SHORE ROAD HISTORIC LANDFILL,

CLIFDEN, CO. GALWAY

APPLICATION TO EPA

FOR

CERTIFICATE OF AUTHORISATION

VOLUME III. SECTION D - PART A

TIER 3 FURTHER SITE INVESTIGATION & UPDATED RISK ASSESSMENT OF FORMER SHORE ROAD LANDFILL (24th March, 2021)

(VOLUME I - REPORT)

24th March, **2021**

GALWAY COUNTY COUNCIL

SHORE ROAD HISTORIC LANDFILL, SHORE ROAD, CLIFDEN, COUNTY GALWAY

TIER 3 FURTHER SITE INVESTIGATION & UPDATED RISK ASSESSMENT

VOLUME I. REPORT

24th March 2021

DOCUMENT ISSUE STATUS

REPORT ISSUE	REFERENCE NO.	DATE	
FINAL	326-02	24/03/21	

TITLE	NAME	POSITION	SIGNATURE	DATE
AUTHOR	Andrena Meegan	Project Manager	A. Meegan	24/03/21
MANAGING DIRECTOR	Padraic Mulroy	Project Director	Padraic Mulroy	24/03/21

TABLE OF CONTENTS

LIST OF TABLES

TABLE NO.	TABLE DESCRIPTION
1	Breakdown of Old Waste Landfilled at Shore Road Historic Landfill from 1920s to 1960s and Recent Construction and Demolition Waste Landfilled in 2018
2	Groundwater Vulnerability Mapping Guidelines
3	Results of Heavy Metal, Anion, TDS and Phenol Lab. Analysis on 10:1 Leachate from Soil Samples and TOC/LOI Lab. Analysis on Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway
4	Results of TPH-CWG, BTEX, Polyaromatic Hydrocarbon, PCB and pH (Total Pollutant) Laboratory Analysis on Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway
5	Results of Heavy Metals (i.e. Total Pollutant) Laboratory Analysis on Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway
6	Identification of Potentially Complete Pollutant Linkages

LIST OF FIGURES

LIST OF APPENDICES

APP. NO.	DESCRIPTION
1	Extracts of Various Planning Applications Submitted on Behalf of Clifden & District Community Council to Galway County Council for the Development of Shore Road Historic Landfill as a Public Park
2	EPA's Code of Practice: Environmental Risk Assessment for Unregulated Waste Disposal Sites Tier 1. Risk Screening & Prioritisation (Post-Site Investigation) Table A1.1. Results of S-P-R Linkage Prioritisation on Former Landfill at Shore Road, Clifden, County Galway (by Mulroy Environmental) Details of S-P-R Linkage Prioritisation on Former Landfill at Shore Road, Clifden, County Galway (by Mulroy Environmental)
3	Ordnance Survey Ireland Historical Aerial Mapping Google Earth Historical Mapping
4	2020 Site Investigation Trialpit Logs CDTP1-CDTP12 Trialpit Photographic Logs For CDTP1-CDTP12 (2020)
5	EPA/Teagasc Soil Mapping EPA/Teagasc Subsoil Mapping GSI Bedrock Mapping GSI Hydrogeological Mapping Clifden-Castlebar Groundwater Body (GWB) Report EPA Coastal Water Mapping EPA Surface Water Mapping WFD Catchment Mapping Flood Mapping
6	2014 Site Investigation Trialpit Logs
7	Table A7.1. Volatile Organic Compound (VOC) Laboratory Results on 10:1 Leachate from Soil Samples and TOC/LOI Lab. Analysis on Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway; and Table A7.2 Semi-Volatile Organic Compound (sVOC) Laboratory Results for Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway
8	Raw Validated Laboratory Results Chemtest Uk
9	HazwasteTool Online Report
10	Tier 2 Site Investigation & Risk Assessment Of Former Shore Road Landfill - Appropriate Assessment Screening Report, 2014

1 INTRODUCTION

1.1 Project Background

1.1.1 Site Investigation & Risk Assessment (2013/2014)

Following a meeting on the 18th March, 2013 with Tony McInerney, Senior Engineer and Tom Dunworth, Senior Executive Technician Galway County Council, Mulroy Environmental were instructed to prepare a fee proposal for a Tier 2 Site Investigation and follow up Generic Quantitative Risk Assessment (GQRA) of Shore Road Historic Landfill, Clifden, County Galway (see Figures 1 to 3 for site location and Plate 1 below). A Fee Proposal PRP214.05.04.2013 was submitted to Galway C.C. by Mulroy Environmental on 5th April 2013. Following the completion of the site investigation, a Tier 2 Site Investigation and Risk Assessment Report was submitted to Galway C.C. on the 16th May, 2014.

1.1.2 Intervening Period – 2014 to 2019

On the 13th September, 2019, Padraic Mulroy and Andrena Meegan of Mulroy Environmental Ltd. met with Mike Melody, Senior Engineer and Tom Dunworth, Senior Technician in the offices of Galway C.C. to discuss (among other items) the risk posed by Shore Road landfill and to ascertain what the necessary actions in order to prepare an application for a Certificate of Authorisation to the EPA (see Plate 1 below).

Plate 1. Aerial Photograph taken by UAV on the 29th June, 2020 at approximately 40m elevation over property to the north of the site facing due south towards the historic landfill site (note area of ground disturbance to the left (i.e. east) where the 2020 site investigation trialpits are visible).

Since the site investigation of 2014, it is understood that the following 3 broad areas of groundworks have been carried out on site. These are in chronological order the demolition of the former handball alley, the on-site illegal landfilling and the installation of 5 land drains on site to prevent ponding of surface water on site. These 3 areas are dealt with in detail in the following sections.

Handball Alley Demolition

It is understood that the handball alley which was located on the north-western corner of the site was demolished in 2018. The rubble from the handball alley which consisted of old stone masonry was broken up and used as infill in the immediate vicinity of the handball alley and site entrance to the north (see Plate 2 below).

Plate 2. Location of site where the former handball alley was located. The broken masonry from the handball alley was used as infill in this area.

Illegal Landfilling

It is understood that in the intervening period since the site investigation of 2013, that illegal landfilling of unprocessed C&D waste had occurred on site. It is understood that on 10th November, 2017, Clifden Community School, which is located to the south of Clifden in Ardbear on the Ballyconneely Road, was demolished. It is understood that the construction and demolition that resulted from this construction project was illegally landfilled at the subject site at Shore Road. It is understood that no segregation or sorting of the demolition waste was carried out on the school construction site and that the waste was removed from the school site and deposited on the Shore Road site in an unsorted state (see Plate 3 following). An RTE investigates program was broadcast on RTE on this subject on the 18th June, 2018.

It is estimated that approximately 2,788 tonnes of C&D waste which originated from the demolition carried out on the Clifden Community School in 2017 was imported to the site in November, 2017. Please see attached a table, Table 1 which shows the breakdown of the original domestic and C&D waste that was imported to the site from the 1920s to the 1960s and the C&D Waste that was landfilled on the site in November, 2018. The C&D Waste imported to the site was unsorted (see Plate 3 following). We understand that the waste was imported and placed on top of the existing topsoil capping layer in the north-eastern area of the site with the purpose of raising the land (i.e. as an aggregate substitute) to assist in the construction of the public park. Our understanding is that, under the instruction of Galway C.C., some processing of the waste was carried out on site which involved removing wood and other contaminants which were then taken off site. The stockpile was then spread out evenly in the north-eastern corner of the site (see Plate 4 following).

Table 1. Breakdown of Old Waste Landfilled at Shore Road Historic Landfill from 1920s to 1960s and Recent Construction and Demolition Waste Landfilled in 2018

WASTE TYPE	SOURCE	LANDFILL OPERATOR	YEAR(S) DEPOSITED	AREA (m^2)	AVERAGE DEPTH (m)	VOLUME (m^3)	DENSITY (kg/l)	WEIGHT (tonnes)
Old Domestic Waste	Clifden town & environs	Galway C.C.	1920s-1960s	1721	4	6884	1.5	10326
Old Construction & Demolition Waste	Clifden town & environs	Galway C.C.	1920s-1960s	1572	4	6288	1.8	11318
New Construction & Demolition	Demolition of Clifden Community School	Illegal landfilling	2018	1156	1.34	1549	1.8	2788

Plate 3. Photograph taken by Galway C.C. on the 13th November, 2017 showing the stockpile of C& D waste removed from the Clifden Community School construction site and illegally landfilled on the site

Mulroy Environmental carried out a desk top study on the planning files associated with the construction of the new community school. It is understood that asbestos was known to be present within the school and that a pre-demolition survey report was requested by Galway C.C. This report is not present within the planning files.

Plate 4. Photograph taken by Galway C.C. on the 14th November, 2017 showing the C& D waste spread out in the north-eastern corner of the site.

Land Drainage Works

In order to improve the drainage on site prior to constructing the public park, a series of 5 land drains were installed on site as part of the preliminary ground works. It is understood that planning permission was obtained by Clifden & District Community Council for these works in 2012 (see drawing for proposed works in Appendix 1). These land drains consist of stone-filled trenches with 225mm perforated twin wall drainage pipes with a gradient of north to south of approximately 1:100 (see Figure 6 and Plate 5 below).

Plate 5. Aerial Photograph taken by UAV on the 29th June, 2020 at approximately 40m elevation over helipad facing eastwards showing outline of 2 of the 5 land drains orientated in an approximate north to south direction (ie. left to right) and discharging into the estuary.

1.1.3 Further Tier 3 Site Investigation & Updated Generic Quantitative Risk Assessment (GQRA) (2020) for Certificate of Authorisation Application

Given the proposed end-use of the site as a public park and the potential for dermal contact by park users with contaminated construction and demolition waste from the school and/or inhalation of asbestos fibres from the afore-mentioned waste, it was concluded that a limited Tier 3 Further Site Investigation with Generic Quantitative Risk Assessment (GQRA) was necessary to determine the footprint and the risk associated with the C&D Waste imported from the Clifden Community School in 2018. The area to the northeast of the site where the infilling was carried out (i.e. as a result of the demolition of the importation of the Clifden Community School) required testing to assess the risk from the imported material. It was proposed that a minimum of 12 trialpits would be excavated across this area and that 6 samples would be taken of the C&D material/made ground/soil in this area to determine the material's waste classification. The primary purpose of the trialpitting was to assess the material imported and/or infilled on site and to determine if this material has contaminated the underlying soil on site. As such, each trialpit was excavated through the overlying infilled material/made ground as far as the underlying indigenous soil (i.e. up to 2.5m in total depth). It should be noted that this further site investigation work is interpreted as a Tier 3 Site Investigation and Updated Risk Assessment. This work was deemed necessary given the importation of the C&D waste from the demolition of the secondary school in 2018.

For the investigation of the school C&D area, a composite sample was taken from the excavated stockpile and the soil profile of each trialpit was logged to BS5930. Each sample was submitted for soil waste acceptance criteria testing by Chemtest UK and each sample was screened for asbestos. The following Tier 3 report presents the findings of the site investigation, soils analysis and a revised conceptual site model on the risk posed by the site to adjacent receptors with its propose end use in mind. It has been concluded that the field works carried out are sufficient to satisfy the requirements of the Certificate of Authorisation Application Process and that a Detailed Quantitative Risk Assessment (DQRA) is not required.

1.2 General Setting

The former Shore Road landfill site is located on the southern side of the Shore Road adjacent to the shore of Clifden Bay and is approximately 0.98 hectares (i.e. 9,800m^2) in area (see Figures 1, 2 & 3). According to Galway C.C., the former municipal landfill at Shore Road, Clifden, County Galway, was in operation from the 1920s to the late 1960s. It is understood that the site was capped and a football field was constructed in the 1970s. However, the football pitch became disused due to water logging. The site is currently disused and had been left fallow until the site investigation carried out in 2013. During this 40-50 year period, as there are no records, it is not clear how many tonnes of mixed waste including domestic and construction & demolition (i.e. C & D) were deposited on site by the people of Clifden and/or the local authority. As stated, the total site area is 10,138m^2. However, the results of the site investigation of 2014 indicated that an area of just 3,293m^2 was used for the deposition of waste i.e. domestic and construction & demolition (i.e. C & D) (see Plate 6 below). Taking an average waste depth of 4m, a total volume for the old waste landfilled on site (i.e. from the 1920s to 1960s) is conservatively estimated at 13,172m^3 (see Table 1 and approximated extent of waste zones in Figure 11). A review of historical 25-inch mapping indicates that the southern 2/3 of the site is located on land that was formerly a part of the estuary (i.e. it is reclaimed land). In 2013, the site was wet under foot during the site investigation with rushes the predominant vegetation on site (see Plate 6 below). In 2020, following the installation of the land drains there was a notable improvement in ground conditions.

Plate 6. Photograph taken in 2013 showing view of former Shore Road Landfill from north-eastern corner facing southeast

1.3 Surrounding Property

A number of public amenities are located along the site's western boundary. A public basketball court and adjacent playground is located on the western boundary of the site. A sailing club boat storage yard owned by the local sailing club and slipway is located on the south-western corner of the site adjacent to the shore (see Figure 3). A helicopter landing pad is located immediately adjacent to the south-western corner of the site. This is provided with an access road. A foulwater pumping station is located besides this access road (see Plates 7 & 8 following).

Plate 7. Aerial photograph taken at 5m elevation on western boundary of the landfill site in 2020 showing view of residence to northwest, basketball court, playground, sailing club yard and slipway

Plate 8. Aerial photograph taken at 30m elevation at north-western corner in 2020 showing view of basketball court, playground, sailing club yard, wastewater pumping station and helipad facing southwards

The site is located in a residential area with 4 residences located within 50m of the site's boundary (see Figure 3). Two of these residences are located approximately 10m to the north of the site's northern boundary, across the Shore Road (see Plates 9 & 10 following). Another residence is located to the northwest of the site (see Plate 7 above). This house is approximately 35m from the site boundary. Another residence is located further along the Shore Road 50m to the northeast of the site. Further housing exists just outside the 50m buffer, with a cluster of properties to the northeast, and a row of houses along the quay to the southwest of the site. The Clifden Town Hall, a public building, is located 36 meters northeast of the site's northern boundary. The site is bordered to the north by the Shore Road (i.e. also known locally as the Beach Road) which rises as it approaches the town centre. This road turns 90º to the south at the north-western corner of the site. As stated, the nearest residences to the site are located across this road to the northeast of the site (see Plate 9 following and Figure 3).

Plate 9. Photograph taken in 2013 Site Investigation showing view of nearest residences to northeast of site facing northwards towards Shore Road

As stated, another residence is located to the northwest of the site to the west of the afore-mentioned corner (see Plate 10). This house is approximately 35m from the site boundary.

Plate 10. Photograph taken in 2013 showing view of residences to northwest of site facing north-westwards towards Shore Road (note former handball alley which was demolished in 2018)

1.4 Site History

It should be noted that a review of historical 25-inch mapping indicates that the site is located on land that was formerly a part of the estuary. A review of historical 6-inch mapping indicates that the site was mostly mudflat with the high water mark (HWM) extending to an area just south of the former handball alley (see Plate 11 below). The surface water body to the northwest of the site can be seen to cross the mudflat in a south-easterly direction and discharge to the estuary.

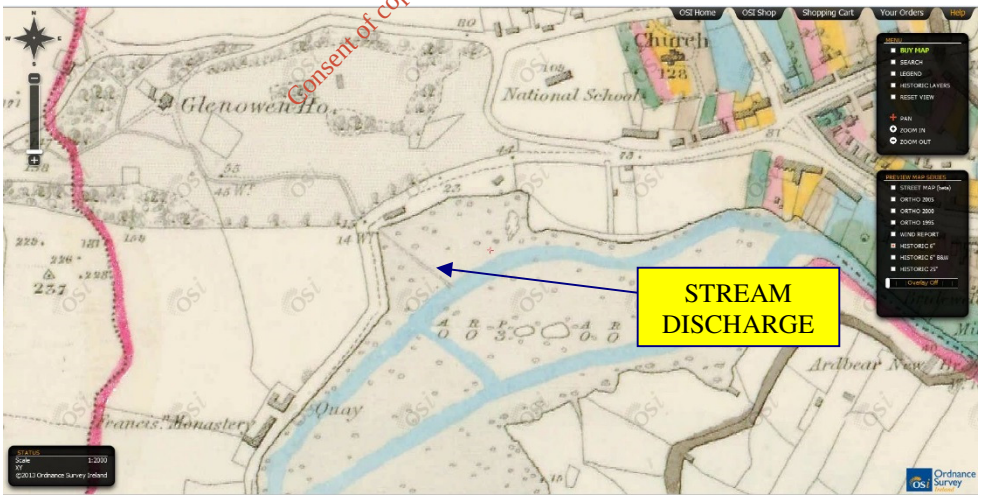


Plate 11. Historical 6-inch Ordnance Survey mapping showing location of surface water body passing through site

A review of historical 25-inch mapping indicates that the site was by 1900, infilled to almost 50% of its current footprint with the high water mark now being marked some 20m to the south of that shown on the 6-inch mapping. The location of the former handball alley to the northwest of the site is clear on the

25-inch mapping (see Plate 12 below). However, it should be noted that the location of the discharge point of the stream which enters the site at its northwest corner is now not clear.

