GOLDER

REPORT

Licence Reference No.	Risk Assessment Methodology Stage and Step	Report Version
N/A	Stage 1 (PSA)	A.4 Final for client

Site 20 Bedford Row to Sheriff Street 38kV: Preliminary Site Assessment Report for Historic Fluid Filled Cable Loss

ESB Engineering and Major Projects

Submitted to:

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Distribution List

Golder Associates Ireland Limited - 1 pdf

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Executive Summary

ESB operates and maintains a large network of fluid insulated electrical cables across Ireland, with the majority (of fluid filled cables) located in urban settings across Dublin City and Cork City. Due to the location and age of the cables, they are potentially subject to third party interference and damage and/or corrosion and defects, which can potentially cause the cable fluid to leak into adjacent soil, groundwater, and/or surface water. This report focuses on a leak of approximately 4,170 L of cable fluid (linear alkyl benzene and mineral oil mix) from a 38 kV section of cable between Bedford Row and Sherriff Street (Site 20). The indicative leak location is adjacent to the River Liffey and opposite the Corn Exchange Apartments on the South Quays.

The objective of the work was as follows:

- To assess the environmental and human health impact associated with legacy cable fluid loss.

This has been completed in a risk-based staged approach, consistent with the process described in "*Guidance on the Management of Contaminated Land and Groundwater at EPA Licenced Sites*" (EPA, 2013). We note that the section of cable assessed in this report does not form part of an EPA licenced site.

In order to provide ESB with this Preliminary Site Assessment report, Golder has completed the following:

- A Site walkover (200 m each way along the cable length from the indicative leak location, and laterally as required);
- A desk study of publicly available information; and
- A preliminary Conceptual Site Model (CSM).

The work has been completed in accordance with the scope provided in the proposal P19126590.P1.V0, dated 28 June 2019. No significant variations from this scope were required to complete the work.

The Preliminary Site Assessment approach is considered conservative as it seeks to identify the potential source, and a broad range of initially theoretical pathway and receptor linkages present for each Site. The preliminary CSM identified potential source, pathway, and receptor linkages that may be present at the Site or caused by the leak. A qualitative risk analysis and evaluation was completed on each potential pollutant linkage identified. It is noted that where a potential risk is identified at this stage it does not necessarily mean a risk is present but that further investigation is required to either confirm the presence or absence of the risk. Where a potential linkage has been classified as either low or very low in the risk assessment no further action has been recommended to address this linkage as the actual risks identified in the low and very low risks have been sufficiently assessed in the PSA.

Further investigation and analysis will be required to assess these potential pollutant linkages identified in this report. A summary of the findings is given below. Golder will produce a letter under separate cover recommending actions to address the below findings:

Summary of Findings
Potential pollutant linkages have been identified that could impact human health and/or controlled waters receptors as follows: ■ There is a potential high risk to the River Liffey adjacent to the spill that mineral oil may have impacted the River;

Summary of Findings

- There is a potential moderate risk to groundwater if the till thickness is not significant enough to provide protection from migrating contaminants; and
- There is a potential moderate risk that residents or workers in basements close to the spill area could be exposed to vapours.

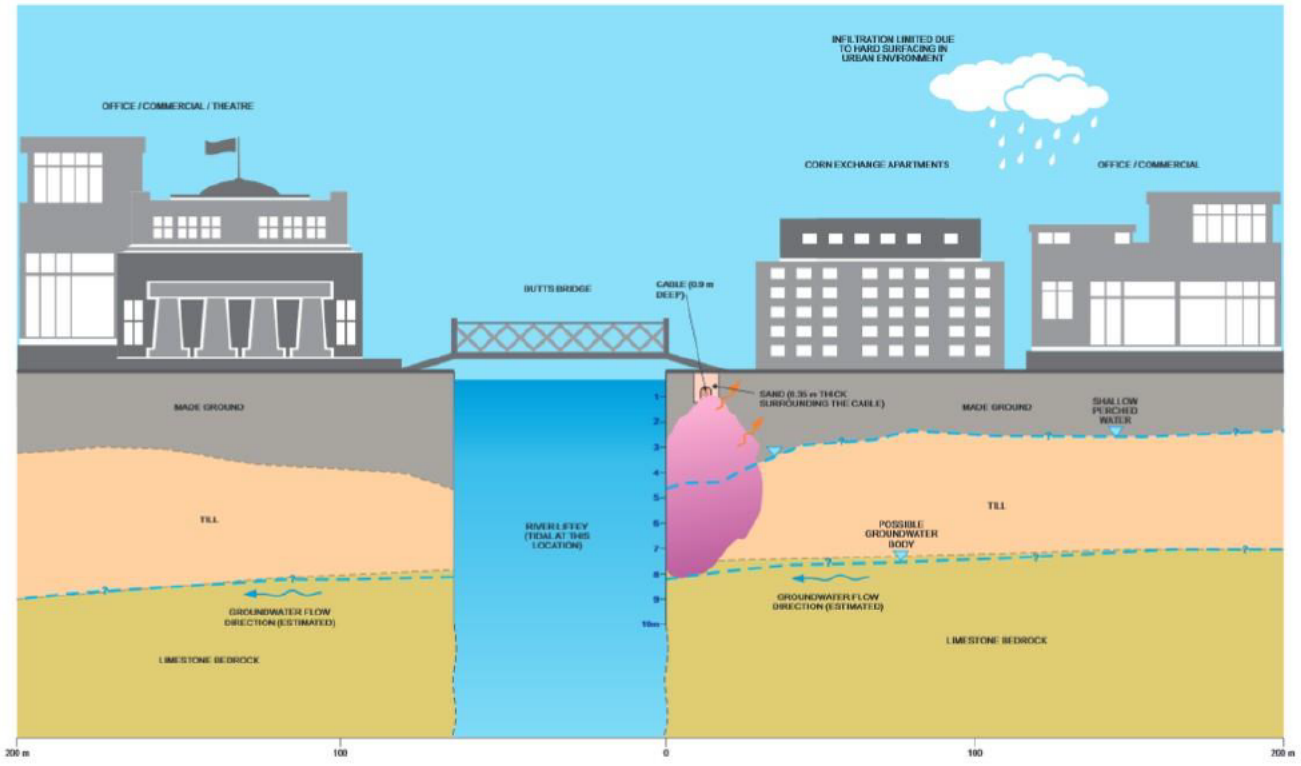

Figure 1: Preliminary Conceptual Site Model for site 20 (Bedford Row to Sherriff Street)

Summary of Report Status within the Overall Context of the Contaminated Land and Groundwater Site Assessment

EPA Contaminated Land and Groundwater Risk Assessment Methodology		Report Reference	Report Date	Status
Stage 1: Site Characterisation and Assessment				
1.1	Preliminary Site Assessment	19126590.604/A.4	06 Jan 2020	A.4 Final
1.2	Detailed Site Assessment			
1.3	Quantitative Risk Assessment			
Stage 2: Corrective Action Feasibility and Design				
2.1	Outline Corrective Action Strategy			
2.2	Feasibility Study and Design			
2.3	Detailed Design			
2.4	Final Strategy and Implementation Plan			

EPA Contaminated Land and Groundwater Risk Assessment Methodology		Report Reference	Report Date	Status
Stage 3: Corrective Action and Implementation and Aftercare				
3.1	Enabling Works			
3.2	Corrective Action Implementation and Verification			
3.3	Aftercare			

Study Limitations

IMPORTANT: This section should be read before reliance is placed on any of the opinions, advice, recommendations or conclusions herein set out.

a) This report has been prepared for and at the request of ESB Engineering and Major Projects (the Client) for undertaking activities pursuant to its appointment of Golder Associates Ireland Ltd (Golder) to act as Consultant.

