Kildare County Council

Remediation of Legacy Landfill Site at Digby Bridge, Sallins, Co. Kildare,
Stage 1: Environmental Risk Assessment and Remediation Plan

Attachment D1- Remediation Plan

July 2020

CDM Smith

Document Control Sheet

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Table of Contents

List of Tables

List of Figures

Section 1 Introduction

1.1 Project Background

Digby Bridge legacy landfill site is located south east of Digby Bridge which crosses the Grand Canal, in the townland of Barrettstown, less than three kilometres from Sallins.

Landfilling first started at Digby Bridge in 20/06/1980 and finished approximately on 31/12/1982. A Tier 1 Risk Assessment of the site was completed in 2008 by Kildare County Council, in line with the Environmental Protection Agency (EPA) Code of Practice: Environmental Risk Assessment for Unregulated Waste Disposal Sites 2007 (CoP). A preliminary Conceptual Site Model (CSM) of the site was developed and the Source-Pathway-Receptor (SPR) linkages were evaluated. The Tier 1 categorized the site as being of 'High Risk (Class A)' due to the number of high risk SPR linkages. The site was entered on Kildare County Council's Waste Management Act Section 22 Register, a list of unregulated waste disposal sites.

Kildare County Council appointed CDM Smith Ireland Ltd (CDM Smith) in 2017 to prepare a Stage 1 Environmental Risk Assessment and Remediation Plan in accordance with the Environmental Protection Agency (EPA) Code of Practice and comprising of Tier 2 Site Investigation and Tier 3 Refinement of CSM and Quantitative Risk Assessment which was then used to inform the Remediation Plan. This will provide the basis for the Council's application for a Certificate of Authorisation to the EPA as required under S.I. No. 524 of 2008 Waste Management (Certification of Historic Unlicensed Waste Disposal and Recovery Activity), Regulations, 2008. It will also be required to inform Stage 2 of the Project: Remediation Works.

In accordance with the objectives of the project, as set out in the Project Brief, three reports will be prepared as part of the project deliverables.

- Tier 2: Site Investigations and Testing (Doc. Ref. 117838/40/DG/11);
- Tier 3: Refinement of Conceptual Site Model and Quantitative Risk Assessment
  - Volume 1 addressing Landfill Gas (Doc. Ref. 117838/40/DG/12); and
  - Volume 2 addressing Groundwater (Doc. Ref. 117838/40/DG/13).
- Remediation Plan (this report).

An additional report (Doc. Ref. 117838/40/DG/10) has been prepared which reviews background information relevant to the project, including the Tier 1 Risk Assessment of the site completed in 2008 by Kildare County Council. An Appropriate Assessment Screening Report (Doc. Ref. 117838/40/DG/16) was also prepared.

1.2 Objective and Scope of Remediation Plan

The objective of this report is to identify the preferred remediation option or options for the Digby Bridge former landfill site for the management of unacceptable risks posed by the SPR linkages identified by the Tier 2 Site Investigation and the Tier 3 Risk Assessment in accordance with EPA CoP.

As noted previously, this will provide the basis for the Council's application for a Certificate of Authorisation to the EPA as required under S.I. No. 524 of 2008 Waste Management (Certification of Historic Unlicensed Waste Disposal and Recovery Activity), Regulations, 2008.

This Remediation Plan has been prepared in accordance with Chapter 7 of the CoP and the requirements of the Project Brief, which also requires cost estimates to be provided.

1.3 Limitations

Recommendations and cost estimates described in this report are subject to a detailed design phase and public procurement considerations.

Section 2 Overview of Approach

2.1 SPR Linkages

Based on the findings of the landfill gas and groundwater risk assessment, an updated SPR linkage for the site is presented on Table 1. The key linkages include:

- Lateral Migration of landfill gas to nearby properties (SPR10) ; and
- Impacted groundwater migration offsite in the Gravel Formation and Rickardstown Formation impacting local groundwater and potentially impacting the drains to the north of the north of the site (SPR5 and SPR6).

It is these linkages that need to be addressed by the Remediation Plan.