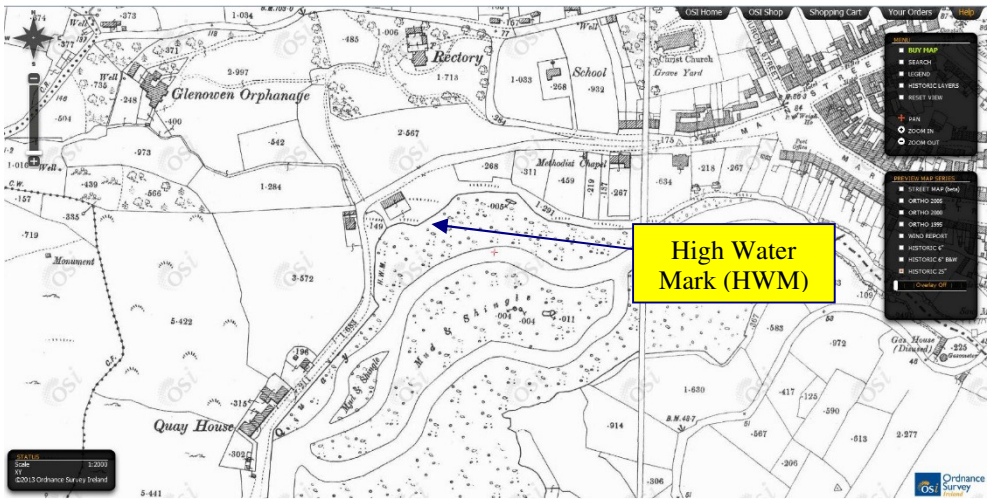


Plate 12. Historical 25-inch Ordnance Survey mapping showing location of new high water mark (HWM) (note position of former now demolished handball alley

As previously stated, it is understood that the site was capped in the 1970s. It is understood that the quay walls/rock armoury was constructed at this time and that no further waste was imported to the site afterwards as it was used as a football pitch by a local GAA club. A review of 1995 aerial photography shows that the site was completely capped at that time and that there appears to be no alteration to the topography of the site from 1995 aerial photography until 2018 when the handball alley was demolished and its broken masonry/demolition waste was used as infill at the site entrance. C&D waste was imported to the site in November 2018 following which the land drainage works were carried out (see Plate 13 below).

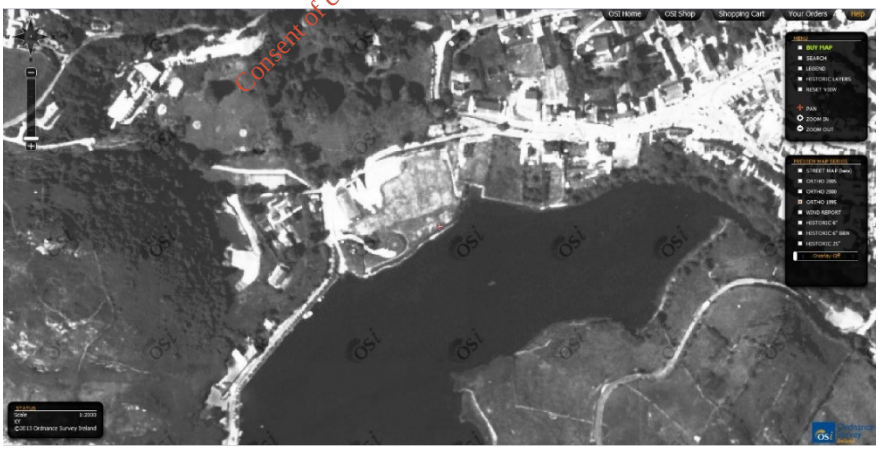


Plate 13. Historical 25-inch Ordnance Survey mapping showing final boundaries of site and Quay Wall

1.5 Underground Site Services passing through site or in vicinity of site

1.5.1 Culverted Stream & Stormwater Drainage

The Quay Wall to the south of the site appears to be constructed primarily as a rock armour and slopes at approximately 40-45° towards the estuary (see Plate 14 below). A stream from the uplands area to the west of the site is culverted under Shore Road at the north-western corner of the site. Please see Figure 5 for its existing route through the site (i.e. information provided by Local Area Engineer). This stream is culverted through the western side of the site and discharges at the south-western corner of the site. This stream also receives stormwater discharge from municipal storm sewers within Clifden Town (see Figure 5). The outfall of the discharge was inspected and no evidence of contamination was observed during the site investigation works of 2020. The hydrology of the site is covered in the following section, Section 4.8.

Plate 14. Aerial photograph at 30m elevation taken at south-western corner of site showing quay wall/rock armoury facing east-northeast. Note location of stream discharge point with non-return valve.

A number of flexible PVC agricultural land drains were encountered during the original site investigation in 2014. A disused concrete sewer (possibly storm or foul) was also encountered running in a north to south direction.

As stated previously, in order to improve the drainage on site prior to constructing the public park, five land drains were installed on site as part of the preliminary ground works in 2018. It is understood that planning permission was obtained by Clifden & District Council for these works (see drawing for proposed works in Appendix 1). These land drains consist of stone-filled trenches with 225mm perforated twin wall drainage pipes with a gradient of north to south of approximately 1:100 (see Figure 6 and previous Plate 5).

1.5.2 Foulwater Drainage

A foulwater gravity sewer collects foul water from upgradient properties in the Shore Road area and this sewer discharges to the wastewater pump station collection chamber (see Figure 7). Foulwater is then pump under a pressurised rising main through Clifden town to the wastewater treatment plant on the southern banks of Clifden Bay.

Plate 15. Aerial photograph taken at 30m elevation showing access manholes to foul sewer on concrete slabbing opposite site entrance.

1.6 Guidance Background & Preliminary Risk Assessment in 2013

No Tier 1 report was prepared for the Former Shore Road Landfill by Galway County Council. However, it should be noted that an 'in-house' Tier 1 Risk Assessment was carried out by Mulroy Environmental prior to the site investigation works in January, 2014. At this time, no information was available on the type of waste within the site, its age nor its position within the curtilage of the site. The results of this Tier 1 Risk Assessment indicated that the highest individual linkage proved to be for '*Leachate to SW*' at 70%. It should be noted that if the score is *'Greater than or equal to 70% for any individual SPR linkage'*, the Highest Risk (Class A) applies.

However, having carried out the site investigation in 2013 and having obtained more accurate information regarding the history of the site, a number of the '*Source Pathway Receptor Linkages*' were revised. The results of this revised assessment are summarised in Table A1.1 which summarises the results of *'S-P-R Linkage Prioritisation'* on the former landfill. The detailed rationale behind the in-house Tier 1 Risk Assessment are also given in Appendix 2.

As can be seen from Table A1.1 in Appendix 2, the highest individual linkage proved to be for '*Leachate to SW*' at 33%. It should be noted that if the score is *'Less than or equal to 40% for any individual SPR linkage'*, the Lowest Risk (Class C) applies. It should be noted that when each Local Authority carries out a Tier 1 Risk Assessment on their inventory of historic waste sites within their boundaries, typically a Lowest Risk (Class C) is regarded as requiring a low density (i.e. an exploratory) site investigation or no site investigation is required. Class C sites are not considered to pose a significant risk to the environment or human health. A verification report on the risk status of the site may be submitted as part of the regularisation process through an administrative system, which will be established for the purpose in the context of Section 22 of the Waste Management Acts, 1996 to 2005. While a Class C site is deemed not to pose a risk at the time of the evaluation a hazard may still be present.

It is critical, therefore that if there is a proposed change in land-use then a reappraisal of the risk, based on detailed site investigations, shall be carried out. All appropriate information shall be made available to the planning authority during the assessment of any planning application for a change in use.

Chapter 5 of EPA Code of Practice, Environmental Risk Assessment for Unregulated Waste Disposal Sites, 2007 deals with the Tier 2 Site Investigation and Testing process and reporting requirements. Following the findings of the trialpit site investigation, the scope of works was revised. The principle reasons for the reduction in the risk and subsequently the scope of works was the quantity of domestic waste identified during the site investigation, the age of the waste and the position of the waste on the southern boundary of the site (i.e. at a distance of greater than 50m downgradient from the nearest residence).

In 2013, given that there was no requirement to take soil samples or groundwater samples (i.e. via the installation of groundwater monitoring boreholes), there was no requirement to carry out a quantitative risk assessments as per Chapter 6 of EPA Code of Practice, Environmental Risk Assessment for Unregulated Waste Disposal Sites, 2007. As such, 14 trialpits were excavated in 2014 but no soil samples

were taken. The findings of the 2014 site investigation and risk assessment are presented in the previous *Tier 2 Site Investigation & Risk Assessment of Former Shore Road Landfill Report, 2014*.

Following the importation and landfilling of the construction and demolition waste on site, it was concluded that there was a possibility of the waste containing asbestos which may present an unacceptable risk to future users of the park and/or adjacent residences.

Prior to the commencement of the site investigation, a detailed walkover survey of the site was carried out with a view to determining where the C&D which originated from the school was deposited on site. It was concluded that this waste was deposited only in the north-eastern corner of the site.

The demolition waste (i.e. broken stone masonry) from the handball alley demolition was deposited in the vicinity of the site entrance, was deemed to be low risk and did not necessitate any investigation.

2 OBJECTIVES

The objectives of the further site investigation carried out in 2020 and the associated update to the risk assessment are as follows:

- To evaluate all potential liabilities associated with historic and more recent landfilling activities and/or current uses of the site, and their impact on soil and groundwater quality;
- To evaluate all potential liabilities associated with historic and more recent landfilling activities and/or current uses of the site, and their impact on surface water quality (i.e. Clifden Bay estuary);
- To evaluate all potential liabilities associated with historic and more recent landfilling activities and/or current uses of the site, and their impact on off-site residences and their residents; and
- If required, to make recommendations on the remediation of the site or mitigation measures to remove the afore-mentioned risks.

3 SCOPE OF WORKS

3.1 Task 1: Update Site Walkover & Desk Study

The Further Investigation work involved a review, an update (i.e. if necessary) and assessment of the following key information which was originally collated in 2013 and 2014:

- Site environmental setting in terms of geology, hydrogeology, hydrology and surrounding land use;
- Site history, specifically with respect to previous unrelated land uses and operations which may have formerly been conducted prior to the construction of the residential area (i.e. sand and gravel extraction, landfilling, etc);
- A review of the previously prepared Tier 1 Qualitative Risk Assessment of the waste body in accordance with the EPA's *'Code of Practice, Environmental Risk Assessment for Unregulated Waste Disposal Sites'* (see Appendix 2);
- The further site investigation work involved an updated walk-about survey of the site. The purpose of this was firstly to review the demolition of the handball alley and the area where its broken masonry was deposited (i.e. near the site entrance). The 2nd purpose was to review preliminary ground improvement works carried out on to improve the drainage of the site (i.e. the construction of the 5 land drains running from north to south and discharging into the estuary. The 3rd purpose was to identify 12 suitable locations within the north-eastern C&D waste deposition area for trialpitting. Padraic Mulroy of Mulroy Environmental conducted this site walkover on the 27th June, 2020.

3.2 Task 2. UAV 4K Drone Photogrammetric Survey & 4K Videos Survey

Due to the weather conditions at the site the site walkover on the 27th June, 2020, it was not possible to carry out the drone survey at that time. The drone survey was carried out after the site investigation was completed on the 29th June, 2020. This orthophotogrammetric survey of the site was carried out by Mulroy Environmental using a DJI Phantom 4 Drone equipped with a 4K camera and DroneDeploy licensed software/modelling service. This enabled the production of a grid referenced orthomosaic and a 3D model to aid in the interpretation of the site's topography. Previous mapping/historical photographs available from Ordnance Survey Ireland and Google Earth were used to determine the approximate extent of the original waste landfilled on site and the more recent C&D waste that originated from Clifden Community School (see Appendix 3). At that juncture, it was determined that the area where the school C&D waste was deposited was approximately 1,155m^2 (see Figure 6).

3.3 Task 3: Site Investigation

The site investigation programme was undertaken in accordance with the *British Standard BS 10175:2011 (Investigation of potentially contaminated sites – Code of Practice).* This enabled the site investigation programme to be undertaken in a systematic manner and provided details of a process of site investigations and interpretation methodology to characterise the geological and hydrogeological setting of the site.

The purpose of the trialpitting was to thoroughly assess the type and thickness of the C&D waste and/or indigenous soil on site, and subsequently the lateral and vertical extent of any contamination within the overburden within the waste deposition area.

It was proposed to subdivide the recent C&D deposition area of the site under inspection into an approximate '10m x 10m' grid. Given the area of the deposition area, it was concluded that 12 trialpits would be sufficient to investigate it thoroughly. Of the 12 trialpits, depending on visual observations during the excavation, 6 trialpits would be selected for soil sampling. This strategy is consistent with Section 7.6.2.5 of the *BS10175, Code of Practice for the Identification of Potentially Contaminated Land and its Investigation.* This section deals with sampling density for various types of suspected contaminated sites. Given the relative low risk of C&D waste and given that upper horizons containing asbestos may pose a risk to future users of the proposed public park, it was decided that a single composited sample of the upper 300mm of waste would be taken in each of 6 trialpits unless other evidence of soil contamination was identified within lower horizons of the infilled material. Trialpitting would be continued into the lower indigenous soil levels to determine if leachate from the infilled made ground had migrated vertically downwards and contaminated the underlying indigenous soils. The purpose of this is also to determine thoroughly the depth of made ground and also to determine the existence of possible lower levels of older made ground or waste introduced prior to the importation of the C&D waste.

Each of the 6 soil/waste samples were taken from the stockpile generated from each trialpit and an assessment was made for the presence of volatile organic compounds through headspace testing. A subsample of each composited soil sample was placed in a zip-lock bag and allowed to equilibrate for approximately 15 minutes. Following this, the headspace within the zip lock bag was measured using a MiniRae 2000 Photo-Ionisation Detector (PID) equipped with a 10.6eV bulb.

Existing autocad drawings of the existing layout and underground services in the area, and digital 2500 Ordnance Survey rasters were reviewed as part of the preliminary desk study work. As standard for a brownfield industrial site, all areas chosen for drilling/excavation were checked using a cable avoidance tool (CATSCAN). The 12 trialpits in the C&D waste deposition area were positioned in a manner to avoid damaging the newly installed land drains on site.

Following the completion of the trialpit logging and sampling, each soil and made ground layer was reinstated back into the trialpit in the correct order. Each horizon was compacted down thoroughly prior to proceeding with the next horizon. The location (i.e. 6 * 6 Irish national grid reference) of each of the 12 trialpits was recorded using a combination of Autocad 2017 topographical mapping and post-excavation a 4k aerial drone orthomosaic. Digital photographs were taken of each trialpit's soil profile and stockpile identifying any key components of the C&D waste encountered (see trialpit Photo Logs in Appendix 4). All digital photos were 'geotagged' to a 6 * 6 Irish national grid reference using a smart phone.

Detailed hydrogeological logging of subsurface media was carried out to *British Standard BS5930 Code of Practice for Site Investigations, 1999* and *BS 10175:2011, Code of Practice for the Identification of Potentially Contaminated Land and its Investigation, BS10175* (see trialpit logs for 2020 Site Investigation in Appendix 4). Any waste material encountered was assessed and identified with regard to the European Waste Catalogue and Hazardous Waste List, 2002.

