this area. The areas beyond the hardstandings are uncapped. The hardstandings will limit rainwater and surface water infiltration to an extent.

1.6. Conceptual Site Model (CSM)

In order to evaluate risks at the site a Source-Pathway-Receptor (S-P-R) based approach has been used. For a risk to exist there must be a source (e.g. landfilled wastes), a receptor (or receptor groups) and an environmental pathway, through which contaminants present within the source can come into contact with an identified receptor. This is the basis for the Source-Pathway-Receptor (S-P-R) conceptual model for environmental management.

- Conceptual Site Models (CSMs) for the different zones of the existing site have been developed based on the following guidance:
- Code of Practice: Environmental Risk Assessment for Unregulated Disposal Sites 2007 (EPA 2007);
- Framework Approach for the Management of Contaminated Land and Groundwater at EPA Licensed Facilities 2012a (EPA 2012a); and
- Model Procedures for the Management of Land Contamination (EA 2004).

The conceptual models are based on the long-established 'source-pathway-receptor' approach that without all three components being in place there can be no risk to the receiving environment. The CSMs for the zones are presented graphically in Plate 1.3 and Plate 1.4 below for Zone 1 and as part of Figures 4.1 to 4.2. Within each figure the CSMs show how the identified source-pathway-receptor linkage will be addressed within the remediation works. The available information (historical aerial photos and the logs from DB09 and DB10) for the area of land to the south of Zones 3 and 4 would indicate that there is no waste in this area, and as such there is no source present and a pollution linkage does not exist for this land.

Whilst there has been no investigation of the area of land known as Tunny's Field, the historical aerial photos would suggest that waste is absent in this area and as such there is no source present and a pollution linkage does not exist for this area of land. Further information relating to the CSMs is available in Chapter 12 of the Environmental Impact Assessment Report available on www.kerdiffstowncleanup.ie

1.7. Scope of Report

This Annual Environmental Report (AER) was prepared by KCC for the reporting year 01 January 2019 to 31 December 2019. The scope of the AER is based on Schedule D of the IEL (P1063-01). **Appendix A** provides a list of AER requirements and signposts the reader to the relevant section where the required information can be found.

The report includes a summary of all site activities, incidents and complaints, engineering works, environmental monitoring results, written procedures, summary waste and leachate records as well as relevant drawings for the year 2019.

A Pollutant Release and Transfer Register (PRTR) for reporting of annual mass emissions and waste transfers has been completed using the Environmental Performance Reporting (EPR) online application as through the EPAs EDEN portal.

1.8. Reporting Completed During 2019

Table 1.3 summarises the reports that have been undertaken as part of the environmental monitoring tasks completed during 2019. It should be noted that some reports are not at final stage, but all data and conclusions have been compiled into this AER.

Table 1.3 Reports Produced in 2019

Discipline	Title
Groundwater	Groundwater Quarterly Monitoring Report for Kildare County Council Q1 to Q4 2019
Surface Water	Surface Water Summary Reports for Kildare County Council January to December 2019
	Surface Water Quarterly Monitoring Report for Kildare County Council Q1 to Q4 2019
Odour Monitoring	Monthly Odour Monitoring Reports

Discipline	Title
VOC Report	Report on Surface Area Monitoring of Volatile Organic Compounds (VOCs) Emissions to Air
Flare	Stack Emissions Testing Report
Geotechnical	Quarterly Inclinometer Readings
Dust	Dust Monitoring Report (Jul-Aug 2019)
	Dust Monitoring Report (Aug-Sep 2019)
Noise	Noise Monitoring Report

2. Management and Staffing Structure

2.1. Management and Staffing Structure of the Installation

The site was managed and maintained by the EPA between February 2011 and June 2015. In June 2015 Kildare County Council took over responsibility for the management of the site. Key KCC staff currently includes Mr. Joe Boland who serves as the Director of Services for the Environment Section of KCC and Mr. Michael Holligan Senior Engineer within the Environment department of KCC.

Ultan Downes is the Site Manager with responsibility for management of all activities and control systems on site. Key contacts are provided in Table 2.1.

Table 2.1 KLRP Project Team

Name	Position
Joe Boland	Director of Services
Michael Holligan	Senior Engineer
Ultan Downes	Site Manager (Senior Executive Scientist)
James Mulligan	Project Manager (Senior Executive Engineer)
Kathleen O'Brien	Executive Engineer
Claire McLaughlin	Executive Scientist
Joan McCormack	Executive Scientist
John Harrison	Administrative Officer
Mary Nevin	Staff Officer

In 2019, KCC also had a supporting team of various contractors and consultants working on the KLRP. RPS Group is providing consultancy advice in relation to engineering aspects of the remediation project.

2.2. Environmental Management System

An environmental management system (EMS) for the facility was developed in June 2013 as part of the first phase of investigative works. **Tables 2.2** and **2.3** provide the names of environmental and standard operating procedures that form part of the EMS. The SOPs provide detailed information on how to manage and maintain several key operations on site including procedures to follow in response to incidents and/or emergency situations and Health and Safety protocols.

The EMS is constantly under review in accordance with the IEL requirements and has been implemented on site since September 2019 to align with site arrangements and procedures to comply with the Licence.

Table 2.2 Environmental Procedures

Environmental Procedures	
EP01	Environmental Objectives and Targets Procedure
EP02	Communication Procedure
EP03	Training Procedure
EP04	Complaints Procedure
EP05	Purchasing Contractors, Goods and Services Procedure
EP06	Document Control and Records Procedure
EP07	Monitoring and Measurement Procedure
EP08	Corrective and Preventative Action Procedure
EP09	Management Review Procedure
EP10	Audit and Compliance Procedure

Table 2.3 Standard Operating Procedures

Standard Operating Procedures	
SOP01	Leachate Management Procedure
SOP02	Landfill Gas Management Procedure
SOP03	Surface Water Management Procedure
SOP04	Environmental Monitoring Procedure
SOP05	Site Security Procedure
SOP06	Control of Contractors Procedure
SOP07	Site Supervision Procedure
SOP08	Spill Procedure
SOP09	Waste Management Procedure
SOP10	Delivery, Storage and use of Chemicals Procedure
SOP11	Emergency Preparedness and Response Procedure
SOP12	Emergency Plan
SOP13	Lone Working Procedure
SOP14	Alarm Activation Procedure

2.2.1. Objectives and Targets 2019

The Environmental Goals outlined in Table 2.4 below have been driven by ensuring compliance with the new licence conditions granted in March 2019.

Table 2.4 Environmental Objectives Achieved in 2019

Environmental Objective	Target Date	Progress
Review and update Management Plans for the installation based on IEL conditions.	Sept 2019 (6 months post licence grant)	Complete
Develop Management Plans for the installation based on IEL conditions.	Sept 2019 (6 months post licence grant)	Complete and ongoing some plans to be further developed by Main Contractor when appointed.
Installation of an engineered capping system (Zones 1A, 1, 2A, 2B, 3) and cover system (Zone 4) to enable water control and limit leachate generation.	Within 7 years of IEAL issue date	Detail Design Complete – subject to tender process currently.
Inspection and repair of existing concrete hardstandings (joints and cracks).	Within 7 years of IEAL issue date	Revised proposal determined for the capping of the areas on hardstanding removing the need to repair existing concrete.
Develop Construction Environmental Management Plan (CEMP) in advance of remediation works.	Prior to commencement of works by Appointed Main Contractor for the Remediation Works	Complete. Outline CEMP developed – Main contractor to finalise prior to works commencing.
Install Installation Notice Board (As per Condition 3.3 of Licence)	April 2019 (1 month post licence grant)	Complete
Environmental Management System (Condition 2.2)	Sept 2019 (6 months post licence grant)	Complete – update of existing EMS

Environmental Objective	Target Date	Progress
		completed and ongoing.
Sumps, storage tanks, lagoons fitted with High level alarms (Condition 3.11)	Sept 2019 (6 months post licence grant)	Complete.
Fugitive Emissions Programme (Condition 6.11)	Sept 2019 (6 months post licence grant)	Complete – included as part of EMS.
Pipe and Tank Integrity Testing (Condition 6.11)	Sept 2019 (6 months post licence grant)	Completed.
Data Management System	Sept 2019 (6 months post licence grant)	Complete. Existing system documented.
Energy Efficiency Audit (Condition 7.1)	Within 12 months of grant	Complete.
Accident Prevention Procedure (Condition 9.1)	Sept 2019 (6 months post licence grant)	Complete.
Emergency Response Procedure (Condition 9.2)	Sept 2019 (6 months post licence grant)	Complete.
CRAMP (Condition 10.2)	Sept 2019 (6 months post licence grant)	Complete.
ELRA (Condition 12.3.2)	Sept 2019 (6 months post licence grant)	Complete.

2.2.2. Objectives and Targets 2020

Our 2020 objectives seek to maintain compliance with the licence and provide for continuous improvements in relation to site operations.

Table 2.5 Environmental Objectives for 2020

Environmental Goal	Target Date
Compliance with IEL Licence • Compliance with IE Licence granted by EPA • Maintenance of Site Documentation • Agreement with EPA regarding Specified Engineering Works.	Ongoing

Environmental Goal	Target Date
Ongoing Management of the Site and associated infrastructure. • Operation of the site on a day to day basis. • Maintenance and control of landfill gas and leachate control systems. • Site fully secured. • Health & Safety management.	Ongoing
Complete Annual Environmental Monitoring Programme in accordance with requirements of Licence • Groundwater and Surface Water Monitoring. • Leachate Monitoring. • Odour Monitoring. • Landfill Gas Monitoring. • Air Monitoring. • Noise Monitoring. • Geotechnical Monitoring. • Meteorological Monitoring.	31/12/2020
Firewater Risk Assessment in accordance with new EPA Guidance.	July 2020
Review and update Monitoring and Control Management Plan to develop Trigger Levels.	Prior to award of main contract - Q3 2020
Soil Monitoring (Condition 6.22)	Within 3 years of grant (March 2022)
Monitoring of Emissions to Sewer - install a composite sampler. (Schedule C.3.2)	Upon start of discharge of wastewater to sewer.
Install new landfill gas flares, sized according to gas pumping trials.	Within 7 years of IEL issue date
Extend gas management system across Zones 1 and 3. Revised as part of detailed design now includes Zone 2A and 2B. Subject to tender process currently.	Within 7 years of IEL issue date
Construct Landfill Infrastructure Compound including leachate treatment plant and leachate transfer pipeline to Johnstown PS for treatment and discharge of leachate from the site. Not completed in 2019 due to detail design and	Within 1 year Main Contract award.

Environmental Goal	Target Date
main works tender delays. This will be completed as part of the first phases of works.	
Extend leachate management infrastructure to Zone 1 monitoring wells to enable monitoring and extraction of leachate (where identified).	Within 7 years of IEL issue date.
Installation of an engineered capping system (Zones 1A, 1, 2A, 2B, 3) and cover system (Zone 4) to enable water control and limit leachate generation.	Within 7 years of IEL issue date

2.3. Statement on Financial Provision

In 2015, the Minister of the Environment confirmed that the Department of the Environment will fund the costs of remediation and ongoing management costs of remediation, estimated to be €30 Million. In carrying forward the remediation project the Minister agreed that the Department of the Environment will act as Sanctioning Authority for the purposes of the Public Spending Code, and Kildare County Council will act as the Project Sponsor. The direct funding role will end when the site has been remediated and this has been confirmed by the EPA to the Minister.

The Council accepts responsibility for the aftercare maintenance and environmental monitoring costs. Furthermore, the minister indemnifies the Council with respect to any unforeseen environmental or related risks that arise in the period from the transfer date to certification by the EPA that remediation if complete and the aftercare period has commenced.

Under the terms of the Memorandum of Understanding the DCCAE will fund the costs of remediation and any liabilities arising during the remediation up to the point where the remediation project has been completed and aftercare period has been deemed to have commenced by the EPA.

Thereafter KCC will make provision for aftercare costs for the facility and will agree documentation with the Agency in this regard prior to the commencement of aftercare period. Appropriate Environmental Insurance will also be put in place to cover any unforeseen events during the aftercare period with an appropriate product agreed to the satisfaction of the Agency at the appropriate time.

KCC submitted an updated Environmental Liabilities Risk Assessment (ELRA) to the EPA in September 2019 and is currently awaiting feedback/approval on the contents of the ELRA report.

2.4. Statement on Closure Aftercare and Management Plan

As the site was left in an unsecured condition with significant waste deposits in predominantly unlined areas by the former operator, an initial screening exercise has identified the site to be a “Category 2 with long term issues (e.g. contaminated land)”. The licence granted to Kildare County Council will enable the remediation of the site forms the basis of the closure, restoration and aftercare proposals for the site, supported by risk assessments (e.g. DQRA) and the Environmental Impact Assessment Report.

The Planned Programme for Improvement includes for the preparation of a Closure Restoration and Aftercare Management Plan to embrace conditions of the IEL and planning approval, taking cognisance of the proposed end-use of the site as a multi-use public park.

It is anticipated that due to the residual contaminated land issues comprising waste in unlined areas remediated with capping system, clean closure may not be achievable. Closure proposals will therefore include consideration of groundwater conditions to determine an appropriate aftercare period and approach.

A revised CRAMP for the site has be provided for agreement by the EPA in September 2019 and included fully detailed and costed plan for the closure, restoration and long-term aftercare of the site. KCC are currently awaiting feedback/approval on the contents of the CRAMP.

2.5. Statement on Environmental Liabilities

KCC are as part of the AER required to provide an annual statement as to the measures taken or adopted at the site in relation to the prevention of environmental damage, and the financial provisions in place, as appropriate in relation to the underwriting of costs for remedial actions following anticipated events (including closure) or accidents/incidents, as may be associated with the carrying on of the activity.

Kildare County Council submitted an Environmental Liabilities Risk Assessment (ELRA) on 06 September 2019. It is KCCs considered position that the contents of the ELRA as submitted remain valid. The overall status of the site remains unchanged from when the ELRA was undertaken and therefore the potential risks identified remain unchanged as do the measures in place to mitigate these risks. It is noted that the ELRA as submitted, and viewing the status if the document on EDEN, has not been assessed by the Agency at this time.

2.6. Communication Programme

At present KLRP communicates with the public via the Kerdiffstown website (http://kildare.ie/CountyCouncil/KerdiffstownPark/) The website provides information about work ongoing at Kerdiffstown Landfill. Further information and updates are posted on the website as the remedial project progresses, to help keep residents, stakeholders and all interested parties fully informed and up to date with progress on the project. Community updates are provided in the '*latest news'* section of the website.

Community Liaison meetings were held on site with residents, local interest groups, Kildare County Council and local government officials to ensure all parties were kept fully informed of progress to date and any updates to the overall remediation programme. Community Liaison meetings took place during 2019 on the following dates:

- 03 April 2019
- 27 June 2019
- 05 September 2019
- 13 November 2019

As the KLRP progresses consultation and/or information events will be rolled out locally. The aim of these events will be to raise awareness of the project and provide further updates on the remediation of the Landfill. These events will be advertised locally and on the Kerdiffstown website.

Road Realignment Works

Beginning in Q4 2019 a widening of the L2005 local road as well of the development of new site entrance to Kerdiffstown Landfill began. These works marked one to the first major steps to enable the remediation of Kerdiffstown Landfill. These works were publicised in the local community as well as letter drops conducted to local residents.

The contractor undertaking the works also met with the Community Liaison Group meeting in Q4 2019.

Communications Plan 2020

KCC will continue to engage with stakeholders, elected members local residents' groups, the Community Liaison Group throughout 2020. Quarterly Meetings will be held with the community liaison group and regular updates supplied via the dedicated web page on the Kildare County Council website.

All press releases, updates and relevant environmental information can be accessed via the website.

Main Remediation Works

The Main Contractor, when appointed, will have a key role in ensuring that the local community are kept informed of planned works for the duration of the remediation.

The above communications methods as well as a co-ordinated communications from both the KCC project team and the main contractor will keep stakeholders informed and provide the necessary outlets for any concerns or issues that may arise.

2.7. Duty & Standby Capacities of Mitigation Measures

A number of interim 'emergency measures' were implemented by the EPA following successful extinguishing of the fire within the wastes at the site in 2011. This was to deal with the key environmental liability issues arising from leachate and landfill gas production. These measures continue to be maintained and improved upon by KCC and are summarised as follows:

Control of landfill gas through the use of gas well fields and a gas flare. Currently only one flare is required (known as the 250 flare) and operates 24 hours a day seven days a week, fed from two independent gas fields situated within the Zone 3 in the south of the site and the Zone 1 in north-western zone of the landfill.

This system also serves to deal with odours generated from the landfill as gas and odour generation is to a large degree interlinked. Wastes in the north-western zone are not capped and thus gas (and odours) will also freely vent to atmosphere.

Waste was deposited in the lined cell during the operation of the site as a landfill, during post-fire clean-up operations and as part of the waste removal activities during the Demolition and Waste Removal Contract in 2017. This waste was covered using a temporary capping system to limit the venting of landfill gases and odours.

Provision of leachate collection facilities from the lined cell, currently involving tankering and off-site disposal of leachate, which collects in a controlled area within the lined cell in the southern area of the site to a licenced facility on a as required basis.

Deployment of a full time site manager and project team who is involved in the daily management of the gas and leachate collection systems and who oversees a number of other key daily environmental monitoring and surveillance activities at the site, (e.g. monitoring of surface water conditions, gas concentrations in monitoring wells etc.), development of interim site management procedures (and continued refinement of such), supervision of contractors, continued liaison with interested third parties etc.

2.8. Incidents, Complaints and Non-compliances

All incidents and complaints are recorded on site by the KCC site management. An incident or complaints report sheet is filled out within 24 hours of an incident occurring or upon receiving a complaint and a record kept in the site incident and complaints folder. The site manager is notified of any incidents or complaints as soon as practically possible. It is the responsibility of the site manager to ensure that all appropriate action is taken to deal with each incident or complaint as soon as possible. Senior personnel are notified of incidents or complaints at monthly team meetings.

2.8.1. Incidents

There were three incidents reported in 2019. Each of these reports were reported to the EPA, one of which is ongoing. **Appendix C** provides a further detail on these incidents.

2.8.2. Complaints

No complaints were received in 2019.

2.8.3. Non-compliances

During 2019 the EPA did not issue any non-compliance notices in relation to the operation of the site.

3. Review of Nuisance Controls

3.1. Litter Control

It is the responsibility of the site management to ensure that the site is kept free from wind-blown litter. Walkovers are undertaken around the perimeter of the facility to check for litter and any fly tipping activities. All contractors working on site have been instructed to implement good hygiene practices and ensure that all litter is collected and disposed of in an appropriate manner.

There were no issues with litter noted during the reporting year.

3.2. Vermin Control

A pest control company was appointed by KCC to manage pest control on site. At present a total of thirty bait boxes are positioned along the southern boundary fence which is close to several residential properties. An additional two bait boxes are positioned at the site offices and at the landfill gas flare. Twice-monthly maintenance checks are carried out whereby bait is replenished, and records kept of vermin activity. Overall, a low amount of vermin activity was noted by the contractor at the bait stations during the reporting year. No complaints were reported by local residents during 2019 in relation to vermin indicating that the current control methods are sufficient to deal with any vermin present on site. Pest control will continue during 2020.

3.3. Bird Control

Birds are no longer a nuisance on site since the facility closed in June 2010 and therefore bird control measures are not required.

3.4. Flying Insects

Flies and other flying insects are no longer a nuisance on site since the facility closed in June 2010.

3.5. Odour Control

Odour control systems have been put in place in the Zone 1 (the north-western area) and Zone 3 (the lined cell). Odour control is managed through the regular monitoring and rebalancing of the in-waste gas extraction wells, gas pipework and landfill gas flares. In Zone 3, a heavy-duty membrane has been placed over the waste material to assist with odour management and to reduce air ingress during gas extraction operations.

In all a total of thirty-nine gas extraction wells have been installed in both areas (twenty-five wells in Zone 1 and fourteen wells in the lined cell area of Zone 3) which are monitored and maintained on a weekly basis as a minimum. Five of these gas wells were brought on-line in early 2017 having been installed during the site investigations during the last quarter of 2016. Odour surveys are conducted offsite on a monthly basis by KCC. As part of a daily site walkover the site management also assesses odours particularly in areas where sensitive receptors are located nearby.

3.6. Dust Control

There are currently no specific ongoing dust control measures in place at the Kerdiffstown facility. There were no issues with dust raised with facility management during 2019. Two dust deposition surveys were conducted during August 2019 and September 2019. There were no exceedances of the licence limit of 350 mg/m^2/day. (see section 7.1.6 for further details).

3.7. Noise Control

There were no issues noted in relation to noise generated by activities on the site during the reporting period (see section 7.1.10 for further details).

4. Emissions Management

4.1. Emissions from the facility

Controlled emissions from the site are limited to landfill gas and leachate as described below.

4.2. Landfill Gas Management

Active gas extraction occurs in two areas of the site; the lined cell in Zone 1 and Zone 3. Zone 3 consists of the lined cell, where the wastes have been covered with a temporary heavy-duty membrane to assist with odour management and to reduce air from being drawn in during gas extraction operations. Gas extraction is accomplished via a network of gas extraction wells and pipework. Gas is removed and burnt in a specially manufactured stainless-steel high temperature gas flare i.e. the 250 flare.

There were formerly are two flares on site, one with capacity 250 m^3/hr (known as the 250 flare), the second with capacity 500 m^3/hr (known as the 500 flare). The 500 Flare was removed from site on 06 July 2018 to another site for operational reasons on the receiving site. It was determined that the 250 flare was capable of maintaining adequate management of the gas fields in Zone 1 and Zone 3 with all gas extracted is burned in the 250 flare.

The flow of gas entering the 250 flare is controlled through the booster unit which is currently set to approximately 80m^3/hr to maximize gas extraction from both areas while ensuring little or no air is drawn in across uncapped areas. Based on gas yields the extraction of gas from Zone 1 compared to the lined cell area is approximately 4:1.

Table 4.1 On site Gas Wells

Zone	Nomenclature	No. of Gas Wells	Approx. Depth (m)
Zone 1	LG1 to LG10	10	6
	LG25 to LG34	10	20
	LG35 to LG39	5	29 to 32
Zone 3	LG11 to LG24	14	3 to 6

Table 4.1 above shows that within the Zone 3 there are 14 gas wells, installed to depths between three metres and six metres (LG11 – LG24). Within Zone 1 there are twenty-five gas wells installed to depths between six metres and twenty metres. The shallow wells are labelled LG1 to LG10 while the deeper wells are labelled LG25 to LG34. Wells LG35 to LG39 vary in depth between twenty-nine and thirty-two metres and were installed in Zone 1 in November 2016 and were connected into the extraction system in early 2017. Refer to Figure 3B 'Onsite Landfill Gas Monitoring Locations' for an overview of the all landfill gas wells.

The landfill gas flare is currently monitored by the site scientists on a daily basis. Continuous flare stack monitoring has been set up on site with remote access from a portable device possible through the Uniflare data logger.

4.3. Flare Shutdowns

In previous years in documenting incidents in AERs for the site flare shutdowns would have been documented as minor incidents. Following receipt of the licence document P1063-01 and as per condition 3.25.7 *'the flare shall be operated at all times that there is combustible gas available'*. It has been determined that flare shutdowns will only be recorded as incidents when there is a reason other than low quality gas is the reason for the shutdown e.g. mechanical failure.

In 2019 there were a total of thirteen flare shutdowns of the onsite 250 flare located in Zone 1. The flare shutdowns were attributed to a combination of decreasing methane concentrations, high pressure, low temperature and high winds. Records of all incidents are kept on file in the site office.

Flare shutdowns are reported immediately to the site manager, site scientist, site security and Uniflare (the flare manufacturers and service operators) by automatic email and text alert. The site manager has responsibility for investigating each incident and restarting the flare either directly on site during standard operational hours or remotely using the Uniflare Data Portal. When the flare shuts down it is restarted by the site manager within 24 hours when combustible gas is present.

Five additional gas extraction wells were installed in Zone 1 during 2016 to boost declining methane concentrations. The location of these wells was aided by a VOC survey, completed by Odour Monitoring Ireland in July 2016, which identified several locations where landfill gas was freely venting to air in the Zone 1 area.

There was no significant impact on the environment arising from any of the flare shutdown events.

4.4. Landfill Gas Production

In overall terms the amount of landfill gas being produced from both the lined cell and the Zone 1 gas fields has been falling since flaring began in 2011 where concentrations had an average value 30.4 % between June 2011 and December 2011 and 23.4% between January and December 2019.

Graphs 4.1 to 4.3 show the landfill gas values recorded on site in 2019, while the below table shows methane concentrations since 2011 and illustrates this overall observed decline. Summary graphs for 2019 for Zones 1 and 3 are provided in **Appendix D**.

Table 4.2 CH_4 Concentrations 2019 to 2011

	2019		
	Avg	Max	Min
250 Flare	23.38	31.6	19.4
Lined Cell	22.68	28.3	15.92

	2018			2017		
	Avg	Max	Min	Avg	Max	Min
250 Flare	23.9	29.0	18.8	23.5	29.8	18.2
Lined Cell	24.9	30.2	18.8	25.3	35.6	17.5

	2016			2015		
	Avg	Max	Min	Avg	Max	Min
250 Flare	23.6	34.4	18.5	21.5	30.2	16.6
Lined Cell	20.4	35	13.1	18.4	30.1	13.5

	2014			2013		
	Avg	Max	Min	Avg	Max	Min
250 Flare	21.5	30.6	16.0	21.3	28.6	17.9
Lined Cell	18.7	31.3	15.1	19.0	26.1	14.6

	2012			2011		
	Avg	Max	Min	Avg	Max	Min
250 Flare	26.4	37.6	12.0	31.1	43.0	14.0
Lined Cell	26.4	43.3	15.7	31.4	50.0	22.9

4.5. Estimated annual and cumulative quantities of landfill gas emitted from the site

The gas extraction system operated at an inlet flow rate ranging from 75 m^3/hr and 84 m^3/hr (average 76 m^3/hr) recorded from daily inlet monitoring during 2019. **Table 4.3** below displays the average values as well as the range of values recorded at the 250 flare throughout 2019. The average concentration of methane (CH_4) flared at the 250 flare during 2019 was 23.3% and the average concentration of carbon dioxide (CO_2) was 21.5%. Corresponding values from 2018 are also provided for comparison purposes.

Table 4.3 250 m^3/hr flare – Average Values 2019

		Average	
	Unit	**2019**	**2018**
CH_4	% v/v	23.8	23.9
CO_2	% v/v	21.5	21.6
O_2	% v/v	0.4	0.3
Flow	m^3/hr	76	100.94
Flare Exhaust Temperature	°C	1010	1003
Gas field Suction Pressure	mbar	0.07	-4.52
Outlet Pressure Gas Booster	mbar	11.31	8.38

The total flare shutdown time was recorded as approximately 175 hours. The total amount of methane flared based on runtime, flow rate and methane concentration were 144,469m^3 or 100,860 kg[1]. Summary graphs of landfill gas flared during 2019 are provided in **Appendix D**.

4.6. Leachate

Only a small part of the overall site is lined i.e. the lined cell in Zone 3, located directly north of the main site entrance. Leachate is collected in this area for subsequent transportation off site for treatment and disposal.

Approximately two thirds of Zone 3 has been infilled with waste. Buildings onsite that were considered dangerous were demolished in 2016. These building contained waste that couldn't be accessed previously as it was unsafe. During demolition works this waste was disposed of in the lined cell.

The waste in Zone 3 has been covered with a temporary heavy-duty membrane to assist with odour management and to prevent air ingress during gas extraction. The membrane also helps to reduce the infiltration of rainwater into the waste body by redirecting surface water run-off from the waste into a series of channels which flow towards a surface water soakaway lagoon located at the lower section of the site. This cover was upgraded following the placement of waste Zone 3. This has resulted in improved gas yield and reduced rainfall infiltration.