Table 1: SPR Linkages

SPR	Linkage	Tier 3
Leachate migration through combined groundwater and surface water pathways		
SPR1	Leachate => surface water	No Leachate to on-site drainage or run-off pathway
SPR2	Leachate => SWDTE	No Leachate to on-site drainage or run-off pathway
Leachate migration through groundwater pathway		
SPR3	Leachate => human presence	Mitigation provided by provision of public water supply
SPR4	Leachate => GWDTE	N/A
SPR5	Leachate => Aquifer	Groundwater is impacted within landfill and migrating off-site
SPR6	Leachate => Surface Water	Impacted groundwater potentially connected to drains north of the canal and River Liffey
SPR7	Leachate => SWDTE	Impacted groundwater shown not to relate to surface water
Leachate migration through surface water pathway		
SPR8	Leachate => Surface Water	No direct pathway
SPR9	Leachate => SWDTE	No direct pathway
LFG migration pathway (lateral & vertical)		
SPR10	Landfill Gas => Human Presence	Risk from atmospheric pumping
SPR11	Landfill Gas => Human Presence	Risk from vertical migration considered low
Risk Rating by Colour		
Lowest Risk (Class C)	Moderate Risk (Class B)	Highest Risk (Class A)

2.2 Overview of Remedial Options

A remediation strategy may involve the use of one or more remedial options to achieve the remedial objectives. Based on the outcomes of the Tier 3 Risk Assessment and the available remedial options discussed in the EPA Landfills Manual, we recommend a minimum viable solution to address the SPR linkages (SPR5, SPR6, SPR10) which involves:

- Landfill Gas (LFG) Management System – to address SPR10; and
- Adaptive Monitoring for Groundwater – to address SPR5 and SPR6.

Other options which would address the SPR linkages, but which were not considered appropriate at this time include:

- Pump and Treat System for Groundwater – while this would address SPR5 and SPR6, it would be expensive and technically difficult to achieve, involving the drilling of pumping wells and testing. It would be potentially prohibitively energy intensive in terms of electricity to run pumps and a treatment plant. Such a scheme would not be warranted by the current known risks to groundwater at the site.
- Installation of a Low Permeability Cap – while this addresses SPR5 and SPR6 by significantly reducing the leachate generated at the site (and accordingly would indirectly mitigate SPR10 by reducing the potential for LFG generation), it would be a significant project to undertake at this site, particularly as the site is not owned by Kildare County Council. Such a scheme would not be warranted by the current known risks to groundwater at the site.
- Excavate Waste Material and Disposal at Landfill – while this address addresses SPR5, SPR6, SPR10, it would not represent a proportionate response to the risks identified. The Tier 2 Investigation estimated the waste volume at 366,600 m^3. Using a standard density of 1.4 tonnes/m^3 for municipal waste, the tonnage is estimated at 513,240 tonnes. The removal of this material will leave a significant void which will need to be backfilled. Using the hazWasteOnline^{tm} software, sample data indicates the waste is non-hazardous; however, asbestos was detected in one sample (TP6). The Waste Acceptance Criteria testing showed that some of the samples were above inert criteria for Total Organic Carbon, Mineral Oil, Sulphate and Total Dissolved Solids. The cost of disposing of 513,240 tonnes at a non-hazardous facility could cost in the order of €30 million, assuming a suitable facility could be located to accept the waste.

Finally, a 'Do Nothing' approach would not address any of the SPR Linkages, and Kildare County Council would be unable to apply for a certificate of authorisation from the EPA. This is not considered to be an appropriate option for consideration.

2.3 Verification Plan

The CoP requires a Verification Plan to be submitted after the remedial options have been implemented.

We recommend that this will involve three stages, and it is indicated where these are discussed in the remainder of the report:

1. Verification of the works completed:
   a. LFG Flaring Assessment (Section 3.4);
   b. Installation of Extraction System and/or Flaring System (Section 3.4); and
   c. Ground Investigation Logs and Monitoring Well Completion Report (Section 4.2).
2. Monitoring and Compliance Reports:
   a. LFG Monitoring Report (Section 3.5); and
   b. Groundwater Monitoring Report (Section 4.3).
3. Final Verification Report:
   a. Demonstrates SPR linkages are broken.

Section 3 Proposed Approach for LFG Management

3.1 Introduction

Installation of an LFG Management System is proposed to address SPR10.