If any suspected contaminated soil was identified during the exercise it was proposed to sample this as part of the composite sample and analyse for the Waste Acceptance laboratory suite. Samples were taken from the trialpit stockpile that was generated from the upper 300m of C&D waste in accordance with *British Standard BS10175:2011*. Samples were collected by hand using a fresh pair of disposable latex gloves for each sample. Trialpit logs were compiled for each trialpit in accordance with BS5930. Field notes on trialpits were then collated and inputted into Bentleys/Keynetix Holebase S.I. software to produce accurate trialpit logs in conformance with BS5930 and AGS formatting (see trialpit logs for 2020 Site Investigation in Appendix 4).

It should be noted that no visible asbestos containing materials (ACMs) were identified during the trialpitting exercise.

3.4 Task 4: Laboratory analysis of Soils

During the trialpitting exercise within the historic landfill, samples were collected into laboratory-supplied bottles and sent in suitably chilled coolboxes by courier to the laboratories of Chemtest Ltd (UKAS accredited laboratory). Precise sampling depth was recorded at each location, and strict chain of custody procedures adhered-to. In total, 6 soil samples were submitted for the following analyses. Following sampling, each sample was maintained at <4ºC in a freezer box using a combination of ice freeze packs and a mobile refrigeration unit prior to dispatch via overnight courier to the laboratories of Chemtest UK (UKAS Accredited) for laboratory analysis.

Each of 6 soil samples were analysed initially for the Inert Waste Acceptance Criteria (WAC) full laboratory suite which involves both 'Total Pollutant' analyses and CEN leachate extraction (i.e. 10:1 liquid to solid) followed by analysis of the leachate. It was also screened for the presence of asbestos fibres.

The laboratory analyses for the leachate was as follows:

- Heavy metals analysis (i.e. antimony, arsenic, barium, cadmium, total chromium, copper, lead, mercury, molybdenum, nickel, selenium & zinc);
- Sulphates;
- Fluoride;
- Chloride;
- Total Dissolved Solids (TDS)
- Total Phenols; and
- Dissolved Organic Carbon.

The Total Pollutant Analyses laboratory suite was as follows:

- Total Petroleum Hydrocarbons (TPH) – Core Working Group (CWG);
- Benzene/Toluene/Ethylbenzene/Xylenes (BTEX);
- Total & Seventeen Individual Polyaromatic Hydrocarbons (PAHs);
- Total PCBs;
- Total Organic Carbon (%) & Loss on Ignition;
- pH analysis;
- Heavy Metals on soil (i.e. Total Pollutant); and

- Chromium III/ Chromium VI Breakdown.

Each of the 6 soil samples were screened for Asbestos using Polarised Light Microscopy (PLM). All of the above analyses were carried out by Chemtest Ltd. in the United Kingdom. Chemtest Ltd. have UKAS accreditation for all of the above.

For 2 of the 6 soil samples, asbestos screening indicated that asbestos was present within the soil. Following this, gravimetric testing (i.e. on a % weight basis) carried out on these 2 soil samples.

For reasons of thoroughness, in addition to soil WAC analysis, all 6 soil samples were tested for Volatile Organic Compounds (VOCs) and Semi Volatile Organic Compounds (SVOCs) analysis.

3.5 Task 5: Data assessment & Reporting

Risk Assessment

A risk assessment is defined as a process of establishing, to the extent possible, the existence, nature and significance of risk. Risk is defined as the probability of the occurrence of, and magnitude of the consequences of, and unwanted adverse effect to a receptor.

There are 4(no.) stages involved in a risk assessment:

1. *Hazard Identification* – This will involve identifying contaminants of concern and will be achieved through a program of site investigation works and environmental monitoring;
2. *Hazard Assessment Stage* - This stage involves the development of a Conceptual Site Model;
3. *Risk Estimation Stage* – A Quantitative Risk Assessment is undertaken as part of this stage to determine risks to human health, groundwater and surface water; and
4. *Risk Evaluation Stage* – This stage involves recommendation of remedial works.

Conceptual Model

The risk to the surrounding environment was assessed based on the geological and hydrogeological information gathered through the site investigation programme. This information was used to develop a conceptual site model of the underlying environment, in terms of identifying potential contaminants, pathways and sensitive receptors.

A conceptual model is defined as a textual and/or schematic hypothesis of the nature and sources of contamination, potential migration pathways (including description of the ground and groundwater) and potential receptors, developed on the basis of the information from the preliminary investigation and refined during subsequent phases of investigation. The development of a conceptual model is an essential base component of the risk assessment process. The development of a conceptual model is an iterative process, which is progressively refined based on additional focused investigations.

The results of site investigations and the development of a conceptual model should define all known aspects of the site that could impinge upon or affect the overall environment. The conceptual model is based on the hazard – pathway – receptor concept, where:

- A hazard represents the inherently dangerous quality of a substance, procedure or event;
- A pathway is a mechanism or route by which a contaminant comes in contact with, or otherwise affects, a receptor; and
- A receptor is a human being, living organism, ecological system, controlled waters, atmosphere, structures and utilities that could be adversely affected by the hazard. Surface water channels and springs are also considered to be sensitive receptors as the groundwater environment may provide baseflow to these features.

GENERIC QUANTITATIVE RISK ASSESSMENT OF SOILS TAKEN FROM TRIALPITS

A Generic Quantitative Risk Assessment uses relevant generic assessment criteria (GAC) (i.e. values which are generally applicable to an entire class or group e.g. based on proposed future land use) or guidelines. To assess risk from contaminated soil, Mulroy Environmental used the following GAC for soils:

Mulroy Environmental used the following GAC for the soil samples taken from the C&D Waste deposition area:

- *National Institute of Public Health and the Environment of The Netherlands - The Soil Protection Guidelines (Dutch Criteria*) – Intervention and Target Values; [3]
- *UK DEFRA C4SLs, 2015* – Public Open Space 1 (Residential) for 1% Soil Organic Matter – Given that the topsoil is located in a publicly available green space within a residential development, this category was chosen. The 1% SOM was selected based on % organic matter results obtained for the 2 topsoils; [1] and
- *LQM/CIEH Suitable for Use Levels (S4ULs) for Human Health Risk Assessment, 2015* – Public Open Space 1 (Residential) for 1% Soil Organic Matter – Given that the topsoil is located in a publicly available green space within a residential development, this category was chosen. The 1% SOM was selected based on % organic matter results obtained for the 2 topsoils. [2]

Soil laboratory results were compared to the following waste acceptance criteria (WAC) to determine the correct waste category for each soil sample:

- Waste Acceptance Criteria at IMS Waste Facility (WA 129-02) in Hollywood, Co. Dublin – Inert Waste Limit.[3]; and

[1] These GACs are Category 4 Screening Levels that arose out of the United Kingdom Department for Environment, Farms and Rural Affairs (Defra) revision of the Statutory Guidance for Part IIA of the Environmental Protection Act (1990). The revision identified a new four category approach for classifying land affected by contamination. Category 4 represents land that would not meet the requirements for classification as contaminated under Part IIA of the Environmental Protection Act.

[2] The S4ULs follow on from the previous LQM/CIEH Generic Assessment Criteria (1st and 2nd editions), which were widely used by many local authorities and private sector practitioners. The S4ULs represent updated assessment criteria in line with recent developments in UK human-health risk assessment practice, including the additional land uses and exposure assumptions presented in Defra's recent C4SL guidance. However, unlike the C4SLs, the S4ULs are all based on Health Criteria that represent minimal or tolerable levels of risks to health as described in the Environment Agency's SR2 guidance, ensuring that the resulting assessment criteria are 'suitable for use' under planning. Assessment Criteria were derived for 89 substances (including SGV substances except lead and PCBs/dioxins). (Copyright Land Quality Management Limited reproduced with permission, Publication Number S4UL3757. All rights reserved).

[3] The results of the soils analysis are compared to the values taken from Section A4 'Limit values for pollutant content for inert waste landfills' of Schedule A from the Waste Licence, WA 129-02 for the IMS Inert Landfill at Gormanstown, County Dublin. These include the 'Total Pollutant Content' limits and the 'L/S = 10 l/kg Limits'. The purpose of comparison with these limits is to determine if an inert landfill such as the landfill operated by Murphy Environmental would be capable of accepting contaminated soil from the site.

- Waste Acceptance Criteria at IMS Waste Facility (WA 129-02) in Hollywood, Co. Dublin – Increased Inert Waste Limits.[4]

In addition, for comparative purposes, the results of the analysis on the soil leachate, Total Metals, TPH-CWG, BTEX, PAH and PCB analysis were compared to Soil Trigger Values derived for Domain 7 of the GSI Mapping Database *'Geochemically Appropriate Levels for Soil Recovery Facilities'*. The Clifden area is within Domain 7 of the aforementioned map (see Plate 16 below). The Soil Trigger Values for heavy metals for Domain 7 are available in Table 3.3 of the EPA's *Guidance on Waste Acceptance Criteria at Authorised Soil Recovery Facilities* which was released in January, 2020.

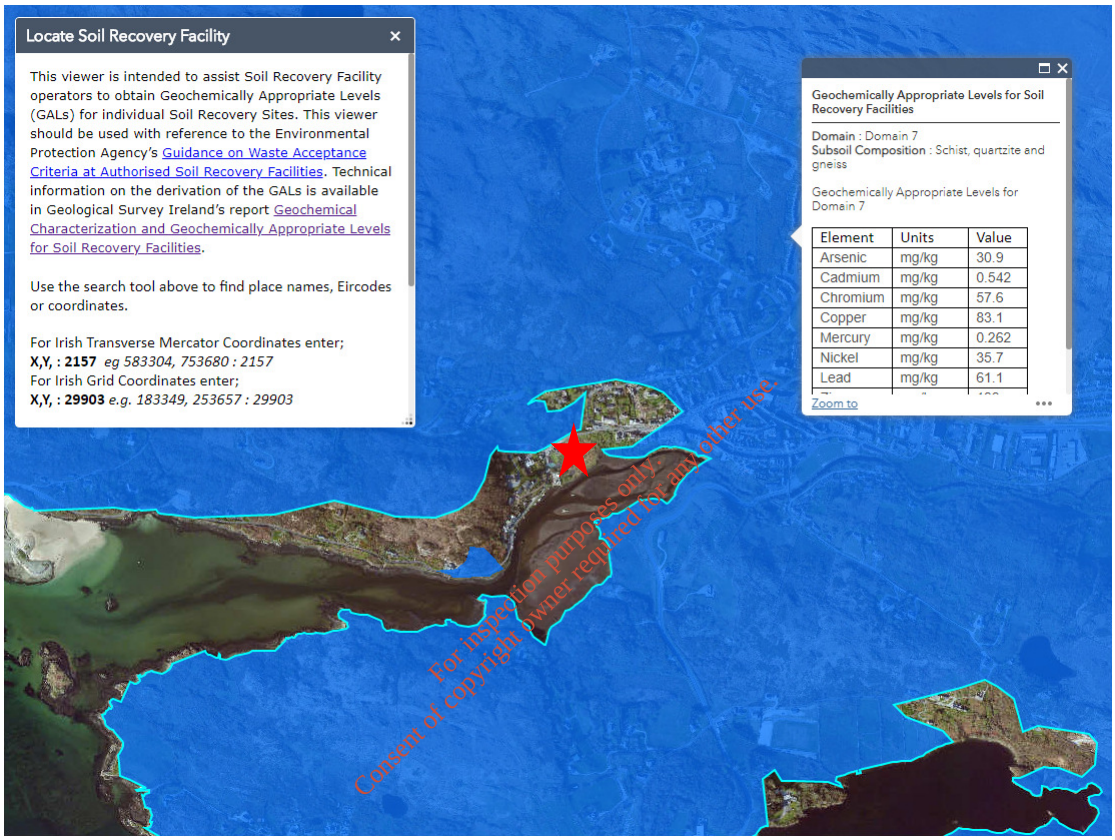


Plate 16. GSI Mapping 'Geochemically Appropriate Levels for Soil Recovery Facilities' showing '*Domain 7 – Schist, quartzite and gneiss*'

Although the material being examined is in effect a soil/C&D mix, it is felt that comparison of the results with these values is useful given that these values are used to determine if clean soil and subsoil from a greenfield site can be defined as a by-product under Article 27 of the European Communities (Waste Directive) Regulations 2011 and can be transferred to an Article 27 Soil Recovery Facility.

Following the collation of this data, it was necessary to carry out an analysis on the data using the Hazardous Waste Classification Tool to determine if the material required disposal as a hazardous waste (i.e. if the soil is hazardous or non-hazardous). This tool requires the input of data acquired for total metals, individual PAHs, total petroleum hydrocarbons and BTEX compounds in order to comply with the definition and characteristics of Non-Hazardous waste soil as defined by the Landfill Directive

[4] IMS Inert Landfill have been granted by the EPA the capacity to take in soil with heavy metals concentrations up to 3 times the inert WAC limits. A site specific Detailed Quantitative Risk Assessment is required by the EPA.

(1999/31/EC) and as stipulated for example, in the waste licence, WA165-02 currently in place at Ballinagran Landfill in County Wicklow.

Qualitative Risk Assessment

A qualitative risk assessment was undertaken to provide a basis for decision making, to ensure the continued safe habitation of the nearest off-site residences (i.e. to the northwest and northeast of the site) for the future safe use of the proposed park and to ensure that there will be no adverse impact to the environment particularly Clifden Bay estuary to the south of the site. A risk assessment is defined as a process of establishing, to the extent possible, the existence, nature and significance of risk. Risk is defined as the probability of the occurrence of, and magnitude of the consequences of, and unwanted adverse effect to a receptor.

There are 4(no.) stages involved in a risk assessment:

1. *Hazard Identification* – This will involve identifying contaminants of concern and will be achieved through the intrusive site investigation programme and the soil and groundwater sampling regime.

2. *Hazard Assessment Stage* - This stage involves the development of a Conceptual Site Model. Conceptual Models are described below.

3. *Risk Estimation Stage* – A Quantitative Risk Assessment is undertaken as part of this stage to determine risks to human health and the surface water and groundwater environments. The proposed Quantitative Risk Assessment for this contract is described in more detail below.

4. *Risk Evaluation Stage* – This stage involves recommendation of remedial works.

As stated previously, given the quantity, age and position of the waste within the curtilage of the site, it was concluded that a quantitative risk assessment, which would require soil and groundwater monitoring, was not merited.

4 ENVIRONMENTAL SETTING

4.1 Introduction

This section describes the site's environmental setting including the site's background (Section 4.2), topography and hydrology (Section 4.3), soil (Section 4.4), geology (Section 4.5) and hydrogeology (Section 4.6) of the area.

4.2 Site Background

As stated in the introduction, the site is located in an urban port area (see Figures 1 & 2). The former Shore Road landfill site is located on the southern side of the Shore Road adjacent to Clifden Bay and is approximately 0.98 hectares (i.e. 9,800m^2) in area. As can be seen from historical mapping, the majority of site was formerly tidal mudflat with the High Water Mark (HWM) being located in proximity to the former handball alley (i.e. now demolished). A public basketball court and adjacent playground is located on the western boundary of the site. A sailing club boat storage yard and slipway is located on the south-western corner of the site. A helicopter landing pad is located immediately adjacent to the south-western corner of the site. This is provided with by an access road. A pumping station is located beside this access road (see previous Plate 14).

As stated previously, according to Galway C.C., the former municipal landfill at Shore Road, Clifden, County Galway, was in operation from the 1920s to the late 1960s. It is understood that the site was capped and a football field was constructed in the 1970s. The football pitch became disused due to water logging. The site was disused and was left fallow until 2018 when the handball alley was demolished. In November, 2018 the C&D waste was deposited in the north-eastern corner of the site. Following this preliminary groundworks were carried out which entailed the installation of 5 land drains to alleviate the ponding of water on site.

During this 40-50 year intervening period, as there are no records, it is not clear how many tonnes of mixed waste including domestic, commercial and C & D were deposited on site by the people of Clifden and/or the local authority. As stated previously, the total site area is 9,800m^2. However, the results of the 2014 site investigation indicate that, at that point, an area of just 2,325m^2 was used for the deposition of waste (i.e. domestic, commercial and C & D). Taking an average waste depth of 4.5m, a total volume of waste was calculated at 10,500m^3 (see Figure 11). A review of historical 25-inch mapping indicates that the southern 66% of the site is located on land that was formerly a part of the estuary i.e. it is reclaimed land.