Although the heavy-duty membrane prevents a substantial amount of rainwater from entering the waste a certain amount of rainwater does infiltrate the waste, generating additional leachate. Rain falling onto the exposed gravel area is another source of leachate generation. The generation of leachate is therefore strongly influenced by weather conditions with leachate levels noted to rise especially during heavy periods

1 Source EPA Landfill Gas Survey 2019 Calculation Total CH4 (kg) based on the calculation of the density of methane at an average temperature of landfill gas of 10 degrees Celsius and the flare inlet pressure provided. The calculation also takes into account the combustion efficiency of open flares (50%) and enclosed flares (99.9%) for methane

of rainfall over a number of days. The daily leachate levels are measured by the level sensors on the pumping system with reading taken at the control panel.

Leachate that collects in the lined cell drains under gravity towards the western and southwest corner where leachate sumps and associated leachate pumps are located. Leachate is pumped from this location up to two temporary static leachate storage tanks at the top of the bank. The tanks are used to store leachate prior to removal off site by road tanker for treatment/disposal. The two tanks hold approximately 28m^3 in total when filled to the maximum fill mark i.e. the black line on the level gauges. Using the existing pumping system, the tanks are filled to capacity in two hours and thirty minutes. A fully automated pumping system was installed in March 2016 whereby level/pressure sensors were installed and a new pump and control system to help aid the filling process. A second pump was installed in the lined cell to enable leachate extraction from both areas of the cell.

4.6.1. Volume of leachate produced and transported off-site

In 2019, a total of 10,724m^3 of leachate (383 loads) was transported off site by Elsatrans Ltd (NWCPO-12-11124-01) to Ringsend wastewater treatment works (EPA Licence: D0034-01). A summary of leachate disposal on a monthly basis is provided in **Table 4.4** below. Leachate levels within the lined cell are noted to correlate with the amount of rainfall that occurs and as a result leachate haulage frequency also increases as illustrated in **Table 4.4**. Leachate is transported from site on an 'as required' basis as determined by the Site Manager. Leachate levels in the lagoon are maintained below a maximum limit of one meter and haulage is carried out between Monday and Friday with up to a maximum of four loads per day.

Table 4.4 Leachate Transported Off Site 2019

Month	No. of Loads	Total volume (m^3)	Total Monthly Rainfall (mm)
January	29	812	33.1
February	13	364	22.2
March	50	1,400	86.2
April	21	588	69.1
May	21	588	26.8
June	18	504	92.5
July	14	392	46.7
August	50	1,400	113
September	26	728	108.7
October	50	1,400	74.2
November	59	1,652	143.5
December	32	896	49.3
Total	**383**	**10,724**	**865**
Monthly Average	32	894	

4.6.2. Minimising generation of leachate for disposal

The upgraded temporary HDPE liner (installed in Q1, 2017) on the lined cell has reduced rainfall infiltration resulting in lower rates of leachate production.

Table 4.5 Leachate vs. Rainfall Historic Comparison

Year	Total Leachate Volume	Total Rainfall (mm)
2016	14,168 m^3 (510 loads)	732
2017	11,144 m^3 (398 loads)	730
2018	9,940 m^3 (355 loads)	648
2019	10,724 m^3 (383 loads)	865

4.7. Environmental Performance Reporting (EPR)

KCC has completed the Environmental Performance Report (REPR) in accordance with the Agency's guidelines. The EPR has replaced the PRTR for 2019 and was submitted via EDEN on 31st March 2020. The Landfill Gas Survey was completed for submission to the EPA and is provided in **Appendix B.**

5. Waste Management & Resource Consumption

5.1. Records

Records for 2019 were maintained by the site management and have been collated and presented below in Tables 5.1 and 5.2 for the purposes of this report.

5.2. Waste Analysis

Waste material generated at the site offices was collected by Greenstar who operate under NWCPO-13-11193-05 as shown in Table 5.1.

Table 5.1 General Waste

Waste Type	EWC Code	Waste Description	Quantity (tonnes)
General Waste	20 03 01	Office and Canteen waste collected in 1100 litre bins at site offices	0.52
Mixed Dry Recyclables	20 03 01	Recycling from office and canteen waste collected in 1100 litre bin at site office	0.29
Construction Materials Containing Asbestos	17 06 05*	Waste Asbestos sheeting from demolition of shed on site.	1.01

The total volume of leachate removed off site during 2019 was 10,724m^3. For a complete breakdown of leachate haulage records during 2019 see section 4.1.3 above.

5.3. Electricity

The use of electricity on site is primarily at the site offices, the operation of the flare, leachate pumps, the two security huts as well as six freestanding exterior flood lamps for use after dark in the vicinity of the site office, flare compounds and security huts.

Table 5.2 Electricity Usage

	Kilowatt Hours Usage 2019											
Day	6,431	5,809	5,001	4,839	2,378	2,302	3,960	(840)	3,840	3,840	4,320	8,880
Night	3,783	3,417	3,171	3,069	2,256	2,184	2,520	(120)	291	2,400	2,760	4,320
Total	**10,214**	**9,226**	**8,172**	**7,908**	**4,635**	**4,485**	**6,480**	**(960)**	**4,131**	**6,240**	**7,080**	**13,200**

5.4. Diesel

The use of diesel on site is limited to the on-site KCC vehicles which used approximately 319.9 litres of diesel during 2019. Additionally, site security vehicles are in use which are owned and operated by Manguard Security and therefore consumption has not been included as part of this report.

6. Restoration Works

6.1. Remaining volumes of historically deposited waste

The estimate of waste volume present at the site has been is determined, following:

- input of the Phase 2 (October 2012) ground investigation data;
- revision of the estimated base contours accordingly; and,
- re-modelling the waste thickness isopachytes.

The estimate of waste volume remains at ***3.1 million cubic metres*** as determined by the Site Profile, Capping and Material Use Appraisal (EPA, 2013). This represents an increase of 32% from the previous 2.35 million cubic metres estimate in March 2012 following the Phase 1 ground investigation and 82% above the original 2010 pre-fire estimate of 1.7 million cubic metres, which was based on desk study information only. The significant regions of additional waste identified at this update were as follows:

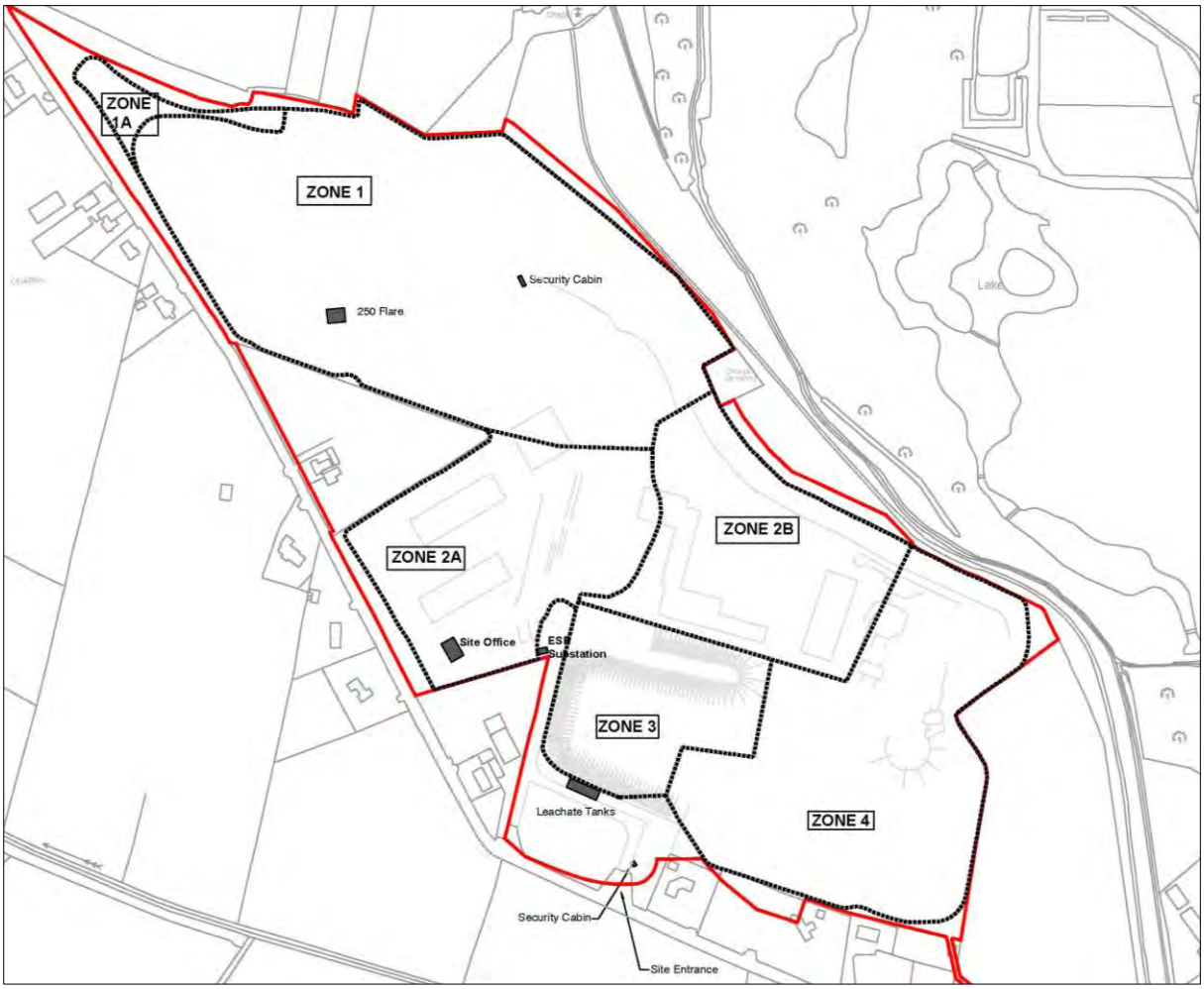
- in the large northern embankment adjacent to Kerdiffstown House, which had been thought previously to be re-worked overburden/natural ground (based on inspection of aerial photographs) but is now considered to be all waste;
- beneath the middle yard (site offices) where Phase 1 data had suggested waste was significantly shallower in one half of the yard, but Phase 2 data indicates this is not the case; and,
- in the south east of the site beneath the sorting sheds, again where there appear to be differences between Phase 1 and Phase 2 data, where Phase 2 boreholes indicate more waste to be present.

The individual volume estimates for the four zones of the site shown on the plan below are shown in Table 6.1. The 2017 EIAR for the site outlined the intention for waste located in Zone 4 to be moved into Zone 3 (the lined cell) which will subsequently be capped. Some re-grading of the slopes will be undertaken in Zone 1 with additional waste from Zone 2 moved to Zone 1. Zone 1 will then be capped.

Table 6.1 Zone Descriptions and Current Condition

Zone	Estimated Area (plan)	Estimated Waste Volume	Basal & Side Lining	Cap Status	Other
1	100,000m^2	2,023,000m^3 (65.2%)	Unlined	None	-
2	83,000m^2	660,000m^3 (21.3%)	Unlined	25,000m^2 uncapped	58,000m^2 concrete hardstanding
3	24,000m^2	193,000m^3 (6.2%)	Lined	Temporary cap	-
4	45,000m^2	227,000m^3 (7.3%)	Unlined	33,000m^2 uncapped	12,000m^2 concrete hardstanding
Total	252,000m^2	3,103,000m^3			

Plate 6.1 Site Zones



6.2. Development / Infrastructural Works Summary

6.3. Works Completed in 2019

In 2019, there are several advance works contracts planned in order to facilitate to main remediation works scheduled to commence in 2020. These works include:

- Stormwater drainage in Kerdiffstown House
- Partial Construction of Outfall from site to the Morell River
- Site Accessibility contract – improving access to the toe of the eastern slopes.
- Surface Water Lagoon – increasing capacity.
- Advance works for L2005 – realignment and new site entrance.
    - Provision of new footpath and cycleway adjacent to realigned road extents.
- Installation of new perimeter fencing to site boundary between Kerdiffstown House and Kerdiffstown Landfill.
- Demolition of existing residential properties.
- Installation of perimeter gas monitoring boreholes along western boundary of site.

6.4. Works Identified for 2020

In 2020, it is anticipated that the contract for the remediation of the site will be awarded ad the below list of specified engineering works will be commenced. Further detail will become available from the successful main works contractor following contract award anticipated in Q2, 2020.

In Q4,2019 an advance works contract commenced on the local road serving Kerdiffstown Landfill (L2005). These works involve the realignment and new site entrance, as well as provision of new footpath and cycleway adjacent to realigned road extents. These works will be completed in Q3, 2020.

The main works contract will involve the following Works:

- Re-profiling and re-placement of waste.
- Installation of final capping.
- Construction of landfill infrastructure compound.
- Installation of landfill gas management infrastructure.
- Construction of storm water outfall to River Morell.
- Construction of swales.
- Construction of leachate pipeline to Johnstown Pumping Station.
- Associated works including surface water management structures.
- Development of elements of multi-use public park.

7. Environmental Monitoring

Since February 2011, a range of environmental monitoring is undertaken to support the KLRP.

In June 2014, an environmental monitoring programme was established covering several environmental disciplines which has continued in order to support the design of the remediation and monitoring the environmental risk profile of the site. Monitoring undertaken in 2019, exceeding requirements of and in compliance with Schedule C of IEL P1063-01 was as follows:

- Groundwater monitoring (monthly, quarterly and bi-annual);
- Surface water monitoring (monthly);
- Leachate (weekly, monthly, quarterly and annually);
- Landfill gas monitoring, (on site weekly, offsite monthly);
- Stack emission testing (bi-annually);
- Dust (bi-annually);
- Odour (monthly);
- Geotechnical assessment (bi-annually);
- VOC Survey (bi-annually);
- Metrological data (monthly); and
- Noise (three daytime, one evening and two night-time).

7.1. Groundwater

Groundwater sampling is undertaken on a monthly basis involving low specification sampling from fifteen monitoring wells for a suite of parameters. An additional five wells were included for quarterly monitoring with a slightly expanded suite of parameters. A higher specification round of monitoring was undertaken on a biannual basis at 35 monitoring wells for an expanded suite of parameters. During 2019 biannual rounds of monitoring were conducted in June and December. Figure 3A provides the location of each of the groundwater monitoring wells.

Groundwater Monitoring Network

Following the operator vacating the site in 2010, the EPA and KCC commissioned a number of site investigations to establish a groundwater monitoring network as summarised in Table 7.1 with the locations of installed monitoring wells shown in Figure 3A.

Table 7.1 Groundwater Monitoring Network and Sampling Frequency

Monitoring Well	Target Stratum	Orientation from the Landfill	Monthly Sampling	Quarterly Sampling	Biannual Sampling
EMW28	Overburden	South (up hydraulic gradient)			
EMW29	Overburden		✓	✓	✓
EMW27D	Overburden		✓	✓	✓
BH2	Overburden				✓
GW1D	Bedrock				✓
EMW11	Overburden	West (cross hydraulic gradient)	✓	✓	✓
EMW12	Bedrock				
EMW24	Bedrock			✓	✓
EMW30	Overburden	East (cross hydraulic gradient)	✓	✓	✓
EMW22	Bedrock	North (cross hydraulic gradient)		✓	✓
EMW23	Overburden			✓	✓
DB02	Overburden		✓	✓	✓
DB03	Overburden		✓	✓	✓
EMW21	Overburden	North East (down hydraulic gradient)		✓	✓
EMW06	Overburden				
BB02	Bedrock		✓	✓	✓
EMW04	Overburden				✓
EMW08	Overburden				✓
EMW19	Bedrock		✓	✓	✓
EMW18	Overburden				✓
EMW02	Overburden				✓
EMW03	Overburden		✓	✓	✓

Monitoring Well	Target Stratum	Orientation from the Landfill	Monthly Sampling	Quarterly Sampling	Biannual Sampling
EMW05	Overburden		✓	✓	✓
EMW07	Overburden				✓
EMW20	Overburden		✓	✓	✓
EMW31	Overburden				✓
EMW32	Overburden				
EMW33	Overburden				✓
EMW13	Overburden	On site (Zone 1)	✓	✓	✓
BH26	Overburden			✓	✓
BH36	Overburden				✓
EMW14	Overburden				✓
BH39	Leachate				
BH40	Overburden	On site (Zone 2)			
EMW15	Overburden		✓	✓	✓
BH68	Bedrock	On site (Zone 3)	✓	✓	✓
BH42 / BH71*	Overburden	On site (Zone 4)			✓
GW1S	Bedrock				✓
GW2D	Overburden				✓
BH6	Overburden				✓
BH7	Overburden				✓
EMW16	Overburden		✓	✓	✓
EMW17	Overburden				
		Totals	**15**	**20**	**36**

*BH42 was replaced with BH71 as BH42 became blocked.

Groundwater Levels and Flow

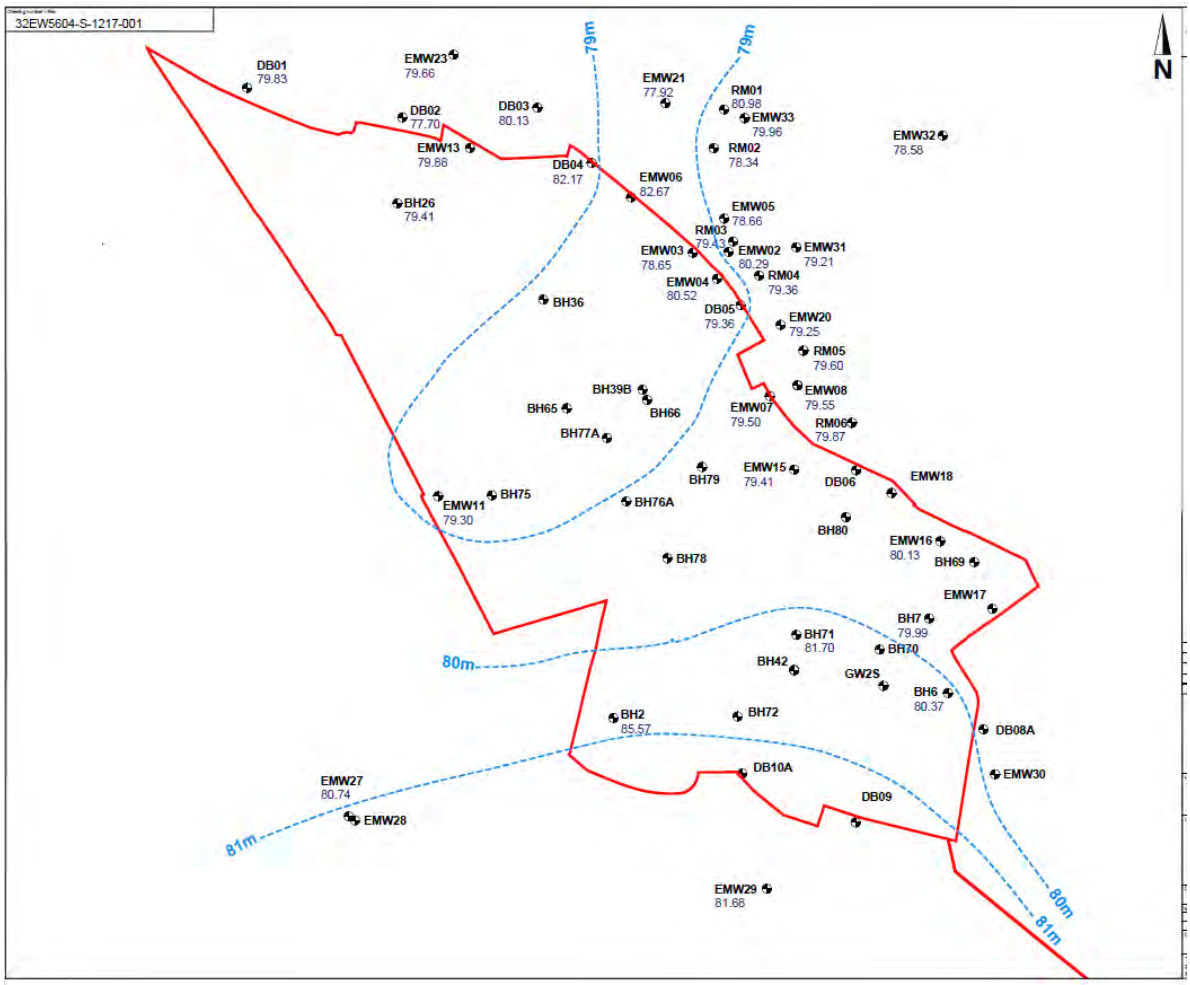
The inferred groundwater flow regime for the overburden groundwater (Plate 7.1) indicates an overall south to north movement of groundwater within the overburden and bedrock aquifer.

The conceptual model for the site shown in Figure 4 includes dilution of leachate from winter rainfall. The model also shows a general increase in groundwater levels within the overburden and bedrock aquifers in response to (likely) increased rates of infiltration. Water levels recorded in both aquifer units during 2019 show an annual trend of decreasing levels through the late spring and early summer months.

Overall flow directions within the overburden are similar to those seen previously with a complex pattern of recharge evident over the footprint of the landfill. The bedrock flow directions have also maintained the previously observed direction of flow in a north or north-easterly direction. See Appendix D for graphs of 2019 water levels in overburden and bedrock which were relatively stable throughout the year.

The only indication of offsite impacts has been to the northeast of the site. Monitoring of the new wells installed in 2016 has also indicated impacts to the north of the site. There are no indications of leachate impact from the site in other directions to the west and south of the site.

Plate 7.1 Shallow Groundwater Levels and Contours (December 2019)



Groundwater Quality Analyses

Groundwater quality data from January to December 2019 has remained largely consistent with results obtained during previous sampling rounds completed between 2011 and 2018. Monitoring during 2019 has shown that there is evidence of leachate impact in the north and north-eastern boundary areas of the site within the overburden aquifer beneath Zone 1 of the landfill. The highest concentrations of key indicators of leachate impact such as ammoniacal nitrogen and chloride are recorded in monitoring wells close to the northern and north-eastern boundary of Zone 1 e.g. DB02 and EMW13, rather than under the central area of this zone e.g. BH26 and BH36.

There are indications of leachate impact (primarily ammoniacal nitrogen, chloride, chemical oxygen demand (COD) and alkalinity) present in some off-site groundwater monitoring wells located between the site and the Morell River, but the concentrations of indicators in these monitoring wells are relatively low. Table 7.2 illustrates the elevated concentrations detected onsite compared to those in near off-site boreholes along the northern and north-eastern boundary.

Table 7.2 Summary Groundwater Concentrations

		Ammoniacal nitrogen average for 2019	Chloride average for 2019
Area	Well Reference	mg/l	
Onsite Zone 1	EMW13	220	207
	BH26	188	361
	EMW15	8.17	37
Eastern boundary	EMW03	14	50
	BB02	1.12	138
	EMW19	0.80	18
Northern boundary	DB02	276	266
Offsite	EMW05	0.47	20
	EMW20	0.48	19

In EMW05, it was noted that the concentration of ammoniacal nitrogen ranged from below the LOD (<0.06 mg/l or <0.01 mg/l) in January, February, March, November and December; to 1.23 mg/l in August. The elevated concentrations during the middle of the year indicate possible seasonal effects influenced by the low rainfall through the latter part of the year. Aside from this seasonal change there is currently little evidence to suggest significant off-site movement of contaminated groundwater towards the Morell River based on the results obtained during 2019.

The following sections and graphs discuss the results for 2019 for the selected leachate indicator parameters ammoniacal nitrogen and chloride. For detailed analysis and interpretation refer to groundwater and surface water monitoring reports completed since June 2011 (reports available upon request).

Ammoniacal Nitrogen

At sites such as Kerdiffstown where there is a history of disposal of municipal and commercial waste streams, ammoniacal nitrogen can typically be present at relatively high concentrations within leachate[2]. Important groundwater nitrogen species include ammoniacal nitrogen (linked to ammonia and ammonium from landfill leachate), nitrate (NO_3) and nitrite (NO_2). The latter is a transitional species and is usually present at relatively trace concentrations (as has been the case at Kerdiffstown).

The Interim Guideline Value (IGV) for ammoniacal nitrogen in groundwater is 0.12 mg/l whereas the Groundwater Threshold Value (GTV) ranges from 0.05 to 0.14 mg/l. Graph 7.1 presents the gathered data from monitoring between January and December 2019.

Graph 7.1 illustrates that throughout 2018 reported ammoniacal nitrogen concentrations in onsite monitoring wells were normally elevated well above the IGV and GTV. Similarly, many of the boundary wells in the lands of Kerdiffstown House, as detailed below, recorded elevated concentrations, with a general reduction towards the Morell River. These results indicate that the leachate migration offsite is currently localised to parts of the site boundary and is not currently getting to the Morell River.

<u>On Site Wells</u>

EMW13 continues to record very elevated levels of ammoniacal nitrogen ranging from 191 mg/l (in November) to 332 mg/l (in March). Concentrations fluctuated throughout the year peaking in March. The elevated concentration recorded in March was the highest since monitoring of this well began in June 2011. The previous highest concentration was 274 mg/l in December 2018. Concentrations decreased back to the normal range through the rest of the year.

Ammoniacal nitrogen in BH26 also peaked in March at 320 mg/l. This is the highest concentration recorded for this well. BH26 in Zone 1 has shown a trend upwards in ammoniacal nitrogen since monitoring of this well began in October 2012 (29.7 mg/l) to a concentration peak in March 2019. Concentrations decreased through the rest of the year to the more typical range of 164 mg/l to 175 mg/l. BH26 is no longer monitored monthly.

Monthly monitoring at EMW15 has revealed variability in ammoniacal nitrogen concentrations since monitoring began in June 2011. Concentrations ranged from 4.78 mg/l in October to 11 mg/l in May. At EMW16 ammoniacal nitrogen concentrations remained relatively stable ranging from 7.35 mg/l in November to 11.2 mg/l in April.

Ammoniacal nitrogen concentrations recorded within other bedrock monitoring wells EMW22 and EMW24 (NW/N of site) were noted to be low at 0.01 mg/l and 0.02 mg/l

[2] This is evidenced by routine chemical analysis of the leachate which is currently collected and removed from the lined cell in Zone 3 of the site where ammoniacal nitrogen is detected.

respectively (and <0.06 mg/l throughout 2019 as previously recorded) indicating no discernible impact from the overlying landfill at these locations.

Boundary Wells

Throughout 2019 ammoniacal nitrogen concentrations were generally found to be elevated at monitoring boreholes along the northern and north-eastern boundary area in Zone 1 at DB02, EMW03 and EMW19. Ammoniacal nitrogen (depicted in graph 7.1) coupled with the presence of other determinands such as chloride (discussed below) is indicative of the presence of landfill leachate in groundwater beneath this area. This is consistent with the results obtained during monitoring over previous years.

During 2019 concentrations of ammoniacal nitrogen in offsite boundary well EMW03 were consistently elevated above the IGV and GTV. The concentration fluctuated throughout the year ranging from 8.14 mg/l in September to 20.4 mg/l in October. This range is consistent with 2018 range of results (6.69 mg/l to 49.9 mg/l).

Ammoniacal nitrogen concentration recorded within BB02, which is also located off site and close to the north-eastern site boundary, fluctuated throughout the year. Concentrations ranged from 0.6 mg/l in November to 1.75 mg/l in July. The peak in July was the highest concentration recorded since monitoring began in February 2017. Ammoniacal nitrogen in EMW04 ranged from 3.5 mg/l in December to 18.7 mg/l in June. This was a significant decrease from the peak of 35.9 mg/l recorded in May 2018. Ammoniacal nitrogen in this well tends to fluctuate.