Section 4, Annex 1 of the 1999 EU Landfill Directive outlines the gas control requirements for all classes. The Landfill Directive was transposed into Irish law by the Waste Management Licensing Regulations 2000 and the Waste Management Act 1996 – 2011. These requirements include:

- Appropriate measures must be taken to control the accumulation and migration of LFG;
- LFG must be collected from all landfills receiving biodegradable waste and the LFG must be treated and, to the extent possible, used;
- Collection, treatment and use of LFG under sub-paragraph (2) must be carried on in a manner, which minimises damage to or deterioration of the environment and risk to human health; and
- LFG which cannot be used to produce energy must be flared.

Considering the requirements for LFG management in the EU Landfill Directive (1999), EPA Management of Low Levels of Landfill Gas (2011), EPA Landfill Site Design (2000) and EPA Landfill Operational Practices (1997). The landfill site at Digby Bridge cannot be considered as following these requirements for LFG management.

3.2 Control Systems for LFG

3.2.1 Overview

There are a number of control systems that could be used to manage the risk posed by LFG migration and they fall under two main categories, Active and Passive Systems:

Active systems

- Install an LFG Collection System, potentially flaring the gas over an extended period if viable.

Passive systems

- Install Ventilation Trenches and/or Barriers; and
- Ventilation of the landfill, which ensures no pressure differentials can develop.

Passive systems rely on natural pressure and convection mechanisms to vent LFG to the atmosphere. They are less efficient than active systems but are cheaper and have lower maintenance requirements.

Some landfills may use a combination of both systems.

3.2.2 LFG Collection System / Flaring

A system could be installed which would actively maintain a negative pressure inside the waste mass, using a vacuum to abstract gas from wells which would prevent lateral migration from the landfill. This could be achieved using an extraction system similar to the LFG extraction test, connected to a number of leachate wells. It would be possible to pump the LFG through granular activated carbon, for the removal of VOCs and non-methane organic compounds (NMOCs) emissions, effectively reducing odour.

Ideally the LFG extracted from the waste mass would be flared, thus reducing the sites impact on greenhouse gas levels. To develop an appropriate design and specification of a flare system, the following additional work would be required to install a flare system.

A testing phase will be required to determine the thermal capacity for the stationary flaring plant. The type of flares that exist seem to be varied for different methane compositions (calorific content). If the test data shows that the thermal capacity of the gas extracted is too low for flaring, then keeping a negative pressure in the landfill is still the primary focus. An extraction unit could then be used to vent gas from the landfill without flaring as described above.

Based on the size of the landfill, the age and the gas production potential, it is considered that installation of a combined heat and power plant would not be economically viable.

3.2.3 Install Ventilation Trenches and/or Barriers;

Using ventilation trenches and/or barriers would require significant earth works which would have to extend below the waste mass to the groundwater table to effectively break the pathway for lateral LFG migration.

The depth to the groundwater table ranges from 0.3 to 13.7 m b TOC and the waste mass perimeter is approximately 1,350 metres. Installing an effective trench or barrier would involve extensive excavations around the site, which would be challenging and expensive, particularly given the proximity of neighbouring houses and farms to the Digby Bridge legacy landfill site.

3.2.4 Ventilation of the Landfill

Ventilation of the landfill would keep the LFG pressure in the landfill equalized with atmospheric pressure and would prevent large differentials forming. Aerobic degradation would also be enhanced and anaerobic methanogenesis would be reduced, thus reducing methane generation.

This would involve an evaluation on fitting-out existing leachate wells with LFG venting stacks or may require new wells to be installed. LFG venting stacks could be used on upgraded or newly installed wells, these would assist with gas venting. These stacks will rotate in speeds as low as three kilometres per hour and ventilation rates in excess of 90 m^3/h are typically achieved with average wind speeds of 16 km/h. As well as releasing methane and carbon dioxide to the atmosphere, venting will release trace landfill gases which do have an odour, this could result in an unacceptable increase in odours at the site, relevant given the proximity of neighbouring houses and farms to the Digby Bridge legacy landfill site.

3.3 LFG Management Options Appraisal

The Landfill Directive (1999) requires that appropriate measures should be taken in order to control the accumulation and migration of LFG.