b) Save for the Client, no duty is undertaken or warranty or representation made to any party in respect of the opinions, advice, recommendations, or conclusions herein set out.

c) Regard should be had to the agreement between Golder and the Client which is taken to be the Golder proposal P19126590.P1.V0 dated 28 June 2019 and the revision P19126590.P1.V1 dated 3 July 2019, when considering this report and reliance to be placed on it.

d) All work carried out in preparing this report has used, and is based upon, Golders' professional knowledge and understanding of the current (July 2019) relevant Irish and European Community legislation, and assumptions set out in this report. Changes in the legislation or assumptions may cause the screening and methodology set out in this report to become inappropriate or incorrect. However, in writing this report, Golder has considered pending changes to environmental legislation and regulations of which it is currently aware. Following delivery of this report, Golder will have no obligation to advise the Client of any such changes, or of their repercussions.

e) Golder acknowledges that it is being retained, in part, because of its knowledge and experience with respect to environmental matters. Golder will consider and analyse all information provided to it in the context of Golders' knowledge and experience and all other relevant information known to Golder. To the extent that the information provided to Golder is not inconsistent or incompatible therewith, Golder shall be entitled to rely upon and assume, without independent verification, the accuracy and completeness of all such information and Golder shall have no obligation to verify the accuracy and completeness of such information. Golder has relied on the Client to provide information on spills, leaks, and other releases of materials to inform potential sources.

f) The content of this report represents the professional opinion of experienced environmental consultants.

g) Golder does not provide specialist legal advice and the advice of lawyers will be required.

h) The scope of work includes interpretation of information from borings and test pits. Attention is drawn to the fact that special risks occur whenever engineering and related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing programme implemented in

accordance with a professional Standard of Care may fail to detect certain conditions. The environmental, geologic, geotechnical, geochemical and hydrogeological conditions that Golder interprets to exist between sampling points may differ from those that actually exist. Passage of time, natural occurrences, and activities near the Site may substantially alter discovered conditions.

i) In the Conclusions section of this report and in the Executive Summary, Golder has set out its key findings and provided a summary and overview of its opinions. However, other parts of this report will often indicate the limitations of the information obtained by Golder and therefore any opinions set out in the Conclusions section and in the Executive Summary ought not to be relied upon until considered in the context of the whole report.

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1.0 INTRODUCTION

ESB Engineering and Major Projects (ESB) has commissioned Golder Associates Ireland Limited (Golder) to complete a Preliminary Site Assessment (PSA) for historical loss of fluid from a high voltage (38 kV) cable run located between Bedford Row and Sheriff Street ('Site 20') (hereafter referred to as the 'Site').

The work has been completed by suitably qualified and experienced Golder (Ireland and UK) consultants. The curriculum vitae of the Golder consultants who worked on this report are available on request.

1.1 Background

ESB operates and maintains a large network of fluid insulated electrical cables across Ireland, with the majority (of fluid filled cables) located in urban settings across Dublin City and Cork City. Due to the location and age of the cables, they are potentially subject to third party interference and damage and/or corrosion and defects, which can potentially cause the cable fluid to leak into adjacent soil, groundwater, and/or surface water. ESB has requested that Golder complete a preliminary risk assessment in accordance with the EPA document "*Guidance on the Management of Contaminated Land and Groundwater at EPA Licenced Sites*" (EPA, 2013).

The Preliminary Site Assessment approach is considered conservative as it seeks to identify the potential source, and a broad range of initially theoretical pathway and receptor linkages present for each Site. The preliminary CSM identified potential source, pathway, and receptor linkages that may be present at the Site or caused by the leak. A qualitative risk analysis and evaluation was completed on each potential pollutant linkage identified. It is noted that where a potential risk is identified at this stage it does not necessarily mean a risk is present but that further investigation is required to either confirm the presence or absence of the risk. Where a potential linkage has been classified as either low or very low in the risk assessment no further action has been recommended to address this linkage as the actual risks identified in the low and very low risks have been sufficiently assessed in the PSA.

1.1.1 Site Location

The location of the cable leak, and 200 m Site limits (200 m each way along the cable length from the cable leak) are summarised in Table 1 and shown on Drawing 1.

Table 1: Table 1: Site Location

	Leak Co-ordinates	200 m Cable Length Limit	200 m Cable Length Limit
Easting	316140	316250	315952
Northing	234407	234515	234335

The Site is located in the urban area of Dublin and runs alongside the River Liffey crossing the River at Butts Bridge. The indicative leak location is adjacent to the southern bank of the River Liffey on Burgh Quay.

1.1.2 Leak Information

The following information regarding the leak has been provided to Golder by ESB.

Table 2: Summary of Leak Information

Site ID	20
Incident Title	20 Bedford Row to Sheriff Street - April 2013

Circuit	Bedford Row – Sheriff Street 38kV
Leak Start Date	October 2010
Leak Repair Date	April 2013
Leak Duration (months)	30 months
Total Leakage (litres)	4,171
Leakage Rate (litres/month)	139 litres/month
Volume of Circuit (litres)	1,963
Year Circuit Installed	1950
Voltage (kV)	38
Cable Length (km)	0.69
Leak Size Minus Circuit Volume (litres)	2,208
Assumed Fluid	Linear alkyl benzene (LAB) / Mineral oil
Comment	Pre 1970 circuit. Leak greater than circuit volume. Assume original fluid replaced.
Local Authority	Dublin City Council
Leak Location	On Liffey Quay. At joint in the circuit.
Fluid/Oil Type	Cable fluid
Chemical Information	Linear Alkyl Benzene
Brand Name	T 3788
CAS Number	67774-74-7
Chemical Information	Blend of highly refined mineral oils and additives
Brand Name	F&G Masse 106 cable mineral oil
CAS Number	No CAS given on MSDS

No historical reports or observations made at the time of the leak discovery or repair were available for review as part of this PSA.

1.2 Objectives

The objective of the work is as follows:

- To assess the environmental and human health impact associated with legacy cable fluid loss.

This has been completed in a risk-based staged approach, consistent with the process described in "*Guidance on the Management of Contaminated Land and Groundwater at EPA Licenced Sites*" (EPA, 2013).

1.3 Scope of Works

A summary of the scope of works proposed, which was developed following best practice guidance and relevant Irish legislation, is as follows:

- Desk study – summary of current and historical publicly available information and site-specific data (where available). This included a visit to Trinity College Dublin map library to collect relevant information;
- Site walkover – a walkover of the site was conducted by a suitably qualified Golder engineer, to identify visual or olfactory evidence of potential contamination or areas of concern. The Site walkover extended a minimum of 200 m along the cable length in each direction, and an appropriate lateral distance from the cable leak was determined following the presence of potential human health and/or environmental receptors and/or alternative potential contaminant sources; and
- Preliminary Risk Assessment – this includes the information gathered as part of the desk study and site walkover, which has been used to determine a preliminary Conceptual Site Model (CSM) identifying the potential source, pathway, and receptor linkages, and next stage recommendations.

More details on the proposed scope of work task summarised are included in proposal (P19126590.P1/V.1). The Site walkover was conducted with no significant deviations from the proposed methodology. The length of the cable run was accessible 200 m each way from the indicative leak location. The wall of Burgh Quay was also assessed from the side and opposite bank, to observe for any visual evidence of contamination within the tidal range of the river such as obviously oily staining on the quay wall or slicks or sheens on the River Liffey. Butts Bridge was also checked for any signs of staining that could be related to the loss of cable oil as it travelled under the bridge across the Liffey.

2.0 SITE DESCRIPTION

The Site walkover was completed on 4 July 2019. The Golder engineer walked along the cable route; 200 m from the leak location in each direction (shown on Drawing 1). Whilst it is not expected that significant impacts will be observed at ground level above the leak location, a walkover was carried out for completeness.