In EMW07 an ammoniacal nitrogen concentrations ranged from 1.26 mg/l in June to 0.5 mg/l in December. This was consistent with previous results for this well.

At the bedrock monitoring well EMW19 concentrations of ammoniacal nitrogen were elevated but remained relatively stable through the year. Ammoniacal nitrogen ranged from 0.51 mg/l (Sep) to 1.2 mg/l (Aug). Since monitoring began in October 2012 seasonal peaks greater than 3.5 mg/l have been observed. This pattern can be seen in Graph 7.2.

At DB02, located off-site and close to the northern boundary, sampling commenced in March 2017. The well recorded very high concentrations of ammoniacal nitrogen ranging from 274 mg/l in November to 321 mg/l in April. This is higher than concentrations recorded in on-site wells and indicates leachate contamination at the northern boundary of the site.

Off Site Wells

During 2019, in keeping with previous years' data concentrations of ammoniacal nitrogen in both EMW05 (2019 average 0.47 mg/l) and EMW20 (2018 average 0.48 mg/l) close to the Morell River were noted to be relatively low compared to concentrations observed in the boundary well EMW03 (2019 average 14.01 mg/l) which is up gradient in terms of hydraulic flow.

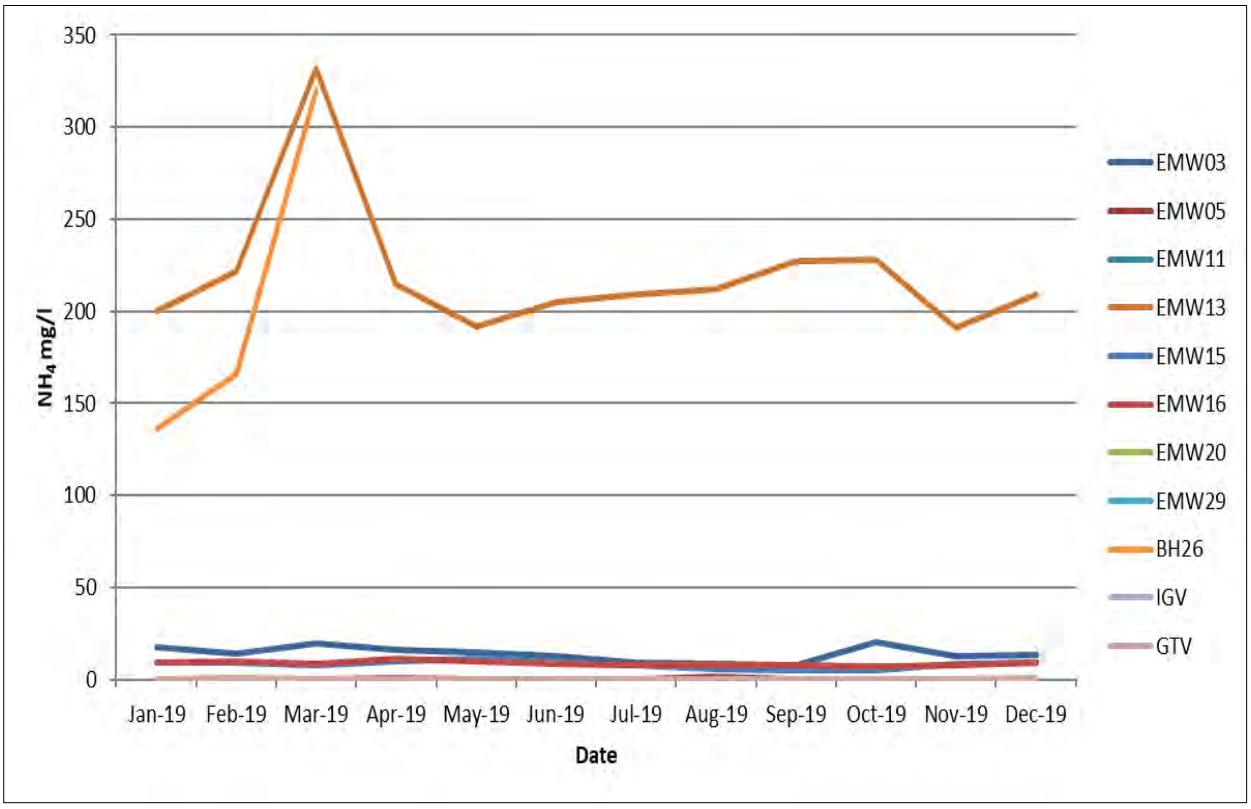
At EMW05, situated within 5m of the Morell River, five of the twelve monthly samples were below the LOD of 0.06 mg/l (0.01mg/l for Nov & Dec). Seven samples, from April to October, were above the LOD with five samples exceeding the IGV of 0.12 mg/l. Concentrations ranged from 0.07 mg/l in May and October to 1.23 mg/l in August. The elevated concentration during the middle of the year indicates that there may be some seasonal variation in this well. EMW05 was added to the monthly groundwater monitoring in 2015 to gather more frequent data regarding the

groundwater chemistry closer to the Morell River. Monthly monitoring will continue in 2020.

At EMW20 ammoniacal nitrogen concentrations were consistent with 2018 concentrations (2018 average 0.6 mg/l). Concentrations remained relatively stable throughout the year ranging from 0.1 mg/l in September to 0.8 mg/l in December.

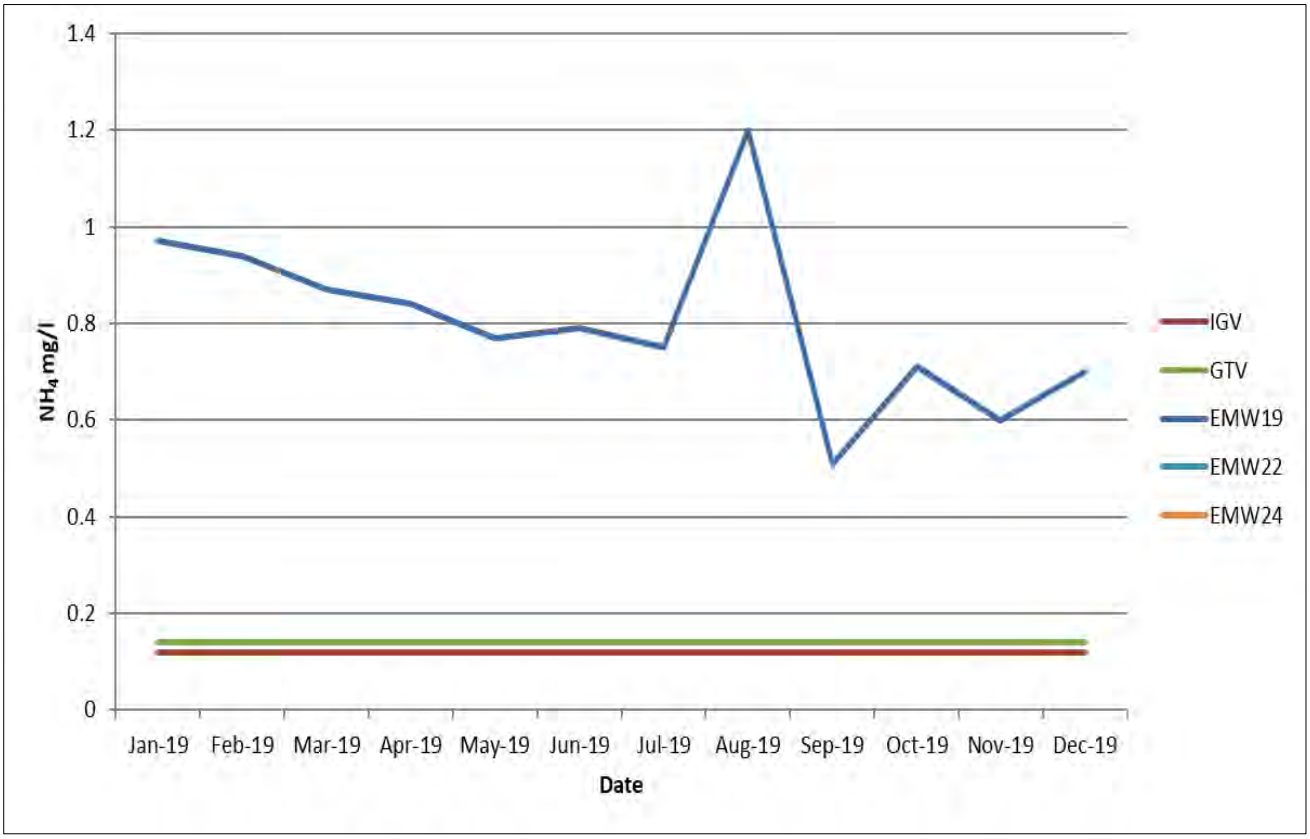
The rest of the offsite wells in Kerdiffstown house (EMW21, EMW22 and EMW23) recorded concentrations ranging from <0.01 mg/l (EMW23) to 0.09 mg/l (EMW21). These wells were sampled quarterly in 2019 and all are typically below the LOD for ammoniacal nitrogen. This continues the trend seen over the past number of years, indicating that the leachate migration offsite to the north of the site is localised close to the site boundary.

Graph 7.1 Ammoniacal Nitrogen in Selected Overburden Monitoring Wells 2019



Note: Axes values are different between Graph 7.1 and 7.2

Graph 7.2 Ammoniacal Nitrogen in Bedrock Monitoring Wells 2019



Note: Axes values are different between Graph 7.1. and 7.2

Chloride

Chloride is used as a common key indicator for the presence of landfill leachate in groundwater. The IGV for chloride is 30 mg/l whereas the GTV is between 24 mg/l and 187.5 mg/l.

Graph 7.3 shows the variation in chloride concentrations for each of the overburden wells sampled on a monthly basis during 2019. A very similar pattern of variation is shown for electrical conductivity (EC) and ammoniacal nitrogen for the corresponding monitoring wells with decreased concentrations generally observed in those samples collected during the winter months, likely as a result of increased rainfall infiltration rates through the waste body in Zone 1 causing dilution of leachate. As with EC and ammoniacal nitrogen this is most pronounced within EMW03.

Chloride concentrations recorded within bedrock monitoring wells during 2019 are shown in Graph 7.4.

<u>On Site Wells</u>

As would be expected, the highest chloride concentrations were recorded in the on-site wells. In 2019 the highest concentration of chloride was detected at on-site monitoring well BH26 located beneath Zone 1 in the northwest of the site. Monthly monitoring at this borehole started in September 2014 to gather more data regarding the groundwater chemistry beneath Zone 1. This well is now monitored quarterly. The average concentration in 2019 was calculated at 360 mg/l (maximum 377 mg/l in January, minimum 332 mg/l in December).

Boundary Wells

Chloride concentrations in EMW03, located at the north-eastern boundary of the site, have consistently shown to be elevated relative to other nearby monitoring wells such as EMW06 and EMW04. The average concentration of chloride detected in EMW03 during 2019 was 50.1 mg/l with the lowest concentration of 45.2 mg/l detected in September 2019, and the peak concentration of 58.7 mg/l detected during July 2019.

BB02 has also recorded consistently elevated chloride concentrations similar to or higher than EMW03. The average concentration of chloride detected in BB02 during 2019 was 138 mg/l with the lowest concentration of 86.9 mg/l detected in June 2019, and the peak concentration of 193 mg/l detected in January 2019.

EMW04 has also shown some seasonal variability in chloride concentration, however it is only sampled on a biannual basis so there is insufficient data to confirm this. A large increase was recorded in June with chloride peaking at 138 mg/l. This decreased in December to 80 mg/l.

EMW07 has shown variability in chloride since monitoring was undertaken in June 2011. The elevated concentrations recorded in 2016 (50.6mg/l in June and 31.1 mg/l in December) had decreased in 2017 (18.9 mg/l in May and 21.3 mg/l in Nov) and 2018 (22.1 mg/l in May). This continued in 2019 with chloride concentrations of 14.9 mg/l in June and 17 mg/l in December.

At EMW19 (bedrock well), chloride remained below the IGV limit of 30 mg/l throughout the year. The average chloride concentration for 2019 at 18.4 mg/l was a decrease on the 2018 average of 26.7 mg/l and the 2017 average of 21.1 mg/l. As with some of the overburden boreholes, EMW19 appears to show seasonal fluctuation with lower chloride concentrations during the winter months when there is increased infiltration of rainfall. At northern boundary, DB02 has recorded very elevated chloride concentrations since monitoring began in March 2017. The average chloride concentration for 2019 was 279 mg/l with the lowest concentration of 262 mg/l recorded in November and December and the peak concentration of 302 mg/l recorded in January. This is higher than the nearby onsite well EMW13 which recorded an average chloride concentration of 207 mg/l for 2019.

Off-Site Wells

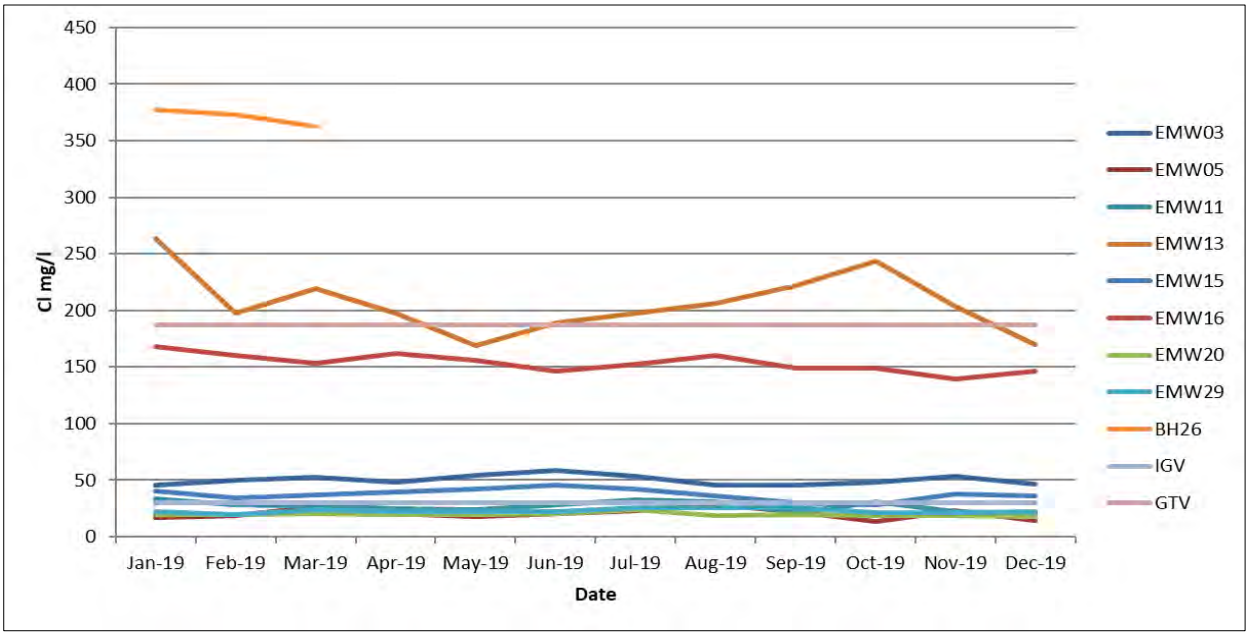
Chloride concentrations were noted to be relatively low in off-site monitoring wells to the north-east during 2019 (e.g. average value of 19.7 mg/l in EMW20 and 20.3 mg/l in EMW05).

EMW05, adjacent to the Morell River, (which may show some limited impact from leachate with elevated ammoniacal nitrogen concentrations and the presence of mecoprop does not show a clear impact from chloride with concentrations below the IGV throughout the year ranging from 13.65 mg/l in December to 28.2 mg/l in August (the maximum chloride concentration ever recorded in EMW05 was 61.3 mg/l in September 2011).

DB03, to the north off the site, recorded elevated chloride concentrations since monitoring began in February 2017. The average chloride concentration was recorded at 104 mg/l with the lowest concentration of 78 mg/l recorded in December and the peak concentration of 126 mg/l recorded in January. Much lower chloride concentrations were noted in EMW22 and EMW23 which are to the north off DB03.

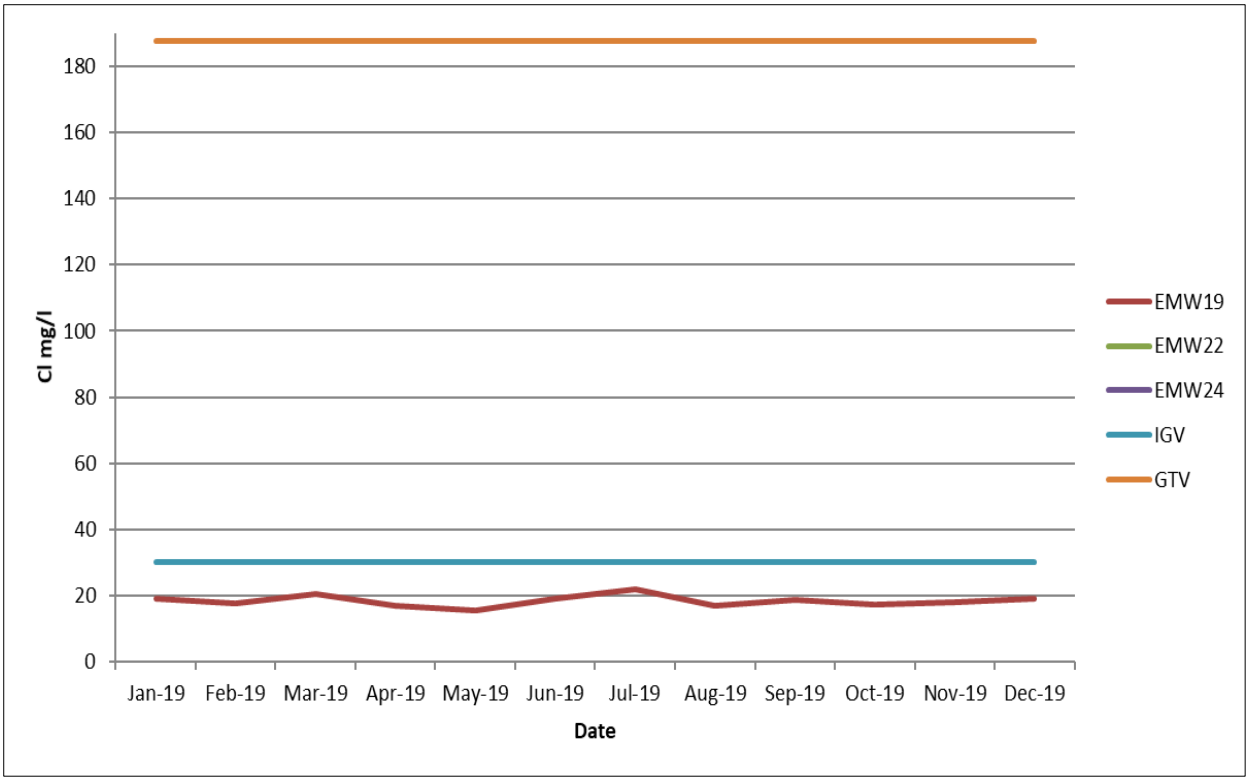
Both of these wells are monitored quarterly. In EMW22 chloride ranged from 32.5 mg/l to 33.7 mg/l. In EMW23 chloride ranged from 11.1 mg/l to 13.9 mg/l. This would indicate that chloride impacts are localised close to the northern boundary. Further monitoring is required to confirm this.

Graph 7.3 Chloride in Selected Overburden Monitoring Wells 2019



Note: Axes values are different between Graph 7.3 and 7.4

Graph 7.4 Chloride in Bedrock Monitoring Wells 2019



Note: Axes values are different between Graph 7.3 and 7.4

Metals

During the quarterly and biannual rounds of monitoring in 2019 additional analysis is undertaken. In certain types of wastes when the pH is low the solubility of many metal ions increases and therefore, they can become mobilised into the developing leachate. As such elevated concentrations of trace metals can be indicative of leachate contamination within groundwater.

In terms of dissolved metals, the groundwater results were broadly similar to those recorded in previous monitoring rounds carried out since 2011, both in terms of the number of exceedances against IGVs and GTVs and the location of the exceedances. In 2019 there were exceedances recorded at both on and off-site wells. The majority of exceedances were in wells on-site or on the site's eastern boundary. There were also exceedances recorded off-site to the southwest. For the most part there were no exceedances between the site boundary and the Morell River, with the exception of EMW20 which was found to have barium concentrations above the limit in June (0.11 mg/l) and December (0.13 mg/l). Table 7.3 summarises the number of exceedances recorded during the 2019.

Table 7.3 Dissolved Metals Exceedances of the IGVs/GTVs during 2019

Parameter	Lower of IGV/GTV (mg/l)	Number of exceedances	Maximum result (mg/l)	Borehole with Maximum Result	Location of maximum result
Arsenic	0.0075	39	0.05	EMW19	Off-site (East)
Barium	0.1	21	0.984	DB02	Off-site (North)
Cadmium	0.00375	1	0.0134	BH7	On-site
Chromium	0.03	0	0.022	EMW27	Off-site (Southwest)
Copper	0.03	7	0.103	EMW27	Off-site (Southwest)
Lead	0.01	10	0.079	EMW27	Off-site (Southwest)
Mercury	0.0001	3	0.00025	EMW23	Off-site (North)
Nickel	0.015	20	0.158	BH7	On-site
Zinc	0.1	8	0.483	BH7	On-site

Organic Compounds

Groundwater samples from all the monitoring wells during June and December 2019 were analysed for a suite of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), phenols, formaldehyde, acid herbicides, organo-chlorine pesticides and total petroleum hydrocarbons (TPH).

Herbicides & Pesticides

The groundwater samples were analysed for a standard suite of acid herbicides and organo-chlorine pesticides.

Mecoprop is an active ingredient in many broadleaf weed killers and has been detected in previous years in selected boreholes. Mecoprop is now monitored on a monthly basis in line with licence requirements. Ten of the fifteen wells monitored monthly have recorded mecoprop above the LOD. Of these two monthly wells have recorded mecoprop above the IGV of 10 µg/l namely EMW13 (10.3 µg/l in Dec to 25.4 µg/l in Oct) and DB02 (18.5 July to 26.7 in September) During the biannual rounds in June and December additional wells exceeded the IGV for mecoprop namely EMW14 (14.4 µg/l and 10.2 µg/l) and BH26 (25.8 µg/l and 21.2 µg/l).

Three additional compounds were detected during the June biannual monitoring. 2,4-D, dicamba and MCPA were detected in onsite BH7. 2,4-D and MCPA were detected in BH7 during the December biannual round also. Three further compounds were detected during the December monitoring round namely Clopyralid (BH71), Dichloroprop (EMW13 & BH26) and MCPB (EMW03, EMW13, EMW14, EMW16 & BH26).

In EMW05, adjacent to the Morell River, mecoprop was detected above the LOD on six occasions with concentrations ranging from 0.05 µg/l to 0.27 µg/l in August. The GTV of 0.075 µg/l was exceeded on four occasions. Mecoprop has been detected at this monitoring point on multiple occasions since February 2013. The concentrations recorded have fluctuated between 0.05 µg/l and 1.24 µg/l in that time, the IGV has never been breached. At EMW20, also adjacent to the Morell River, mecoprop was not detected above the LOD of 0.04 during the year.

Semi Volatile Organic Compounds (SVOCs)

Excluding phenols (see below for consideration of phenolic compunds), SVOCs were absent in groundwater samples in 2019. Trace concentrations of target list compounds have been detected in past monitoring rounds in on-site boreholes; however, in all cases they have been reported close to the limit of detection and to date no compounds have been reported consistently in any of the boreholes monitored.

Volatile Organic Compounds (VOCs)

As with SVOCs, VOCs were generally absent in groundwater samples in 2019. Benzene was detected in DB02 in June at 1.71 µg/l exceeding the IGV of 1 µg/l. 1,4-Dichlorobenzene and n-propylbenzene were detected in EMW14 at 4.43 µg/l and 1.43 µg/l respectively in June. Chloroform was detected in EMW24 (Zone 1) at a concentration of 2 µg/l in December. Chloroform has previously been detected at EMW24 during 2013 and 2014 at concentrations ranging from1.4 µg/l to1.7 µg/l. 1,2 Dichloroethane was detected in BH71 at a concentration of 2 µg/l. No other

compounds on the target list of VOCs were detected during the 2019 biannual sampling.

Polycyclic Aromatic Hydrocarbons (PAHs)

In common with previous monitoring results, PAHs were detected at low-to-trace concentrations in a small number of boreholes including on-site boreholes BH6, BH7, BH26, EMW13, EMW14, BH36 and BH71. The highest total PAH concentration reported in on-site groundwater was 0.759 µg/l in EMW14 in Zone 1 (near the northern boundary of the site during June 2019).

PAHs were also detected in off-site borehole EMW31 and boundary borehole DB02.

In overall terms, concentrations of PAHs detected in groundwater in on and off-site boreholes were similar to those measured in previous years. Based on the pattern of results obtained there is no evidence of significant PAH concentrations in groundwater or off-site migration of PAHs from an on-site source.

Phenolic compounds

Phenolic compounds (principally comprising phenol) were reported above analysis detection limits in many of the on-site boreholes. The highest concentrations were in Zone 1 with lower concentrations detected in boreholes in the southern part of the site. Phenol is now monitored monthly as required by the licence. Total phenols above the IGV of 0.5 µg/l are regularly detected in EMW13 ranging from 47 µg/l to 120 µg/l; EMW16 ranging from 0.1 µg/l to 60 µg/l; DB02 ranging from 0.14 µg/l to 1480 µg/l. The biannual wells BH7 and EMW14 also detected total phenols above the IGV.

Formaldehyde

Formaldehyde has previously been identified in eleven boreholes located primarily along the north-eastern site boundary (both on-site and near off-site). In June 2019 formaldehyde was detected in three wells all onsite namely EMW14 (0.032 mg/l), EMW15 (0.505 mg/l) and EMW16 (0.073 mg/l). A higher LOD of 0.2 mg/l was reported in December and there were no exceedances.

7.1.1. Compliance with Groundwater Regulations[3]

Background to Regulations

The European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010) places a duty on public authorities to take all reasonable

steps to prevent the input of hazardous substances and limit the input of non-hazardous substances to groundwater and reverse any significant and sustained upward trend in the concentration of any pollutant resulting from the impact of human activity in order to progressively reduce pollution of groundwater.

The ‘prevent’ objective relates to hazardous substances, whereby all necessary and reasonable measures should be taken to avoid the entry of such substances into groundwater and to avoid any significant increase in concentration in groundwater,

[3] Extracts from Environmental Impact Assessment Report (EIAR) Volume 2 of 4: Main Report

even at a local scale. The 'limit' objective relates to non-hazardous substances, whereby all necessary measures should be taken to limit inputs into groundwater to ensure that such inputs do not cause deterioration in status of groundwater bodies, or a significant and sustained upward trends in groundwater concentrations.

Under the regulations, the EPA may issue exemptions to the 'prevent and limit' requirements of the regulations if, for example:

- Inputs are considered to be of a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater;
- Inputs are considered incapable, for technical reasons, of being prevented or limited without using:
- measures that would increase risks to human health or to the quality of the environment as a whole, or
- disproportionately costly measures to remove quantities of pollutants from or otherwise control their percolation in, contaminated ground or subsoil.

An example of where such an exemption could apply is given in Guidance on the Authorisation of Discharges to Groundwater (EPA December 2011) as an old, unlined landfill where full remediation may do more environmental harm than good.