The options for LFG management are limited because:

- The installation of a trench or barrier around the waste body presents a challenging and expensive programme of works, particularly given the proximity of neighbouring houses and farms to the Digby Bridge legacy landfill site; and
- Passive ventilation of bulk and trace gases to the atmosphere could result in unacceptable odours to dwellings adjacent to the site.

Furthermore, the Landfill Directive indicates that where technically possible, LFG must be collected and treated and used if possible. Where the gas collected cannot be used to produce energy, it must be flared. The collection, treatment and use of LFG should be applied in a manner which minimises damage to, or deterioration of the environment and risk to human health.

We consider that a combined heat and power plant would not be economically viable because of the size, age and the gas production potential of the landfill. Therefore, we recommend that a gas extraction system with flaring would be the most suitable option for the Digby Bridge legacy landfill site. This system will require an initial testing phase and detailed design to determine its exact specifications.

3.4 Preliminary Design of Proposed LFG Extraction System and Flaring

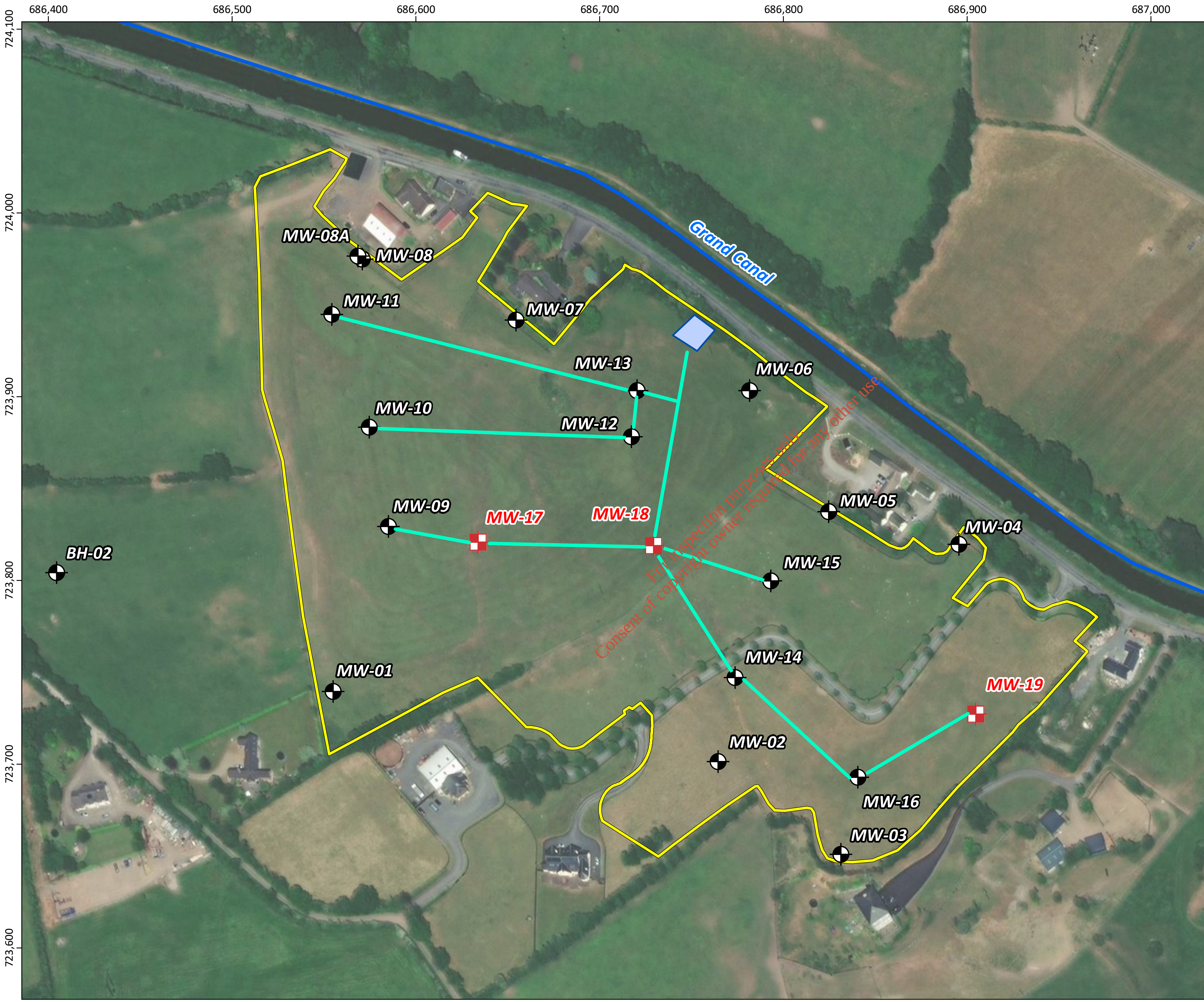
To determine the design (i.e. the thermal capacity) for the stationary plant, an initial testing phase should be undertaken, involving the following:

- Gas extraction with a temporary flare system at selected wells for several weeks as necessary;
- Determination of the gas composition from extraction wells and in the surrounding areas over a longer period; and
- Empirical determination of the residual gas potential.

For this initial testing phase, we propose that three additional new gas wells are installed in the waste mass for LFG extraction wells.

Proposed locations for these are shown on Figure 1 in addition to the gas connection lines which will be required to connect them to the LFG extraction and flaring plant. The final locations of this infrastructure are subject to detailed design, and consultation with the landowner.

An example of the LFG extraction and flaring plant is presented on Figure 2. The actual plant and detailed design will be based the assessment for suitability for flaring.



0 50 100 m

N W E S

Legend

Site Boundary

Proposed New Gas Wells

Proposed Gas Connection Lines

Proposed Temporary Flare Location

Coordinates are in Irish Transverse Mercator

Client: Kildare County Council

Consultant: CDM Smith

Project Code: 117838

Project: DIGBY BRIDGE

Drawing Title: **FIGURE 1: GAS REMEDIAL PLAN**

Drawn By: SM

Date: 11/05/2020

Following the completion of the testing phase, the permanent LGF extraction and flaring system would be designed and sized. In our experience, this will be needed for a period of approximately 6-8 years at the Digby Bridge legacy landfill site. This estimate may be refined during the detailed design. We have used 8 years for the purposes of cost estimation.

The permanent system will use much the same infrastructure as the initial testing phase, shown on Figure 1. The final locations of this infrastructure are subject to detailed design, and consultation with the landowner. While the initial testing phase can use a mobile generator to provide power, a connection the mains power supply will be required for the permanent system. The system will need ongoing maintenance over its operational lifetime (of 6-8 years). The system should also be fitted with an alarm should the vacuum and flare system stop for any unplanned reason, which would notify the Local Authority and maintenance person of any issue.

As part of the Verification Plan (Section 2.3), the following should be completed:

- The detailed design should be used as the basis of construction sign off by a qualified professional; and
- An LFG Flaring Assessment should be undertaken.

Figure 2: Example of Flare System

3.5 Proposed LFG Monitoring Programme

As part of the Verification Plan, we recommend a LFG monitoring programme is undertaken to ensure that the system is performing as intended, i.e. to maintain a negative pressure inside the waste mass thus preventing migration to off-site locations. This should extend over the lifetime of the LGF extraction and flaring system. We recommend it should involve bi-annual monitoring LFG monitoring rounds to confirm that the negative pressure inside the landfill has been achieved by monitoring LFG levels and LFG flows in the waste mass and monitoring wells around the landfill.

3.6 Cost Estimate for LFG Management

Table 2 presents a cost estimate for the preferred strategy for LFG Management. These are based on CDM Smith's experience of developing similar infrastructure, but actual costs will depend on public procurement and other factors. As discussed previously, a temporary system will precede the design and development of a permanent system. The duration for which this permanent system will be required will be refined during detailed design, but it is estimated that it will operate for at least five years.

No allowance has been made for landowner compensation or land purchase.

All cost estimates are exclusive of VAT.