2.1 Description of Leak Event

The ESB has provided Golder with information on the estimated quantities and types of fluid lost as presented in Section 1.1.2 above.

2.2 Current Site Conditions

2.2.1 Leak Location

No evidence of potential contamination from cable fluid/oily substances was observed at the indicative leak location during the Site walkover. Selected photographs of potentially relevant observations made during the Site walkover are provided in APPENDIX A with commentary.

2.2.2 Cable and Area in Proximity to Leak

No evidence of potential contamination from cable fluid/oily substances was observed along the 400 m cable length (200 m each way from the leak location) that we examined during the Site walkover. Selected photographs of potentially relevant observations made during the Site walkover are provided in APPENDIX A with commentary.

3.0 SITE HISTORY

3.1.1 Information Sources

- The Geological Survey of Ireland (GSI) online map viewer – dcenr.maps.arcgis.com, accessed 12 July 2019;
- The Geological Society of Ireland (GSI) Groundwater Bodies Summary for Dublin: https://secure.dccae.gov.ie/GSI_DOWNLOAD/Groundwater/Reports/GWB/DublinGWB.pdf, accessed on 27 November 2019;
- Environmental Protection Agency (EPA) online map viewer - https://gis.epa.ie/EPAMaps/, accessed 12 July 2019;
- The National Monuments Service's Historic Environment Mapping Viewer - http://webgis.archaeology.ie/historicenvironment/, accessed 12 July 2019;
- The National Parks and Wildlife Service (NPWS) map data - https://www.npws.ie/maps-and-data, accessed 12 July 2019;
- The European Pollutant Release and Transfer Registers (E-PRTR) – http://prtr.ec.europa.eu, accessed 12 July 2019;
- The Geohive by Ordnance Survey Ireland – https://geohive/ie/, accessed 12 July 2019; and
- The Ireland Grid Reference - http://gridreference.ie/, accessed 12 July 2019.

Trinity Map Library was visited on 10 July 2019 to consult available historical maps relating to the indicative leak location, the 400 m cable length, and areas of interest located laterally from the cable run.

3.1.2 Potential Historical Sources

Historical activities that may have resulted in contamination sources are summarised in Table 3.

Table 3: Historical Activities within 500 m of the Site Boundary

Date	Detail
1892 (5 ft: 1mile)	■ Corn exchange and general footprint of present buildings along Burgh Quay south of the Site. ■ Not many buildings are labelled on this edition. ■ Tramway along O'Connell - D'Olier Streets. ■ Morgue noted between Eden Quay and Abbey Street. ■ Weighing machines noted at several locations along the quays. ■ Westmoreland Lock Hospital noted on Townsend/Tara street junction.

Date	Detail
1907-1908 (5 ft:1 mile)	■ Tramway is marked along O'Connell - D'Olier Street. ■ Corn Exchange is noted along Burgh Quay. ■ Tivoli Theatre adjacent to the Corn Exchange to the east. ■ Royal theatre further south. ■ Entertainment/theatre district and industrial dominate the area - industry related to docks. ■ No coal yard is noted to the east along George's Quay. ■ Hospital noted on Luke Street/Townsend Street.
1935-1936 (1:2,500)	■ The land use varies between industrial (custom houses and cranes along the quays and tramways), commercial (banks), and recreational (theatre district). ■ Some of the buildings may be residential. ■ Lavatories adjacent to O'Connell Bridge on Burgh Quay corner. ■ Crane coal yard to the east along George's Quay. ■ Electrical station noted on north side of River Liffey. ■ Tramway along O'Connell - D'Olier Street. ■ Rail line along George's Quay (same as present day line). ■ Gas testing station at intersection of Tara Street and Townsend Street (exact location is not clear due to the labelling on the map). ■ Map is very similar to the Cassini map except tramway and gas testing is marked on.
1938 (40 ft:1 in)	■ There is a Building Insurance Sheet which shows internal rooms for insurance purposes. ■ Tank noted on roof of building block 99 (where the government office is currently at corner of Corn Exchange Pl and Poolbeg St). ■ Building blocks 100 and 101 noted as builders supplies (building blocks immediately east of 99). ■ Corn exchange noted on map to the south of Site.
1969- 1970 (1:1,000)	■ Corn exchange Building along Burgh Quay. ■ Toilets noted on Burgh Quay/O'Connell Street. ■ Garda noted on Pearse Street.
1985 (1:1,000)	■ Toilets noted by Burgh Quay/O'Connell Street. ■ No tramway on O'Connell/D'Olier Street. ■ Apollo House noted on Tara Street. ■ Lots of open space along Poolbeg Street.

Date	Detail
1994 (1:2,500)	■ Largely commercial/recreational/industrial – high density co-location. ■ Theatre district is present. ■ The Abbey theatre, Custom House, Hotels, and cinemas are located to the north of Site. ■ Rail noted to the east of Site by George's Quay. ■ No weighing machines or cranes noted along quays as per previous maps.

4.0 CHEMICALS OF CONCERN

The information provided by ESB (summarised in Table 2) defines the chemicals present in the cable fluid as Linear Alkyl Benzene (LAB) present in cable fluid T 3788 (CAS 67774-74-7) and a blend of highly refined mineral oils and additives (CAS unknown). LAB and blended mineral oils and additives are the Chemicals of Potential Concern (COPC) discussed further in this PSA.

The European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. 9 of 2010) establish a new strengthened regime for the protection of groundwater in line with the requirements of the Water Framework Directive (2000/60/EC) and the Groundwater Directive (2006/118/EC). Regulations 9(c) – (f) requires the Environmental Protection Agency to identify and publish a list of substances which are to be considered hazardous or non-hazardous and which the Agency considers to present an existing or potential risk of pollution.

The EPA published such a list of such substances in their guidance document "*Classification of Hazardous and Non-Hazardous Substances in groundwater*" (2010). In this document the EPA has classified four Linear Alkyl Benzene compounds as hazardous (CAS numbers 134211-53-3, 115963-94-5, 115733-08-9 and 96792-49-3) in groundwater. The LAB compound used by the ESB identified with CAS number 6777-74-7 is not classified in this list. It is noted that the EPA document referenced above states that only substances that have been reviewed may be classified as hazardous or non-hazardous. If a substance is yet to be reviewed, then it cannot be classified as non-hazardous. There may be several reasons that a substance has not been reviewed, such as a lack of data on toxicity or bioaccumulation. In this instance Golder consider that the LAB used by ESB is not classified by the EPA with respect to being hazardous or non-hazardous in groundwater.

Mineral oil is listed as a hazardous substance in groundwater in the 2010 EPA guidance document.

The European Chemicals Bureau 1st Priority List (Volume 3) "Union Risk Assessment Report CAS No 67774-74-7" (1999) completed a risk assessment for LAB. The following conclusions about LAB were made in the report:

- In relation to incidental contact of workers with LAB there is no need for additional risk reduction measures beyond normal precautions for this material (such as correct use of PPE);
- It degrades aerobically;
- It is moderately volatile from water with a Henry's Law constant of 95 Pa.m^3/mol;
- It is highly adsorptive to soil particles;
- It was not classified as toxic or hazardous under the EU legislation at the time of report issue;

- It was not classified as a skin irritant under EU legislation at the time of report issue;
- It was not classifiable as an eye irritant under EU legislation at the time of the report issue; and
- It was not classified as a skin sensitiser under EU legislation at the time of the report issue.