Determination of compliance

Groundwater data shows elevated concentrations compared to upstream groundwater quality and environmental quality standards for certain compounds. For the areas of the site where no basal liner is present, i.e. all zones excluding Zone 3, the requirements of the EC Environmental Objectives (Groundwater) Regulations 2010, S.I. No. 9 of 2010 cannot be achieved. The remediation works will offer mitigation to this continued release of contamination to groundwater but hazardous substances are likely to continue to discharge to groundwater following the works.

In considering the remedial options available for the site, it was determined that the alternatives which could lead to the prevention of the discharge of hazardous substances such as excavation and removal of wastes would either present significant risks to human health and the environment as a whole or were too costly.

Part II of S.I. No. 9 of 2010 details the requirements of a Public Authority to ensure compliance. These include prevention, protection, and reverse of any damage to groundwater. It is deemed that the remediation work reaches these requirements and the monitoring of the Aftercare Phase will ensure continued compliance.

Conclusion

Previous studies for the proposed remediation works concluded that the best solution, with the lowest environmental impact involves capping the current areas of waste, following only minimal excavating and movement of these wastes. Capping is a technology that forms a barrier between the waste and the surface, thereby protecting people and the environment from potential harmful effects and limiting the migration of pollutants including landfill gas and leachate. The movement of some

wastes and material within the site is required in order to achieve stable engineered slopes and to allow for the management of surface water drainage.

Baseline data for groundwater collected over a number of years has identified that due to the historical use of the site as a landfill site, landfill leachate has locally contaminated the groundwater system. There is no evidence that this contamination is impacting adversely on local surface watercourses or groundwater abstractions.

This baseline data gathered for these determinands a will be used to assess if there is any improvement or deterioration in groundwater quality in the remediation or aftercare phases as a result of the works.

Leachate from the landfill has relevant hazardous substances associated with it including ammoniacal nitrogen, metals/metalloids (including nickel, zinc and arsenic) and certain organic substances including phenol and mecoprop. These substances are likely to continue to be released to groundwater from the waste during the remediation works and in the aftercare period.

Given the potential impacts of the contaminants associated with leachate on water quality and ecology within the Morell River, principally through potential migration in a shallow groundwater pathway, leachate must be managed to prevent it entering water or to ensure the risk of impact is at an acceptable level. This will be achieved by installing a capping system over the predominant areas of waste in the site to reduce infiltration and managing leachate head in Zone 3 (lined cell) to an appropriate level. The assessment of viable remediation options has established that the complete prevention of leachate ingress into the groundwater system is not technically feasible and/or would be disproportionally costly, where the Groundwater Directive permits exemptions in this scenario.

The installation of engineered capping and soil cover systems across the site will reduce infiltration of water and hence the potential for leachate generation and migration to groundwater, giving a reduction to the environmental risk profile of the site to a likely acceptable level.

7.2. Surface Water

The existing Monitoring and Control Plan for the site was revised in April 2019 following the grant of IEL P1063-01 and an amended surface water monitoring programme was implemented from July 2019. As part of this revision, frequency of monitoring has changed for some monitoring locations as well as the suite of parameters to be analysed.

Monitoring of surface water samples from the Morell River (east of site) was undertaken at key strategic locations (shown in Table 7.6) during the monthly monitoring rounds to assess whether the landfill is having an adverse impact upon water quality. Monthly monitoring of SW04 on the Morell River took place up to April 2019, while monthly monitoring of SW03A on the Morell River took place up to May 2019. Both locations were also included in the biannual round of monitoring in June.

A sample of water from the former surface water runoff discharge onsite was also collected each month from January to September 2019. The site discharge to the canal feeder was disconnected in January 2018 and the site discharge was diverted to the surface water lagoon onsite. From October 2019 the surface water lagoon has replaced the former site discharge in the monitoring programme.

A quarterly sampling round was introduced in September 2019 which added SW08 to the monitoring locations to be monitored. This location is on the Hartwell River, a tributary of the Morell River, and is accessed on the Palmerstown Golf Club (PGC) estate to the east, beyond the Morell River.

The annual monitoring round was changed to biannual in the updated plan for surface water monitoring. During the biannual sampling rounds in June and December 2019, samples were obtained from all monthly monitoring locations, SW04 on the Morell River, and SW08 and SW16 which are located on the Hartwell River on Palmerstown Golf Club (PGC) estate.

Refer to Figure 3B ‘Surface Water Monitoring Locations’ for an overview of the all surface water monitoring locations.

Table 7.6 Surface Water Sampling Locations and Sampling Frequency

Water Body	Sampling Location	Orientation from site	Monthly Sampling	Quarterly Sampling	Biannual Sampling
Morell River	SW01	Upstream SE	✓	✓	✓
	SW02	Upstream E	✓	✓	✓
	SW03	Adjacent E	✓	✓	✓
	SW03A	Adjacent E	✓		✓*
	SW04	Adjacent E	✓		✓
	SW05	Downstream NE	✓	✓	✓

Water Body	Sampling Location	Orientation from site	Monthly Sampling	Quarterly Sampling	Biannual Sampling
Onsite Waterbody	SW Lagoon	Onsite	✓		✓
	Site Discharge	Onsite	✓	✓	✓*
Watercourse on PGC (Hartwell River)	SW08	Upstream SE		✓	✓
	SW16	Upstream SE			✓

*SW03A and the former site discharge were not sampled as part of the December biannual monitoring event.

Surface Water Quality Analyses

Surface water sampling in 2019 consisted of collecting grab samples from the Morell River, the former site discharge, the onsite surface water lagoon, and the Hartwell River in the Palmerstown Golf Club estate to the east of the Morell River. During the monthly rounds, up to 7 no. surface water samples were obtained (Table 7.6) and analysed for a suite of inorganic analytes including major ions.

In the quarterly sampling round in September 2019 a total of 6 locations upstream and downstream of the landfill were sampled (Figure 3) in order to assess any changes in water quality linked to the site. In the biannual sampling rounds in June and December 2019 8 no. locations upstream and downstream of the landfill were sampled (Figure 3). The samples were analysed for the same suite of inorganic analytes as the groundwater samples including major ions and metals/metalloids. The main results for 2019 are summarised below.

Ammoniacal Nitrogen

Table 7.7 gives a summary of surface water ammoniacal nitrogen results during 2019. Up to October 2019 most surface water sampling locations reported ammoniacal nitrogen levels below the analytical limits of detection (LOD) of 0.06 mg/l. A new laboratory was contracted for analysis of samples taken in November and December 2019 which could achieve a lower LOD of 0.01 mg/l for ammoniacal nitrogen. Subsequent to this all monitoring locations reported levels of 0.01-0.02 mg/l ammoniacal nitrogen. The results are further discussed below.

For illustrative purposes the “good status” surface water quality standard for ammonia (as N) as stipulated in European Union Environmental Objectives (Surface Waters) Regulations 2009, as amended, is ≤0.065 mg/l (mean).

Morell River

Ammoniacal nitrogen was below the laboratory LOD (<0.06mg/l) in all samples from the Morell River up to October 2019. In November and December 2019, results ranged from 0.01-0.02mg/l. On review of the results reported, all samples taken in the Morell River during 2019 comply with the ≤0.065 mg/l mean for “good status” surface waters.

Palmerstown House Estate (Hartwell River)

Biannual monitoring was completed for the surface waters taken from the Hartwell River in Palmerstown Golf Club in June and December 2019, and a quarterly round of monitoring was completed in September 2019. Both monitoring locations were below the limit of detection (<0.06 mg/l) for the June and September monitoring events. In December 2019, results ranged from 0.01-0.02mg/l. On review of the results reported, all samples taken in the Hartwell River during 2019 comply with the ≤0.065 mg/l mean for "good status" surface waters.

Table 7.7 Ammoniacal Nitrogen in Surface Water Samples -2019

Water Body	Sampling Location	2019 Range Ammoniacal Nitrogen (mg/l)	Orientation from site
Morell River	SW01	0.02 - <0.06*	Upstream SE
	SW02	0.02 - <0.06*	Upstream E
	SW03	0.02 - <0.06*	Adjacent E
	SW03A	<0.06	Adjacent E
	SW04	0.02 - <0.06*	Adjacent E
	SW05	0.02 - <0.06*	Downstream NE
Onsite Waterbody	Site Discharge	<0.06 - 0.11	Onsite
	SW Lagoon	0.05 - <0.06	Onsite
Watercourse on PGC (Hartwell River)	SW08	0.02 - <0.06*	Upstream SE
	SW16	0.01 - <0.06*	Upstream SE

*The laboratory LOD reduced for November and December 2019 due to analysis being carried out by a different laboratory with a lower LOD for ammoniacal nitrogen.

Total Organic Carbon (TOC), Chemical Oxygen Demand (COD) & Biochemical Oxygen Demand (BOD)

As discussed above, in terms of major ions, the presence of inorganic macro components which include commonly occurring cations and anions may be indicative of leachate generated from a landfill such as Kerdiffstown. The results during 2019 for major ions in surface water samples were generally consistent with those observed since October 2013. The BOD value in rivers often increases during periods of heavy rain and high flows as organic matter is washed in from the land and farmyards. The determination of total organic carbon (TOC) is complementary to the oxygen demand analyses (biochemical and chemical) and in strict terms, it is a better indicator of organic content in that it is a direct measurement of carbon.

Results of TOC, COD and biochemical oxygen demand (BOD) are summarised below. For illustrative purposes the “good status” surface water quality standard for BOD as stipulated in European Union Environmental Objectives (Surface Waters) Regulations 2009, as amended, is ≤1.5 mg/l (mean).

In the absence of COD limits under the above legislation, the limits for waters used for drinking water abstraction for COD is 40 mg/l (Ref: European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989.)

Morrell River

The concentrations of TOC in the Morell River during 2019 ranged from 0.8 mg/l up to 4.3 mg/l (Table 7.8). There was no significant difference observed in the TOC concentrations between upstream and downstream sampling points.

BOD results for surface water samples obtained from the Morell River in 2019 were close to or below the limit of detection in all instances, ranging from <1 mg/l to 3 mg/l.

The trend for COD as expected follows a similar pattern and all results were below the 40 mg/l limit for A3 waters in 2019.

Palmerstown House Estate (Hartwell River)

TOC concentrations were relatively stable on the PGC Estate between 1.7 mg/l in SW08 and 3.9mg/l in SW16 during 2019 (Table 7.8), which is similar to that of the Morell River.

BOD results for surface water samples obtained from the golf course waterbodies in 2019 were close to or below the limit of detection in all instances, ranging from <1 mg/l to 2 mg/l. SW08 recorded the highest BOD result at 2 mg/l in September 2019. COD concentrations for both Hartwell River monitoring locations ranged from 10 mg/l to <11 mg/l.

Table 7.8 Total Organic Carbon in Surface Water Samples -2019

Water Body	Sampling Location	2019 Range TOC (mg/l)	Orientation from site
Morell River	SW01	1.3 - 2.7	Upstream SE
	SW02	1.2 - 3.8	Upstream E
	SW03	1.4 - 4.1	Adjacent E
	SW03A	1.1 - 2.3	Adjacent E
	SW04	1.3 - 2.2	Adjacent E
	SW05	1.3 - 4.3	Downstream NE
Onsite Waterbody	Site Discharge	0.8 - 2.5	Onsite

Water Body	Sampling Location	2019 Range TOC (mg/l)	Orientation from site
	SW Lagoon	2.4 - 2.7	Onsite
Watercourse on PGC (Hartwell River)	SW08	1.7 - 2.4	Upstream SE
	SW16	2.6 - 3.9	Upstream SE

Table 7.9 COD and BOD in Surface Water Samples -2019

Water Body	Sampling Location	2019 Range BOD (mg/l)	Mean (mg/l)	2019 Range COD (mg/l)	Orientation from site
Morell River	SW01	<1 - 3	1.86	<11 - 28	Upstream SE
	SW02	<1 - 1.5	1.16	<11 - 36	Upstream E
	SW03	<1 - 1.5	1.25	6 – 24.0	Adjacent E
	SW03A	<1	<1	<11 - 22	Adjacent E
	SW04	<1	<1	<11 - 28	Adjacent E
	SW05	<1 - 2	1.5	6 – 26.0	Downstream NE
Onsite Waterbody	Site Discharge	<1 - 3	1.4	<11 - 30	Onsite
	SW Lagoon	1.1 - 2	1.4	<5 - 16	Onsite
Watercourse on PGC (Hartwell River)	SW08	<1 - 2	1.3	10 - <11	Upstream SE
	SW16	<1	<1	10 - <11	Upstream SE

Chloride

For illustrative purposes the parametric value for chloride in drinking water and water to be abstracted for drinking is 250 mg/l.

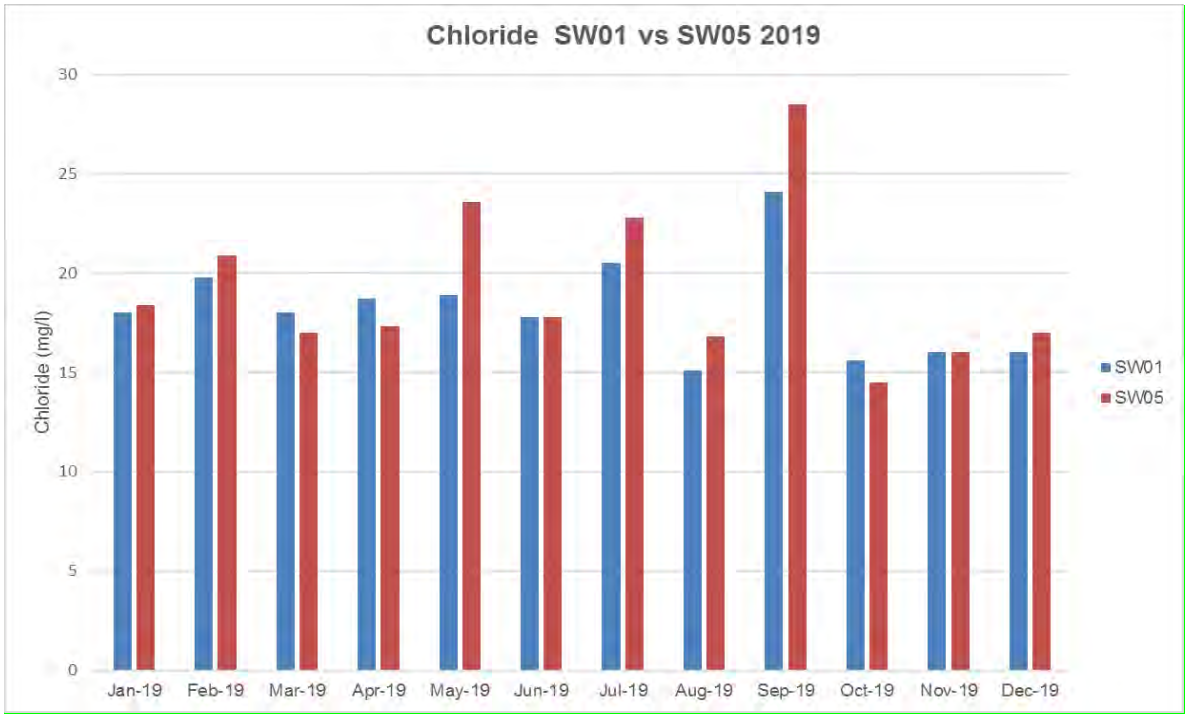
Morrell River

Chloride was observed at low concentrations in the Morell River samples in 2019 with an average concentration of between 18.2 mg/l and 19.3 mg/l. The monthly concentrations ranged from 14.5 mg/l at SW05 in October to 28.5 mg/l at the same

location in September 2019. Graph 7.5 and Table 7.10 shows there is little variation in chloride concentrations in the river. In 2018, there was a pattern of slight increases in chloride downstream from SW01 to SW05, while in 2019 it fluctuates from month to month, with SW05 being higher in concentration in seven out of twelve monitoring events.

Given the small magnitude of the changes in concentration, it is uncertain if this could be attributable to landfill leachate discharging to the river or other sources or laboratory uncertainty. In all surface water samples taken from the Morell River the concentrations of chloride detected were below the Drinking Water and Surface Water Regulations limit of 250 mg/l for 2018.

Graph 7.5 Chloride in Morell River – Upstream (SW01) vs downstream (SW05) 2019



Palmerstown House Estate (Hartwell River)

Concentrations of chloride in samples obtained from the Hartwell River on the PGC Estate in 2019 were broadly similar to those in the Morell River with concentrations ranging from 15 mg/l at SW16 to 19.7 mg/l at SW08. The chloride levels recorded in 2019 are similar to previous years. All of the results from PGC Estate were well below the drinking water limit of 250 mg/l.

Table 7.10 Chloride in Surface Water Samples -2019

Water Body	Sampling Location	2019 Range Chloride (mg/l)	Orientation from site
Morell River	SW01	15.1 – 24.1	Upstream SE
	SW02	16.0 – 25.3	Upstream E
	SW03	14.8 – 27.4	Adjacent E
	SW03A	17.1 – 21.7	Adjacent E
	SW04	17.0 - 20.7	Adjacent E
	SW05	14.5 - 28.5	Downstream NE
Onsite Waterbody	Site Discharge	<3.7	Onsite
	SW Lagoon	<3.7 – 16.0	Onsite
Watercourse on PGC (Hartwell River)	SW08	16.0 - 19.7	Upstream SE
	SW16	15.0 - 16.4	Upstream SE

7.2.1. Biological Q-rating assessment

The last biological Q-rating assessment was undertaken in May 2018. Biological monitoring of the Morell River is not required until Kerdiffstown Landfill begin to discharge from the site. KCC may choose to begin resume monitoring in advance of this date.

In May 2018 the assessment involved macroinvertebrate sampling at nineteen locations, eleven on the Morell River and eight on the Hartwell. This included the ten locations monitored in 2016 plus the additional six locations added in the 2017 survey: six in the Morell River (M1-6); and one in its tributary, the Hartwell River (H1) and three additional site; two further upstream on the Morell (M7 & M8, 1 km upstream from M1) and one on the Hartwell (H2) above the existing monitoring site (H1). Two near the headwaters of the Hartwell (H3 & H4), two on the Morell (M9 & M10) and two on the Morell tributary (M11 & M12). Four additional sites were included in the 2018 survey, one at Arthurstown (H6), one between Arthurstown and Johnstown (H5) and two on the small tributary in Rathmore village. The macroinvertebrate data was used to derive a Q-value for each monitoring location based on the proportions of different macroinvertebrate groups.

The Q-value results are listed in Table 7.9 below. This assessment found that both the Morell and Hartwell rivers are impacted. The water quality of the Morell River is moderately polluted (Q3) upstream of the landfill at both M1, approximately 300m upstream of the site at the bridge beside Johnstown Garden Centre; and M2 just upstream of the landfill and the confluence of the Morell and Hartwell. It improves to good quality (Q4) downstream of the confluence with the Hartwell River and decreases to slightly polluted Q3-4 downstream of the site. The conclusions of the assessment state that it is likely that the good quality waters from the Hartwell help to improve the water quality of the Morell. It is also possible that recharge from groundwater is helping to improve it. This most recent assessment concluded that it was difficult to determine if the site was having an impact on the water quality in the Morell due to the moderate water quality status upstream of the site.

A previous assessment completed in December 2012 found that the water quality was good along the Morell River's length with sites achieving scores of Q4 and most achieving Q4-5. The biological water quality has therefore deteriorated since the 2012 assessment. This deterioration between the two assessments are indicative of this catchment as both the Morell and its tributary the Harwell have been fluctuating in water quality over the last 30 years. It is possible that this deterioration is due to flood improvement works upstream. (Full report available upon request.)

Table 7.11 2018 Q-values results for biological assessment locations

Monitoring Point	Location	Q-Value
M1	Upstream of landfill	Q3
M2	Upstream of landfill, just upstream of tributary	Q3
M3	East of landfill, just downstream of tributary	Q4
M4	East of landfill	Q4
M5	Northeast of landfill	Q4
M6	Downstream of landfill	Q3-4
M7	Upstream of landfill (1km)	Q3-4
M8	Upstream of landfill (1km)	Q3
M9	Upstream of landfill (Beggar's End crossroads)	Q3
M10	Upstream of landfill (near Newtown Great)	Q3-4
M11	Morell Tributary (near Eadestown)	Q3
M12	Morell Tributary (N.E. Baysland)	Q3-4
H1	Hartwell River (tributary of Morell)	Q4.5
H2	Hartwell River (tributary of Morell)	Q4
H3	Hartwell River (near Rathmore)	Q4
H4	Hartwell River (upstream of H3)	Q4
H5	Hartwell River (south east of Kill)	Q4-5
H6	Hartwell River (adjacent to Arthurstown)	Q4-5
H7	Hartwell Tributary	Q3

Monitoring Point	Location	Q-Value
H8	Hartwell Tributary	Q3-4

7.3. Leachate

Monitoring of leachate pumped from the lined cell was carried out by the site management on a weekly basis comprising a single sample taken at the leachate storage tanks and sent to the laboratory for analysis for the following parameters:

pH, electrical conductivity, COD, chloride and ammonia.

Analysis for an expanded suite of parameters on a quarterly, biannual and annual basis was completed during 2019. These included dissolved methane, heavy metals and priority substances.

A summary of the results for 2019 is provided in Table 7.12.

Table 7.12 Summary Composition of Leachate

	Max (mg/l)	Date Concentration observed	Min (mg/l)	Date Concentration observed	Average (mg/l)
Ammoniacal Nitrogen as N	466	26th February	112	16th April & 5th September	248
Chloride	453	26th February	140	1st October	238
COD	1170	16th January	190	16th April	437

Analysis of leachate from the lined cell area during 2019 was noted to be broadly similar to results obtained for 2018, where ammoniacal nitrogen results ranged from 113 mg/l to 490 mg/l, chloride results ranged from 121 mg/l to 462 mg/l, and COD ranged from 163 mg/l to 866 mg/l.

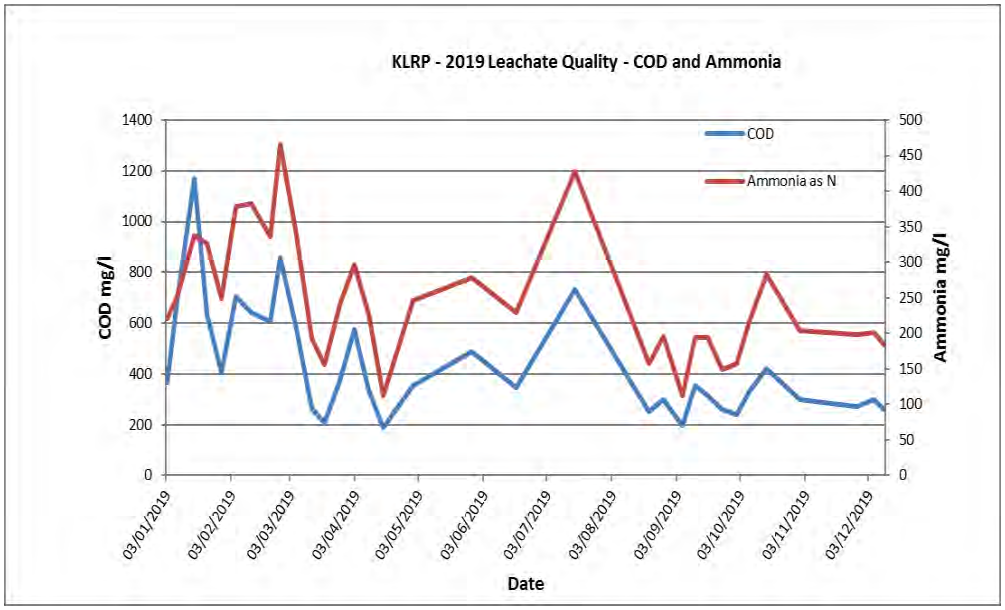
As shown in Table 7.12 concentrations of COD ranged from a maximum of 1170 mg/l in January to a low of 190 mg/l recorded in April. Ammoniacal nitrogen ranged from a maximum of 466 mg/l in February to a low of 112 mg/l recorded in April and September. Chloride ranged from a maximum of 453 mg/l in February to a low of 140 mg/l recorded in October.

Concentrations can vary dramatically during the year as can be seen in Graphs 7.7 and 7.8. This is largely due to the fact that leachate production and quality is very much rainfall dependant. High rainfall levels or prolonged rainfall events lead to increased volumes of leachate, but it also dilutes the leachate meaning that the leachates produced can often contain lower concentrations of pollutants. Graphs 7.7 and 7.8 show peaks and troughs throughout 2019. The peaks generally correspond with dryer periods (in February for example), while wetter periods show decreases in pollutant concentrations (in September for example).

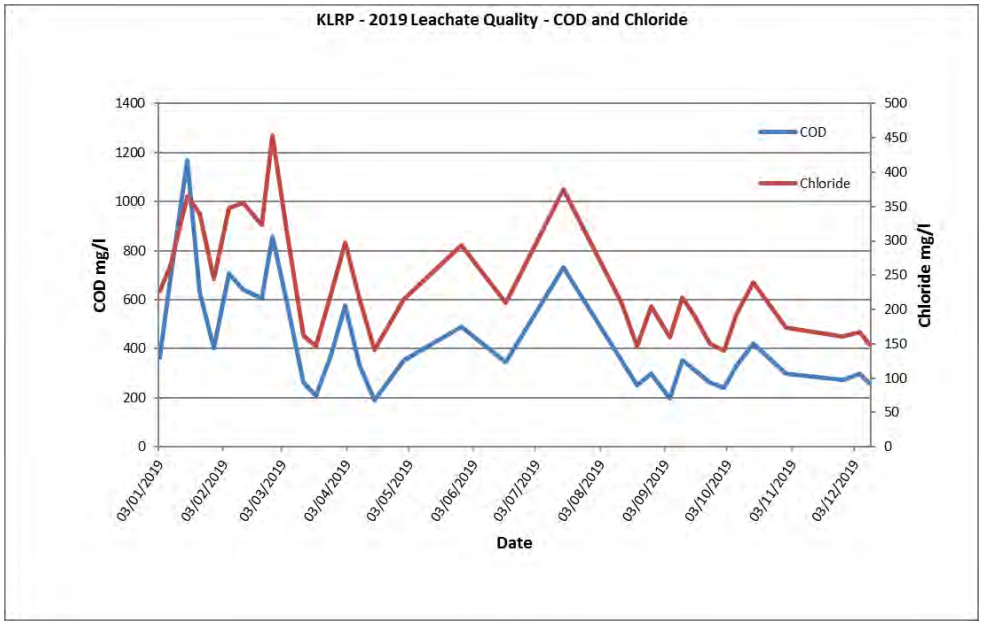
During 2011 the average concentration of ammoniacal nitrogen and COD in leachate was noted to be 505 mg/l and 1,140 mg/l respectively. Concentrations of these

parameters peaked during the summer months when the leachate was most concentrated due to a lack of rainfall to cause dilution. During the winter and spring months there was a reduction in these concentrations attributed to dilution from rainfall both directly onto the open cell area and also through the waste body itself. The averages and peaks have been reducing since 2011, with 2015's average being the lowest recorded at 224 mg/l for ammoniacal nitrogen and 2018's average the lowest recorded at 360 mg/l for COD.

Graph 7.7 Leachate Composition - COD and Ammoniacal Nitrogen



Graph 7.8 Leachate Composition - COD and Chloride



7.4. Landfill Gas

7.4.1. Perimeter/Offsite Landfill Gas Monitoring

In-waste landfill gas monitoring in Zone 1 and the Lined Cell is undertaken by KCC on a regular basis with results recorded in monitoring spreadsheets. Trend graphs are updated to assess gas concentrations over time and are discussed in Section 4.1.2 Landfill Gas Management and provided as part of **Appendix D**.

Off-site and perimeter landfill gas monitoring is undertaken by KCC on a monthly basis (refer to Figure 3b 'Perimeter Landfill Gas Monitoring Locations' for an overview of the all perimeter landfill gas wells).