4.3 Topography

Given that the site is located in a harbour area, the overall regional gradient is from east to west (see Figures 1 to 3) towards the Atlantic Ocean. The existing site layout and its surrounding property is illustrated in Figure 3. However, it should be noted that the topographical survey illustrated in Figure 5 is now outdated as the land has been raised through the spreading of demolition rubble from the handball alley, the spreading of gravel originating from a local quarry over most of the site and preliminary groundworks and the introduction of 5 land drains. As stated, approximately 200m of unsorted sandy gravel from a local quarry was laid on top of the old clay cap in 2019. An updated topographical survey has not been carried out.

The existing site layout with topographical data is illustrated in Figure 5. The gradient on site is generally north to south. The highest point on site in 2014 was at an elevation of 10.14m AOD on a small area within the north-eastern corner. This position still stands. The lowest point still appears to be at 2.28m AOD on the southern boundary to the east of the helipad. It should be noted however that the afore-mentioned elevated area exists on site in the north-eastern corner which is over 6.5m higher than the land surface to the south and west. The elevation on the northern boundary of the site varies from 3.69m AOD on the western end of the site to 4.47m AOD towards the eastern end. This gradient from the northern boundary of the site to the southern boundary represents a gradient of 1:60.

4.4 Soils

4.4.1 Soil (Top Horizon)

The formation of topsoil is known as the 'pedogenic' process. Reference to the General Soil Map of Ireland, published by An Foras Talúntais (1980) indicates that the predominant or principal soil type in the area west of Clifden town are Peaty Podzols (75%) with Lithosols (15%) with and blanket peats (10%) mapped as secondary soils. The parent material for Soil Association 1 are granite and sandstone

A National Soil Mapping Project carried out jointly by the EPA and Teagasc have identified the northern footprint of the site as soil type: MADE (i.e. made ground). The southern half of the site does not appear to have been mapped but the findings of the site investigation would indicate that the lower southern half of the site should be classified as MADE also. The nearest soil type to the north is classed as AminDW (i.e. an Acid Brown Earths/Brown Podzolics (Deep Well Drained Mineral) soil) (see Appendix 3). The nearest soil type to the west is classed as AminSW (i.e. Lithosols/Regosols (Shallow Well Drained Mineral) soil.

Based on Mulroy Environmental's site-specific observations during the trialpitting exercise, the general classification for the area is considered appropriate for the site. The surface soils encountered in the north-eastern corner of the site would appear to be indigenous and consistent with Acid Brown Earths/Brown Podzolics,

4.4.2 Subsoil (Quaternary) Geology

The origin of the subsoil material in this region is associated with the movement and deposition from glaciers during the last Ice Age. The ice sheets ground down the underlying bedrock, breaking the rock

and grinding it to small sizes ranging from clays to boulders. The powerful erosive force of these ice sheets are considered to have moulded/sculpted the landscape in the area, with glacial features evident in the area. Glacial deposits in the area consist of tills, which were deposited at the base of moving glaciers, and to a lesser extent fluvio-glacial sand and gravels, which were deposited by glacial meltwaters.

The National Soil Mapping Project carried out jointly by the EPA and Teagasc have identified the northern footprint of the site as subsoil type: MADE (i.e. ground). The southern half of the site does not appear to have been mapped but the findings of the site investigation would indicate that the lower southern half of the site should be classified as MADE also. The nearest subsoil type to the north is classed as TMP (i.e. Metamorphic Till). The nearest subsoil type to the west is classed as Rck (i.e. Rock outcrop). In effect to the west of the site in upland areas, Lithosols/Regosols type subsoils lie directly on the bedrock (see Appendix 5).

Based on Mulroy Environmental's site-specific observations during the trialpitting exercise, the general classification for the area is considered appropriate for the site. The subsoils encountered in the north-eastern corner of the site would appear to be indigenous and consistent with Metamorphic Till (TMP).

4.5 Geology

4.5.1 Regional Geology

General information concerning the bedrock geology of the region is contained in the Geological Survey of Ireland (GSI) 1:100,000 scale Sheet No. 10 "Geology of Connemara and South Mayo" (see Appendix 5). The Clifden area is composed primarily of Precambrian Quartzites, Gneisses & Schists, Ordovician Metasediments and Silurian Metasediments and Volcanics. Precambrian Marbles cross cut the southern half of the Clifden area into two areas, at Clifden and Letterfrack.

The bedrock map indicates that Lakes Marble Formation (LM) underlies the southern 2/3 of the site (see Plate 17 below). This group consists essentially of limestones and calc-silicate granulites. The limestone which are commonly ophicalcites are bright green in colour and are well known as a beautiful decorative marble. The matrix of the rock is white calcite while the green discoloration is caused by chlorite and serpentine after diopside and tremolite.

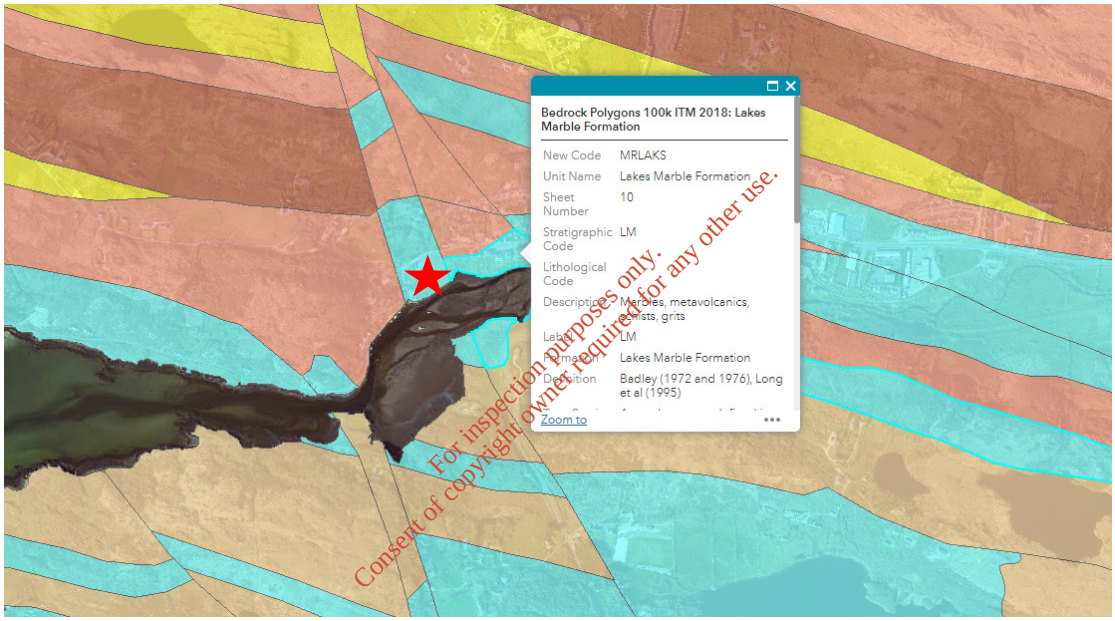


Plate 17. Regional geology mapping showing Lakes Marble Formation underlying under historic landfill site (blue polygon) with Streamstown Schist Formation (pink polygon) to the north.

Approximately 250m to the northwest of the site the Streamstown Schist Formation (ST) is located. This formation consists of Pre-cambrian quartzite, gneisses and schists.

Approximately 200m to the north of the site the Barnanoraun Schist Formation (BZ) is located. This formation consists of aluminous schists and hornblendic rocks.

A review of GSI geological records within 1km of the site revealed only 1 borehole record. This record which contains a map location is presented in Appendix 5. This borehole is a bored well approximately 960m to the northeast of the site. A total depth of 35m is given with bedrock at the surface. A poor yield class (i.e. 21.8m^3) was given. This yield would be expected for a poor aquifer such as that with the Streamstown Formation.

4.5.2 Site Geology

4.6.2.1 Subsoil/Made Ground in 2014 Site Investigation

In the original site investigation of 2014, seventeen trial pits were dug by Mulroy Environmental from the 20th to the 21st January, 2014. Trial pit depths varied between 1.5 and 4.2m below the ground level (i.e. depending on bedrock and maximum reach of the excavator) (see trialpit logs, TP1 to TP17 from the 2014 site investigation in Appendix 6 and see Figure 8). Only indigenous soil (i.e. the ground not disturbed) was found in 2 of a total of the 17 trial pit locations i.e. TP1 and TP2. In both of these trialpits a yellow/light brown sandy gravelly CLAY with boulders and cobbles was found to overlie loose grey/white coarse sandy GRAVEL.

In 15 of the 17 trialpits, a 0.2m thick horizon of soft light brown sandy CLAY acts as a 'Landfill cap'.

Varying thicknesses of a soft grey gravelly CLAY (MADE GROUND) was found under the clay cap in trialpits, TP3 to TP10.

Loose clayey gravelly COBBLES/ BOULDERS or GRAVEL were found in trialpits TP3, TP4 and TP7. These were found to lie directly on weathered bedrock.

In trialpits, TP3 to TP10, no waste or very little waste was observed.[5] However, the ground was classed as MADE GROUND as it was noted to have been disturbed with different soils imported and infilled on site. As stated previously, a number of shallow land drains (i.e. plastic and concrete) were observed on site.

Of the seventeen trial pits, construction and demolition WASTE (C&D) was encountered at trialpits, TP13, TP15, TP16 and TP17. This type of waste consisted mostly of builder's rubble, tarmac, concrete and some timber (see Appendix 6).

Of the seventeen trial pits, municipal solid waste (MSW)/commercial WASTE was encountered at 3 trialpits, TP11, TP12 and TP14. This waste was found to be composed of black plastic bin bag waste/ plastics, skip waste, residential, renovation waste, electric cables, timber shards, plastic and glass bottles, ash and cinder, rubber hosing, car parts, etc. It should be noted that negligible 'domestic waste-type odours' were observed at each of the 3 trialpits. The waste, although exhibiting sulphur staining and slight sulphide odours, gave no evidence of putrescible materials (i.e. a carbon source) still remaining within the waste. As such, it was concluded that the methanogenesis phase within the waste body had concluded. This is consistent with the age of the waste i.e. 40-50 years old (see Appendix 6).

The location of the domestic/commercial waste along the southern boundary of the site is consistent with local knowledge of the site i.e. that the waste was pushed out by bulldozer in the 1960s prior to being capped.

[5] *Where non-soil materials (e.g. wood fragments, masonry, etc.) are found within a subsoil matrix and where the volume would be less than 10% of the dominant matrix, the soil would be regarded as a MADE GROUND and not as a WASTE.*

4.6.2.1 Subsoil/Made Ground in 2020 Site Investigation of C&D Waste Deposition Area

In the June 2020 site investigation of the school C&D Waste Deposition area, 12 trial pits, CDTP1-CDTP12 were dug by Mulroy Environmental on the 29th June, 2020 (see trial pit logs in Appendix 4 and Figures 9 & 10). For this investigation it should be noted that reaching bedrock was not prioritised as sufficient information on bedrock depth had been acquired through the previous site investigation in 2014. Trialpitting at each location was terminated after undisturbed underlying indigenous soils were reached and assessed for any vertically downward migration of contaminants from the overlying made ground.

Trial pit total depth of excavation varied between 1.0 and 2.5m below the ground level (i.e. depending on the depth of the overlying made ground/C&D waste and depth to underlying undisturbed indigenous soils (see trialpit logs, CDTP1 to CDTP12 in Appendix 4). Made ground/C&D Waste/soil mix was identified at various depths in all 12 of the trialpits excavated within the C&D Deposition Area.

It was concluded that the waste found in 11 of the 12 trialpits was deposited in November 2018 and originated from the Clifden Community School. The southernmost trialpit, CDTP3 contained an older darker waste with bricks, ash and cinders which was more consistent with the domestic waste identified as part of the original investigation in 2014 (see Appendix 4). This waste was significantly deeper (i.e. 2.25m below ground level) than that waste found in the other 11 trialpits. It should be noted a review of the trialpit logs for the 2014 site investigation indicates that CDTP3 is quite close in proximity to trialpit TP14 which was excavated in the site investigation in 2014 (see Appendix 6). This trialpit, TP14 was also found to contain domestic waste (see Figures 8, 9 & 10).

Each of the 12 trialpits excavated was found to have an overlying layer of a soft to firm yellow/light brown sandy CLAY (MADE GROUND) which varied from 200m to 250mm thickness.

Beneath this sandy CLAY, an erratic mixture of construction and demolition waste and sandy gravelly CLAY was found to varying depths. The C&D waste consisted of blocks, concrete shards with and without rebar, large angular and subangular boulders, plastic/PVC pipes and plastic pipe shards, metal piping, electrical ducting, etc.

At each trialpit, a soil sample was taken in the MADE GROUND/C&D Waste horizon, examined for visual and/or olfactory evidence of contamination and tested for the presence of volatile organic compounds (VOCs)/hydrocarbons. This procedure involved placing the soil sample in a zip-lock bag for 15 minutes and following equilibration, testing the headspace testing using a MiniRae 2000 Photoionization Detector (PID). No visual or olfactory evidence of VOCs/hydrocarbons were noted during the examination of the 12 trialpits and all 12 headspace samples tested gave a '0' parts per million (ppm) result for Total VOC using the PID (see Appendix 4).

No visible Asbestos Containing Materials (ACMs) were identified during the inspection and sampling of the material excavated at each trialpit.

Indigenous undisturbed soil was found closest to the surface at trialpits CDTP12 (i.e. 0.5m bgl), CDTP8 (i.e. 0.75m bgl), CDTP2 (i.e. 0.8m bgl) and CDTP6 (i.e. 0.9m bgl). Indigenous undisturbed soil was found at its deepest at CDTP2 and CDTP7 where it was found at 2.25m bgl. In the other 7 trialpits, the depth to indigenous soil ranged from 1.5m to 1.75m bgl.

The indigenous soil was found to be consistently a soft to firm grey/black or grey/brown or green/brown sandy CLAY and showed some evidence of iron mottling which would be expected given the tendency of water to pond on the site in the past.

4.6.2.2 On-site Bedrock

In 2014, bedrock was encountered in 15 of the 17 trialpits and at its shallowest at approximately 1.5m below ground level (bgl) at TP1. Bedrock was found at its deepest at 3.95m bgl in TP12. In 2 of the trialpits, TP7 and TP8 bedrock was not encountered due to collapsing sides wherein trialpitting had to be halted for health and safety reasons (see Appendix 6).

Bedrock, as expected, sloped steeply from the northern end of the site towards the south with the trialpits on the northern end encountering bedrock from 1.5m to 2.10m bgl. As you move southwards, the depth to bedrock increased to 3.9 in TP6 and 3.5m bgl in TP10. This is equivalent to a gradient of 1:10 across the site.

The depth to bedrock found at the northern end of the site is consistent with the regional geology of the area with the presence of thin lithosols/regosols type soils overlying bedrock on upland areas to the west of the site.

No information on depth to bedrock was obtained during the 2020 site investigation.

4.6 Hydrogeology

4.6.1 General Hydrogeological Classification

The Lakes Marble Formation (LM), which underlies the site, and the adjacent Streamstown Schist Formation (ST) are classed as a '*Poor Aquifer - Bedrock which is generally unproductive except for local zones'* (see Plate 18 below).