4.1 Review of Material Safety Data Sheet

4.1.1 Linear Alkyl Benzene

The Material Safety Data Sheet (MSDS) provided by ESB (H&R ESP, undated) to Golder identified the cable fluid as T 3788 which is a *"low viscosity compound based on a blend of linear alkyl benzenes that have side alkyl chains of 10 – 13 carbon atoms in length."* The MSDS is provided in APPENDIX B. A summary of the chemical properties for LAB as listed in the MSDS are as follows:

- Concentration range is 100%;
- Not classified as a dangerous substance in accordance with The Chemical (Hazard Information and Packaging for Supply) Regulations 2002;
- Clear, colourless liquid;
- Mild petroleum odour;
- pH not determined;
- Boiling point of 280 ˚C;
- Flash point of >135 ˚C;
- Not flammable (but will burn);
- Not explosive;
- Vapour pressure is low at 20 ˚C is <0.02 kPa;
- Density of 0.86 g/cm^{-3} at 20 ˚C;
- Insoluble in water; a solubility value of 0.041 mg/L has been reported in the literature;
- Low volatility;
- Vapour density is >1 (air = 1);
- Evaporation rate is not determined;
- Human effects include skin and eye irritant, nausea and vomiting following ingestion, and irritant of the mucous membranes, cause dizziness, headaches, and nausea if inhaled; and
- No specific environmental hazards under normal use conditions.

LAB is used and manufactured extensively, most commonly in the production of linear alkyl benzene sulphonates (LAS), which are used in household and industrial cleaners and detergents. LAB has minor uses as a solvent and binder in speciality applications namely, cable oil, paint, insulation, electricity, and printing. Up to 1 % of LAS is expected to be LAB as the consequence of incomplete conversion during manufacture (Fernandez et al., 2002). Due to the wide use of LAS as a detergent and the discharge of LAS into the domestic

sewer, the ultimate receiving environment for LAS and LAB is often the aquatic ecosystem. Concentrations of0.001 – 2.2 mg/l of LAB has been reported in effluent discharge waters from municipal sewage treatment plants (Europe) (Fernandez et al., 2002).

LAB is produced from petroleum derivatives: benzene and linear paraffins and forms a mixture of long-alkyl chain LAB, with the alkyl group in various ranges (EC, 1997). The LAB used by ESB contains an alkyl chain group restricted to the range of C_{10} – C_{13} carbon atoms, and which are produced under the Chemical Abstract Service (CAS) registration number: 67774-74-7.

The "LAB and Derivatives" REACH Consortia (ReachCentrum, 2012) list LAB as a "*substance of unknown variable composition, complex reaction products or biological materials*", or 'UVCB', for the purpose of chemical classification, labelling, and registration in the information for suggested entry into the International Uniform Chemical Information Database (IUCLID).

LAB is less dense than water, and due to its insolubility, it is likely to act as a Light Non-Aqueous Phase Liquid (LNAPL) when in contact with water (e.g. groundwater or surface water

4.1.2 Blended Mineral Oil and Additives

The Material Safety Data Sheet (MSDS) provided by ESB (F&G, 1995) to Golder identified the cable fluid as Masse 106 which is a *"blend of highly refined mineral oils and additives."* The MSDS is provided in APPENDIX B. A summary of the chemical properties for the blended mineral oil as listed in the MSDS are as follows:

- Yellow liquid (under most environmental conditions);
- Pourpoint of < -60˚C;
- Flashpoint of 145 ˚C;
- Flammability lower limit 0.6 vol %, and higher limit of 6.5 vol%;
- Vapour pressure at 20˚C is <0.01 hPa;
- Density of 888 kg/m^3 (floats on water);
- Negligible solubility;
- N-octane/water partition coefficient is not applicable;
- Stable under normal conditions;
- Readily adsorbed to soil particles (limited mobility);
- May bioaccumulate;
- Expected to be practically non-toxic to aquatic organisms, LC/EC50 >100 mg/l;
- Not readily biodegradable; and
- Human health effects include aspiration to lungs may cause chemical pneumonitis from inhalation or ingestion, and dermatitis through skin contact.

At present without further information identifying the mineral oil (no CAS number is available for the product) it is not possible make specific comments about this product. Golder notes that mineral oils are typically aliphatic range hydrocarbons with chain lengths of between 11 and 40 carbon atoms. The additives to these mineral oils are unknown. The vapour pressure indicates that the product is not volatile.

It is noted that the EPA classifies mineral oil as a hazardous substance in groundwater as per the EPA (2010) guidance on this issue.

5.0 ENVIRONMENTAL SETTING

5.1.1 Information Sources

Information regarding geology, hydrology, hydrogeology and environmentally sensitive areas for the Site and surrounding area has been primarily obtained from publicly available sources outlined in Section 3.1.1.

5.1.2 Topography

The Site lies at an elevation of approximately 9 m above Ordnance Datum (m AOD) according to Ireland Grid Reference.

5.1.3 Current Surrounding Land Use

A summary of land use surrounding the leak location is provided is Table 4.

Table 4: Summary of Current Surrounding Land Use

Direction from Leak Location	Description of Current Land Use
North	North beyond the River Liffey lies commercial and residential areas. Approximately 30 m northwest lies the Rosie Hackett bridge, and approximately 115 m to the northeast lies Butts bridge.
East	Burgh Quay runs east into George's Quay surrounded by primarily commercial buildings. Tara Street Station lies approximately 160 m east of Site.
South	Immediately south lies commercial and residential buildings. Trinity College Dublin lies approximately 220 m south of Site.
West	Burgh Quay road runs west surrounded by primarily commercial buildings.

Overall, the Site is generally surrounded by commercial buildings, infrastructure (Rosie Hackett bridge, Butts bridge and Tara Street station), and the River Liffey. There are private residences (Corn exchange building) to the south of the spill location across Burgh Quay road.

5.1.4 Current Waste Permits, IPC and IE Licences in Area of Site

A review of the data available on the EPA online map shows there is one Industrial Emission license (IE) and IPPC facility approximately 340 m northeast of the Site both held by Independent Newspapers Ltd. There are no registered waste permit holders for processing of mineral oil or LAB containing fluids within 500 m of the Site.

5.1.5 Sensitive Ecological Receptors

A review of the data available on the National Parks and Wildlife Service (NPWS) map viewer shows that there are no special protection areas (SPAs), natural heritage areas (NHAs), or special areas of conservation (SAC) within 500 m of the Site. The nearest protected sites are the South Dublin Bay SAC (000210) and the South Dublin Bay and River Tolka Estuary SPA (004024) located approximately 5.2 km east and downstream of the

Site. We note that this report does not represent an ecological assessment and that if such assessments are required will be completed separately by a suitably qualified ecologist as appropriate.

5.1.6 Hydrology

5.1.6.1 Surface Water Features

The Site lies within the “Liffey and Dublin Bay” Water Framework Directive catchment. The nearest surface water feature is the River Liffey located approximately 5 m north of the identified spill.

5.1.6.2 Surface Water Quality

According to the EPA Transitional Waterbodies Risk map, the River Liffey located approximately 5 m north of Site is at risk of deteriorating or being at less than ‘Good’ status under the Water Framework Directive 91/271/EEC on Urban Waste Water Treatment and S.I. 254 / 2001, S.I. 440/2004 and S.I. 48/2010. The River Liffey is also eutrophic according to the EPA transitional water quality map and is listed as a nutrient sensitive area. The most recent WFD classification is moderate.

5.1.6.3 Surface Water Abstraction

The GSI online map viewer did not show any Group Water Scheme Abstraction points within a 500 m radius of the Site.

5.1.6.4 Discharges to Surface Water

A review of the data available on the EPA map register shows there are no Section 4 Discharges to water within a 500 m radius of the Site.

5.1.6.5 Surface Water Flooding

The Office of Public Works (OPW) flood maps indicates that the Site has a medium probability for coastal flood extents. Sections surrounding the site have a high probability (1 in 10 chance of occurring or being exceed in any given year) to be directly flooded by rainfall in a moderate rainfall event.