A GA5000 infra-red gas analyser is used to record methane, carbon dioxide and oxygen concentrations as well as atmospheric pressure. The older wells monitored (i.e. EMW02-EMW08 and EMW10) are groundwater monitoring wells with gas taps fitted. 13 new perimeter gas monitoring wells were installed during 2019 and have been monitored on a monthly basis since July 2019. Additional perimeter wells will be installed as the remediation project progresses with some being added to the monitoring programme in early 2020.

Table 7.13 provides a summary of the results from perimeter and off-site landfill gas monitoring completed in 2019.

Low levels of methane (0.1-0.2% v/v) were detected in offsite monitoring wells during the first half of 2019. This may be due to drift in the zero readings on the analyser itself which was corrected during external calibration and service of the instrument.

In 2019 carbon dioxide was detected in offsite and perimeter monitoring wells. The concentration of carbon dioxide in a number of the perimeter wells was found to be consistently higher than the IEL limit level for carbon dioxide (1.5% CO2 v/v). Table 7.14 provides a summary of the results with highlighted cells indicating exceedance of 1.5 v/v % trigger limit for CO_2. These exceedances were reported as an incident on the EDEN portal.

Table 7.13 Offsite and Perimeter Landfill Gas Monitoring Results 2019 - Methane (CH_4)

	Methane (CH_4) % v/v											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EMW02	0.2	0.2	NR	0.2	0.1	0	0	NR	0	NR	NR	NR
EMW03	0.2	0.2	0.1	0.1	0.1	0.1	0	0	0	0	0	0
EMW04	0.2	0.2	0.2	0.2	0.1	0	0	NA	NA	0	0	0
EMW05	0.2	0.2	0.1	0.2	0.1	0	0	0	0	0	0	0
EMW06	0.2	0.2	0.2	0.2	0.1	0	0	0	0	0	0	0
EMW07	0.2	0.2	0.1	0.2	0.1	0	0	0	0	0	0	0

	Methane (CH_4) % v/v											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EMW08	0.2	0.2	0.1	0.2	0.1	0	0	0	0	0	0	0
EMW10	0.2	0.2	0.1	0.2	0.1	0	0	0	0	0	0	0
GM05							0	0	0	0	0	0
GM06							0	NR	0	0	NR	0
GM06A							0	0	0	0	0	0
GM07							0	0	0	0	0	0
GM08							0	0	0	0	0	0
GM09							0	0	0	0	0	0
GM10							0	0	0	0	0	0
GM12							0	0	0	0	0	0
GM28A							0	0	0	0	0	0
GM29							0	0	0	0	0	0
GM30							0	0	0	0	0	0
GM31							0	0	0	0	0	0
GM35							0	0	0	0	0	0

NR – no result as wells were flooded at the time monitoring.

NA – not accessible due to new boundary fencing being installed on the site.

Table 7.14 Offsite and Perimeter Landfill Gas Monitoring Results 2019 - Carbon Dioxide (CO_2).

	Carbon Dioxide (CO_2) % v/v											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EMW02	0.4	0.4	NR	0.4	2.1	2.2	2.8	NR	2.8	NR	NR	NR
EMW03	0.1	0.2	0.1	0.2	2.3	0	2.8	3.6	2	3	3.5	0.9
EMW04	1	2.2	2.2	0.2	1.6	2	2.1	NA	NA	4.9	4.9	0.9
EMW05	0.3	0.3	0.2	0.5	0.6	0.7	1.6	0.5	0.4	0.4	0.3	0.6
EMW06	1.5	1.5	1.7	1.9	1.9	2.3	2.7	2.9	3	3.3	2.9	2.2
EMW07	0.6	0.7	0.6	0.8	0.7	0.7	0.9	0.6	0.9	0.9	0.6	0.7
EMW08	0.3	0.3	0.3	0.3	0.5	0.7	0.7	0.1	0.1	0.2	2.4	0.4
EMW10	0.8	0.4	1	0.9	2.1	1.2	0.9	0.4	1.3	1.2	2.8	0.7
GM05							1.1	1.2	0.4	1.3	1.1	1.1
GM06							0.5	NR	0.5	0.6	NR	0.5
GM06A							1.5	1.7	1.6	1.8	1.5	1.5
GM07							1.8	2.7	2.4	2.6	2.6	1.3
GM08							3.2	3.3	3.8	1.4	0.4	0.9
GM09							6.6	8.9	8.6	9.1	2.4	5.6
GM10							6.8	8.2	4.7	11	10.4	8.4
GM12							3.6	3.7	4.8	5.5	5.4	4.9
GM28A							0.9	1.4	0.1	2	0.2	0.2
GM29							0.1	1.3	0.1	1.7	1.4	1.1
GM30							0.5	1.6	0.1	1.3	0.1	0.1
GM31							0.4	1.4	0.1	1.1	0.1	0.2
GM35							3.2	0.1	0.1	4.2	4.1	4.2

NR – no result as wells were flooded at the time monitoring.

NA – not accessible due to new boundary fencing being installed on the site.

7.4.2. Hydrogen Sulphide Analysis

From April 2019, samples were taken on a monthly basis from 4 no. landfill gas extraction wells (LG04, LG05, LG09 and LG10) in Zone 1 and sent to a laboratory for Hydrogen sulphide (H_2S) analysis. The levels recorded onsite using the landfill gas analyser for these wells were frequently above the concentration range (0-10,000ppm).

The results of the analysis are presented as part of **Appendix D**. A summary of the results for 2019 is provided in Table 7.15.

Table 7.12 Summary of Hydrogen Sulphide Concentration 2019

Monitoring location	Max (ppm)	Date Concentration observed	Min (ppm)	Date Concentration observed	Average (ppm)
LG04	10600	10th December	7850	30th July	9058
LG05	12300	15th October	2330	5th June	4512
LG09	11100	15th October	4880	28th August	6513
LG10	12100	15th October	7690	28th August	9886

Concentrations vary considerably during the year with the highest levels being recorded in late Autumn-Winter and the lowest levels being recorded during the Summer months. The peaks generally correspond with cooler periods when atmospheric pressure is lower.

7.4.3. Trace Gas Analysis

Gas samples were extracted from two landfill gas extraction wells onsite (LG10 and LB19) and sent for laboratory analysis in order to measure the trace gas components as per Environment Agency document “Guidance for Monitoring Trace Components in Landfill Gas (LFTGN 04). The results are presented in Table 7.13 overleaf.

Table 7.13 Trace Gas Analysis of gas Extraction Wells LG10 and LG19

Parameter	LG10	LG19
	Concentration (mg/m^3)	Concentration (mg/m^3)
Vinyl Chloride	<0.002	<0.002
1,3-Butadiene	<0.002	<0.002
Methanethiol	0.042	<0.008
Chloroethane	<0.002	0.014
1-Pentene	0.016	<0.003
Furan	0.013	0.005
Ethanethiol	0.582	<0.002
1,1-Dichloroethene	0.004	0.002
Dimethylsulphide	0.134	0.006
DCM	<0.002	0.007
CS2	3.934	2.518
trans-1,2-Dichloroethene	<0.001	<0.001
1,1-Dichloroethene	0.004	0.003
cis-1.2-Dichloroethene	0.050	0.007
Propanethiol	<0.006	<0.006
1,2-Dichloroethene	0.004	0.028
Carbon tetrachloride	<0.001	<0.001
Benzene	1.180	0.629
Trichloroethylene	0.027	<0.001
Butanethiol	<0.006	<0.006
Dimethyldisulphide	0.025	<0.002
Butyric Acid	<0.002	<0.002
Toluene	0.009	0.003
Ethylbutyrate	<0.002	<0.002
2-Butoxyethanol	<0.002	<0.001
Styrene	<0.001	<0.001
Arsenic (as As)	<0.02	<0.02
Acetaldehyde	<0.02	<0.02
Formaldehyde	0.030	0.030
Hydrogen sulphide	51.8	45.59

7.5. Air Monitoring

7.5.1. Stack Emissions

Odour Monitoring Ireland were commissioned by Kildare County Council to carry out stack emissions testing on the Landfill Gas Flare at Kerdiffstown Landfill. Two rounds of flare stack monitoring were carried out in 2019. Round one was completed on the 21st June and the second round was completed on the 5th December 2019. The results are shown in Table 7.15 below. For Oxides of Nitrogen and Carbon Dioxide, all concentrations were well within the Emission Limit Values as set out in Schedule B.1.1 of the licence.

Table 7.15 Air Stack Monitoring Results 2019

Parameter	Units	Round 1	Round 2	Limit
Hydrogen Chloride	mg/m^3	-	<0.50	
Hydrogen Fluoride	mg/m^3	-	0.31	
Sulphur Dioxide	mg/m^3	442.88	609.99	
Total VOCs	mg/m^3	-	3.75	
Oxides of Nitrogen (as NO_2)	mg/m^3	5.24	55.25	150
Carbon Monoxide	mg/m^3	<1.7	2.95	50
Carbon Dioxide	% v/v	10.11	8.66	
Oxygen	% v/v	7.76	10	
Water Vapour	% v/v	9	-	

7.5.2. Dust Monitoring

Dust is airborne particulate matter in the size range of 1–75μm. In general dust can present a nuisance if it is present at high concentrations.

The first deposition survey was undertaken during July and August 2019 from 31/07/19 to 29/08/19), followed by another during August and September 2019 from 29/09/19 to 27/09/19. They were completed using Bergerhoff gauges in accordance with the *German Standard VDI 2119*, *(Measurement of Dustfall, determination of dustfall using the Bergerhoff Instrument).* A total of seven locations situated within the site boundary and two locations off site were selected for monitoring purposes as presented in Figure 3C. An additional monitoring point was located in the southeast of the site to ensure all areas of the site were covered.

The gauges were left exposed to the ambient air for a period of one month during which time the dust deposition in the area passively collected in glass vessels. The collected samples were sent to a laboratory for gravimetrical analysis. The sample results are expressed as mg of dust deposited per day (mg/m^2/day).

Table 7.16 presents the results for the monitoring. There were no exceedances of the licence limit of 350 mg/m^2/day during either of the monitoring periods in 2019. The highest dust level was detected at KLRP 1 during September. KLRP7 also recorded an elevated dust level during this monitoring period. KLRP 1 recorded elevated dust levels during the August monitoring period as well. It should be noted that all levels were within the licence limits.

During the August monitoring period there was one exceedance recorded at KLRP 1. KLRP 1 is located at the northern boundary of the site near Naas Golf Club and adjacent to the L2005 County Road from Sallins to Johnstown. A quarry is located along this road and may be the source of the elevated dust levels. There were no site operations ongoing in this area during the monitoring periods that would have caused any dust generation.

KLRP 7 is located onsite to the south east. Drilling work was ongoing nearby to install boreholes for perimeter gas monitoring during the September monitoring period. This may account for the higher dust levels when compared to the August monitoring period.

Table 7.16 Dust Monitoring Results 2019

	(mg/m^2/day)		
Location	Licence Limit	Jul-Aug 2019 Result	Aug-Sep 2019 Result
KLRP1	350	130	140
KLRP2		61	<10
KLRP3		11	<10
KLRP4		42	76
KLRP5		<10	11
KLRP6		39	19
KLRP7		18	120
KLRP8		33	47
KLRP9		39	26

7.6. Odour

Monthly odour monitoring has been undertaken by KCC personnel since April 2016. Prior to this, monthly odour monitoring was carried out by Jacobs' staff from August 2014 to March 2016. 10 locations are assessed comprising eight off site and two on-

site areas (see Figure 3d). Odour monitoring is completed in line with the EPA AG5 ‘Odour Impact Assessment Guidance for EPA Licensed Sites’ and carried out by suitably qualified personnel.

Particular emphasis is placed in areas where previous odour complaints have been received or where there is a history of strong odours from time to time. In line with the EPA Guidance Note (AG5), an odour intensity of 0 to 4 (most intense) is logged, and an odour persistence of between 0 and 2 (most persistent). Weather conditions and atmospheric pressure are recorded during each of the surveys to aid with the overall assessments and conclusions.

No odour complaints were received during 2019.

The main sources of odour from Kerdiffstown Landfill are due to diffuse gases arising from the decomposition of waste in the landfill, particularly in the NW area. Since odour monitoring began in August 2014 a number of on-site odour sources have been identified. Intermittent faint odours were noted in the area around the 250 flare compound in three monitoring events during 2019. In the area around the high security hut intermittent faint landfill gas type odours were detected during two monitoring events. Landfill gas odour was not detected off site during the monthly odour monitoring events in 2019. Tables 7.17a and 7.17b summarise the results of the odour assessments conducted in 2019. For further details please refer to the Monthly Odour Reports (Ref 12).

Table 7.17a Summary of odour monitoring (January-June 2019)

	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence
Location \ Month	January		February		March		April		May		June	
Offsite												
OMP1	0	0	0	0	0	0	0	0	0	0	0	0
OMP2	0	0	0	0	0	0	0	0	0	0	0	0
OMP3	0	0	0	0	0	0	0	0	0	0	0	0
OMP4	0	0	0	0	0	0	0	0	0	0	0	0
OMP5	0	0	0	0	0	0	0	0	0	0	0	0
OMP6	0	0	0	0	0	0	0	0	0	0	0	0
OMP7	0	0	0	0	0	0	0	0	0	0	0	0
OMP8	0	0	0	0	0	0	0	0	0	0	0	0
Onsite												
250 Flare Compound	1	1	0	0	0	0	0	0	0	0	1	1
Security Hut in North west (Zone 1)	0	0	0	0	0	0	0	0	1	1	0	0

Table 7.17b Summary of odour monitoring (July-December 2019)

	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence	Intensity	Persistence
Location \ Month	July		August		September		October		November		December	
Offsite												
OMP1	0	0	0	0	0	0	0	0	0	0	0	0
OMP2	0	0	0	0	0	0	0	0	0	0	0	0
OMP3	0	0	0	0	0	0	0	0	0	0	0	0
OMP4	0	0	0	0	0	0	0	0	0	0	0	0
OMP5	0	0	0	0	0	0	0	0	0	0	0	0
OMP6	0	0	0	0	0	0	0	0	0	0	0	0
OMP7	0	0	0	0	0	0	0	0	0	0	0	0
OMP8	0	0	0	0	0	0	0	0	0	0	0	0
Onsite												
250 Flare Compound	0	0	0	0	0	0	0	0	0	0	1	1
Security Hut in North west (Zone 1)	0	0	0	0	0	0	0	0	1	1	0	0

7.7. Geotechnical

An reassessment of all slopes on site in conjunction with the taking of inclinometer readings at two locations was undertaken by RPS and NVM Ltd during 2018. The slope stability assessment involved a detailed walkover of the site to assess all slopes. A review of all existing geohazard maps was also undertaken. The objectives of the walkover survey were to:

- Visually assess the condition of the slopes on site by determining the presence of any indicators of slope instability and other relevant geotechnical parameters;
- Categorise the site in terms of risk of instability accounting for the impact on any sensitive receptors; and
- Produce of a revised slope stability risk zonation plan of the site if applicable. Inclinometer readings were compared with readings taken during 2012 to 2018 and included in the overall slope stability assessment.

An inclinometer borehole is a borehole fitted with specially designed pipe that allows for measurement of ground movements. Movements are assessed by dropping a probe into the pipe and measuring any changes in the verticality of the pipe when compared to previous readings.

KLRP has two inclinometers in place on slopes that have been assessed as being at high risk. Inclinometer monitoring was undertaken in accordance with ASTM D6230 - 13 “Standard Test Method for Monitoring Ground Movement Using Probe-Type Inclinometers”. Both inclinometer boreholes were monitored monthly between July and November 2018. In July 2018, the readings from the inclinometer in BH41D showed slight movement of less than <1.11 mm on the A axis and less than <1.18 mm on the B axis whereas BH38 showed movement of less than 5.62 mm on the A axis and less than 15.35 mm on the B axis. As a result of this movement detected in BH38 a program of monthly monitoring was instigated followed by a detailed review of the slope stability across the entire site.

The detailed inspection of all slopes site was carried out in December 2018. The inspection did not reveal any significant change to slope stability across the site. However, the increasing degree of vegetation of the slopes does make a visual assessment difficult in parts of the site. Vegetation of the slopes will reduce the risk of slumping and small scale near-surface failures by ‘reinforcing’ the wastes but will make little difference to the macro stability of the higher slopes.

The slopes of most concern continue to be southern side of the lined cell in Area A and the exterior slopes of Areas I, L and N. The table below should be reviewed in conjunction with Figures 5a and 5b Geohazard Zonation Plans.

Table 7.18 Slope Stability Summary Table

Area	Likelihood	Consequence	Overall Risk	Monitoring frequency	Other
A	Medium	Low/Medium	Medium	Monthly	Annual inclinometer measurements
B	Medium	Low	Low/Medium	Quarterly	
C	Medium	Low	Low/Medium	Quarterly	
D1	Medium/High	Low	Low/Medium	Quarterly	
D2	Medium	Medium	Medium	Monthly	
E	Medium	Low	Low/Medium	Quarterly	
F	Medium	Low/Medium	Medium	Monthly	
G	Medium/High	Medium	Medium	Monthly	
H	Low/Medium	Medium/High	Medium	Monthly	
I	High	Medium	Medium/High	Weekly	
J	High	Low/Medium	Medium	Monthly	
K	Medium/High	Low	Low/Medium	Quarterly	
L	Medium/High	Medium/High	Medium/High	Weekly	Quarterly inclinometer measurements
M	Medium	Medium	Medium	Monthly	
NE (exterior)	Low	Medium	Low/Medium	Quarterly	
NE (interior)	Medium/High	Low	Low/Medium	Quarterly	
NI	Low	Medium	Low/Medium	Quarterly	
O	Low/Medium	Low/Medium	Low/Medium	Quarterly	
P	Medium	Medium	Medium	Monthly	
Q	Low	Low	Low	Annually	
R	Medium	Low/Medium	Medium	Monthly	
S	Low	Low	Low	Annually	
T	Low	Medium	Low/Medium	Quarterly	

7.8. VOC Survey

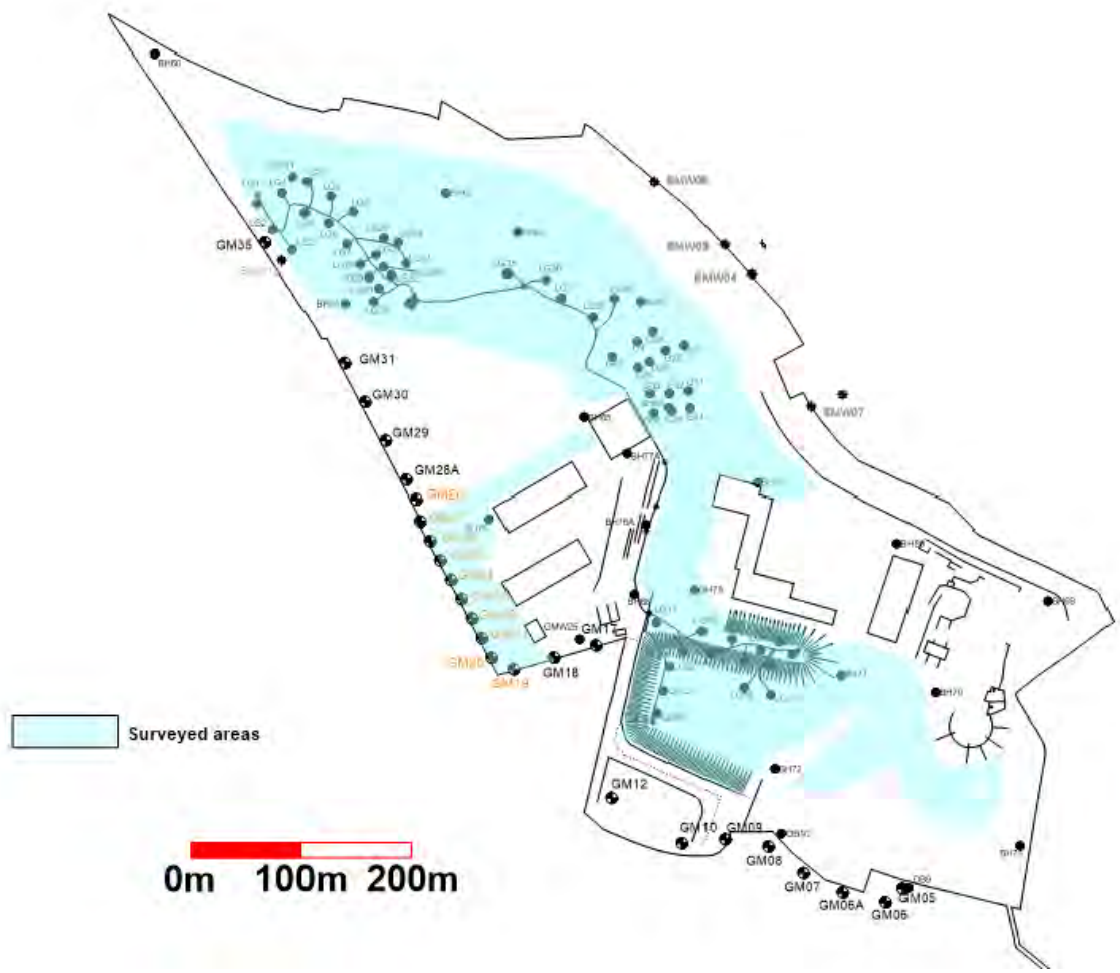
Odour Monitoring Ireland were engaged to complete a biannual independent assessment and report on surface VOC emissions. Two surveys were undertaken during 2019. The first survey was carried out on 21st June and the second on the 5th December to ascertain any areas of potential surface VOC emissions from the facility.

VOCs were measured around the areas of Zone 1 & Zone 3 using an “Odour Hog” comprising a flame ionisation detector (FID) to measure the methane fraction of emissions; and a photo ionisation detector (PID) to measure the odourous volatile compounds. The unit was calibrated before and after the surveys using reference isobutylene and methane.

The “odour hog” has a sample response time <3.5 seconds for the FID and an integrated GPS (Magellan Professional). The capping of the facility was surveyed for potential surface emissions areas and these areas were geo-referenced

The sample response time of the MiniRAE 3000 is < 3 seconds. It was operated in the 0 - 999.9ppm range with a resolution of 0.1ppm. The team on site walked the area in a grid formation logging any detections of gas, and recording the GPS location of the detection using the Viewranger GPS accurate to 1 meter. VOC surface emission monitoring was undertaken in accordance with EPA document AG6 'Surface VOC Emissions Monitoring on Landfill Facilities' requirements.

Plate 7.4 2019 Map of Areas Surveyed for Surface VOC Emissions



The survey assessed VOC emission points across the main uncapped waste bodies on a grid basis and subsequently marked these emission points on a map for comparison with previous surveys completed during 2011- 2017.

Measurement of surface emissions was in accordance with of AG6 'Surface VOC Emissions Monitoring on Landfill Facilities'. The emission limits as per the licence are <50 ppm as methane average over capped areas or <100 ppm methane instantaneous reading on open surfaces within the landfill footprint; and <500 ppm as methane around identified features.

Results

The first survey identified nine individual surface emissions zones. During the second survey seven individual surface emissions zones were identified. These are detailed in the following tables.

Plate 7.5 2019 Map of Surface VOC Emissions Detected in Round 1 Survey

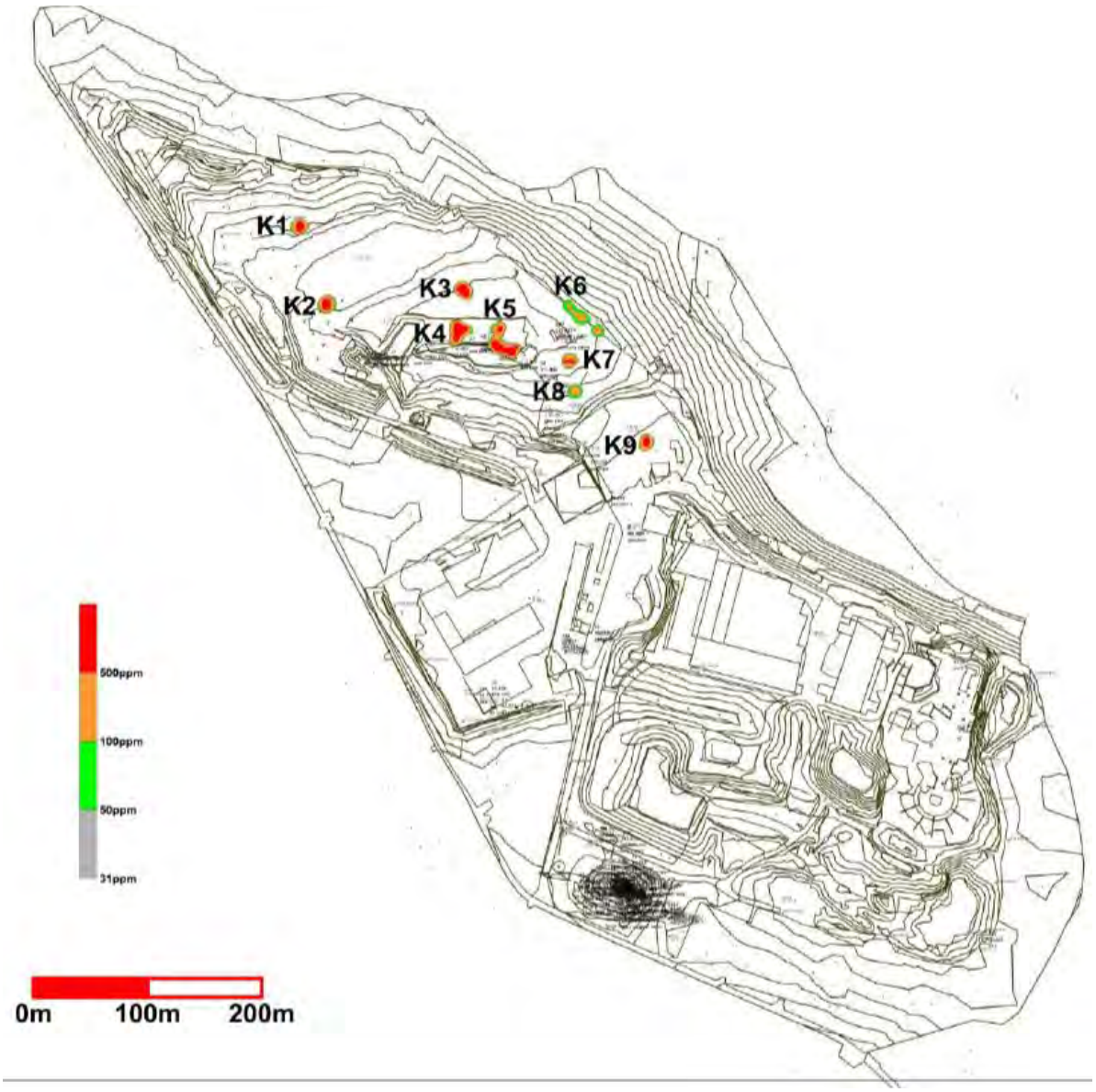


Table 7.19: Round 1 Survey Data Table

Location	Map ID	VOC maximum (ppm)	Reference	Recommended Trigger Levels (ppm)
Zone 1	K1	850	Vertical well	<500 ppm
Zone 1	K2	1,100	LG25	<500 ppm
Zone 1	K3	950	Surface area	<100 ppm

Location	Map ID	VOC maximum (ppm)	Reference	Recommended Trigger Levels (ppm)
Zone 1	K4	2,650	LG35	<500 ppm
Zone 1	K5	2,641	Vertical well	<500 ppm
Zone 1	K6	150	Surface area	<100 ppm
Zone 1	K7	1,200	Vertical well	<500 ppm
Zone 1	K8	650	Vertical well	<500 ppm
Zone 1	K9	1,100	Vertical well	<500 ppm