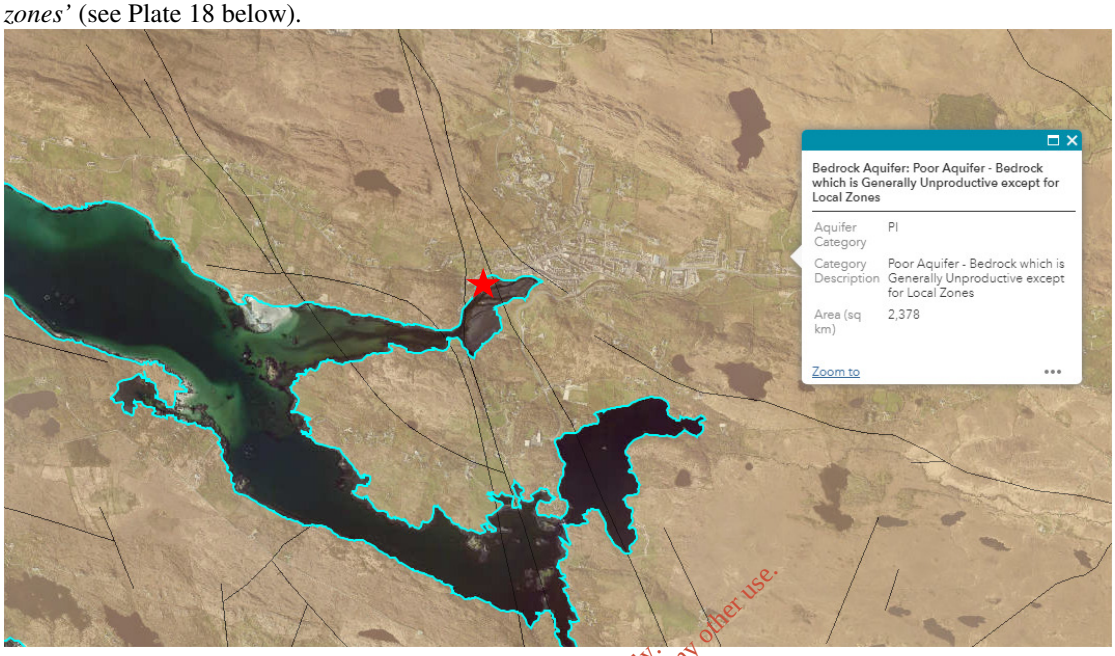


Plate 18. GSI Mapping showing Poor Aquifer (Pl) in Clifden Area

As stated previously, a review of GSI geological records within 1km of the site revealed only 1 record which is for a poor yield borehole 990m from the site which appears to be within the Streamstown Schist Formation (ST). Bedrock was found at the surface at this borehole.

The site is located with the Clifden Groundwater Body (see Appendix 5). This GWB is composed primarily of Precambrian Quartzites, Gneisses & Schists, Ordovician Metasediments and Silurian Metasediments and Volcanics. Most groundwater flux will be in the uppermost part of the aquifer; comprising a broken and weathered zone typically less than 3m thick; a zone of interconnected fissuring 10-15 m thick; and a zone of isolated poorly connected fissuring typically less than 150 m, in which strikes are noted between 40-50 m and 50-56 m below ground level in two boreholes near Louisburgh, but yields are from these isolated depths are low.

Well data are sparse in the GWB. Three boreholes located in the schists north of Clifden, at Glenbricken and Coolacloy, have reported yields of 33, 26 and 15 m^3/d with specific capacities of 15, 1.3 and 0.6 $m^3/d/m$ respectively. The data indicate low transmissivities – in the range of 0.7-20 m2/d. Two wells near Louisburgh also have similar yields and implied transmissivities. In the vicinity of faults, transmissivity may be higher. Storativity is expected to be low (<0.5%). The data are inadequate to calculate groundwater gradients, however, these are expected to be greater than 0.01 (see Appendix 5).

Subsoil thickness data are sparse. Available data indicate the thickness of the subsoils is generally less than 3m over the GWB. Subsoils are thicker in the low lying flatter areas of the GWB. The thickness of the blanket peat ranges from 0-6 m, depending on topography.

Diffuse recharge occurs via rainfall percolating through the subsoil and rock outcrops. Due to the low permeability of much of the subsoil (blanket peat) and the aquifers, a high proportion of the available recharge will discharge to the streams. In addition, the steep slopes in the mountainous areas promote surface runoff. The stream density is approximately 1.5 km/km^2, indicating the high proportion of surface runoff (see Appendix 5).

4.6.2 Groundwater Flow

Groundwater flow is most likely through the underlying overburden which consists of metamorphic tills and gravels and to a lesser extent through the underlying schist or marble bedrock. Groundwater follows the topography of the site and land to the south towards Clifden Bay. Probable groundwater flow direction is indicated on Figure 14. Groundwater flow is expected to be concentrated in fractured and weathered zones and in the vicinity of fault zones.

Shallow groundwater is likely to discharge to streams and lakes, but the limited bedrock transmissivity means that the baseflow component of the total streamflow will be low. Small springs and seeps are likely to issue at the stream heads and along their course. Seepages will develop on the coastal cliff faces.

Groundwater flow is expected to be concentrated in fractured and weathered zones and in the vicinity of fault zones. Generally, water levels are 0-8 m below ground level. Flow paths are likely to be short (30-300m) with groundwater discharging rapidly to nearby streams and small springs. There are observed deep water strikes, indicating that there is a component of deep groundwater flow, however shallow groundwater flow is dominant. Groundwater flow directions are expected to follow topography – overall in a westerly direction.

Groundwater will discharge locally to streams and rivers crossing the aquifer and also to small springs and seeps. Owing to the poor productivity of the aquifers in this body it is unlikely that any major groundwater - surface water interactions occur. Baseflow to rivers and streams is likely to be relatively low. Lakes comprise approximately 3% of the GWB.

4.6.3 Groundwater Vulnerability

Groundwater vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities. The vulnerability category is based on the relative ease with which infiltrating water and potential contaminants may reach groundwater in a vertical or sub-vertical direction. The permeability and thickness of the subsoil, which influences the attenuation capacity, are important elements in determining the vulnerability of groundwater.

The DoE-LG, EPA and GSI have produced guidelines on groundwater vulnerability mapping that aim to represent the intrinsic geological and hydrogeological characteristics that determine how easily groundwater may be contaminated by human activities. Vulnerability depends on the quantity of

contaminants that can reach the groundwater, the time taken by water to infiltrate to the water table and the attenuating capacity of the geological deposits through which the water travels. These factors are controlled by the types of subsoils that overlie the groundwater, the way in which the contaminants recharge the geological deposits (whether point or diffuse) and the unsaturated thickness of geological deposits from the point of contaminant discharge.

For vulnerability assessments with regard to bedrock aquifers the relevant geological layer is the subsoil between the release point of contaminants and the top of the bedrock. Any unsaturated bedrock layer is not considered as it is assumed that bedrock has little or no attenuation capacity due to its fissure flow characteristics. Groundwater encountered in low permeability glacial tills, or other non-aquifer subsoils, is not considered to be a target. Therefore, where low permeability subsoils overlie the bedrock it is the thickness of subsoil between the release point of contaminants and bedrock that is considered when assessing vulnerability of bedrock aquifers, regardless of whether the low permeability materials are saturated or not.

The DoE-LG, EPA and GSI vulnerability mapping guidelines allow for the assignment of vulnerability ratings from "extreme" to "low", depending upon the subsoil type and thickness. With regard to sites where both low and high permeability subsoils are present, the following thicknesses of unsaturated zone are specified:

Table 2. Groundwater Vulnerability Mapping Guidelines

VULNERABILITY RATING	HIGH PERMEABILITY (SAND/GRAVEL)	MODERATE PERMEABILITY (SANDY TILL, SUBSOIL)	LOW PERMEABILITY (CLAYEY SUBSOIL, CLAY, PEAT)
Extreme	0 – 3.0m	0-3.0 m	0 – 3.0m
High	>3.0m	3.0-10.0m	3.0 – 5.0m
Moderate	N/A	>10m	5.0 – 10.0m
Low	N/A	N/A	>10.0m

Groundwater Source Protection

The DoE-LG, EPA and GSI guidelines for Groundwater Protection Schemes allow for the combination of aquifer classification and vulnerability rating giving classifications of groundwater protection zones. The purpose of these zones is to place a control on the activities practised within a zone and thus provide protection to any underlying groundwater resources. Using DoE-LG, EPA and GSI criteria and the aquifer classification and vulnerability categories defined for the northern half of the site, a *Pl/H, 'Poor Aquifer with High vulnerability'* classification is assigned to the entire subject site (see Table 1 above and vulnerability mapping in Plate 19 following). It should be noted that the southern half of the site has not been given an aquifer class or a vulnerability rating. It should be noted that the *'Extreme'* vulnerability classification given by the GSI to the east of the site is most likely based on rock outcrops in this area.

Plate 19. GSI Mapping showing Aquifer Vulnerability in the Clifden Area (note site is most likely 'High Vulnerability' given depth of overburden on site and mapping to north)

It should also be noted that the a study carried out by the Western River Basin Management Body under the Water Framework Directive in 2008 has classed the 'Clifden' Groundwater Body, in which the site is located as *'2a – Probably Not at Risk'*.

4.7 Hydrology

The site is located in hydrometric area No. 32 and in the Erriff-Clew Bay Catchment. The site is located in Subcatchment Management Unit Bunnahowna_SC_010 and in the WFD Sub-basin OWENGLIN_030. As stated in the previous section, Section 1.5.1, the stream, which is identified as IE_WE_32O030300, flows towards the site from the uplands area to the west of the site and is culverted under the Shore Road. The original route of this stream is evident on 6-inch historical mapping shown on Plate 11. This stream is culverted through the western side of the site and discharges at the south-western corner of the site (see previous plate, Plate 14 and following Plate 20).

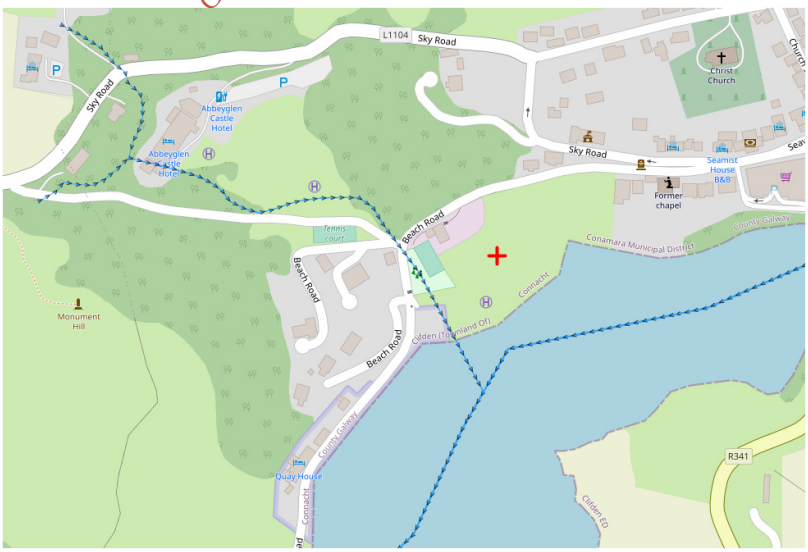


Plate 20. EPA hydrological mapping showing stream from upland area which is culverted through the western side of the site (please note that the route on the above map is incorrect) with Figure x being correct

The site although adjacent to Clifden Bay is located in the periphery of Owenglen-Dauros-Culin-Traheen-Coastal Catchment and is part of Hydrometric Area 32/Erriff Clew Bay of the Western River Basin District. Its Water Management Unit is West Galway.

As stated previously, a review of historical 25-inch mapping indicates that the site is located on land that was formerly a part of the estuary. A review of historical 6-inch mapping indicates that the site was mostly mudflat with the high water mark (HWM) extending to an area just south of the current handball alley (see Plate 5 previous). The surface water body to the northeast of the site can be seen to cross the mudflat and discharge to the estuary.

A review of historical 25-inch mapping indicates that the site was by 1900, infilled to almost 50% of its current volume with the high water mark now being marked some 20m to the south of that shown on the 6-inch mapping. The location of the former handball alley to the northwest of the site is clear on the 25-inch mapping (see Plate11 previous).

A review of flooding archives indicates that 2 flood events have occurred in the vicinity of the site. Both of these occurred on the Shore Road to the north of the site. An extract of the Local Area Engineer's report states *'C20. 5/6 Jan 1991– Exceptional storm caused tidal flood all along the coast'* (see Appendix 5).

A public beach is located 1.km to the west of the site. This beach has been classed by the EPA as having 'Poor Water Quality' (see Appendix 5).

A review of public records indicates that the Clifden Public Wastewater treatment plant is located 320m to the south of the site across the estuary. It is understood that this plant *'Failed due to lack of secondary treatment in operation'* (see Appendix 5).

A study carried out by the Western River Basin Management Body under the Water Framework Directive in 2008 has classed the *'Owenglin-Dauros-Culin-Traheen-Coastal Catchment'* Surface Water Body, in which the site is located as *'1a – At Risk'* (see Appendix 5).

The EPA have carried out biological monitoring approximately 510m upstream of the site at the Ardbear Old Bridge in Clifden since 2004. A biological quality value (Q-Rating) of 4 or *'Good'* overall status has been given by the EPA (see Appendix 5 for EPA monitoring point location). No detailed historical data on the Q-status of the river at the point was obtainable from the EPA website.

5 SOIL ENVIRONMENTAL RESULTS

5.1 Laboratory Suite & Generic Assessment Criteria

The results of laboratory analyses carried out by Mulroy Environmental on the 6 composite soil samples taken from the 6 selected trialpits are presented in the following 6 tables. Please note that Tables 2 to 4 are located within the body of the text while Tables A7.1 and A7.2 are located within Appendix 7:

- Table 3. Results of Heavy Metal, Anion, TDS and Phenol Lab. Analysis on 10:1 Leachate from Soil Samples and TOC/LOI Lab. Analysis on Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway (Parts A to C);
- Table 4. Results of TPH-CWG, BTEX, Polyaromatic Hydrocarbon, PCB and pH (Total Pollutant) Laboratory Analysis on Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway (Parts A to C);
- Table 5. Results of Heavy Metals (i.e. Total Pollutant) Laboratory Analysis on Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway;
- Table A7.1. Volatile Organic Compound (VOC) Laboratory Results on 10:1 Leachate from Soil Samples and TOC/LOI Lab. Analysis on Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway; and
- Table A7.2 Semi-Volatile Organic Compound (sVOC) Laboratory Results for Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway

The results in the above tables are laid out as far as achievable to determine compliance with the inert Waste Acceptance Criteria (WAC) as detailed in Section 3.5 of this report.

The raw validated laboratory results from Chemtest UK are located in Appendix 8.