5.1.6.6 Pollution Releases to Land, Air and Water

The European Pollutant Release and Transfer Register (E-PRTR), compiles data on releases of pollutants and transfer of wastes for specified industries across the EU for 91 pollutants. LAB and mineral oil are not listed as specified pollutants in this register.

5.1.7 Geology

5.1.7.1 Artificial Ground

The EPA National subsoils map shows that Made Ground deposits are present beneath the Site. The depth, according to a borehole approximately 115 m southeast of the site, is to 2.5 m below Ground Level (bGL) (GSI Reference R2371/86504). However, the thickness of made ground can be expected to be significantly higher and variable at this location.

5.1.7.2 Superficial and Bedrock Geology

The GSI Subsoils (Quaternary Sediments) maps shows the subsoil beneath the Site to be classified as urban. A review of the Bedrock Geology 1:100,000 map (GSI) shows that the underlying bedrock geology to be Lucan Formation. This is described as dark limestone and shale.

5.1.7.3 Faulting

The Bedrock Geology 1:500,000 map (GSI) indicates that there are no faults within a 1 km radius of the Site.

5.1.8 GSI Borehole Logs

The GSI geotechnical viewer showed a borehole located approximately 35 m southeast of the Site, which was drilled to a depth of 5.8 m below Ground Level (b GL) (GSI reference R236/B23829). The geology encountered was recorded as made ground to 1.5 m bGL, underlain by silty sandy alluvium to 4.5 m bGL. Glacial Till was encountered between 4.5 m bGL and 5.8 m bGL. Boulders within the Glacial Till were encountered between 5.5 and 5.8 m bGL.

The GSI geotechnical viewer showed a borehole located approximately 35 m southwest of the Site, which was drilled to a depth of 5.8 m bGL (GSI reference R236/B23828). The geology encountered was recorded as made ground to 1.5 m bGL, underlain by silty gravelly sand and silty sandy gravel alluvium to 4.5 m bGL. Glacial Till, and specifically potential boulders, were encountered between 4.5 and 5.8 m bGL.

5.1.9 Hydrogeology

5.1.9.1 Groundwater Vulnerability

The GSI Bedrock Aquifer map shows the Site has moderate vulnerability to groundwater contamination. Immediately north of the Site the groundwater vulnerability is low. Approximately 155 m southwest of Site the vulnerability is high and approximately 240 m southwest the vulnerability is extreme. The bedrock aquifer is described as a locally important aquifer. According to GSI, this is bedrock that is moderately productive only in local zones and is capable of supplying locally important abstractions (smaller public water supplies, and group schemes).

5.1.9.2 Discharges to Groundwater

A review of the data available on the EPA map register shows there are no known Section 4 discharges to within 500 m.

5.1.9.3 Groundwater Group Water Scheme Abstraction Points

The GSI online map viewer did not show any Group Water Scheme Abstraction points within a 500 m radius of the Site. The Site does not lie within a groundwater source protection zone.

5.1.9.4 Groundwater Flow Directions

There is no published information on groundwater levels or flow direction for the area of the Site. It is anticipated that groundwater beneath the Site will flow in a northern direction towards the River Liffey. However, this has not been confirmed at this time, with Site-specific data.

5.1.9.5 Groundwater Quality

The Groundwater Body (GWB) underlying the Site is known as the Dublin GWB. The Dublin GWB is approximately 837 km^2 in areal extent. The GSI classifies this GWB as poorly productive bedrock. According to the EPA Ground Waterbody WFD map, the groundwater waterbody status is classified as good. The groundwater is also listed as flowing through SAC species areas and habitats, and SPA habitats. This statement applies to the entire GWB and is not specific to the leak location.

6.0 PREVIOUS SITE SAMPLING AND MONITORING DATA

ESB has confirmed that there is no Site sampling and monitoring data, or observation reports available for the Site.

7.0 PRELIMINARY CONCEPTUAL SITE MODEL

The PSA is the first tier of a risk assessment; the purpose of the PSA is to develop a preliminary Conceptual Site Model (CSM) for the Site and establish whether or not there are any potentially unacceptable risks. The outcome of the PSA is a decision as to whether or not further action is needed.

7.1 Context of the PSA

This PSA is being conducted to assist ESB with managing its potential liabilities associated with the Site.

7.2 Development of the Preliminary CSM

A preliminary CSM has been established from the data obtained from the following sources:

- Publicly available data;
- Trinity College Dublin Map library;
- ESB provided data; and
- Site walkover observations.

In the definition that has become accepted by the environmental industries and regulators (and discussed in the EPA (2013) "*Guidance on the management of contaminated land*"), there are three components to consider when developing a CSM:

- The *source* is the COPC identified, specifically it is the leak of the known cable fluid;
- The *pathways* are any routes linking the source with the receptors (in which degradation processes may also occur); and
- The *receptors* are humans and controlled waters that are connected to the source by the pathways, such as soils, vapours, aquifers, surface watercourses, local supply boreholes, or springs. Whilst ecological receptors are not normally considered in preliminary risk assessment protected sites are considered here to flag any potential issues that may require further detailed assessment

These three components are linked within a conceptual model for a site. Should either one of the source, pathway, or receptor be absent from the site setting, the pollutant linkage is deemed not to be present therefore negligible risk will be posed to human health and/or controlled water environments.

7.3 Description of the Source

The source is the indicative leak location of the fluid filled cable (Eastings: 316140, Northing: 234407) (locations obtained from georeferenced ESB provided drawing, reference QD-354120-01-D460-001-026-000, dated 26 June 2019 (provided in Drawing 1). ESB estimate the total loss of cable fluid over the leak period as approximately 4,171 L. ESB has stated that the leak was repaired in April 2013.

A summary of the sources (LAB and blended mineral oil) is provided in Section 4.0.

7.4 Description of the Pathways

A description and summary of the potential pathways identified is provided in Table 5.

The trenches for the cable runs are likely to be the primary potential pathway for the cable fluid migrate away from the indicative leak location. Details of a typical cable trench construction (provided by ESB) is as follows:

- Depth to the base of trench 1,200 mm;

- Depth to top of cable 900 mm – 1,000 mm;
- Thickness of sand surrounding cables 350 mm;
- Width of trench 1,100 mm; and
- Backfill is either arisings or Clause 804 (gravel up to 75 mm diameter).

7.5 Description of the Receptors

A description and summary of the potential receptors identified is provided in Table 6.

Drawing 2 provides an overview of the source and potential sensitive receptors located within 1 km of the Site. Sensitive receptors comprise of human health risks (e.g. schools or hospitals), or risks to controlled waters (e.g. rivers or lakes). Groundwater receptors (unless a potable borehole abstraction point is identified) are not shown on Drawing 2.

7.6 Preliminary Conceptual Site Model Risk Analysis

The potentially significant source-pathway-receptor linkages present at the Site and surrounding area (200 m along the cable length from the indicative leak location each way, and up to 500 m laterally from the cable run) are summarised in Table 6.

The level of potential risk of the identified pollutant linkage to human health and/or controlled waters and protected sites has been completed with reference to CIRIA guidance document C522 "*Contaminated Land Risk Assessment a Guide to Good Practice*" (2002). This document presents a qualitative framework for evaluating risk which is useful at the PSA stage, prior to intrusive investigations being completed. C522 presents a risk matrix that allows a qualitative expression of:

- Magnitude of a potential consequence (severity) of a risk occurring; and
- Magnitude of the probability (likelihood) of the risk occurring.

Table 5: Risk Matrix – Consequence versus Probability.