Plate 7.6 2019 Map of Surface VOC Emissions Detected in Round 2 Survey

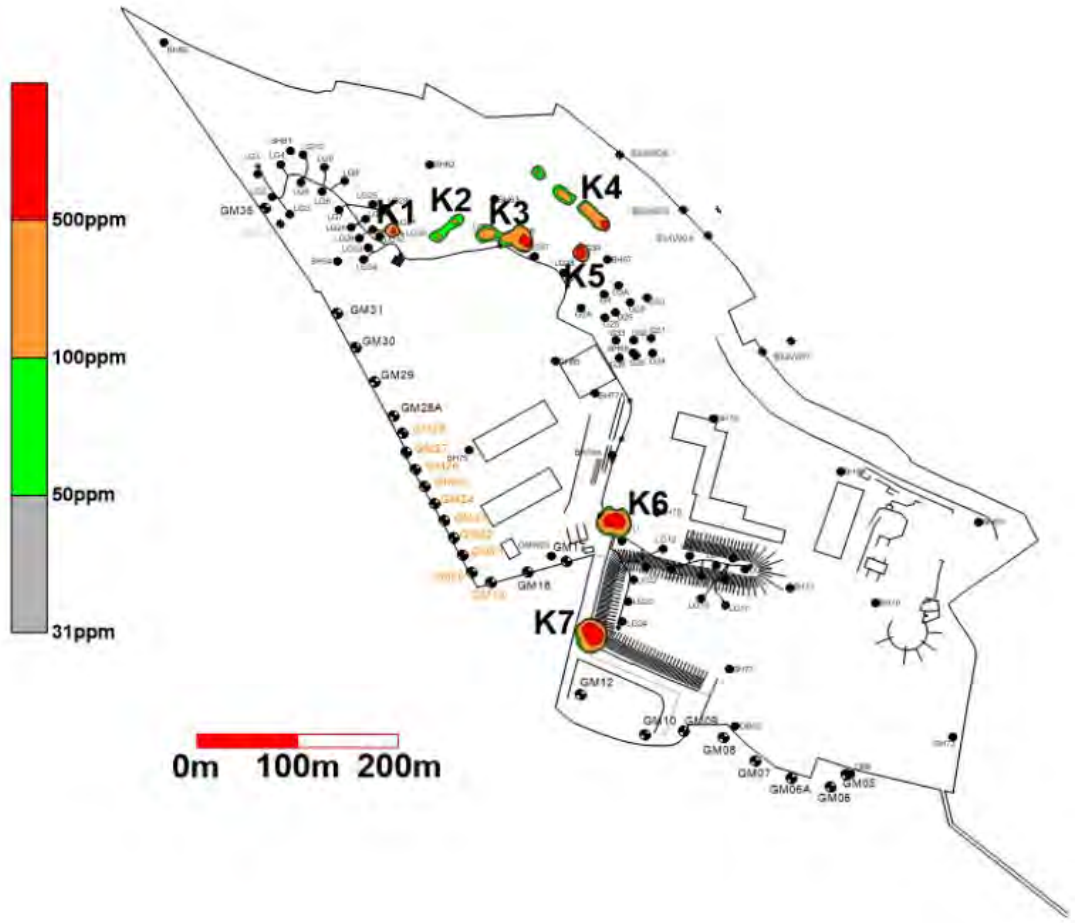


Table 7.20: Round 2 Survey Data Table

Location	Map ID	VOC maximum (ppm)	Reference	Recommended Trigger Levels (ppm)
Zone 1	K1	890	LG31	<500 ppm
Zone 1	K2	350	Surface area	<100 ppm
Zone 1	K3	2,941	Surface area and LG36	<100 ppm
Zone 1	K4	1,280	Surface area	<100 ppm
Zone 1	K5	950	LG39	<500 ppm
Zone 3	K6	1,102	Leachate Riser	<500 ppm
Zone 3	K7	2,204	Leachate Riser	<500 ppm

7.9. Meteorological Data

A weather station is present on site; however, for much of 2019 the wind speed and direction were not accurate and have not been used to inform the information contained in **Appendix E** Meteorological Information is obtained from the on-site weather station. Monthly information on rainfall, temperature, wind speed and direction are obtained from Met Éireann weather station at Casement Aerodrome for inclusion in reports including the monthly environmental report and the groundwater and surface water report. Meteorological information from Casement Aerodrome is also collated and presented on a monthly basis as part of the reports with graphs showing trends over time.

Overall rainfall for 2019 was a significant increase from 2018 with total rainfall for the year at 865.3mm compared to 657.7 mm for 2018. This equated to approximately 114% of the historical average annual rainfall. November was the wettest month of the year with rainfall of 143.5 mm, 195% of the average**. Appendix E** presents the summary data for the weather at Casement Aerodrome for 2019.

7.10. Noise Monitoring

Daytime noise monitoring was carried out in July (11th & 26th) and November (8th, 11th & 14th). Evening-time noise monitoring was carried out in November (18th) and December (2nd). Night-time noise monitoring was completed in November (18th/19th). All monitoring was completed in accordance with the EPA Guidance Note for Noise in Relation to Scheduled Activities (NG4) using a Brüel and Kjær 2250 Type 1 Sound Level Meter (SLM) with an outdoor microphone unit Type 4198. A total of eight locations (N1 to N9) situated at the site boundary or close to sensitive receptors were selected for monitoring purposes. The results were compared to the noise limits set out in NG4. Emission limits specified in the licence are 55 dB $L_{Aeq,30mins}$ for daytime, 50 dB $L_{Aeq,30mins}$ for evening and 45 dB $L_{Aeq,15mins}$ for night-time. A summary of results is set out in Table 7.2

Table 7.20 Noise Monitoring Results

	Daytime ($L_{Aeq,30min}$)			Evening ($L_{Aeq,30min}$)	Night-time ($L_{Aeq,15min}$)	
	Round 1	**Round 2**	**Round 3**	**Round 1**	**Round 1**	**Round 2**
N1	51.5	50.4	50.3	48.3	41.2	40.4
N2	45.7	**58.1**	52.5	**50.3**	**49.2**	**50.4**
N3	47.1	52.3	53.3	**53.9**	**46.5**	**45.5**
N4	41.9	50.3	49.2	49.1	**47.2**	**46.5**
N5	48.1	**56.4**	52.2	49.2	44.8	43.7
N6	43.4	46.8	**56.2**	**50.5**	44	44.6
N7	**55.1**	**60**	**61.2**	**56.2**	**52.1**	**53.3**
N9	49.5	51.2	53.4	**52.1**	42.9	**45.1**

There were six exceedances of the daytime noise limit of 55 dBA, five exceedances of the evening limit of 50dBA and nine exceedances of the night-time noise limit of 45 dBA.

The daytime exceedances at N2 and N5 were due to a helicopter in the area for a prolonged period during the survey. The exceedance at N6 was due to fencing works that were ongoing offsite. The exceedances at N7 were due to traffic noise from the N7 motorway.

Exceedances of the evening limit were recorded at five locations, namely N2, N3, N6, N7 and N9. The dominant noise observed at each of the locations was traffic on the N7 and the L2005. It should be noted that the landfill site closes at 18:00 and there were no activities ongoing that would have contributed to noise levels in the area.

There were nine exceedances of the night-time emission limit of 45 dBA recorded at five locations. N2, N3, N4 and N7 recorded exceedances for both rounds of monitoring. N9 recorded one exceedance during the Round 2 monitoring. The dominant noise observed at each of the locations was traffic on the N7 and the L2005. It should be noted that the landfill site closes at 18:00 and there were no activities ongoing that would have contributed to noise levels in the area.

8. Summary

8.1. Management

The site is under the control of Kildare County Council with responsibility for implementing the remediation and ongoing management of the site. The statutory approvals required to undertake the remediation have been put to facilitate the remediation.

8.2. Incidents and Complaints

Two incidents were recorded in 2019, with one remaining as an ongoing minor incident.

8.3. Emissions management

Controlled emissions from the facility are limited to landfill gas and leachate. Landfill gas emissions are managed the enclosed landfill gas flares. Leachate is collected from the lined cell and transported off site for treatment.

8.4. Waste Management and Resource Consumption

Minimal amounts of waste were generated as a result of KLRP activities in 2019. During 2019 a small amount of waste was generated from the site office.

8.5. Restoration works

During 2019, no significant restoration works were undertaken.

8.6. Environmental Monitoring

8.6.1. Groundwater Results

Groundwater chemical analysis results are generally consistent with previous monitoring events completed on behalf of the EPA since 2011 and indicate elevated concentrations of key landfill leachate indicators (ammoniacal nitrogen, depleted oxygen levels, increased electrical conductivity, chloride, iron and manganese concentrations) in on-site monitoring wells completed in the overburden deposits, also with evidence in seasonal variations in concentrations for certain parameters. Monitoring indicates limited evidence of off-site leachate impact, including elevated concentrations of certain parameters in monitoring wells located along the northern and north-eastern boundary of the site near to the unlined and uncapped area of the landfill. Furthermore, monitoring wells completed in the underlying bedrock show slight impact from landfill leachate.

8.6.2. Surface Water Results

The analytical results from the surface water samples collected during the January to December 2019 monitoring period indicate that water quality in both the Morell River and the Hartwell River is good. Water quality in the downstream samples was very similar to water quality in the respective upstream samples.

While the site remains in its current form and in particular the wastes in the northern part of the site remain uncapped (and unlined) there remains the potential for

increased generation of leachate through rainfall infiltration into the waste mass and therefore increased potential for leachate migration towards the Morell River.

8.6.3. Biological Q-rating

A biological q-rating assessment took place in May 2018. It findings were consistent with the previous assessment in 2017. There was no indication that the landfill is having any discernible impact on the Morell River as it passes the site.

8.6.4. Leachate

Leachate analysis from the lined cell area completed during 2019 is broadly similar to those results obtained from previous sampling events in recent years. However, over the longer term, the concentration of ammoniacal nitrogen and COD has fallen from the initially recorded concentrations.

8.6.5. Landfill Gas

Landfill gas results from both the lined cell area and the north-western area obtained during 2019 were noted to be generally stable. There has been a gradual decline in methane and carbon dioxide concentrations over time with both well fields showing a gradual reduction in gas concentrations as landfill gas is extracted and burnt off at the 250 flare since July 2011. However, in 2017 there was an improvement in the quality of gas in the lined cell due to the emplacement of waste from the demolished buildings and improvements to the rain cover and these concentrations remained relatively stable in 2019.

8.6.6. Dust

Dust monitoring was completed in July/August 2019 and again in August 2019. Three exceedances were recorded of the licence limit of 350 mg/m^2/day.

8.6.7. Odour Monitoring

Odour monitoring has been conducted on a monthly basis since 2014. No odours were detected at off-site monitoring locations 2019. At the two on-site monitoring locations intermittent faint odours were observed around the 250 flare and at the high hut. Odours are commonly detected in both these areas depending on prevailing winds.

At the present time it is considered that odour occurrences are being minimised at the site through best practice and regular monitoring. This is in line with guidance provided in the EPA Landfill Manuals, Landfill Monitoring.

8.6.8. Geotechnical

Slope stability and geo-hazard mapping was undertaken in December 2018 with no significant change to slope stability across the site noted.

8.6.9. VOC Surface Emissions

Two VOC surface emissions surveys were undertaken in June and December 2019 to ascertain sources of facility gas surface emissions and make recommendations regarding potential improvements to the existing landfill gas infrastructure.

8.6.10. Meteorological Data

Meteorological information was collated on an daily basis during 2019.

8.6.11. Noise Monitoring

Noise monitoring was completed as follows:

- Daytime monitoring was carried out on 11 and 26 July and 08, 11 and 14 November.
- Evening-time noise monitoring was carried out on the 18 November and 02 December.
- Night-time noise monitoring was completed on 18 and 19 November.

Exceedances of the licence limits were not as a result of activities undertaken on Kerdiffstown Landfill.

Appendices

Appendix A AER REQUIREMENTS (FROM P1063-01)

The below table outlines the information as per Schedule D of the Proposed Decision (P1063-01) where it can be found.

P1063-01 Schedule D AER Requirements	Section of report / Comment
Emissions from the installation.	Chapter 4
Waste Management Record.	Section 5.2
Resource consumption summary.	Section 5.3 & Section 5.4
Complaints summary.	Section 2.7.2
Schedule of Environmental Objectives and Targets.	Section 2.2
Environmental management programme – report for previous year.	Section 2.2
Environmental management programme – proposal for current year.	Section 2.2
Pollutant Release and Transfer Register – report for previous year.	Section 4.7
Pollutant Release and Transfer Register – proposal for current year.	Section 4.7
Noise monitoring report summary.	Section 7.11
Ambient monitoring summary.	Chapter 7
Tank and pipeline assessment report.	Not included in report (available upon request)
Reported incidents summary.	Section 3.1 / Appendix C
Energy efficiency audit report summary.	Not included in report (available upon request)
Report on the assessment of the efficiency of use of raw materials in processes and the reduction in waste generated.	Not currently applicable
Report on progress made and proposals being developed to minimise water demand and the volume of trade effluent discharges.	Not currently applicable
A report on compliance with recommendations of the Detailed Quantitative Risk Assessment (DQRA) submitted to the Agency.	Section 7.1.1

P1063-01 Schedule D AER Requirements	Section of report / Comment
Development/Infrastructural works summary (completed in previous year or prepared for current year).	Chapter 6
Reports on financial provision made under this licence, management and staffing structure of the installation, and a programme for public information.	Section 2.3
Review of Closure, Restoration & Aftercare Management Plan.	Section 2.4
Statement of measures in relation to prevention of environmental damage and remedial actions (Environmental Liabilities).	Section 2.5
Environmental Liabilities Risk Assessment Review (every three years or more frequently as dictated by relevant on-site change including financial provisions.	Under development
Any other items specified by the Agency.	N/A

Appendix B **Landfill Gas Survey 2019**

Environmental Protection Agency

A survey of landfill sites to determine the quantity of methane flared and or recovered in utilisation plants for 2019

Please choose from the drop down menu the licence number for your site	Select
Please choose from the drop down menu the name of the landfill site	Select
Please enter the number of flares operational at your site in 2019	1
Please enter the number of engines operational at your site in 2019	0
Total methane flared	100,860 kg/year
Total methane utilised in engines	0 kg/year

Please note that the closing date for receipt of completed surveys is 31/03/2020

Introduction

The Office of Environmental Sustainability (OES) of the Environmental Protection Agency acts as the inventory agency in Ireland with responsibility for compiling and reporting national greenhouse gas inventories to the European Commission and the United Nations Framework Convention on Climate Change. In addition to meeting international commitments Ireland's national greenhouse gas inventory informs national agencies and Government departments as they face the challenge to curb emissions and meet Ireland's emission reduction targets under the Effort Sharing Decision (No. 406/2009/EC). The national inventory also informs data suppliers, making them aware of the importance of their contributions to the inventory process and a means of identifying areas where input data may be improved.

It is on this basis that the Environmental Protection Agency is asking landfill operators to partake in this survey so that the most uptodate information on methane flaring and recovery in utilisation plants at landfills sites is used in calculating the contribution of the landfill sector to national greenhouse gas emissions

The Environmental Protection Agency wishes to thank you for partaking in this survey. If you have any questions about the survey and how to complete it please view the "Help sheet" worksheet. If however, your query is not answered by viewing the "Help sheet" worksheet please contact:
LFGProject@epa.ie

Once completed please send the completed file as an attachment clearly stating the name and or licence number of the landfill site (e.g. W000 Xanadu landfill_2019) to:
LFGProject@epa.ie

	to be filled in by licensee		calculated by spreadsheet	

Flare No. 1

Flare type ?	Other	UNIFLARE UF10-250	
Is the flare an open or enclosed flare ?	Enclosed	Rated flare capacity ?	250 m3/hr
Month /year comissioned ?	July	2011	
Month decomissioned if decomissioned in 2019 ?	Select		
What is the function of the flare ?	Odour control	If "other" enter flare function here	

Monthly	Method M/C/E	Runtime days/month	Runtime hrs/day	Downtime hrs	Total runtime hrs/month	Average Inlet Pressure (mbg)	Average Inlet Temp ◦C	Average Flow Rate (m^3/hr)	Average CH_4 %v/v	Average CO_2 %v/v	Average O_2 %v/v	Combustion efficiency (%)	Total CH_4 m^3	Total CH_4 kgs
January	MCE	31	24.0	0.0	744	10	10	75	23.10	21.50	1.00	99.9	12,877	8,979
February	MCE	28	24.0	238.0	434	11	10	75	21.90	21.60	1.00	99.9	7,121	4,970
March	MCE	31	24.0	142.5	602	15	10	75	24.20	22.00	1.00	99.9	10,906	7,642
April	MCE	30	24.0	88.5	632	11	10	75	25.20	21.50	1.00	99.9	11,923	8,322
May	MCE	31	24.0	37.5	707	11	10	75	24.10	21.50	1.00	99.9	12,757	8,904
June	MCE	30	24.0	0.0	720	11	10	75	22.00	21.10	1.00	99.9	11,868	8,283
July	MCE	31	24.0	0.0	744	12	10	75	22.10	20.70	1.00	99.9	12,319	8,607
August	MCE	31	24.0	0.0	744	11	10	75	23.00	21.50	1.00	99.9	12,821	8,948
September	MCE	30	24.0	0.0	720	11	10	75	22.80	21.80	1.00	99.9	12,300	8,585
October	MCE	31	24.0	0.0	744	11	10	75	24.00	21.60	1.00	99.9	13,379	9,338
November	MCE	30	24.0	0.0	720	11	10	75	23.90	21.90	1.00	99.9	12,893	8,999
December	MCE	31	24.0	73.5	671	11	10	84	23.70	21.80	1.00	99.9	13,303	9,285
Total					8,180								144,469	100,860

Please note: Only fill the "Yearly" table if data is not availabe or cannot be calculated nor estimated on a monthly basis

Yearly	Method M/C/E	Runtime days/year	Runtime hrs/day	Downtime hrs	Total runtime hrs/year	Average Inlet Pressure (mbg)	Average Inlet Temp ◦C	Average Flow Rate m^3/hr	Average CH_4 %v/v	Average CO_2 %v/v	Average O_2 %v/v	Combustion efficiency (%)	Total CH_4 m^3	Total CH_4 kgs
2019					0		10					98.0	0	0

Appendix C **Incidents and Complaints Summary**

Incidents					
#	Date & Time	Type	Summary	Corrective Action	Recommendation & Follow up actions
1	13/03/2019	Minor	Trigger Level Reached	Ongoing Monitoring	None. Monitoring continues
2	02/09/2019	Minor	Uncontrolled Release	Release contained and spillage cleaned.	No further action

Complaints					
#	Date & Time	Type	Summary	Corrective Action	Recommendation & Follow up actions
No complaints received in 2019.					

Appendix D **GAS AND WATER TIME SERIES GRAPHS**

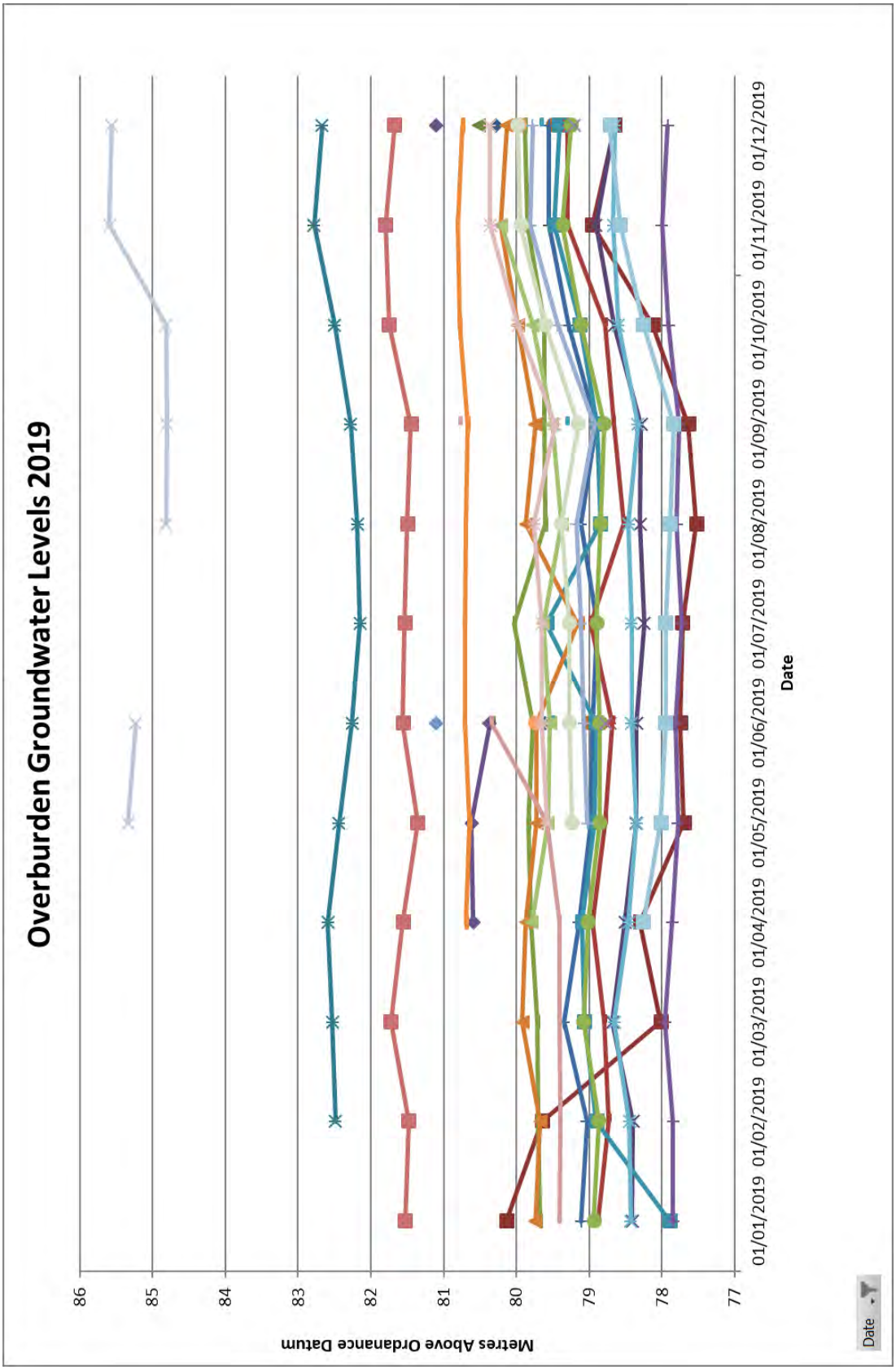
G1 Groundwater Dip Levels

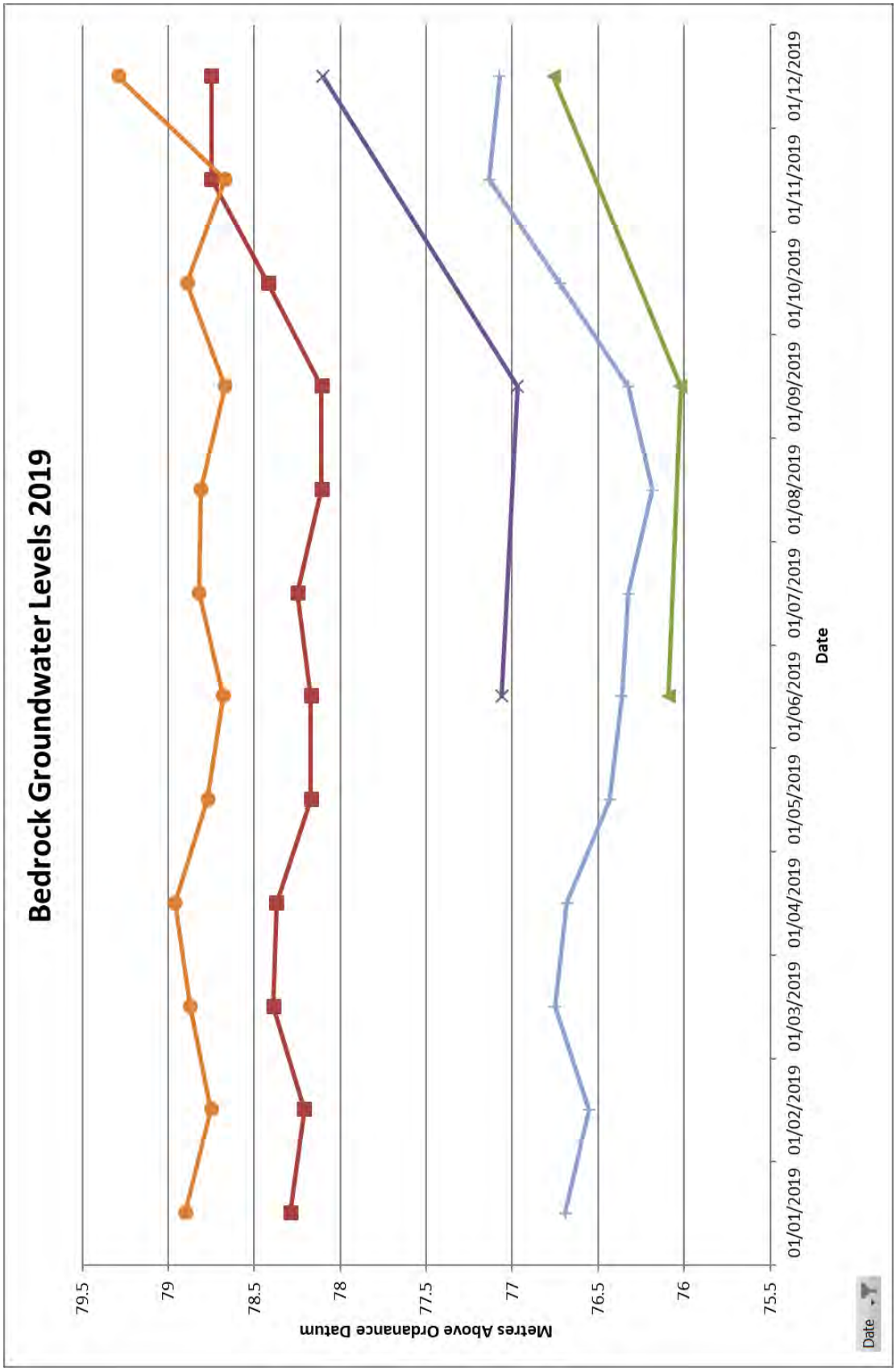
G2 Leachate Level

G3 Landfill Gas – methane in waste monitoring graphs

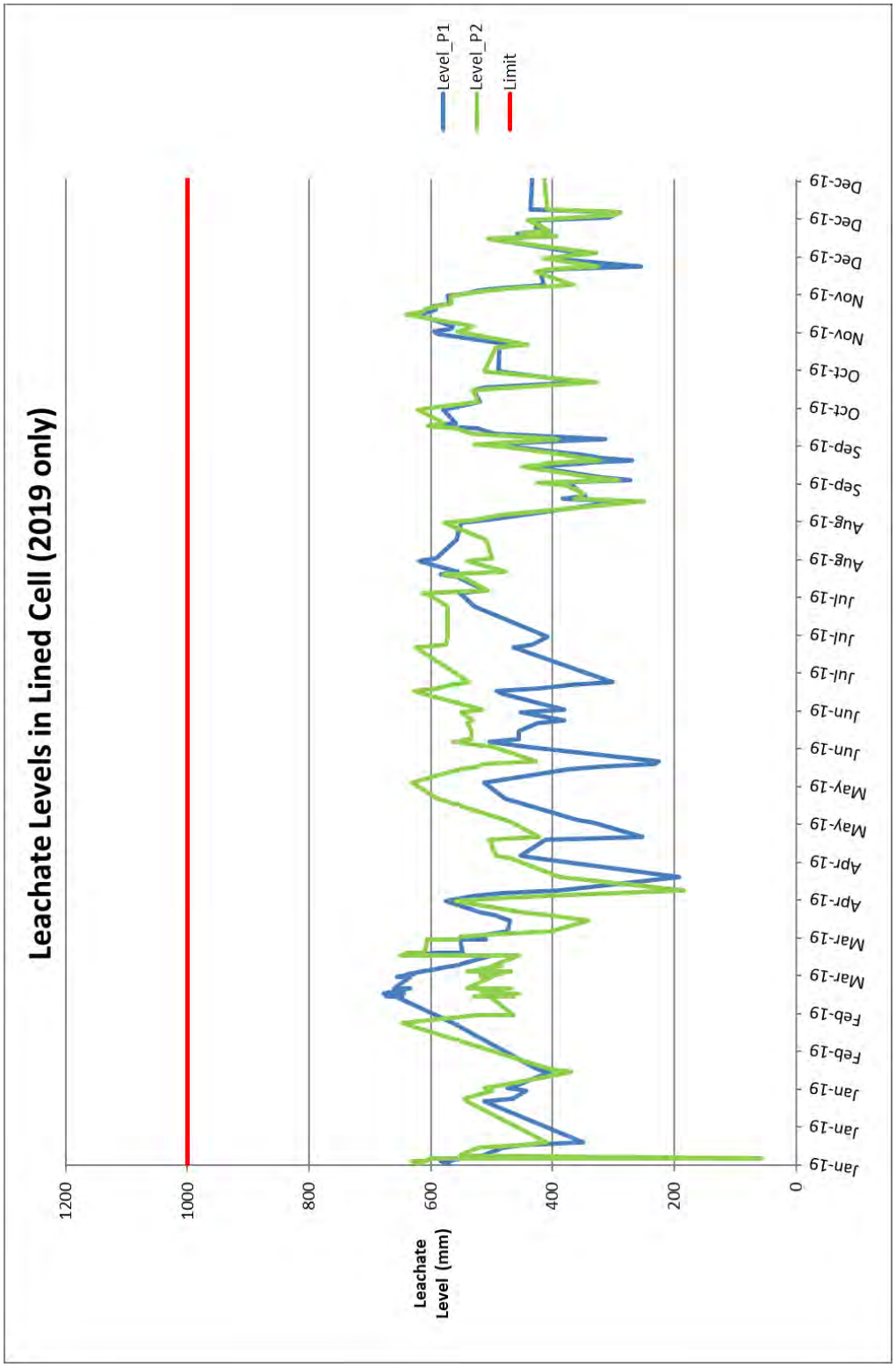
G4 Hydrogen Sulphide levels in Zone 1 gas extraction wells graph