Table 3. Results of Heavy Metal, Anion, TDS and Phenol Lab. Analysis on 10:1 Leachate from Soil Samples and TOC/LOI Lab. Analysis on Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway

CHEMICAL SUBGROUPING				Heavy Metal Leachate												Anions			TDS	Phenols	Organic/ Carbon Content of Leachate	Organic/Carbon Content of Soil (Total Pollutant)		EWC Codes	Confirmed Asbestos Free through Screening by Stereo Microscopy	Results of Gravimetric Analysis (%)	Asbestos Type	Soil Waste Classification
				Antimony Low Level CEN 10:1 Leachate	Arsenic Low Level CEN 10:1 Leachate	Barium Low Level CEN 10:1 Leachate	Cadmium Low Level CEN 10:1 Leachate	Chromium Low Level CEN 10:1 Leachate	Copper Low Level CEN 10:1 Leachate	Lead Low Level CEN 10:1 Leachate	Mercury Low Level CEN 10:1 Leachate	Molybdenum Low Level CEN 10:1 Leachate	Nickel Low Level CEN 10:1 Leachate	Selenium Low Level CEN 10:1 Leachate	Zinc Low Level CEN 10:1 Leachate	Sulphate CEN 10:1 Leachate	Fluoride in CEN 10:1 Leachate	Chloride in CEN 10:1 Leachate	Total Dissolved Solids	Total Phenols	Dissolved Organic Carbon	Total Organic Carbon (%)	Loss on Ignition				
Source	Units	WASTE CRITERIA		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	%					
IMS HOLLYWOOD WASTE LICENCE WA 0129-02	WAC Values	INERT WASTE		0.06	0.5	20	0.04	0.5	2	0.5	0.01	0.5	0.4	0.1	4	1000	10	800	4000	1	500	3	-					
IMS HOLLYWOOD, CO. DUBLIN W0129-02	WAC Values	INERT INCREASED LIMITS		0.18	1.5	20	0.04	0.5	2	0.5	0.01	1.5	0.4	0.3	4	3000	10	2400	12000	1	500	6	-					
EPA SOIL TRIGGER VALUES JANUARY 2020 - DOMAIN 7 SCHIST				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-					
SOURCE	SAMPLE ID	DATE OF SAMPLING	SAMPLE DEPTH (m bgl)																									
Soil/C&D Mix	SO-TP2-01	29/06/2020	0-0.3	<0.010	<0.050	<0.50	<0.010	<0.050	<0.050	0.087	<0.0050	<0.050	<0.50	<0.010	<0.050	340	2.0	23	1400	<0.30	280	1.2	4.3	17 05 04	N	0.083	Chrysotile bitumen	INERT
Soil/C&D Mix	SO-TP5-01	29/06/2020	0-0.3	<0.010	<0.050	<0.50	<0.010	<0.050	<0.050	<0.010	<0.0050	<0.050	<0.50	<0.010	<0.050	120	1.3	12	7800	<0.30	270	0.75	3.2	17 05 04	Y	N/A	-	NON-HAZARDOUS - Exceendance of TDS WAC Limit of 4000mg/kg
Soil/C&D Mix	SO-TP6-01	29/06/2020	0-0.3	<0.010	<0.050	<0.50	<0.010	<0.050	<0.050	<0.010	<0.0050	<0.050	<0.50	<0.010	<0.050	69	2.0	<10	1200	<0.30	210	1.1	4.2	17 05 04	Y	N/A	-	INERT
Soil/C&D Mix	SO-TP7-01	29/06/2020	0-0.3	<0.010	<0.050	<0.50	<0.010	<0.050	<0.050	<0.010	<0.0050	<0.050	<0.50	<0.010	<0.050	72	2.3	27	560	<0.30	270	0.68	3.6	17 05 04	Y	N/A	-	INERT
Soil/C&D Mix	SO-TP10-01	29/06/2020	0-0.3	<0.010	<0.050	<0.50	<0.010	<0.050	<0.050	<0.010	<0.0050	<0.050	<0.50	<0.010	<0.050	120	1.5	20	1300	0.68	300	1.4	1.3	17 05 04	Y	N/A	-	INERT
Soil/C&D Mix	SO-TP11-01	29/06/2020	0-0.3	0.027	<0.050	<0.50	<0.010	<0.050	<0.050	<0.010	<0.0050	<0.050	<0.50	<0.010	<0.050	210	2.1	16	1500	<0.30	170	1.3	4.1	17 05 04	N	0.16	Chrysotile bitumen	HAZARDOUS - Chrysotile bitumen >0.1% Volume/Volume

Notes:	
553	Values are in Purple bold wherever EPA Soil Trigger Values (January 2020) have exceeded
553	Values are in Red bold wherever IMS Waste Licence WA129-2 WAC Value is exceeded
553	Values are shaded yellow and in Red bold wherever IMS Waste Licence WA129-2 WAC increased limits Value is exceeded
~	'~' signifies laboratory analysis not carried out.
-	'-' signifies no Murphy Environmental Waste Licence WAC Value available.

5.2 Laboratory Results

5.2.1 Asbestos screening

It should be noted that of the 6 soil samples screened for asbestos, 4 of the samples were negative for asbestos fibres (i.e. NAD – No Asbestos Detected) (see Table 3).

Following the positive screening for asbestos in the soil samples taken from trialpits TP2 and TP11 (i.e. qualitative testing), gravimetric analysis (i.e. quantitative testing) was carried out to determine what volume of the overall volume of soil matrix the asbestos containing materials (ACMs) were (i.e. % volume).

The type of asbestos found in both soil samples was bitumen chrysotile. The concentration of chrysotile bitumen found in TP2 was 0.083% (i.e. Volume/Volume). The concentration of chrysotile bitumen found in TP11 was 0.16% (i.e. Volume/Volume).

5.2.2 Laboratory Results on Leachate

CEN leachate extraction (i.e. 10:1 liquid to solid) was carried out on each of the 6 soil samples in Table 3. It should be noted that only Waste Acceptance Criteria values are available for leachate concentration assessment and that no Dutch Criteria values, LQM/CIEH GACs or CLEA SGVs (i.e. 2009 or 2008) are available for leachate. The Waste Acceptance Criteria presented are for inert and the inert-increase limits which are in place in the IMS Facility in Hollywood, Co. Dublin (WA0129-02)

The results for TOC and LOI are also located in Table 3. These analyses are carried out directly on the soil (i.e. Total Pollutant).

Heavy Metals - As, Ba, Cd, Cr, Cu, Hg, Mo, Ni, Pb, Sb, Se and Zn

As can be seen from Table 2, none of the leachate samples that were prepared from the 6 samples when tested exceeded their respective Inert Waste Acceptance Criteria limit.

Sulphate

As can be seen from Table 3, for the 6 soil samples analysed, sulphates (SO_4^{2-}) were detected at levels ranging from 69mg/kg to 340mg/kg and these levels were significantly below their respective Inert Waste Acceptance Criteria limit of 1,000mg/kg.

Fluoride (F^-)

As can be seen from Table 3, for the 6 soil samples analysed, fluorides were detected at levels ranging from 1.3mg/kg to 2.3mg/kg and these levels were significantly below their respective Inert Waste Acceptance Criteria limit of 10mg/kg.

Chloride (Cl^-)

As can be seen from Table 3, for the 6 soil samples analysed, chlorides were detected at levels ranging from <10mg/kg to 27mg/kg and these levels were significantly below their respective Inert Waste Acceptance Criteria limit of 800mg/kg.

Total Dissolved Solids (TDS)

Of the 6 soil samples analysed, total dissolved solids (TDS) were detected within the leachate extracted from 1 of the samples above the inert WAC value of 4,000mg/kg (see Table 3). This soil sample was taken from trialpit, TP5 and TDS in the leachate was found at 7,000mg/kg.

Total Phenols

Total Phenol analysis was carried out on the leachate extracted from the 6 soil samples (see Table 3). No Phenols were detected within the leachate extracted from the 6 soil samples above the WAC limit of 1.0mg/kg. All levels were below the Limit of Detection (LOD).

Dissolved Organic Carbon (DOC)

As can be seen from Table 3, for the 6 soil samples analysed, Dissolved organic carbon (DOC) was detected at levels ranging from 170mg/kg to 300mg/kg and these levels were below their respective Inert Waste Acceptance Criteria limit of 500mg/kg.

5.2.3 Laboratory Results on Soil (Total Pollutant Analysis)

Total Petroleum Hydrocarbons (TPH)/Mineral Oil Total/Core Working Group (CWG)

As can be seen from Table 4, of the 6 samples analysed, hydrocarbons were detected in the soil sample from trialpit, TP6. The Total Aromatic fraction of 140mg/kg was found in the 'heavy' C16-C35 carbon range and the Total Aliphatic fraction (i.e. Mineral Oil) of 75mg/kg was found in the 'heavy' C16-C35 carbon range.

The total concentrations of aliphatics (i.e. Total Aliphatic/Mineral Oil) was 75mg/kg and as such, was significantly less than the inert WAC limit of 500mg/kg for mineral oil.

BTEX (Benzene, Toluene, Ethylbenzene, o-, m- and p-xylenes)

Of the 4 BTEX compounds analysed, none were detected in the 6 samples tested (see Table 4).

Methyl-tertiary Butyl Ether (MTBE)

MTBE was not detected in the 6 samples tested (see Table 4).

Polyaromatic Hydrocarbons (17 speciated including Coronene)

PAHs were detected in the 2 of the 6 samples. The concentration of Total PAHs found in the soil samples taken from TP2 and TP6 were 2.4mg/kg and 2.8kg/kg respectively. These levels are significantly less than the WAC limit of 100mg/kg for Total 17 PAHs (see Table 4).

Polychlorinated Biphenyls (PCBs - 7 congeners)

Total polychlorinated biphenyls (PCB) concentrations were below the limits of detection in all 6 samples (see Table 4).

Table 4. Results of TPH-CWG, BTEX, Polyaromatic Hydrocarbon, PCB and pH (Total Pollutant) Laboratory Analysis on Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway

CHEMICAL SUBGROUPING					Aliphatics									Aromatics								
GENERIC ASSESSMENT CRITERIA	Parameter				EC C5-C6	EC>C6-C8	EC>C8-C10	EC>C10-C12	EC>C12-C16	EC>C16-C35		EC>C35-C44	Total Aliphatics	EC C5-C7	EC>C7-C8	EC>C8-C10	EC>C10-C12	EC>C12-C16	EC>C16-C21	EC>C21-C35	EC>C35-C44	Total Aromatics
				% Organic Matter/Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
DUTCH CRITERIA CRITERIA	Dutch Intervention Levels (IV)				-	-	-	-	-	-	-	-	5000	-	-	-	-	-	-	-	-	-
	Dutch Target Level (TV)				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C4SL	Public Open Space 1 (Residential) (mg/kg)	C4SL	C4SL based on 6 % SOM but not sensitive to SOM so unlikely to change for other SOM %ages	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
				2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
				6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S4UL	Public Open Space 1 (Residential) (mg/kg)	LQM / CIEH, 2015	S4UL based on 6 % SOM but not sensitive to SOM so unlikely to change for other SOM %ages	1	570000	600000	13000	13000	13000	250000	250000	250000	-	56000	56000	5000	5000	-	-	-	-	-
				2	590000	610000	13000	13000	13000	250000	250000	250000	-	56000	56000	5000	5000	-	-	-	-	-
				6	600000	620000	13000	13000	13000	250000	250000	250000	-	56000	56000	5000	5000	-	-	-	-	-
KYLETALESHA, CO. LAOIS W0026-03 IMS HOLLYWOOD, CO. DUBLIN W0129-02 WALSHESTOWN RESTORATION, CO. KILDARE W0254-01	Inert WAC Values				-	-	-	-	-	-	-	-	500	-	-	-	-	-	-	-	-	-
IMS HOLLYWOOD, CO. DUBLIN W0129-02	INERT INCREASED LIMITS				-	-	-	-	-	-	-	-	500	-	-	-	-	-	-	-	-	-
EPA SOIL TRIGGER VALUES JANUARY 2020	SOIL TRIGGER VALUES - DOMAIN 7				-	-	-	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-
SOURCE	SAMPLE ID	SAMPLE DEPTH		DATE OF SAMPLING																		
Soil/C&M Mix	SO-TP2-01	0-0.3m bgl		29/06/2020	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0
Soil/C&M Mix	SO-TP5-01	0-0.3m bgl		29/06/2020	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0
Soil/C&M Mix	SO-TP6-01	0-0.3m bgl		29/06/2020	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	75	< 1.0	75	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	140	< 1.0	140
Soil/C&M Mix	SO-TP7-01	0-0.3m bgl		29/06/2020	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0
Soil/C&M Mix	SO-TP10-01	0-0.3m bgl		29/06/2020	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0
Soil/C&M Mix	SO-TP11-01	0-0.3m bgl		29/06/2020	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0

Notes:

Copyright:	Mulroy Environmental Ltd. are licensed to use 2015 'The LQM/CIEH S4ULs for Human Health Risk Assessment', "Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3484, All rights reserved", values above are calculated for 1% Soil Organic Matter in a sandy loam soil.
553	Values are in **Purple bold** wherever Soil Trigger Values have been exceeded (January 2020)
553	Values are underlined wherever Dutch-TV is exceeded
553	Values are shaded yellow and in Red **bold** wherever Dutch-IV and/or **Residential without consumption of homegrown produce** LIEH/LQM S4UL is exceeded
553	Values are in Blue **bold** wherever Dutch-IV and/or **Commercial** LIEH/LQM S4UL is exceeded
~	'~' signifies laboratory analysis not carried out.
-	'-' signifies no Dutch-IV and/or LIEH/LQM S4UL are available.

Table 4. Results of TPH-CWG, BTEX, Polyaromatic Hydrocarbon, PCB and pH (Total Pollutant) Laboratory Analysis on Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway

CHEMICAL SUBGROUPING					TPH		GROs								
GENERIC ASSESSMENT CRITERIA	Parameter				Total Petroleum Hydrocarbons	Mineral Oil	MTBE	Benzene	Toluene	Ethylbenzene	o-xylene	m-xylene	p-xylene	Total Xylene	TOTAL BTEX
				% Organic Matter/Units	mg/kg	mg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	mg/kg
DUTCH CRITERIA CRITERIA	Dutch Intervention Levels (IV)				-	5000	-	1000	130000	50000	-	-	-	25000	-
	Dutch Target Level (TV)				-	50	-	10	10	30	-	-	-	100	-
C4SL	Public Open Space 1 (Residential) (mg/kg)	C4SL	C4SL based on 6 % SOM but not sensitive to SOM so unlikely to change for other SOM %ages	1	-	-	-	140	-	-	-	-	-	-	-
				2	-	-	-	140	-	-	-	-	-	-	-
				6	-	-	-	140	-	-	-	-	-	-	-
S4UL	Public Open Space 1 (Residential) (mg/kg)	LQM / CIEH, 2015	S4UL based on 6 % SOM but not sensitive to SOM so unlikely to change for other SOM %ages	1	-	-	-	72	56000	24000	41000	41000	41000	41000	-
				2	-	-	-	72	56000	24000	42000	42000	42000	42000	-
				6	-	-	-	73	56000	25000	43000	43000	43000	43000	-
KYLETALESHA, CO. LAOIS W0026-03 IMS HOLLYWOOD, CO. DUBLIN W0129-02 WALSHESTOWN RESTORATION, CO. KILDARE W0254-01	Inert WAC Values				-	500	-	-	-	-	-	-	-	-	6
IMS HOLLYWOOD, CO. DUBLIN W0129-02	INERT INCREASED LIMITS				-	500	-	-	-	-	-	-	-	-	6
EPA SOIL TRIGGER VALUES JANUARY 2020	SOIL TRIGGER VALUES - DOMAIN 7				-	50	-	-	-	-	-	-	-	-	0.05
SOURCE	SAMPLE ID	SAMPLE DEPTH		DATE OF SAMPLING											
Soil/C&M Mix	SO-TP2-01	0-0.3m bgl		29/06/2020	< 10	< 10	<10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.010
Soil/C&M Mix	SO-TP5-01	0-0.3m bgl		29/06/2020	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.010
Soil/C&M Mix	SO-TP6-01	0-0.3m bgl		29/06/2020	210	75	<10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.010
Soil/C&M Mix	SO-TP7-01	0-0.3m bgl		29/06/2020	< 10	< 10	<10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.010
Soil/C&M Mix	SO-TP10-01	0-0.3m bgl		29/06/2020	< 10	< 10	<10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.010
Soil/C&M Mix	SO-TP11-01	0-0.3m bgl		29/06/2020	< 10	< 10	<10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.010

Notes:	
Copyright:	Mulroy Environmental Ltd. are licensed to use 2015 'The LQM/CIEH S4ULs for Human Health Risk Assessment', "Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3484, All rights reserved",
553	Values are in **Purple bold** wherever Soil Trigger Values have been exceeded (January 2020)
553	Values are underlined wherever Dutch-TV is exceeded
553	Values are shaded yellow and in Red **bold** wherever Dutch-IV and/or **Residential without consumption of homegrown produce** LIEH/LQM S4UL is exceeded
553	Values are in Blue **bold** wherever Dutch-IV and/or **Commercial** LIEH/LQM S4UL is exceeded
~	'~' signifies laboratory analysis not carried out.
-	'-' signifies no Dutch-IV and/or LIEH/LQM S4UL are available.