Table 2: Cost Estimate for LFG Management

Item	Unit Cost	Estimated Cost €
Temporary System		
Design & Procurement of Temporary System	10,000	
Gas Boreholes: drilling, supervision and logging	10,000	
Temporary Flare Installation, commissioning and decommissioning. Operation for 12 weeks	40,000	
Monitoring of LFG and Operation of Flare (for 12 weeks)	20,000	
Generator Hire	10,000	90,000
Permanent System		
Design & Procurement of Permanent System	30,000	
Installation and commissioning	150,000	
Provision of permanent power supply	10,000	
Operation for 8 years	30,000	220,000
Monitoring		
Gas monitoring Programme for 8 years	3,000	
Compliance and Reporting for 8 years	2,000	40,000
TOTAL		**350,000**

Section 4 Proposed Approach for Adaptive Groundwater Monitoring

4.1 Introduction

Adaptive Groundwater Monitoring is proposed to address SPR5 and SPR6

The Tier 3 Risk Assessment for Groundwater, based on a generic quantitative risk assessment and a detailed quantitative risk assessment, found that there are localised impacts to groundwater by landfill leachate, which is adding both hazardous and non-hazardous substances to groundwater. The EPA guidance on discharges to groundwater (EPA, 2011) states that:

"For historical inputs (e.g. contaminated land or accidents/spills/losses) where pollutants, including hazardous substances, are known to have already entered groundwater and are causing pollution to a receptor, the examination and review process will determine the need for, and scope of, remediation that is appropriate for the situation, while considering technical feasibility and costs. "

For the Digby Bridge legacy landfill site, monitored natural attenuation is an appropriate option where it can be verified that extent of off-site migration and nature of off-site impact is limited. It is noted that there is a public water main supplying water to the residents living in proximity of the landfill, which mitigates a risk to water users which existed when groundwater sources were utilised.

To address SPR5 and SPR6 by monitored natural attenuation, an adaptive monitoring programme involving additional monitoring infrastructure and a programme of monitoring is recommended:

- To establish conclusively, from sampling, the distance downgradient where Drinking Water Standards or Groundwater Threshold Values/Interim Threshold Values are no longer exceeded;
- To confirm whether the downgradient springs/seeps and associated land drains may be hydraulically linked to the site; and
- To verify that existing private wells within groundwater pathways are not used for potable water, at least within the established distance of groundwater quality impact.

Additionally, further investigation is recommended:

- To verify if hydrocarbon compounds (which are classed as hazardous substances) are present in groundwater at the site;
- To build a database that allows for patterns and trends with regards to chemical loading and associated groundwater quality to be established; and
- To quantify seasonal groundwater level fluctuations and determine whether the waste mass becomes saturated (periodically or otherwise).

The recommendations have been tabulated and are presented in Table 3.

Table 3: Recommendations for Adaptive Monitoring of Groundwater

Recommendation	Detail	Comment
Onsite		
Routine sampling of leachates	Chemical sampling, including hazardous substances, quarterly	
Routine sampling of groundwater	Chemical sampling, including hazardous substances, quarterly	
Routine monitoring of groundwater levels	Quarterly measurement of water levels with a water level meter	Timed with wet or dry weather events to the extent possible.
Installation of pressure transducers (x4) in monitoring wells	Continuous recording of leachate and groundwater level fluctuations	One well at the upgradient site boundary One well at the downgradient site boundary One (leachate) well in the waste mass One groundwater well near the waste mass
Offsite		
Drilling and installation of off-site monitoring wells	Two nested well pairs (Gravel Formation / Rickardstown Formation) Two individual wells in the Gravel Formation One individual well in the Rickardstown Formation	At suitable locations between the site and Liffey. Will require landowner agreements. Placement of wells must consider the existence of potential off-site sources of pollution
Routine sampling of groundwater	Chemical sampling, including hazardous substances, quarterly	Duration and scope of sampling may be reduced in time depending on results
Initial sampling of the shallow springs and seep and land drains north of the Grand Canal	Chemical sampling assumed at three locations	Done during dry weather conditions so that the samples are not influenced by surface run-off.
Installation of pressure transducers (x2)	Continuous recording of groundwater level fluctuations	One well in Gravel Formation One well in Rickardstown Formation
Offsite reconnaissance and topographic survey	Ground-truthing of springs and seeps, as well as land drain details, to the north of the Grand Canal, with measurements of flow and other karst features in a wider area downstream of the site	One-time field activity

4.2 Preliminary Design of Groundwater Monitoring Compliance Wells.

We propose that seven new off-site monitoring wells are installed as shown with proposed specifications on Table 4. The monitoring wells should be installed in line with best practice (for example, Environment Agency, 2006). The locations of the proposed off-site wells are shown in Figure 3.