G1: Groundwater Dip Levels 2019



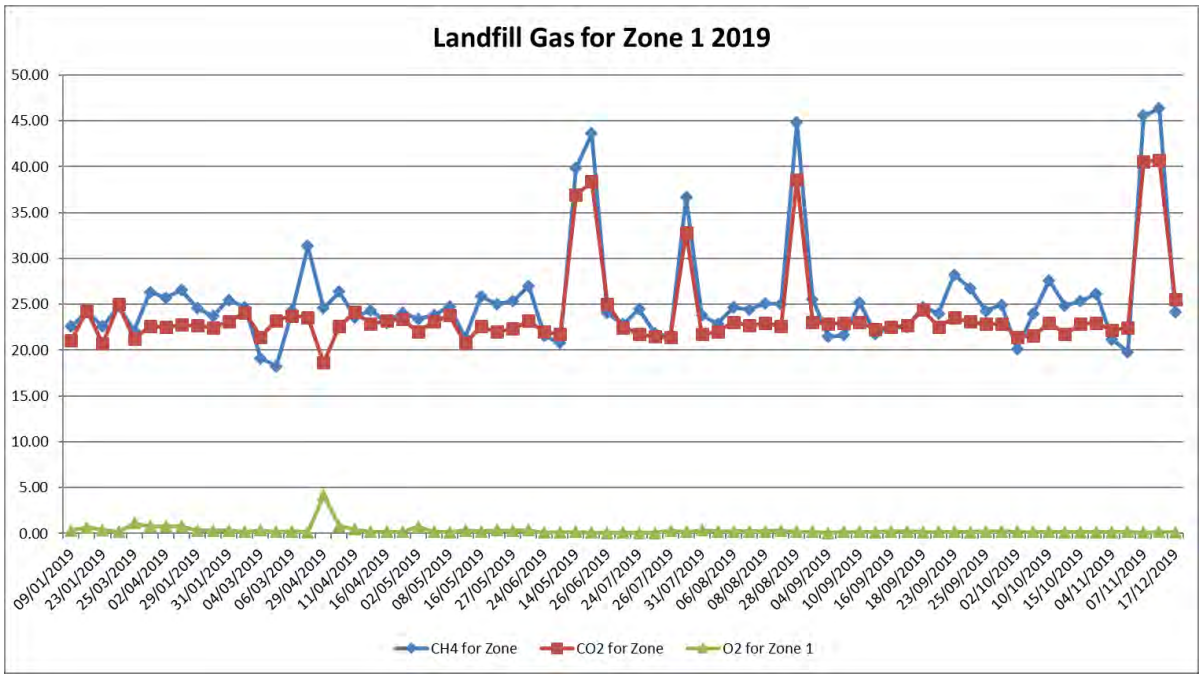

Bedrock Groundwater Levels 2019
Metres Above Ordnance Datum
79.5
79
78.5
78
77.5
77
76.5
76
75.5
01/01/2019
01/02/2019
01/03/2019
01/04/2019
01/05/2019
01/06/2019
01/07/2019
01/08/2019
01/09/2019
01/10/2019
01/11/2019
01/12/2019
Date
Date

G2: Leachate Level 2019

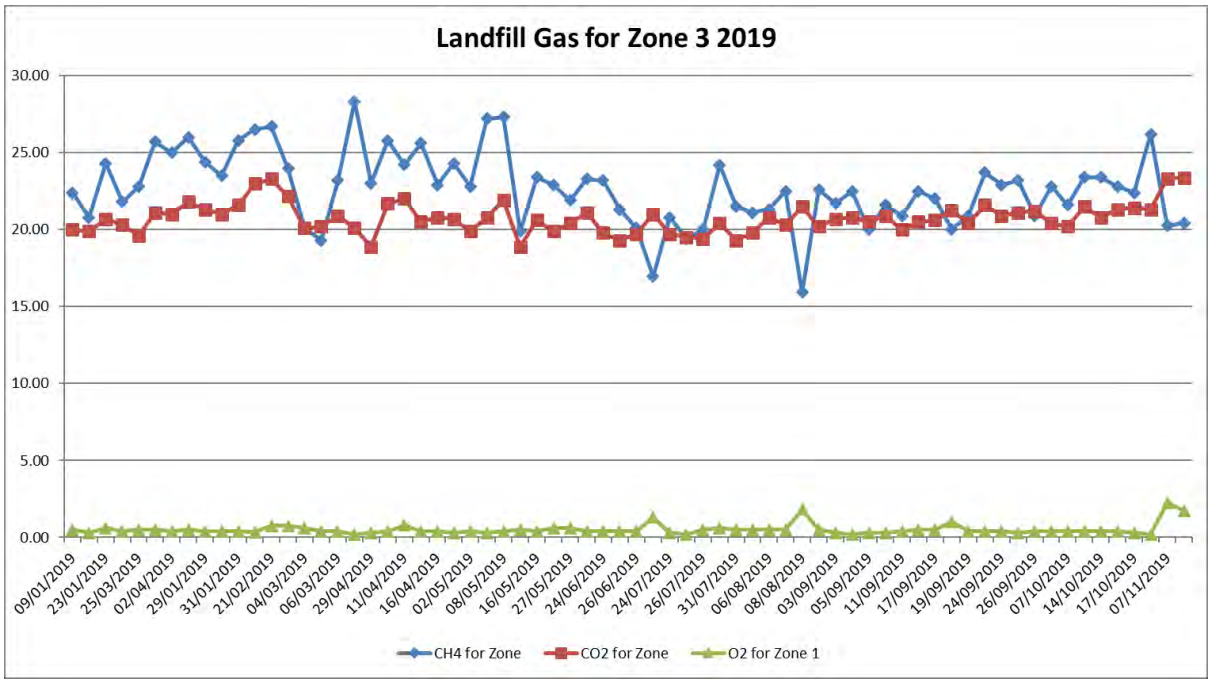


G3: Landfill Gas

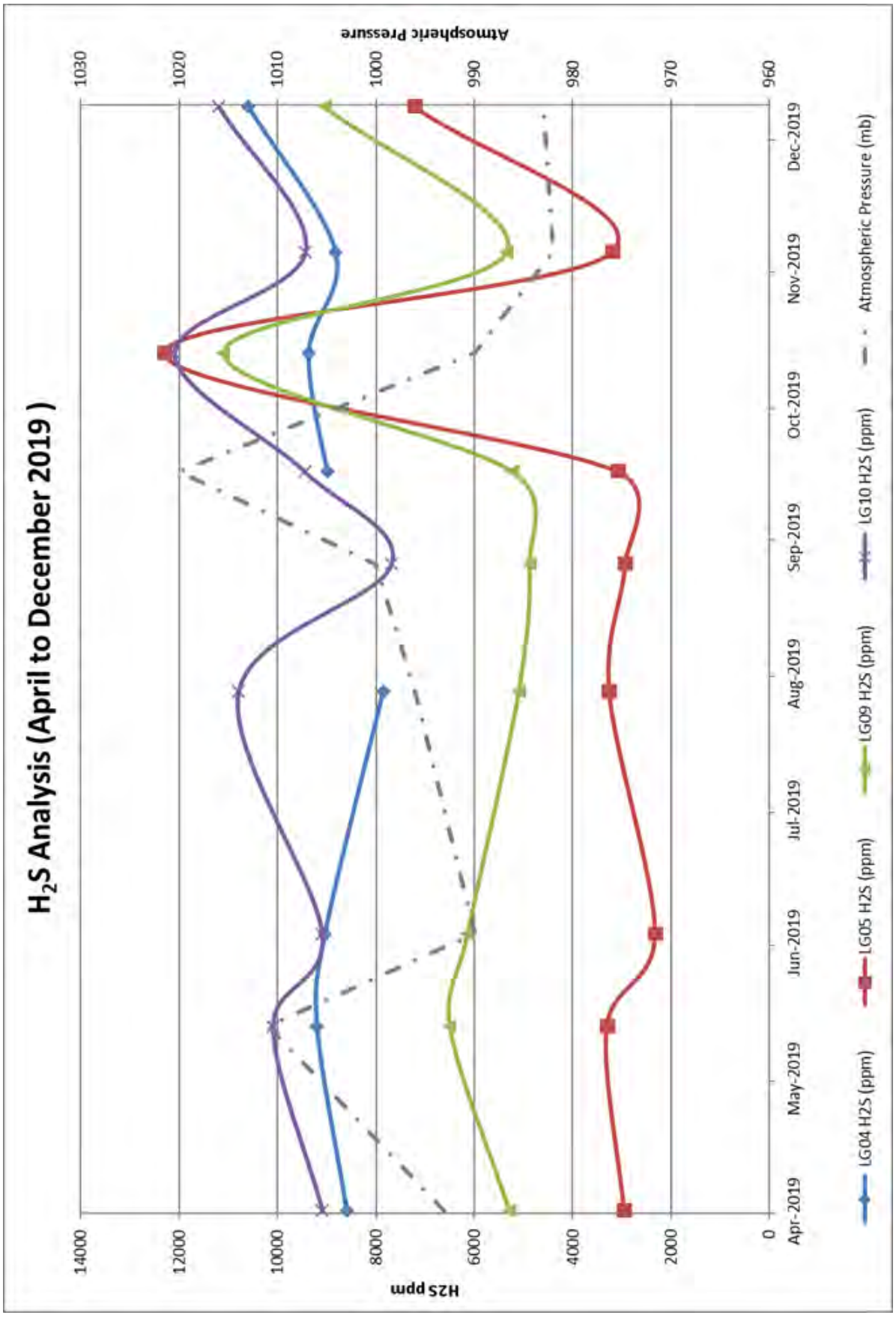
Zone 1 Landfill Gas



Zone 3 Landfill Gas



G4: Hydrogen Sulphide levels in Zone 1 gas extraction wells



Appendix E **Meteorological Data Graphs & Tables**

Temperature 2019

	Average of Daily Max Temp (°C)	Average of Daily Min Temp (°C)	Average of Daily Min Grass Temp (°C)
Jan	7.64	2.67	0.84
Feb	11.28	3.21	0.80
Mar	11.25	2.91	1.44
Apr	12.42	4.37	2.19
May	15.50	6.27	3.96
Jun	16.81	9.06	7.05
Jul	20.57	12.11	10.23
Aug	19.73	11.55	9.94
Sep	17.46	8.57	7.28
Oct	12.67	5.61	3.46
Nov	8.86	3.07	0.47
Dec	8.92	3.28	0.43

Rainfall & Potential Evapotranspiration 2019

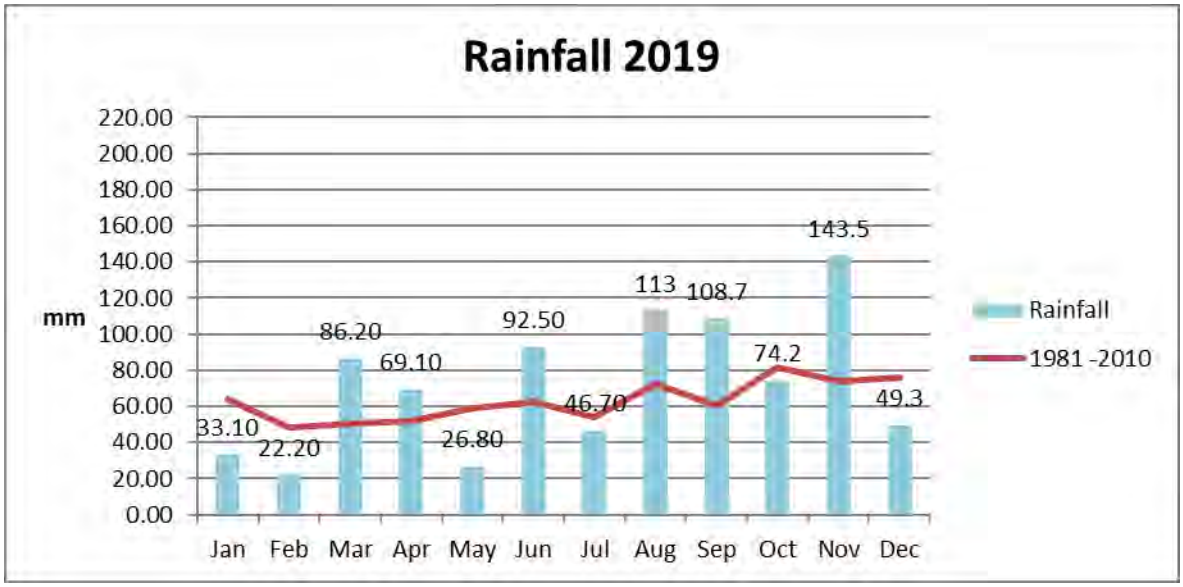
	Dry Days	Wet Days	Max Daily Rainfall	Average Potential Evapotranspiration (mm)
Jan	12	19	5.5	0.40
Feb	14	14	3.8	0.85
Mar	11	20	20.9	1.21
Apr	13	17	10.1	1.73
May	17	14	8.2	2.51
Jun	9	21	28.2	2.76
Jul	18	13	14.5	3.00
Aug	8	23	29.8	2.75
Sep	10	20	23.2	1.58
Oct	8	23	10	0.86
Nov	9	21	19.4	0.40
Dec	11	20	11.9	0.50

Comparison of monthly rainfall with historical average

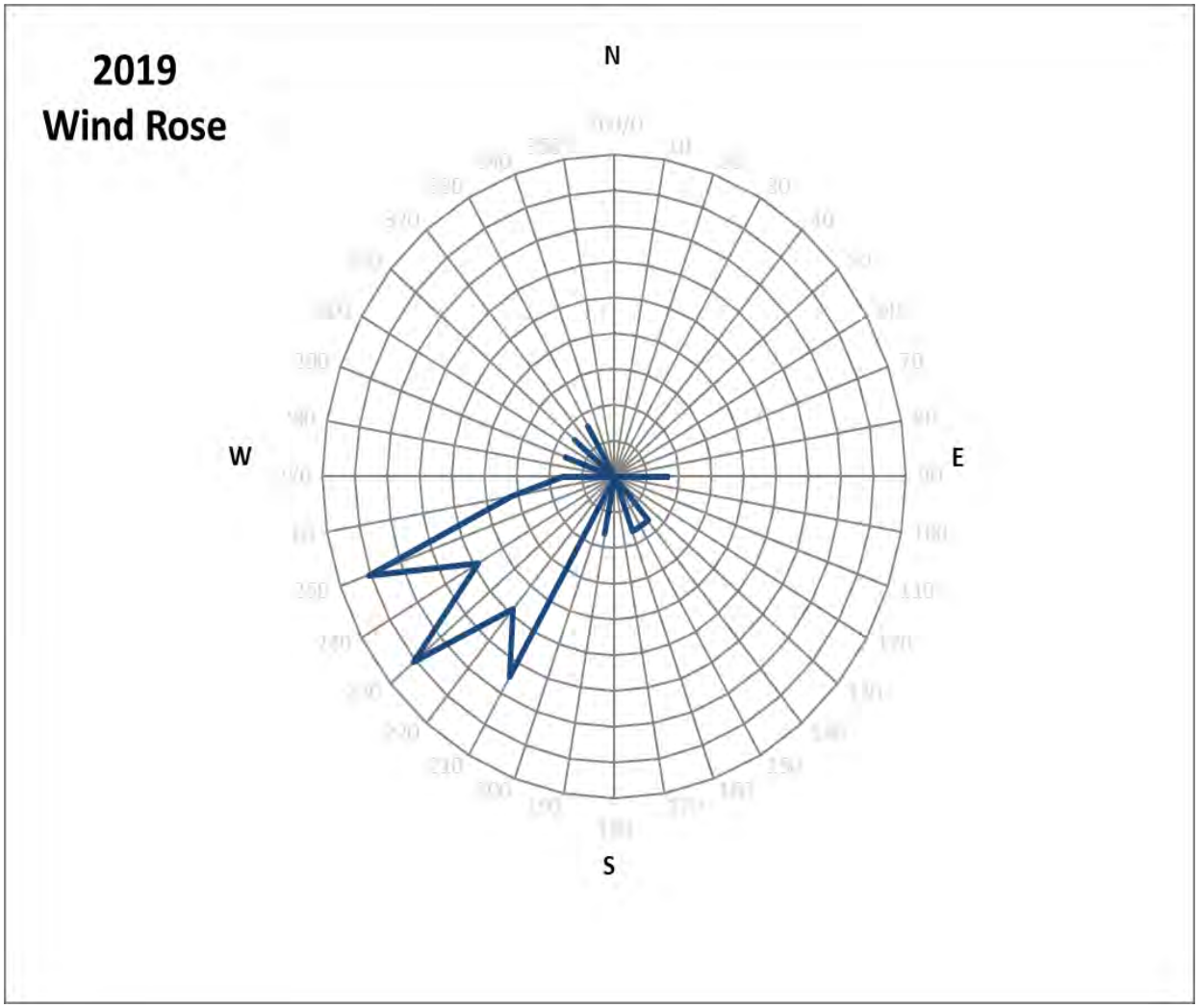
	Monthly Rainfall (mm)	Historic Average (1981 -2010) (mm)
Jan	33.10	63.8
Feb	22.20	48.5
Mar	86.20	50.7
Apr	69.10	51.9
May	26.80	59.1
Jun	92.50	62.5
Jul	46.70	54.2
Aug	113.00	72.3
Sep	108.70	60.3
Oct	74.20	81.6
Nov	143.50	73.7
Dec	49.30	75.7
Average	72.11	62.8

Wind & Sunshine 2019

	Average of Daily Wind speed (knots)	Wind Direction Degrees (average)	Average Pressure (hPa)	Monthly Total of Sunshine (Hours)
Jan	9.39	238.06	1007.13	40.30
Feb	12.01	203.57	1002.88	117.00
Mar	12.52	230.65	1002.46	130.30
Apr	8.29	157.00	1001.03	120.30
May	7.11	207.10	1006.15	161.30
Jun	8.32	175.00	1002.05	175.90
Jul	7.65	226.13	1004.42	184.10
Aug	10.47	219.03	999.26	190.20
Sep	9.30	225.00	1004.30	146.10
Oct	9.13	201.61	997.82	109.50
Nov	7.50	157.33	989.56	49.20
Dec	12.43	214.19	992.90	57.10



A wind rose showing wind direction for 2019 is provided below and shows that the prevailing wind direction was from a westerly or south westerly direction.



Figures

FIGURE 1 SITE LOCATION

Drawing number / Rev
KER1204_00/1

288000
289000
290000
290000
291000
292000
293000

224000
223000
222000
221000
220000

Sallins
Kill
Johnston
Naas
N7

N

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KEY:

P1063-01 Licence Boundary

0 200 400 600 800
METRES

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
1	26/03/19	Revised Licence Boundary	KOB	UD		UD
0	03/10/18	FIRST ISSUE	KOB	UD		UD

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SITE REMEDIATION PROJECT

Drawing title
AER
FIGURE 1
SITE LOCATION

Drawing status
FIRST ISSUE

Scale	1:20,000 @ A3	DO NOT SCALE

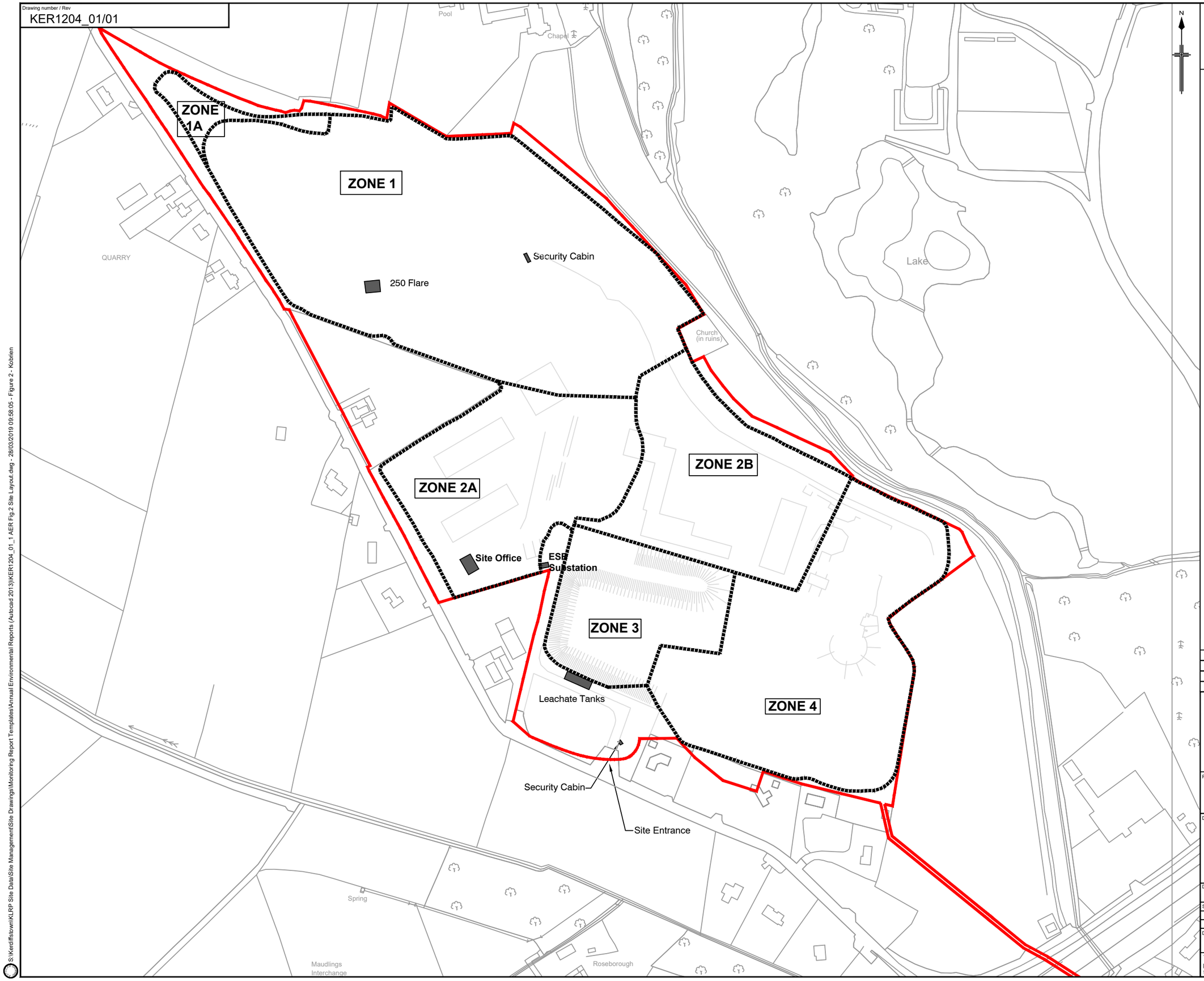
Drawing number
KER1204_00

Rev
1

S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_00_1 AER Fig. 1 Site Location.dwg - 28/03/2019 09:53:35 - Figure 1 - Kobrien

FIGURE 2 SITE LAYOUT

Drawing number / Rev
KER1204_01/01



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KEY:

- EPA Reg No. P1063-01
- Site Infrastructure
- Zones

0 50 100 150
METRES

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
1	26/03/19	Update Zones & Boundary	KOB	UD		UD
0	03/10/18	FIRST ISSUE	KOB	UD		UD

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Drawing title
AER
FIGURE 2
SITE LAYOUT