Table 4. Results of TPH-CWG, BTEX, Polyaromatic Hydrocarbon, PCB and pH (Total Pollutant) Laboratory Analysis on Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway

CHEMICAL SUBGROUPING					PAHs																		PCBs									
GENERIC ASSESSMENT CRITERIA	Parameter				Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(bk)fluoranthene	Benzo(j)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(123cd)pyrene	Dibenzo(ah)anthracene	Benzo(ghi)perylene	Coronene	Total 17 EPA PAHs	PCB Congener 28	PCB Congener 52	PCB Congener 101	PCB Congener 118	PCB Congener 138	PCB Congener 153	PCB Congener 180	PCB Total of 7 Congeners	pH Soil
				% Organic Matter/Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	mg/kg	pH Units
DUTCH CRITERIA CRITERIA	Dutch Intervention Levels (IV)				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Dutch Target Level (TV)				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C4SL	Public Open Space 1 (Residential) (mg/kg)	C4SL	C4SL based on 6 % SOM but not sensitive to SOM so unlikely to change for other SOM %ages	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
				2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
				6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S4UL	Public Open Space 1 (Residential) (mg/kg)	LQM / CIEH, 2015	S4UL based on 6 % SOM but not sensitive to SOM so unlikely to change for other SOM %ages	1	4900	15000	15000	9900	3100	74000	3100	7400	29	57	-	7.1	190	5.7	82	0.57	640	-	-	-	-	-	-	-	-	-	-	-
				2	4900	15000	15000	9900	3100	74000	3100	7400	29	57	-	7.2	190	5.7	82	0.57	640	-	-	-	-	-	-	-	-	-	-	-	-
				6	4900	15000	15000	9900	3100	74000	3100	7400	29	57	-	7.2	190	5.7	82	0.58	640	-	-	-	-	-	-	-	-	-	-	-	-
KYLETALESHA, CO. LAOIS W0026-03 IMS HOLLYWOOD, CO. DUBLIN W0129-02 WALSHESTOWN RESTORATION, CO. KILDARE W0254-01	Inert WAC Values				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-	-	-	1	-
IMS HOLLYWOOD, CO. DUBLIN W0129-02	INERT INCREASED LIMITS				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-	-	-	1	
EPA SOIL TRIGGER VALUES JANUARY 2020	SOIL TRIGGER VALUES - DOMAIN 7				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	0.05	-
SOURCE	SAMPLE ID	SAMPLE DEPTH		DATE OF SAMPLING																												
Soil/C&M Mix	SO-TP2-01	0-0.3m bgl		29/06/2020	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 2.0	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.10	8.0
Soil/C&M Mix	SO-TP5-01	0-0.3m bgl		29/06/2020	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 2.0	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.10	8.1
Soil/C&M Mix	SO-TP6-01	0-0.3m bgl		29/06/2020	< 0.10	< 0.10	< 0.10	< 0.10	0.14	< 0.10	0.42	0.38	0.18	0.19	0.29	0.29	< 0.10	0.29	< 0.10	< 0.10	0.26	< 0.10	2.4	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.10	8.2
Soil/C&M Mix	SO-TP7-01	0-0.3m bgl		29/06/2020	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 2.0	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.10	8.3
Soil/C&M Mix	SO-TP10-01	0-0.3m bgl		29/06/2020	< 0.10	< 0.10	< 0.10	< 0.10	0.35	0.12	0.54	0.55	0.22	0.19	0.27	0.27	< 0.10	0.22	< 0.10	< 0.10	0.13	< 0.10	2.8	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.10	8.4
Soil/C&M Mix	SO-TP11-01	0-0.3m bgl		29/06/2020	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.10	0.11	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 2.0	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.10	8.5

Notes:

Copyright:	Mulroy Environmental Ltd. are licensed to use 2015 'The LQM/CIEH S4ULs for Human Health Risk Assessment', "Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3484, All rights reserved", values above are calculated for 1% Soil Organic Matter in a sandy loam soil.
553	Values are in **Purple bold** wherever Soil Trigger Values have been exceeded (January 2020)
553	Values are underlined wherever Dutch-TV is exceeded
553	Values are shaded yellow and in Red **bold** wherever Dutch-IV and/or **Residential without consumption of homegrown produce** LIEH/LQM S4UL is exceeded
553	Values are in Blue **bold** wherever Dutch-IV and/or **Commercial** LIEH/LQM S4UL is exceeded
~	'~' signifies laboratory analysis not carried out.
-	'-' signifies no Dutch-IV and/or LIEH/LQM S4UL are available.

Volatile Organic Compounds (VOCs)

Fifty five volatile organic compounds were analysed for as part of the US EPA suite. No VOCs were detected in the 6 soil samples tested (see Table A7.1 in Appendix 7).

Semi-volatile Organic Compounds (sVOCs)

Forty seven volatile organic compounds were analysed for as part of the US EPA suite. No sVOCs were detected in the 6 soil samples tested (see Table A7.2 in Appendix 7).

Total Organic Carbon (%)

Of the 6 samples submitted for TOC analysis, all were significantly less than the inert WAC value of 3% (see Table 3).

Loss on Ignition (LOI)

Loss on Ignition (LOI) analysis was carried out on the 6 soil samples (see Table 3). Loss on ignition concentrations ranged from 1.3% to 4.3%.

Heavy Metals- As, Ba, Cd, Cr, Cu, Hg, Mo, Ni, Pb, Sb, Se and Zn

For the 6 samples, of the 12 metals analysed there was no exceedance of the relevant LQM/CIEH S4UL (Public Open Space/Residential Use) or C4UL Generic Assessment Criteria (Public Open Space/Residential Use) or Dutch Intervention Values (see Table 5).

There was however, for the soil sample taken from trialpit, TP11, a marginal exceedance of the Domain 7 level for zinc which is 122mg/kg. This exceedance (i.e. 130mg/kg) should be regarded as negligible.

pH

The pH for 6 samples analysed ranged from 8.0 to 8.5 (see Table 4). The normal pH for metamorphic tills in the Clifden area is slightly acidic. These moderately alkaline pH readings are quite possibly caused by liming (i.e. if the soil originated from landscaped topsoil from the school site) and/or the soil being mixed with alkaline concrete construction waste.

5.3 Summary of Laboratory Results

The results of the soil characterisation indicate low levels of hydrocarbons and polyaromatic hydrocarbons. These levels are significantly lower than their respective inert WAC limits. The lack of evidence of contamination in the field combined with headspace results would indicate that trace levels of diesel contamination is the source of contamination and/or possible the presence of ash within the soil.

It should be noted that the levels of hydrocarbons and PAHs identified in TP6 and TP10 within the soil (in conjunction with the low levels of Total Pollutant levels of heavy metals identified) are significantly lower than their respective *C4SL* and *S4UL Public Open Park – For Residential Use* Generic Assessment Criteria (GACs) values. These GACs have been derived for Public Parks which are located beside residential areas and used by families and young children (i.e. the risk sensitivity is regarded as high for this use) with dermal contact expected between users and the ground surface (i.e. children with soil and associated landscaping).

An elevated Total Dissolved Solids reading for the soil sample from TP5 exceeds its corresponding inert WAC limit. It should be noted that frequently elevated TDS is associated with elevated sulphates from cement run-off. Sulphate levels were low within the soil sampled in TP5. As such, 5 of the 6 soil samples can be classed as inert. The soil sample from TP5 shows no obvious evidence of elevated contamination.

Quantifiable levels of asbestos were detected in the soil samples taken from TP2 and TP11. Given the type of asbestos found (i.e. bituminous chrysotile), it is possible that this Asbestos Containing Material originated from the roof of the old Clifden Community College.

5.4 Hazardous Waste Assessment

An assessment of the hazardous properties of all 6 soil samples was conducted using the HazWasteOnline™ tool (see Appendix 9). The parameters assessed included the total heavy metals, speciated chromium, pH, individual PAHs, BTEX compounds, PCBs and TPH.

It should be noted that of the 6 samples examined, 5 were found to be not hazardous in nature. The sample taken from trialpit, TP11 was found to be hazardous due to the identification of quantifiable levels of asbestos (i.e. chrysotile bitumen). The volume of asbestos identified was found to be at 0.16% Volume/Volume which marginally exceeded the default hazardous limit set within the HazWasteOnline™ tool which is 0.1% Volume/Volume (or 0.1mg/kg).

It should be noted however that the HazWasteOnline™ tool does not differentiate between different types of asbestos e.g. white chrysotile asbestos, brown amosite asbestos and blue crocidolite asbestos. White chrysotile asbestos was manufactured by a number of historical Tegral manufacturing facilities in Ireland. It was used extensively in the 1970s and 1980s in the manufacture of roof slates and to a lesser extent in the manufacture of chrysotile bitumen. These materials were used extensively in the construction of roofs for farm, commercial and industrial buildings in Ireland. This type of asbestos is still very much present in historical industrial, commercial and farm buildings throughout Ireland and requires specialist removal when the demolition of these buildings is carried out. The general lack of public concern about this type of asbestos is principally down to its relative low risk in comparison to brown and blue asbestos which represent a far higher risk. The low risk of white asbestos is down to its general makeup where the asbestos fibres are 'locked in' and stabilised by the manufacturing process which involves cementation.

5.5 Conclusions

The soil laboratory results in conjunction with results of the HazWasteOnline Tool indicate that the risk associated from the trace levels of organic contamination found in TP5, TP6 and TP10 are negligible given the proposal to cover the site with landscaping and hardscaping.

However, given the proposed use of the site as a public park, it is possible that an unacceptable risk exists with regard to the potential for dermal contact between future users of the site and the construction and demolition waste deposited on the eastern end of the site.

All of the sources of contamination on site, their pathways and potential receptors are dealt with in the next section, which deals with a revised Conceptual Site Model.

Table 5. Results of Heavy Metals (i.e. Total Pollutant) Laboratory Analysis on Soil Samples taken from C+D Waste Area, Shore Rd. Historic Landfill, Clifden, Co. Galway

CHEMICAL SUBGROUPING					Heavy Metals (Total Pollutant)													
GENERIC ASSESSMENT CRITERIA	Parameter			% Organic Matter	Antimony Low Level	Arsenic Low Level	Barium Low Level	Cadmium Low Level	Total Chromium Low Level	Chromium (III) Low Level	Chromium (VI) Low Level	Copper Low Level	Lead Low Level	Mercury (Elemental) Low Level	Molybdenum Low Level	Nickel Low Level	Selenium Low Level	Zinc Low Level
	Units		Superceded		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
DUTCH CRITERIA CRITERIA	Dutch Intervention Levels (IV)				15	55	625	12	380	-	-	190	530	10	200	210	100	720
	Dutch Target Level (TV)				3	29	160	0.8	100	-	-	36	85	0.3	3	35	0.7	140
C4SL	Public Open Space 1 (Resi) (mg/kg)		N	1	-	79	-	-	-	-	21	-	630	-	-	-	-	-
S4UL	Public Open Space 1 (Resi) (mg/kg)		N	1	-	79	-	-	-	1500	7.7	12000	-	-	-	230	1100	81000
EPA SOIL TRIGGER VALUES	DOMAIN 7 (TABLE 3.3 OF GUIDELINES FOR DISPOSAL AT RECOVERY FACILITIES)				-	30.9	-	0.542	57.6	-	-	83.1	61.1	0.262	-	35.7	-	122
SAMPLE LOCATION	SAMPLE ID	DATE OF SAMPLING																
Soil/C&D Mix	SO-TP2-01	29/06/2020		1	< 2.0	12	64	0.14	29	29	< 0.50	18	18	0.17	< 2.0	30	< 0.20	160
Soil/C&D Mix	SO-TP5-01	29/06/2020		1	< 2.0	10	59	0.15	30	30	< 0.50	22	24	< 0.10	<2.0	27	0.35	100
Soil/C&D Mix	SO-TP6-01	29/06/2020		1	< 2.0	12	52	0.11	28	28	< 0.50	18	32	< 0.10	< 2.0	26	< 0.20	67
Soil/C&D Mix	SO-TP7-01	29/06/2020		1	< 2.0	15	67	0.11	32	32	< 0.50	26	33	< 0.10	<2.0	31	0.34	79
Soil/C&D Mix	SO-TP10-01	29/06/2020		1	< 2.0	15	54	0.15	34	34	< 0.50	26	41	0.19	< 2.0	30	0.21	120
Soil/C&D Mix	SO-TP11-01	29/06/2020		1	< 2.0	14	59	0.40	31	31	< 0.50	21	30	0.26	<2.0	27	< 0.20	**130**

Notes:

553	Values are in Purple bold wherever EPA Soil Trigger Values (January 2020) have exceeded
553	Values are underlined wherever Dutch-TV is exceeded
553	Values are shaded yellow and in Red bold wherever Dutch-IV and/or Public Open Space 1 (Residential)LIEH/LQM C4SL is exceeded
553	Values are in Blue bold wherever Dutch-IV and/or Public Open Space 1 (Residential) LIEH/LQM S4UL is exceeded
~	'~' signifies laboratory analysis not carried out.
-	'-' signifies no EPA 2020 Guideline Soil Trigger Value, Dutch-IV, LIEH/LQM S4UL or C4SL are available.

6 INVASIVE ALIEN PLANT SPECIES ON SITE & RECOMMENDATIONS

It should be noted that 2 invasive alien plant species were observed on site during the site investigation of June 2020 and shortly afterwards. The 2 plant species identified were Japanese Knotweed *(Reynoutria japonica)* and wild rhubarb (*Gunnera tinctoria*).

The Japanese Knotweed was found in a location adjacent to the fence on the south-eastern corner of the site (please see Plate 21 below). It should be noted that is not likely that the Japanese Knotweed was imported into the site with the landfilling of the school C&D waste in 2018 given its distance from the C&D waste area to the north. The primary risk from Japanese Knotweed is its capacity to cause structural damage through its root system. It is recommended that as part of the proposed landscape masterplan for the site that an Invasive Alien Plant Species (IAPS) Management Plan is drafted. It is recommended that a specialist subcontractor is employed to kill the Japanese Knotweed stands that have been identified over a period of time. This process may take 2-3 dosages. The preferred methodology is stem injection with glyphosate. Following this it may be possible to use a deep burial remedial solution on site. This process would involve excavating the Japanese knotweed and the surrounding soil and burying it on site in a 5m deep excavation using proprietary LLDPE root barrier membrane to cover all sides of the buried material and prevent the spread of its root system. This burial area would preferably be in area on site which will not be disturbed in the future (i.e. preferably a grassed area on site).

Plate 21. Aerial photograph taken at 30m elevation to the south of the site facing northwards towards south-eastern corner showing stands of Japanese Knotweed near boundary fence (see red makers). Note position of backfilled trialpits excavated in new C&D Waste Area approximately 15m away to the north.

It is unclear at this stage what are the most preferable methods to manage the wild rhubarb (*Gunnera tinctoria*) on site. It should be noted that Gunnera does not pose a risk to the structural integrity of a future cap or hardstanding on site. However, it can dominate other plants species and will spread rapidly during groundworks (i.e. ground disturbance) if uncontrolled in an area. The IAPS Management Plan for the site will require a methodology to deal with the Gunnera.

7 RISK ASSESSMENT & UPDATED CONCEPTUAL SITE MODEL

The conceptual site model (CSM) identifies sources of contamination, receptors that could be impacted together with pathways, termed potentially complete pollutant linkages that connect the two. When a potentially complete pollutant linkage is identified, an estimation of the risk should be made which may involve further investigation or risk assessment.

It should be noted that this conceptual site model looks again at all of the risks that were identified in the previous report given the 4 years that have passed. It also takes into account the risks posed by the introduction of the C&D waste from the demolition of Clifden Community College. Areas of this waste have been proven to be contamination with asbestos.