		Consequence (of risk being realised)			
		Severe	**Medium**	**Mild**	**Minor**
Probability (of risk being realised)	**High Likelihood**	**Very High Risk**	**High Risk**	**Moderate Risk**	**Moderate/Low Risk**
	Likely	**High Risk**	**Moderate Risk**	**Moderate/Low Risk**	**Low Risk**
	Low Likelihood	**Moderate Risk**	**Moderate/Low Risk**	**Low Risk**	**Very Low Risk**

		Consequence (of risk being realised)			
		Severe	**Medium**	**Mild**	**Minor**
	Unlikely	**Moderate/Low Risk**	**Low Risk**	**Very Low Risk**	**Very Low Risk**

A detailed description of the probability and consequence definitions is provided in CIRIA guidance document C522. These definitions are also provided in APPENDIX C. Golder has applied this methodology to the identified pollutant linkages for this Site and presented the findings in Table 6. Each identified pollutant linkage has been numbered and a qualitative risk rating applied to the linkage. Comments are provided for consideration of the risk evaluation for each linkage.

Table 6: Summary of the Preliminary Source, Pathway, Receptor Linkages

Linkage Number	Source	Pathway	Receptor	Consequence of Risk Being Realised	Probability of Risk Being Realised	Risk Classification	Comments
1	Free-phase LAB and blended mineral oil from the cable leak	Migration along the cable trench through the permeable infill materials	1a) Groundwater and/or 1b) surface water: direct contact or adjacent to the trench, likely to act as a LNAPL	Medium	1a) Likely 1b) High Likelihood	1a) Groundwater Moderate 1b) Surface water - High Risk	1a) The thickness of the Till at the Site is unknown, and as groundwater vulnerability status' changes from 'low' immediately north of the site and then from 'high' to 'extreme' within 155 to 240 m of the Site ('moderate' at the Site location), this indicates that there may be variability in the thickness in this location. The bedrock groundwater body is designated as 'poorly productive', but quality is 'good'. Shallow/perched groundwater may be present in the Made Ground. Mineral oil is classified as hazardous in groundwater. Considering the relative geology there may be shallow groundwater at the spill location which may be hydraulically linked to surface water levels in the River Liffey, which could be then impacted. Low water levels in the River Liffey could increase the hydraulic gradient in the shallow groundwater from the spill location into the river, increasing the potential for contaminant migration. This needs to be confirmed.

Linkage Number	Source	Pathway	Receptor	Consequence of Risk Being Realised	Probability of Risk Being Realised	Risk Classification	Comments
							1b) The nearest surface water receptor is the River Liffey approximately 5 m north of the Site. Migration in the cable trench will be gradient driven and the surface water receptor is likely downgradient of the trench and so surface water is considered to be a high risk based on the short pathway linkage.
2		Migration along other service trenches/pipes	2a) Groundwater and/or 2b) Surface water: direct contact or adjacent to the trench, likely to act as a LNAPL	Medium	2a) Likely 2b) High Likelihood	2a) Groundwater - Moderate Risk 2b) Surface Water - High Risk	2a) The thickness of the Till at the Site is unknown, and as groundwater vulnerability status' changes from 'low' immediately north of the site and then from 'high' to 'extreme' within 155 to 240 m of the Site ('moderate' at the Site location), this indicates that there may be variability in the thickness in this location. The bedrock groundwater body is designated as 'poorly productive', but quality is 'good'. Shallow/perched groundwater may be present in the Made Ground. Mineral oil is classified as hazardous in groundwater. Considering the relative geology there may be shallow groundwater at the spill location which may be hydraulically linked to surface water levels in the River Liffey, which could be impacted. Low

Linkage Number	Source	Pathway	Receptor	Consequence of Risk Being Realised	Probability of Risk Being Realised	Risk Classification	Comments
							water levels in the River Liffey could increase the hydraulic gradient in the shallow groundwater from the spill location into the river, increasing the potential for contaminant migration. This needs to be confirmed. 2b) The nearest surface water receptor is the River Liffey approximately 5 m north of the Site. Migration in the cable trench will be gradient driven and the surface water receptor is likely downgradient of the trench and so surface water is considered to be a high risk.
3			Mains water pipes	Mild (due to presence of mineral oil)	Unlikely	Very Low Risk	Mains water pipes remain in positive pressure, ensuring that any water in areas of damaged pipework/leaks is forced out from the pipe, rather than allowing ingress into the water pipes. At this time, LAB and mineral oil are not known to be aggressive to plastic or metal pipework, or cause leaching from plastic pipework.
4	Free-phase LAB and blended	Volatilisation and migration of vapours,	Residents, in basements / cellars	Medium	Likely	Moderate Risk	At this time, it is not known if LAB and blended mineral oil has migrated to building footings adjacent to the spill location or into possible

Linkage Number	Source	Pathway	Receptor	Consequence of Risk Being Realised	Probability of Risk Being Realised	Risk Classification	Comments
	mineral oil from the cable leak	accumulation in subsurface ducts, services, cellars, basements etc via inhalation					building basements. LAB is not considered toxic. Mineral oil may aspirate to lungs and may cause chemical pneumonitis from inhalation. We note the low vapour pressure of the cable fluids, but considering the proximity of the leak to buildings that may have basements and the tidal nature of the River Liffey at this location, which can reverse groundwater flow and drive contaminants towards residential receptors, this is considered a moderate risk.
5	LAB and blended mineral oil in unsaturated soils from the cable leak	Vertical and lateral migration of LAB and blended mineral oil through the unsaturated zone	Local residents (apartments – no gardens): Volatilisation only	Medium	Likely	Moderate Risk	At this time, it is not known if LAB and blended mineral oil has migrated to building footings adjacent to the spill location or into possible building basements. LAB is not considered toxic. Mineral oil may aspirate to lungs and may cause chemical pneumonitis from inhalation. We note the low vapour pressure of the cable fluids, but considering the proximity of the leak to buildings that likely have basements and the tidal nature of the River Liffey at this location, which can reverse groundwater flow and drive contaminants towards residential receptors, this is considered a moderate risk.

Linkage Number	Source	Pathway	Receptor	Consequence of Risk Being Realised	Probability of Risk Being Realised	Risk Classification	Comments
6	LAB and blended mineral oil in unsaturated soils from the cable leak	Infiltration of rain, leaching of contaminants, and vertical/horizontal migration of dissolved contaminants	Groundwater	Medium	Likely	Moderate Risk	The thickness of the Till at the Site is unknown, and as groundwater vulnerability status' changes from 'low' immediately north of the site and then from 'high' to 'extreme' within 155 to 240 m of the Site ('moderate' at the Site location), this indicates that there may be variability in the thickness in this location. The bedrock groundwater body is designated as 'poorly productive', but quality is 'good'. Shallow/perched groundwater may be present in the Made Ground. Mineral oil is classified as hazardous in groundwater. Considering the local geology there may be shallow groundwater at the spill location which could be impacted. This needs to be confirmed.
7		Volatilisation (low volatilisation) and migration of vapours, accumulation in subsurface ducts, services,	Residents, in basements/cellars exposed to vapours in basements	Medium	Likely	Moderate Risk	At this time, it is not known if LAB and blended mineral oil has migrated to building footings adjacent to the spill location or into possible building basements. LAB is not considered toxic. Mineral oil may aspirate to lungs and may cause chemical pneumonitis from inhalation. We note the low vapour pressure of the cable fluids, but considering the proximity of the leak to buildings that likely have basements and the