Table 4: Summary Evaluation of Options for Off-Site Monitoring Wells

MW-ID	Target	Proposed depth (m)	MW Internal Diameter	Easting	Northing
MW20(A)	Bedrock	20-25	50 mm	686969	724049
MW20(B)	Quaternary Sediments	10-15	50 mm	686971	724039
MW21	Bedrock	20-25	50 mm	687680	724295
MW22	Quaternary Sediments	10-15	50 mm	687209	723762
MW23(A)	Bedrock	20-25	50 mm	687241	723291
MW23(B)	Quaternary Sediments	10-15	50 mm	687235	723286
MW24	Quaternary Sediments	10-15	50 mm	687509	722673

We also recommend that during the works for the monitoring well installation, a level survey of the drains to the north of the Grand Canal is completed. This is because groundwater levels need to be verified against an up-to-date level survey of off-site drains, for future analysis.

As part of the Verification Plan (Section 2.3), the Ground Investigation Logs and Monitoring Well Completion Reports should be signed off by a competent professional hydrogeologist.

4.3 Adaptive Groundwater Monitoring Programme

As part of the Verification Plan, the proposed adaptive monitoring programme for groundwater is recommended to be undertaken quarterly until trends in the concentrations of the determinands in the leachate and the groundwater can be established. This is expected to take up to four years.

Groundwater level monitoring will have pressure transducers deployed on-site and off-site wells:

- In the on-site monitoring wells:
  - One pressure transducer in a upgradient well;
  - One pressure transducer in a downgradient well
  - One pressure transducer in a cross gradient well; and
  - One pressure transducer in a leachate well
- In the off-site monitoring wells:
  - One pressure transducer will be deployed in a well in the Gravel Formation; and
  - One pressure transducer will be deployed in a well in the Rickardstown Formation.

The monitoring programme will need to have hazardous substances and non-hazardous substances. The recommended list of determinands for testing and trigger levels will be agreed with the EPA. There will also need to be an agreement with the EPA for the duration of the monitoring programme. We recommend that the programme extends over a period of at least four years.

If it is found in due course that Trigger Values for determinands are being exceeded significantly and/or frequently, this may trigger further assessment which may recommend additional remedial options at site. These remedial options include by are not limited to:

- Pump and Treat System for Groundwater; and
- Installation of a Low Permeability Cap.