To recap, the key findings of the desk based review of ordnance survey historical mapping, geological, quaternary, hydrogeological and hydrological data and the trialpit investigation in 2014 were:

- The quantity of domestic waste identified during the site investigation was calculated at 10,500m^3. This quantity was significantly less than that expected and would be regarded as relatively small for closed/historic landfills;
- Consultation with local construction workers with a comprehensive knowledge of the site, indicate that most of the waste within the site is over 40 years old. This is consistent with the findings of the trialpit investigation that was carried out in 2014;
- The domestic waste is confined to the southern boundary of the site and is over 55m from the nearest house;
- The methane generating potential of the site's domestic waste has effectively disappeared given the age of the waste. The lack of landfill gas type odours during the site investigation indicated that methanogenesis within the site has long since ceased (i.e. most landfills cease to produce viable quantities of methane approximately 25 years after the importation of waste has ceased and the site has been capped);
- It is unlikely that any risk from methane gas to the residences to the northwest and northeast of the site exists given the lack of any evidence of landfill gas during the site investigation. It is unlikely that even in the event of significant disturbance of the waste in the southern half of the site, that a risk is posed by the site (i.e. there are no ground gases to migrate);
- Given that the site is effectively an infilled mudflat, the groundwater table on site fluctuates significantly with the tidal pattern within Clifden Bay (i.e. albeit following a lag period). It should be noted that this was observed during the site investigation in trialpits that were left open for 9 hours in the southern half of the site. The tidal effect on the waste material is significant in that it works to 'flush out' leachable contaminants which come into contact with the estuarine water table, effectively drawing contaminants into the estuary as the water table falls at low tide;
- The dilution of contaminants within Clifden Bay is very significant and any impact now posed by low levels of contaminants still leaching from the site would be regarded as negligible;
- The nearest protected site is pNHA/SAC No. 002031, The Twelve Bens/Garaun Complex (see Appendix 10 for Appropriate Assessment Screening Report carried out in 2014). This is the closest protected site to Shore Road landfill site, located approximately 266m hydraulically upgradient to the southeast of the site. Given that this site is upstream, even though Clifden Bay is tidal, as stated

previously, the dilution of contaminants within Clifden Bay would be very significant and as such, any impact now posed by contaminants on the upgradient protected site would be negligible;

Following the updating of the afore-mentioned desk based information in conjunction with the trialpit investigation and soils analysis in 2020, and the proposed use of the site as a public park, the key findings are:

- The soil laboratory results in conjunction with results of the HazWasteOnline Tool indicate that the risk associated from the trace levels of organic contamination found in TP5, TP6 and TP10 are negligible given the proposal to cover the site with landscaping and hardscaping. The proposed construction of the public park will introduce a surface water collection system and soft and hard (i.e. impermeable surfacing) which will impede rainfall and the generation of potential leachate from the new C&D waste introduced to the site; and
- However, given the proposed use of the site as a public park, it is possible that an unacceptable risk exists with regard to the potential for dermal contact between future users of the site and the construction and demolition waste deposited on the eastern end of the site which has been shown to contain asbestos. There is also the potential for inhalation of asbestos fibres originating from the C&D waste by future users of the park and/or construction workers carrying out groundworks on the site in future.

The following table, Table 5 is updated from the previous pollutant linkage table in the 2014 report and incorporates those findings of the 2020 investigation. Table 5 records the potential pollutant linkages that have been identified at the site. Justifications for the identification of a potential pollutant linkage together with the likelihood are also discussed in Table 5.

Table 6. Identification of Potentially Complete Pollutant Linkages (Part A-Landfill Gas)

SOURCE	PATHWAY	RECEPTOR	LINKAGE?
Potential Landfill gas generated by domestic waste to south of site	Lateral Migration via overburden or preferential pathways (i.e. underground services)	Residences to northwest and northeast of site	**Incomplete:** Landfill gas not present and distance to residents significant. No complaints by residents to Galway C.C.
		Basketball court, handball alley& playground users	**Incomplete:** Landfill gas not present and distance to public amenities significant
		Sailing club boat yard	**Incomplete:** Landfill gas not present and distance to yard significant
		Single borehole within 1km from site	**Incomplete**. Landfill gas not present and distance to well significant
	Vertical migration and inhalation of vapours	Future users of public park on site of former landfill for recreation (i.e. football, etc)	**Incomplete**. Any remaining vapours likely to migrate vertically and then dilute with air at the surface hence plausible pathway considered absent.

Table 6. Identification of Potentially Complete Pollutant Linkages (Part B – Old Domestic Waste)

SOURCE	PATHWAY	RECEPTOR	LINKAGE?
Potentially contaminated soil (not tested and contamination is hypothetical) or domestic waste identified in 2014 on the southern end of the site	Direct contact; ingestion, dermal contact and inhalation of dust and soils.	Residents of houses to northwest & northeast of site	**Incomplete.** Site currently covered in 200mm capping, plausible pathway absent. Public park will results in entire site being covered with soft and hardscaping so dermal contact with underlying waste is prevented. Residents not expected to come into contact with underlying soil or waste during routine activities.
		Livestock or ponies	**Incomplete.** Access to livestock is currently prevented and will be prevented in public park. Site is currently covered in 200mm capping, plausible pathway absent. Public park will results in entire site being covered with soft and hardscaping.
		Future construction workers	**Incomplete.** Construction workers may come into contact with site soil and/or waste during intrusive works. However the use of suitable PPE and good hygiene measures should mitigate risks posed through this pathway.
	Leaching and subsequent migration	Adjacent culverted stream on western boundary	**Incomplete:** Short section of stream potentially in contact with domestic waste is unlikely to be impacted currently due to the age of the waste and effect of tidal flushing of contaminants. Stream discharges to Clifden Bay to the south of the site. The generation of leachate has been reduced due to the construction of the 5 land drains which are removing ponded water from the site and discharging directly to the estuary.
		Groundwater in Poor aquifer	**Incomplete:** Waste is outside of aquifer and is tidally effected (i.e. brackish). The generation of leachate has been reduced due to the construction of the 5 land drains which are removing ponded water from the site and discharging directly to the estuary.
		Groundwater (shallow) body within superficial sand & gravel deposits	**Incomplete:** Waste is outside of aquifer and is tidally effected (i.e. brackish). The generation of leachate has been reduced due to the construction of the 5 land drains which are removing ponded water from the site and discharging directly to the estuary.
		Clifden Bay	**Incomplete:** Contaminants within waste have most likely dissipated to negligible level. Dilution within Clifden Bay likely to be very significant. SAC is hydraulically upgradient of the site. The generation of leachate has been reduced due to the construction of the 5 land drains which are removing ponded water from the site and discharging directly to the estuary.
		Boreholes within 1km site; closest 990m upgradient to the northeast of the site	**Incomplete**. Plausible pathway absent due to distance and direction of groundwater flow.

Table 6. Identification of Potentially Complete Pollutant Linkages (Part C – C&D Waste-TDS)

SOURCE	PATHWAY	RECEPTOR	LINKAGE?
Total Dissolved Solids (TDS) contaminated soil in C&D Waste deposited in 2018 on north-eastern end of the site (TDS only exceedance of Inert WAC value)	Direct contact; ingestion, dermal contact and inhalation of dust and soils.	Residents of houses to northwest & northeast of site	**Incomplete.** Site currently covered in 200mm capping, plausible pathway absent. Public park will results in entire site being covered with soft and hardscaping so dermal contact with underlying waste is prevented. Residents not expected to come into contact with underlying soil or waste during routine activities.
		Livestock or ponies	**Incomplete.** Access to livestock is currently prevented and will be prevented in public park. Site is currently covered in 200mm capping, plausible pathway absent. Public park will results in entire site being covered with soft and hardscaping.
		Future construction workers	**Incomplete.** Construction workers may come into contact with site soil and/or waste during intrusive works. However the use of suitable PPE and good hygiene measures should mitigate risks posed through this pathway.
	Leaching and subsequent migration	Culverted stream on western boundary	**Incomplete:** Stream is a significant distance from the C&D Waste Deposition area and lateral migration of possible leachate is not likely. The generation of leachate has been reduced due to the construction of the 5 land drains which are removing ponded water from the site and discharging directly to the estuary.
		Groundwater in Poor aquifer	**Incomplete:** Waste is outside of aquifer and is tidally effected (i.e. brackish). The generation of leachate has been reduced due to the construction of the 5 land drains which are removing ponded water from the site and discharging directly to the estuary.
		Groundwater (shallow) body within superficial sand & gravel deposits	**Incomplete:** Waste is outside of aquifer and is tidally effected (i.e. brackish). The generation of leachate has been reduced due to the construction of the 5 land drains which are removing ponded water from the site and discharging directly to the estuary.
		Clifden Bay	**Incomplete:** Contaminants causing TDS exceedance within C&D waste will not impact on Clifden Bay as dilution in estuary is likely to be very significant. SAC is hydraulically upgradient of the site. The generation of leachate has been reduced due to the construction of the 5 land drains which are removing ponded water from the site and discharging directly to the estuary.
		Boreholes within 1km site; closest 990m upgradient to the northeast of the site	**Incomplete**. Plausible pathway absent due to distance and direction of groundwater flow.

Table 6. Identification of Potentially Complete Pollutant Linkages (Part D–C&D Waste - Asbestos)

SOURCE	PATHWAY	RECEPTOR	LINKAGE?
Asbestos contaminated soil in C&D Waste deposited in 2018 on north-eastern end of the site	Direct contact; ingestion, dermal contact and inhalation of dust and soils.	Public park users	**Potentially Complete.** Site currently covered in 200mm capping, plausible pathway absent. Public park will results in entire site being covered with soft and hardscaping so dermal contact with underlying waste is prevented. Public park users are not expected to come into contact with underlying soil or waste during routine play activities. Recommended that a constructed hard cap with hardstanding is placed over the C&D Deposition area to rule out future contact. Asbestos Management Plan to be prepared to prevent future disturbance of C&D Waste area and possible spreading of asbestos fibres by air migration during dry weather (e.g. use of asbestos warning membrane for groundworks contractors)
		Residents of houses to northwest & northeast of site	**Incomplete.** Site currently covered in 200mm capping, plausible pathway absent. Public park will results in entire site being covered with soft and hardscaping so dermal contact with underlying waste is prevented. Residents not expected to come into contact with underlying soil or waste during routine activities.
		Livestock or ponies	**Incomplete.** Access to livestock is currently prevented and will be prevented in public park. Site is currently covered in 200mm capping, plausible pathway absent. Public park will results in entire site being covered with soft and hardscaping.
		Future construction workers	**Incomplete.** Construction workers may come into contact with site soil and/or waste during intrusive works. However the use of suitable PPE and good hygiene measures should mitigate risks posed through this pathway.
	Leaching and subsequent migration	Culverted stream on western boundary	**Incomplete:** Stream is a significant distance from the C&D Waste Deposition area and lateral migration of possible leachate is not likely.
		Groundwater in Poor aquifer	**Incomplete:** Waste is outside of aquifer and is tidally effected (i.e. brackish)
		Groundwater (shallow) body within superficial sand & gravel deposits	**Incomplete:** Waste is outside of aquifer and is tidally effected (i.e. brackish)
		Clifden Bay	**Incomplete:** Contaminants causing TDS exceedance within C&D waste will not impact on Clifden Bay as dilution in estuary is likely to be very significant. SAC is hydraulically upgradient of the site
		Boreholes within 1km site; closest 990m upgradient to the northeast of the site	**Incomplete**. Plausible pathway absent due to distance and direction of groundwater flow.

A Plan Site Conceptual Model illustrating the potentially complete pollutant linkages is included in Figure 14.

Future risks to construction workers will be task specific and can be managed with appropriate health and safety protocols thus are not considered further in this report.

8 CONCLUSIONS & RECOMMENDATIONS

The site poses negligible risk to human receptors within the vicinity of the site (i.e. in the residences to the northwest and northeast of the site).

The site poses negligible risk to the culverted stream on the western boundary of the site and to Clifden Bay to the south of the site. However, it may be beneficial to carry out a round of surface water monitoring at upgradient and downgradient locations to confirm that there is no negative impact from the landfill

The site poses negligible risk to pNHA/SAC No. 002031, The Twelve Bens/Garaun Complex located 266m hydraulically upgradient of the site.

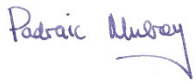
The asbestos containing materials within the Construction and Demolition waste that was deposited in the north-eastern end of the site poses an unacceptable risk to future users of the proposed public park. The 'Potentially Complete Linkage' identified is regarded as strictly a potential linkage because as yet, the site is not a public park and the site is currently not being visited.

It is recommended that the proposed layout for the public park is amended to account for the risk posed by the asbestos containing materials within the Construction and Demolition waste. It is recommended that a constructed hard capping layer with hardstanding is placed over the entire C&D Deposition area (i.e. that area indicated with a yellow hatch on Figure 13 of the report). The purpose of this to rule out future dermal contact with park users. It is recommended that those proposed recreational activities that require tarmac hardstanding (i.e. skateboarding, etc) are located in this area. The capping and hardstanding should be designed and constructed to prevent future disturbance of the C&D Waste area (e.g. future groundworks, service installation, etc). This could be achieved through the use of an asbestos warning/hazard membrane which would be placed under the capping layer and over the C&D waste for the benefit of future groundworks contractors. Landscaping should not be planted in this area (i.e. to prevent disturbance of the cap by root penetration).

Galway County Council is in the process of procuring the services of a design team to develop a design for the public park. The aim of the design will be to meet both the remediation needs of the landfill site and the recreational needs of the local community. In this regard the design team will oversee the execution of an Asbestos Management Plan (AMP) which will be prepared by a specialist Asbestos consultant. The AMP will inform the design of the public park.

As there are Invasive Alien Plant Species present at the site (Japanese Knotweed and Gunnera) an Invasive Alien Plant Species (IAPS) Management Plan will be developed by a specialist contractor. The IAPS Management Plan will also inform the design of the public park. Once finalised the Public Park design can be made available to the EPA if required.

If you have any questions or require clarification with regard to any item of this report, please contact me at 086-8770380.



Padraic Mulroy, BSc., MSc., MIEI, MIPSS, C.Sci.
BREEAM AP, CEEQUAL Assessor
Managing Director
Mulroy Environmental

9 REFERENCES

1 Interim Report "Towards Setting Guideline Values for the Protection of Groundwater in Ireland May 2003.

2 Information and Guidance Note: The Selection of Materials for Water Supply Pipes to be Laid in Contaminated Land. No 9-04-03 Issue 1. Published by Water Regulations Advisory Scheme (WRAS), October 2002.

3 BS10175. Investigation of Potentially Contaminated Sites -Code of Practice. BSi. 2001.

4 Department of the Environment. Handbook of Model Procedures. Contaminated Land Research Report Number 11, London.

5 Risk-Based Corrective Action (RBCA) Tool Kit Version 2.0, Groundwater Services, 2003.

6 Department of the Environment. The Contaminated Land Exposure Assessment Model (CLEA): Technical basis and algorithms, Contaminated Land Research Report No. 10, London; Department of the Environment.

7 CLEA Briefing Note 2 – Update of Estimating Vapour Intrusion into Buildings. Version 1.1 dated July 2004

8 CLEA Briefing Note 3 – Update of supporting values and assumptions describing UK Building Stock. Version 1.1 dated July 2004.

9 Environment Agency. Review of the Fate and Transport of Selected Contaminants in the Soil Environment. Draft Technical Report P5-079/TR1. September 2003.

10 Hartman, B. 2002. How to collect reliable soil-gas data for risk-based applications. Part 1: Active Soil-Gas Method. LUST Line Bulletin, 42, October 2002.

MULROY ENVIRONMENTAL
SERVICE CONSTRAINTS

1. This report and the Environmental Site Assessment carried out in connection with the report (together the "Services") were compiled and carried out by Mulroy Environmental for Galway County Council (the "client") in accordance with the terms of a contract, Proposal PRP473.22.12.2019 , between Mulroy Environmental and the "client" dated 22nd December, 2020. The Services were performed by Mulroy Environmental with the skill and care ordinarily exercised by a reasonable Environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by Mulroy Environmental taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between Mulroy Environmental and the client.

2. Other than that expressly contained in paragraph 1 above, Mulroy Environmental provides no other representation or warranty whether express or implied, in relation to the Services.

3. Unless otherwise agreed the Services were performed by Mulroy Environmental exclusively for the purposes of the client. Mulroy Environmental is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, Mulroy Environmental does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and Mulroy Environmental disclaims any liability to such parties. Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.

4. It is Mulroy Environmental understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without Mulroy Environmental be requested to review the report after the date hereof, Mulroy Environmental shall be entitled to additional payment at the then existing rates or such other terms as agreed between Mulroy Environmental and the client.

5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of Mulroy Environmental. In the absence of such written advice of Mulroy Environmental, reliance on the report in the future shall be at the client's own and sole risk. Should Mulroy Environmental be requested to review the report in the future, Mulroy Environmental shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between Mulroy Environmental and the client.

6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the client and Mulroy Environmental. Mulroy Environmental has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and Mulroy Environmental. Mulroy Environmental is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, Mulroy Environmental did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.

7. The Services are based upon Mulroy Environmental's observations of existing physical conditions at the Site gained from a walk-over survey of the site together with Mulroy Environmental's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which Mulroy Environmental was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by Mulroy Environmental and the observations possible at the time of the walk-over survey. Further Mulroy Environmental was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. Mulroy Environmental is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to Mulroy Environmental and including the doing of any independent investigation of the information provided to Mulroy Environmental save as otherwise provided in the terms of the contract between the client and Mulroy Environmental.

8. The Phase II or intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and Mulroy Environmental] [based on an understanding of the available operational and historical information,] and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site.