Linkage Number	Source	Pathway	Receptor	Consequence of Risk Being Realised	Probability of Risk Being Realised	Risk Classification	Comments
		cellars and basements etc via inhalation					tidal nature of the River Liffey at this location, which can reverse groundwater flow and drive contaminants towards residential receptors, this is considered a moderate risk.
8	LAB and blended mineral oil in unsaturated soils from the cable leak	Dissolution of contaminants, vertical and lateral migration of dissolved contaminants in groundwater	8a) Groundwater: Impacts to the groundwater body beneath the Site which has currently "Good" status and/or 8b) surface water: direct contact or adjacent to the trench.	Medium	8a) Likely 8b) High Likelihood	8a) Groundwater - Moderate Risk 8b) Surface water - High Risk	8a) The thickness of the Till at the Site is unknown, and as groundwater vulnerability status' changes from 'low' immediately north of the site and then from 'high' to 'extreme' within 155 to 240 m of the Site ('moderate' at the Site location), this indicates that there may be variability in the thickness in this location. The bedrock groundwater body is designated as 'poorly productive', but quality is 'good'. Shallow/perched groundwater may be present in the Made Ground. Mineral oil is classified as hazardous in groundwater. Considering the local geology there may be shallow groundwater at the spill location which may be hydraulically linked to surface water levels in the River Liffey, which could be impacted. Low water levels in the River Liffey could increase the hydraulic gradient in the shallow groundwater from the spill location into the

Linkage Number	Source	Pathway	Receptor	Consequence of Risk Being Realised	Probability of Risk Being Realised	Risk Classification	Comments
							river, increasing the potential for contaminant migration. This needs to be confirmed. 8b) The nearest surface water the River Liffey approximately 5 m north of the Site. Although not proven the surface water receptor is considered to be downgradient of the trench and so surface water is considered to be a high risk.
9		Volatilisation (low volatilisation) and migration of vapours, accumulation in subsurface ducts, services, cellars and basements etc via inhalation	Residents in basements/cellars exposed to vapours in basements	Medium	Likely	Moderate Risk	At this time, it is not known if LAB and blended mineral oil has migrated to building footings adjacent to the spill location or into possible building basements. LAB is not considered toxic. Mineral oil may aspirate to lungs and may cause chemical pneumonitis from inhalation. We note the low vapour pressure of the cable fluids, but considering the proximity of the leak to buildings that likely have basements and the tidal nature of the River Liffey at this location, which can reverse groundwater flow and drive contaminants towards residential receptors, this is considered a moderate risk.

Linkage Number	Source	Pathway	Receptor	Consequence of Risk Being Realised	Probability of Risk Being Realised	Risk Classification	Comments
10	LAB and blended mineral oil in groundwater from the cable leak (low solubility)	Migration in groundwater	The South Dublin Bay SAC and South Dublin Bay and River Tolka Estuary SPA	Medium	Unlikely	Low Risk	The closest protected sites are the South Dublin Bay SAC and South Dublin Bay and River Tolka Estuary SPA. The pathway for COPCs to reach these sites is migration to the River Liffey and transport downstream to the protected area. The medium consequence is applied as LAB can bioaccumulate. The overall risk is considered low however as at this location the attenuation capacity of the Liffey and the travel distance is significant (5.2 km).

Notes: PPE = Personal Protective Equipment.

Drawing 2 provides a visual representation of Table 6 and highlights the potential pollutant linkages identified in the preliminary CSM assessment.

As defined in the guidance, risk is only realised when a linkage is proven between the source, pathway, and receptor. The linkage must be present between all three elements for a risk to be realised. Risk due to short term exposure, for example ground workers, are not considered here as they should be managed by appropriate use of PPE or other measures identified in a contractors Risk Assessment and Method Statement (RAMS) documents. During the risk analysis, Golder reviewed several relevant source, pathways, and receptors, and subsequently discounted the risks show in Table 7, as there are incomplete linkages i.e. a potential risk not possible for a given scenario.

Table 7: Summary of Incomplete Source, Pathway, Receptor Linkages Considered

Source	Pathway	Receptor	Pollutant Linkage Identified?
4,171 L LAB and blended mineral oil from cable approximately 0.9 m deep under Burgh Quay	Dust and soil (from near surface soils) ingestion – area covered by hardstanding and leak occurring approximately 0.9 m from surface.	Short-term Public (i.e. passers-by, not workers)	Pathway linkage not viable
4,171 L LAB and blended mineral oil from cable approximately 0.9 m deep under Burgh Quay	Plant uptake and consumption of homegrown produce.	Residential receptors	Pathway linkage not viable
4,171 L LAB and blended mineral oil from cable approximately 0.9 m deep under Burgh Quay	Dermal contact (from near surface soils) – area covered by hardstanding and leak occurring approximately 0.9 m from surface (not in contact with surface soils).	Short-term Public (i.e. passers-by, not workers)	Pathway linkage not viable
4,171 L LAB and blended mineral oil from cable approximately 0.9 m deep under Burgh Quay	Dust (from near surface soils) inhalation – area covered by hardstanding and leak occurring approximately 0.9 m from surface.	Short-term Public (i.e. passers-by, not workers)	Pathway linkage not viable
4,171 L LAB and blended mineral oil from cable approximately 0.9 m deep under Burgh Quay	Soil ingestion from homegrown vegetables- residential housing is mostly apartments, source like to stay at depth (minimum 0.9 m).	Local residents with gardens	Pathway linkage not viable

4,171 L LAB and blended mineral oil from cable approximately 0.9 m deep under Burgh Quay	Volatisation and migration of vapours, accumulation in underground ducts, services, cellars and basements	Workers – Short term exposure risk is not assessed in the PSA as it is outside the scope of this report. Short term exposure risks to workers are assessed as part of the Health and Safety Risk assessment (RAMS). Standard PPE measures apply for workers engaged in groundworks in Made Ground to minimise contact with potential contaminants and additional measures are not considered necessary	Short term exposure risks not examined in the PSA which deals with long term (chronic) risks to receptors.

8.0 RISK EVALUATION

Potential pollutant linkages that could impact the identified receptors have been identified in the Preliminary CSM assessment. These linkages have been identified where the source, pathway, and receptor are all present and potentially viable, and the source is therefore considered to pose a theoretical risk to the identified receptors.

Golder recognises that at present the ability of LAB and mineral oil to penetrate water pipes is not a fully understood risk, albeit likely to be a low risk. In the event that LAB was able to penetrate water pipes, then it is possible to examine the potential for LAB to dissolve in the water in the pipes and compare this to potential toxicity and drinking water limits available (e.g. WHO guideline values).

As discussed in the CSM, The nearest protected sites are the South Dublin Bay SAC (000210) and the South Dublin Bay and River Tolka Estuary SPA (004024) located approximately 5.2 km east of the spill. The risk is considered low however as at this location the attenuation capacity of the Liffey and the travel distance is significant.

The WHO drinking water guideline value for EC_{10}–EC_{12}, EC_{12}–EC_{16} aromatic fraction (*Petroleum Products in Drinking-water, Background document for development of WHO Guidelines for Drinking-water Quality, 2008*) is 0.09 mg/l. The solubility limit of LAB is 0.041 mg/L (OECD). Therefore, it is not possible for LAB to dissolve into water in supply pipes above the drinking water limit i.e. the drinking water guidance cannot be exceeded. Furthermore, presuming permeation of LAB through the pipe is occurring, the maximum solubility limit (0.041mg/l) could potentially be reached if water within the pipe was stagnant and allowed to fully dissolve or equilibrate over time; however, Golder understands that water will be moving in the pipe making it difficult for LAB to reach its solubility limit.

Accordingly, the probability of the risk would be considered unlikely i.e. pollutant linkage may be present in such a scenario, but the circumstances under which harm would occur are improbable. Therefore, along with a medium potential hazard, this would result in an overall rating of 'Low Risk'.