Drawing status
FIRST ISSUE

Scale: AS SHOWN

Drawing number: KER1204-01
Rev: 1

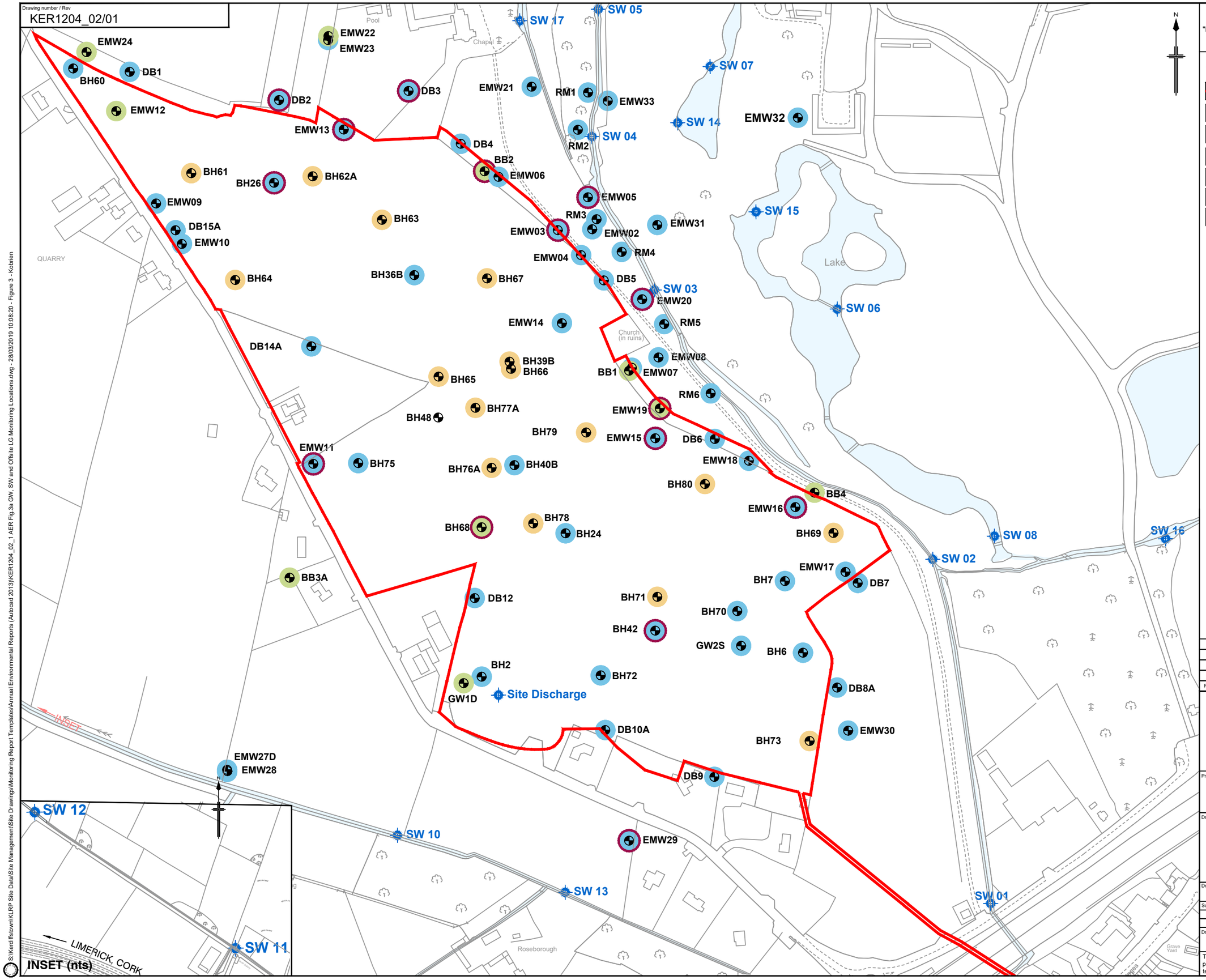
S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_01_1 AER Fig 2 Site Layout.dwg - 28/03/2019 09:58:05 - Figure 2 - Kobrien

FIGURE 3 MONITORING LOCATION REFERENCE DRAWINGS

FIGURE 3A GROUNDWATER, SURFACE WATER AND OFFSITE LANDFILL GAS MONITORING LOCATIONS

Drawing number / Rev

KER1204_02/01



KEY:

- EPA Reg No. P1063-01
- Groundwater Monitoring Point
- Surface Water Monitoring Point
- Monthly Wells
- Overburden
- Bedrock
- In-Waste Boreholes

Rev	Rev. Date	Purpose of revision	Drawn	Checked	Rev'd	Apprv'd
1	26/03/19		KOB	UD		UD
0	03/10/2018	FIRST ISSUE	KOB	UD		UD

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AER

FIGURE 3a

GROUNDWATER AND SURFACE WATER MONITORING LOCATIONS

Drawing status

FIRST ISSUE

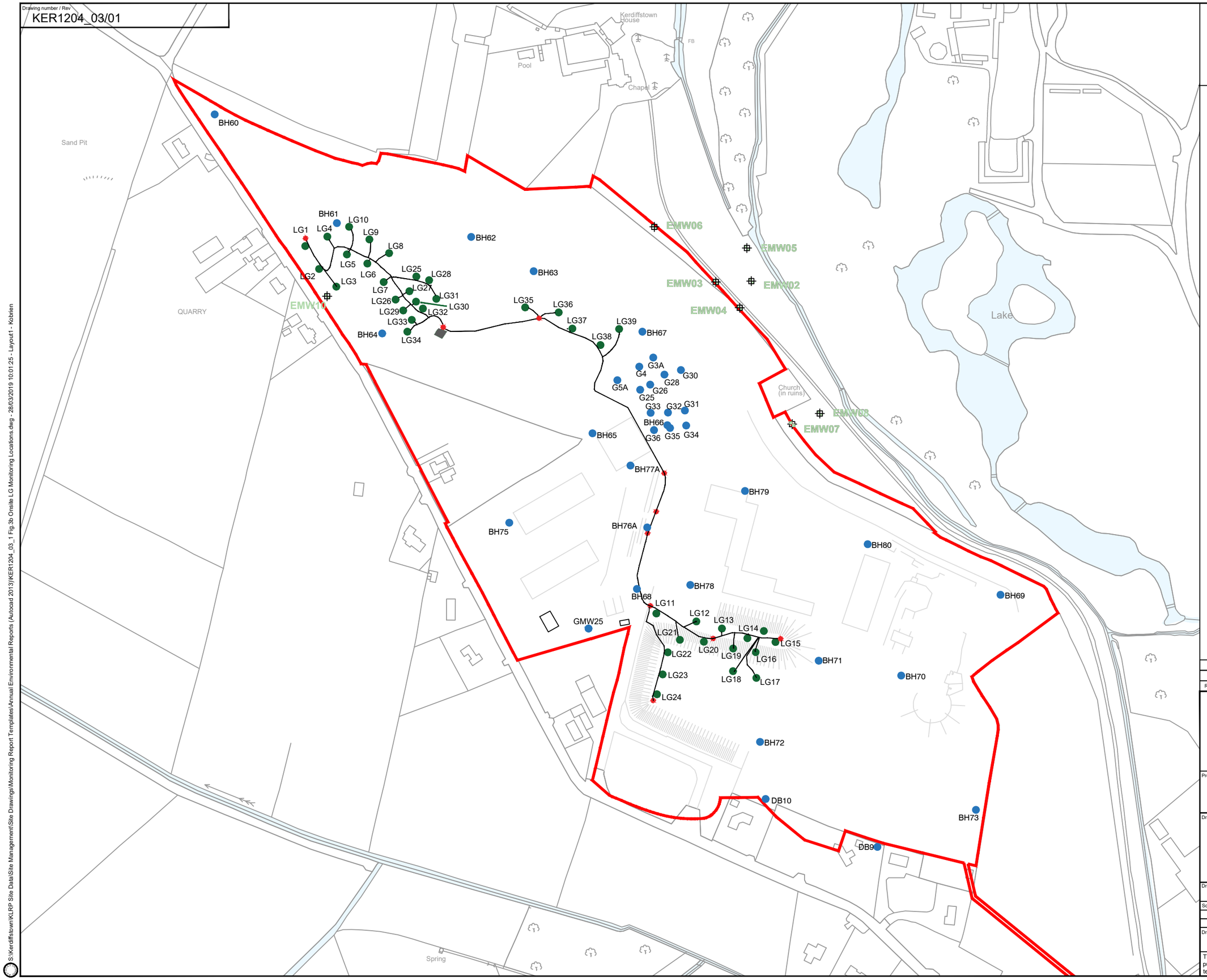
Scale	AS SHOWN	DO NOT SCALE

Drawing number: KER1204_02 — Rev: 1

S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_02_1 AER Fig.3a GW, SW and Offsite LG Monitoring Locations.dwg - 28/03/2019 10:08:20 - Figure 3 - Kobrien

FIGURE 3B ONSITE LANDFILL GAS MONITORING LOCATIONS

Drawing number / Rev
KER1204_03/01



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KEY:

- EPA Reg No. P1063-01
- Flare
- LG39 Gas Extraction Well
- G3A Gas Well
- Condensate Pot
- Groundwater/Gas Monitoring Well

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
1	26/03/19	Revised GWs	KOB	UD		UD
0	10/10/2018		KOB	UD		UD

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Drawing title
AER
FIGURE 3b
LANDFILL GAS EXTRACTION AND GAS MONITORING WELLS

Drawing status
FIRST ISSUE

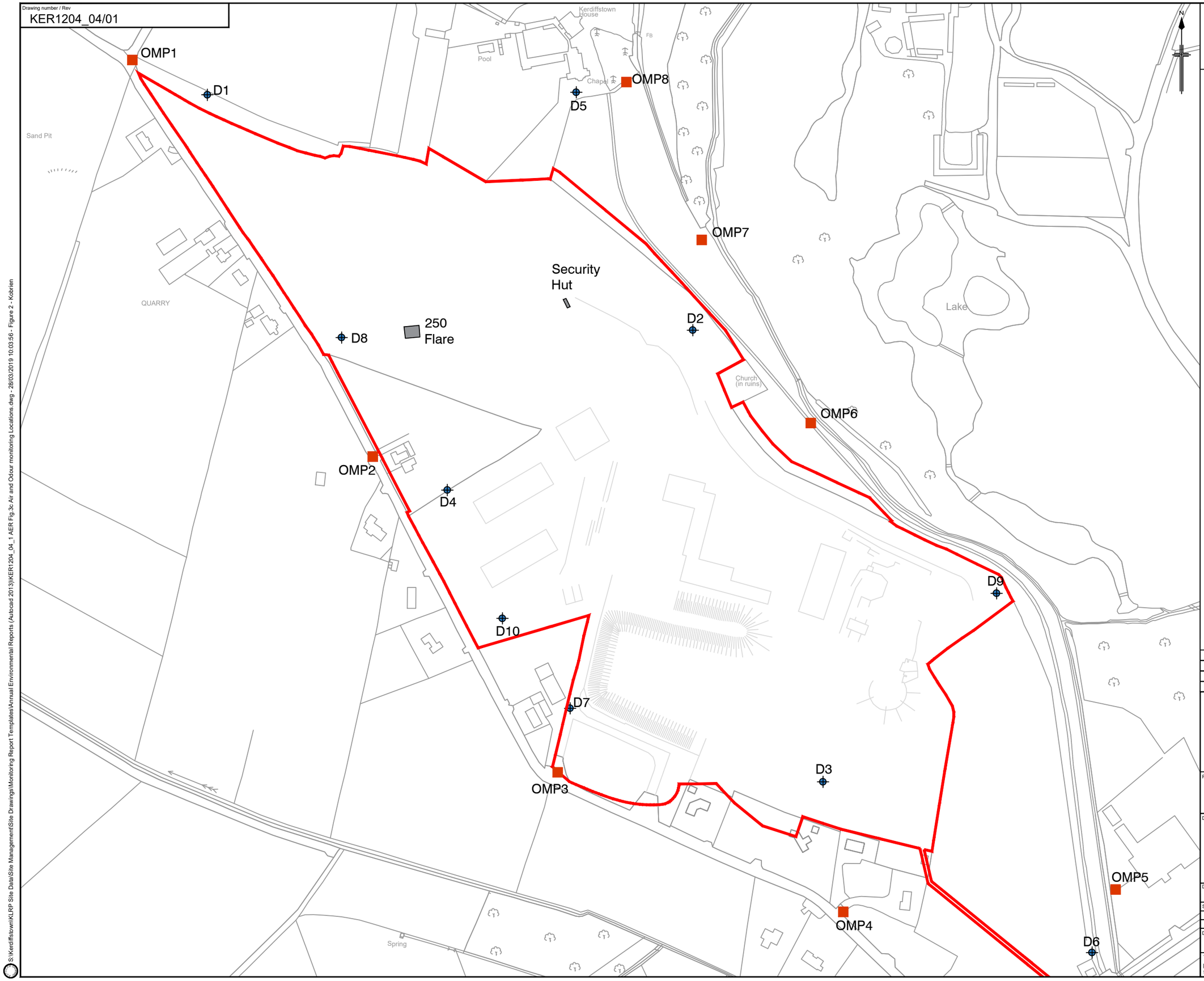
Scale: NTS — DO NOT SCALE

Drawing number: KER1204_03
Rev: 1

S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_03_1 Fig.3b Onsite LG Monitoring Locations.dwg - 28/03/2019 10:01:25 - Layout1 - Kobrien

FIGURE 3C AIR / ODOUR / NOISE MONITORING LOCATIONS

Drawing number / Rev
KER1204_04/01



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KEY:

- EPA Reg No. P1063-01
- Air Quality Monitoring Locations
- Off-site Odour Monitoring Point
- Site Infrastructure

0 50 100 150
METRES

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
1	27/03/19	Revised Boundary	KOB	UD		UD
0	03/10/18	FIRST ISSUE	KOB	UD		UD

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SITE REMEDIATION PROJECT

Drawing title
AER
FIGURE 3c
AIR AND ODOUR
MONITORING LOCATIONS

Drawing status
FIRST ISSUE

Scale: AS SHOWN

Drawing number: KER1204-04
Rev: 1

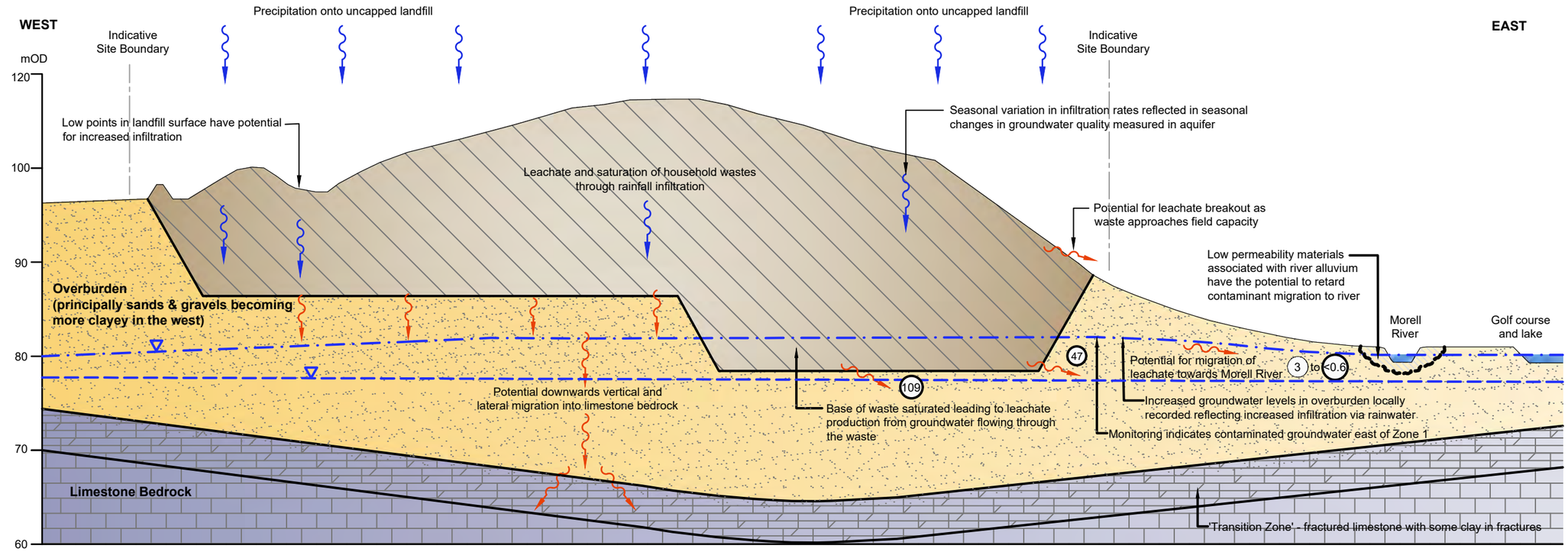
S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_04_1 AER Fig.3c Air and Odour monitoring Locations.dwg - 28/03/2019 10:03:56 - Figure 2 - Kobrien

FIGURE 4 CONCEPTUAL SITE MODELS (EIAR VERSIONS)

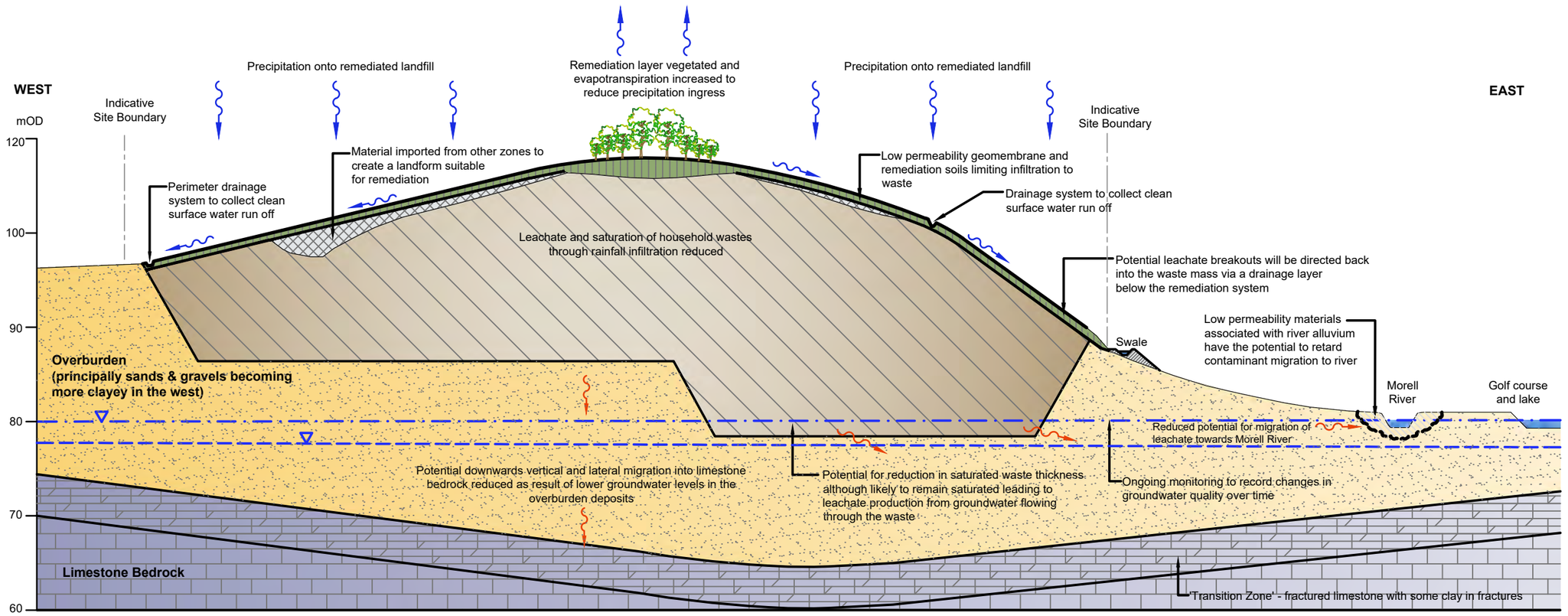
Hydrogeology Conceptual Site Model (Zone 1)

Landfill Gas Management Conceptual Site Model (Zone 1)

Drawing number / Rev
KER1204_5/0



Groundwater Conceptual Site Model for Zone 1: Current Scenario



Groundwater Conceptual Site Model for Zone 1: Post Remediation

FIGURE 4a

KEY:

- Groundwater Level in the Overburden
- Groundwater Head in the Limestone Bedrock
- Migrating Leachate
- (47) Ammoniacal Nitrogen Concentration July 2016 (mg/l)

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
0	10/10/2018	FIRST ISSUE	KOB	UD		UD

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Drawing title
AER
FIGURE 4a
HYDROGEOLOGY CONCEPTUAL SITE MODEL (ZONE 1)

Drawing status
FIRST ISSUE

Scale: NTS [A3]
DETAILS SHOWN ARE NOT FOR CONSTRUCTION PURPOSES HENCE DRAWING SHOULD NOT BE SCALED

Drawing number: KER1204_5
Rev: 0

S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_05_0 AER Fig. 4a Hydrogeology CSM.dwg - 28/03/2019 10:09:14 - EIAR - Kobrien

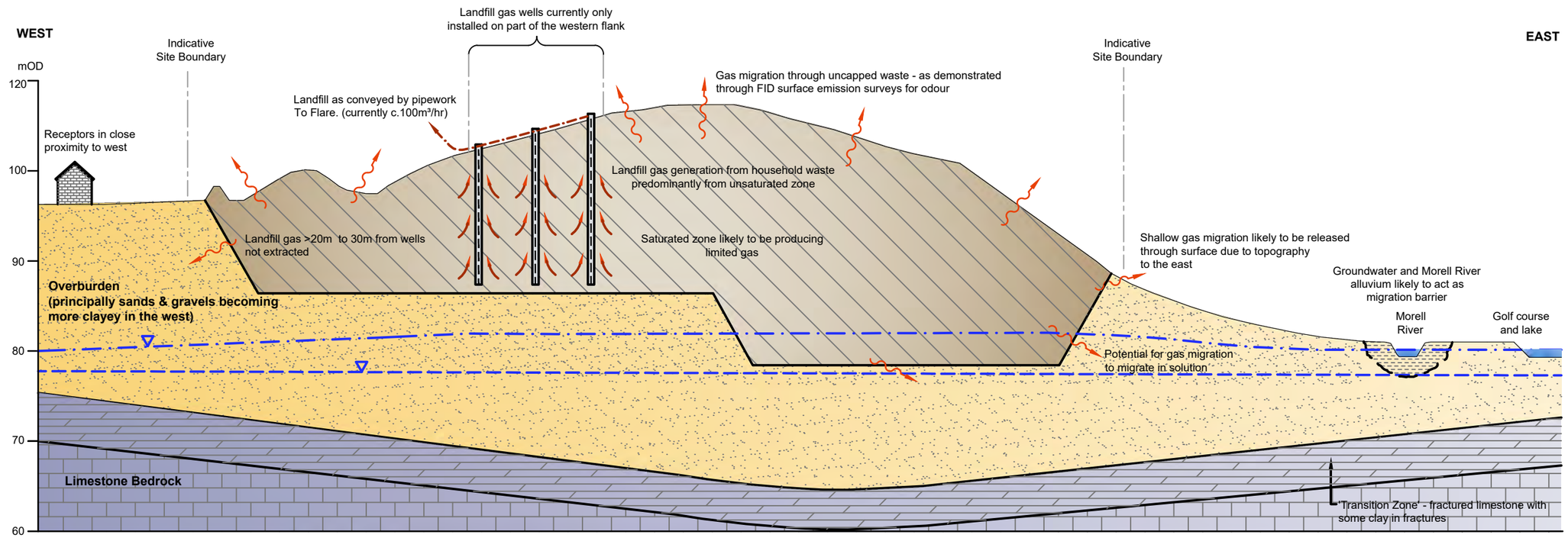
Drawing number / Rev
KER1204_06/0

FIGURE 4b

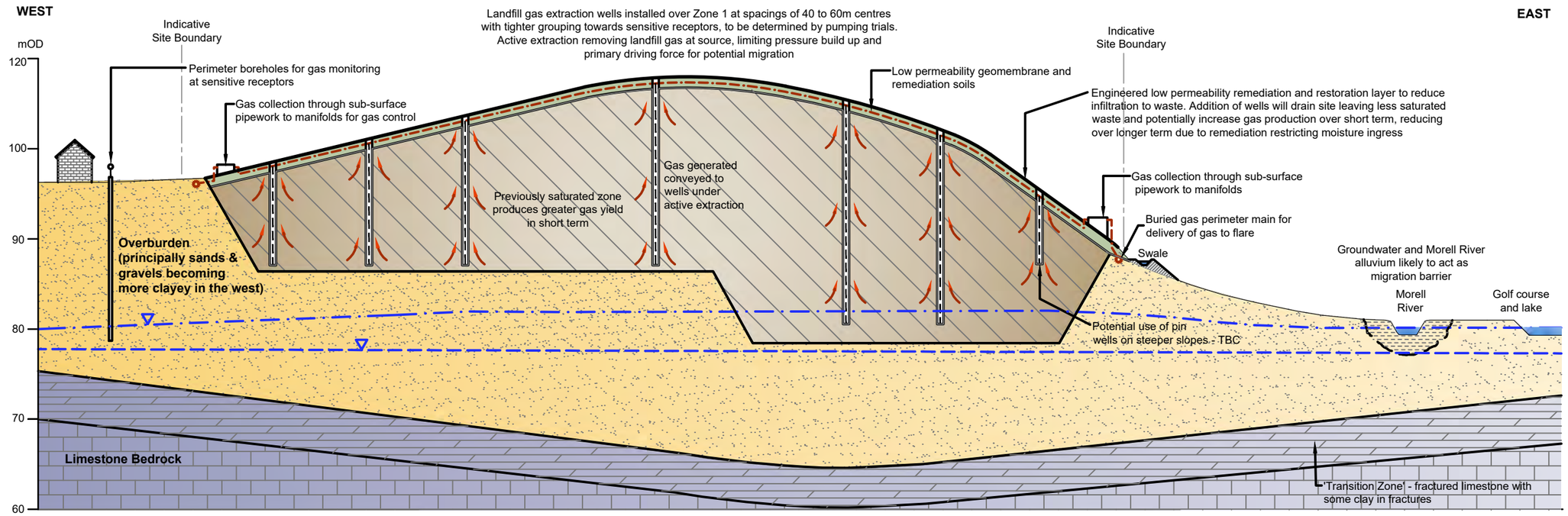
KEY:

Groundwater Level in the Overburden

Groundwater Head in the Limestone Bedrock



Gas Conceptual Site Model for Zone 1: Current Scenario



Gas Conceptual Site Model for Zone 1: Post Remediation

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
0	10/10/2018	FIRST ISSUE	KOB	UD		UD

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Drawing title
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FIGURE 4b
LANDFILL GAS MANAGEMENT
CONCEPTUAL SITE MODEL (ZONE 1)

Drawing status
FIRST ISSUE

Scale: NTS [A3] — DETAILS SHOWN ARE NOT FOR CONSTRUCTION PURPOSES HENCE DRAWING SHOULD NOT BE SCALED

Drawing number: KER1204_06
Rev: 0

S:\Kerdiffstown\KLRP Site Data\Site Management\Site Drawings\Monitoring Report Templates\Annual Environmental Reports (Autocad 2013)\KER1204_06_0 Fig 4b LG Management CSM.dwg - 28/03/2019 09:58:52 - EIAR - Kobrien

FIGURE 5A GEOHAZARD ZONATION PLAN - SLOPE STABILITY HAZARD ZONATION PLAN - SOUTH AREA

LEGEND

- SITE EXTENTS (FUTURE LICENCED BOUNDARY)
- WASTE BOUNDARY
- STABILITY ASSESSMENT ZONE BOUNDARY
- INCLINOMETER

STABILITY RISK

- LOW
- LOW / MEDIUM
- MEDIUM
- MEDIUM / HIGH
- HIGH

Client

Kildare County Council
Aras Chill Dara,
Devoy Park,
Newbridge Road,
Naas, Co. Kildare

General Notes

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(v) All Levels refer to Ordnance Survey Datum, Malin Head.

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Model File Identifier

Scale 1:1250 @ A1, 1:2500 @ A3

Created on 28.01.19

Sheets

Project **KERDIFFSTOWN LANDFILL REMEDIATION**

Title SLOPE STABILITY ZONES AND RISK ASSESSMENT

File Identifier FIGURE 1

Status

Rev

FIGURE 5B GEOHAZARD ZONATION PLAN - SLOPE STABILITY HAZARD ZONATION PLAN - NORTH AREA

Client

Kildare County Council
Aras Chill Dara,
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Scale	1:1250 @ A1 1:2500 @ A3
Created on	28.01.19
Sheets	
Project	KERDIFFSTOWN LANDFILL REMEDIATION
Title	SLOPE STABILITY ZONES AND RISK ASSESSMENT
Model File Identifier	
File Identifier	FIGURE 2
Status	
Rev	

\\dub-wp-das-fp\Work_Block_A\MDR1406 - Kerdiffstown Landfill Remediation Project\6.3 Geotech\12 Existing Slope assessment\Slope stability hazard zonation.dwg