4.4 Cost Estimate for Adaptive Monitoring

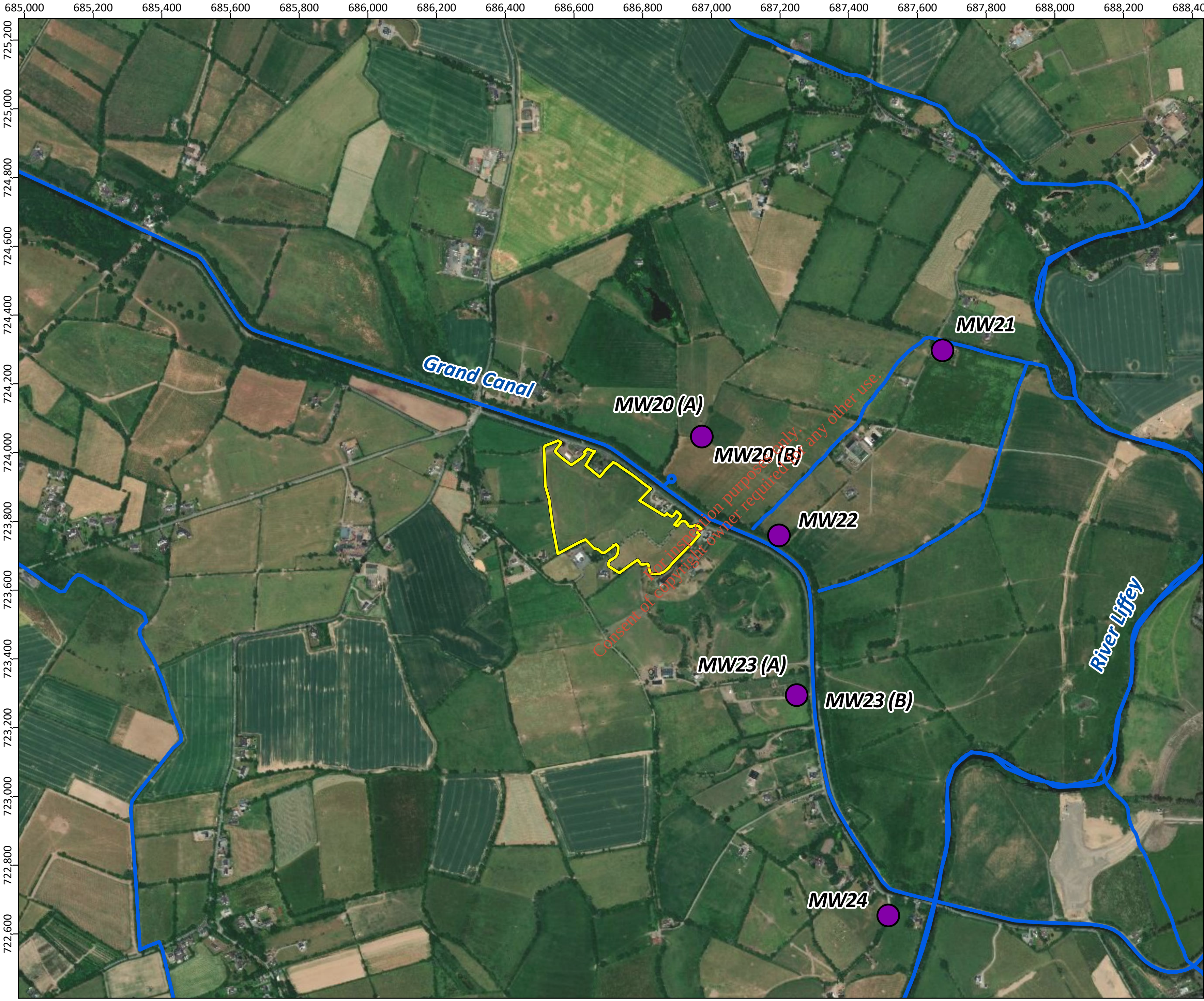
Table 5 presents a cost estimate for the preferred strategy for adaptive monitoring of groundwater. These are based on CDM Smith's experience of developing similar infrastructure, but actual costs will depend on public procurement and other factors. As discussed previously, new monitoring wells and a monitoring programme are recommended. The duration for which this permanent system will be required will be refined during detailed design and in consultation with the EPA, but it is estimated that it will operate for at least four years, and likely longer.

No allowance has been made for landowner compensation or land purchase.

All cost estimates are exclusive of VAT.

Table 5: Cost Estimate for Adaptive Monitoring of Groundwater

Item	Unit Cost	Estimated Cost €
Offsite Groundwater Boreholes		
Drilling Costs	20,000	
Design & Supervision & Reporting	12,500	
Additional Surveys	5,000	
Equipment (Pressure Transducers) & Deployment)	2,500	**40,000**
Monitoring		
Quarterly Groundwater Monitoring Reporting (3 nr per annum)	3,000	
Annual Groundwater Monitoring Reporting (1 nr per annum)	6,000	
Annual Monitoring Cost (assume 4 years)	15,000	**60,000**
TOTAL		**100,000**



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N W E S

Legend

Site Boundary

Proposed Monitoring Well

Streams

Coordinates are in Irish Transverse Mercator

Client: Kildare County Council

Consultant: CDM Smith

Project Code: 117838

Project: DIGBY BRIDGE

Drawing Title:

FIGURE 3: GROUNDWATER REMEDIAL PLAN

Drawn By:	Date:
SM	08/05/2020

Section 5 References

The principal sources of information and standards used for this report are as follows:

- European Communities, Council Directive on the Landfill of Waste (1999);
- Environment Agency (2004) Guidance on the management of Landfill Gas. LFTGN 03;
- Environment Agency (2006) Guidance on the design and installation of groundwater quality monitoring points. Science Report SC020093;
- Environmental Protection Agency (1997) Landfill Manuals: Landfill Operational Practices;
- Environmental Protection Agency (1999) Landfill Manuals: Landfill Restoration and Aftercare;
- Environmental Protection Agency (2000) Landfill Manuals: Landfill Site Design;
- Environmental Protection Agency (2003) Landfill Manuals: Landfill Monitoring;
- Environmental Protection Agency (2011) Management of Low Levels of Landfill Gas.

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