At present Golder consider that the potential vertical migration of LAB and blended mineral oil through the Dublin Boulder Clays (estimated as several metres thick) is low and consider the risks to the deep groundwater body from this leak to be low. However, it is likely that a shallow or perched groundwater body may be present within Fluvial/Alluvial Deposits (depth not confirmed) and/or Made Ground within close proximity of the River Liffey, which are not protected from migration of LNAPL/dissolved phase cable fluids by the Boulder Clay. Migration into shallow groundwater is likely to be a significant pollutant linkage for both LAB and blended mineral oils. We consider the River Liffey to be the primary receptor at present.

The availability of lateral preferential pathways along ducting routes is likely to be a significant pollutant linkage due to the significant presence of industrial, commercial, residential infrastructure within close proximity of the indicative leak location. In addition, buildings in this part of the city are likely to have basements or cellars. As such, volatilisation and accumulation of vapours in basements, cellars and ducts is seen as a moderate risk to residents.

8.1 Conclusions

Due to the known leak of cable fluid into the permeable cable trench material, and the unknown characteristics (e.g. permeability) of the Made Ground likely to be surrounding the trench, there is the potential for lateral migration of contaminants along ducting routes and laterally into shallow/perched groundwater bodies. There is also potential for volatilisation and accumulation of vapours in nearby basements, cellars and ducts. The close location of the leak to the River Liffey means that pathways for free-phase fluid and/or vapours may be influenced by the tidal range of the River Liffey, and the River is a likely receptor at present also.

Golder will present recommendations to address the potential risks under separate cover.

9.0 REFERENCES

CIRIA (2002) “Contaminated Land Risk Assessment a Guide to Good practice” (C522).

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The European Chemicals Bureau 1st Priority List (Volume 3) “Union Risk Assessment Report CAS No 67774-74-7” (1999)

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Fernandez, C., Alonso, C., Garcia, P, Tarazona, J.V., Carbonell, G. (2002) *Toxicity of Linear Alkyl Benzenes (LABs) to the Aquatic Crustacean Daphnia magna through Waterborne and Food Chain Exposures.* Bulletin for Environmental Contamination and Toxicology, vol 68, issue 5, pp 637-643.

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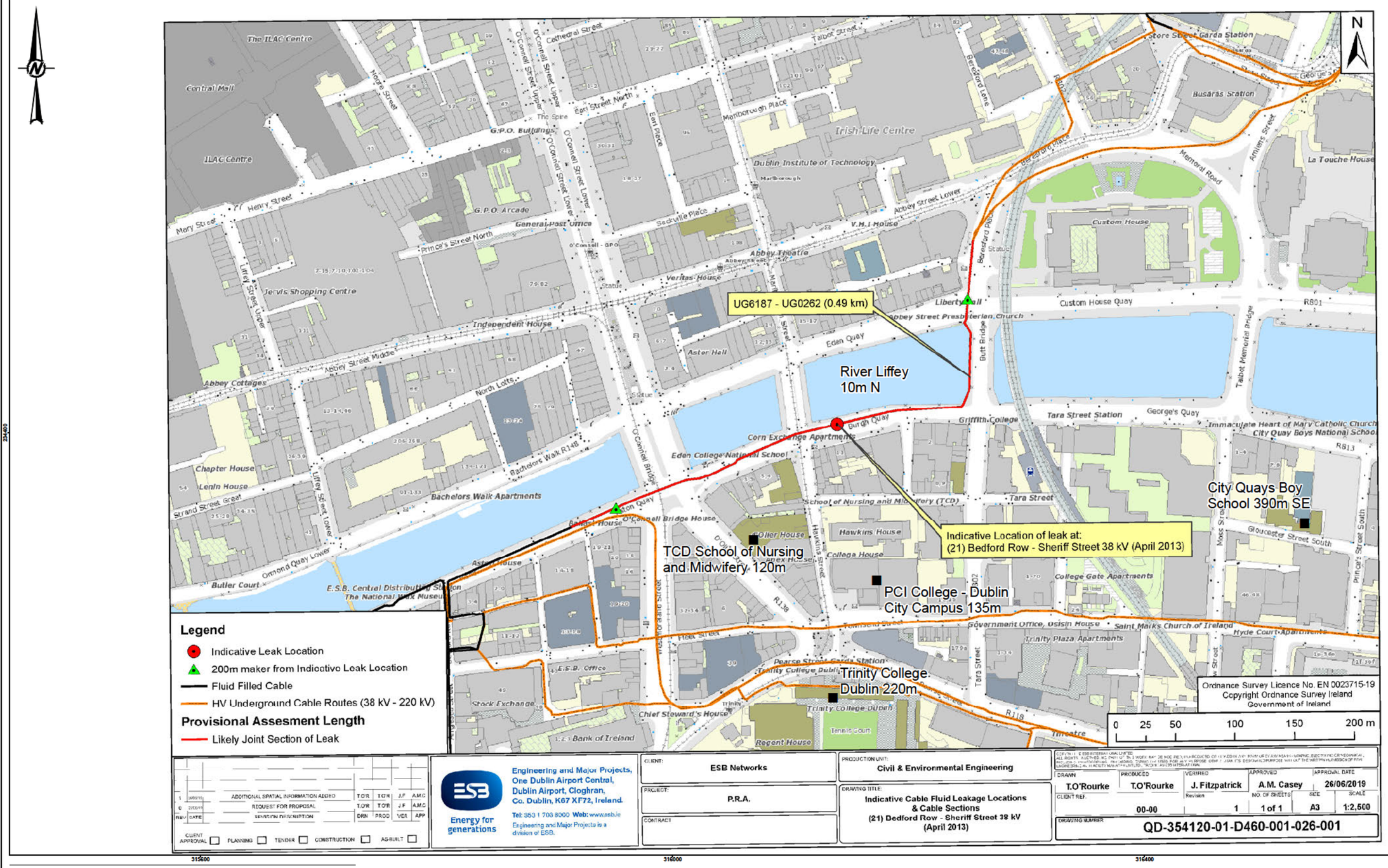
Drawings



1	26/06/19	ADDITIONAL SPATIAL INFORMATION ADDED	TOR	TOR	J.F	A.M.C
0	21/06/19	REQUEST FOR PROPOSAL	TOR	TOR	J.F	A.M.C
REV	DATE	REVISION DESCRIPTION	DRN	PROD	VER	APP

CLIENT APPROVAL ☐ PLANNING ☐ TENDER ☐ CONSTRUCTION ☐ AS-BUILT ☐

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Engineering and Major Projects is a division of ESB.

CLIENT: ESB Networks
PRODUCTION UNIT: Civil & Environmental Engineering
PROJECT: P.R.A.
CONTRACT
DRAWING TITLE: Indicative Cable Fluid Leakage Locations & Cable Sections (21) Bedford Row - Sheriff Street 38 kV (April 2013)

DRAWN	PRODUCED	VERIFIED	APPROVED	APPROVAL DATE
T.O'Rourke	T.O'Rourke	J. Fitzpatrick	A.M. Casey	26/06/2019
CLIENT REF.		Revision	NO. OF SHEETS	SIZE	SCALE
00-00		1	1 of 1	A3	1:2,500

DRAWING NUMBER: QD-354120-01-D460-001-026-001

LEGEND

■ Receptor

Receptors 500 - 1000 m from Leak Location

Distance in Metres	Receptor Description	Direction from Leak Location
980	Georges Hill Convent	NW,(GH)
785	Rotunda Hospital	NW,(EPA)
525	Larkin Community Hospital College	N,(GH)
380	Central Infants School	N,(GM)
440	Scoil Chaoimhín	N,(GM)
411	Central Model Senior School	N,(GH)
615	Inner Door	NE
925	Saints Stephen Green	SW
730	College Health Centre	SE,(EPA)
745	Westland Row CBS School	SE

0 75 150
1:3,300 METRES

REFERENCE(S)
1. COORD NATE SYSTEM: TM65 IRISH GRID

CLIENT
ESB

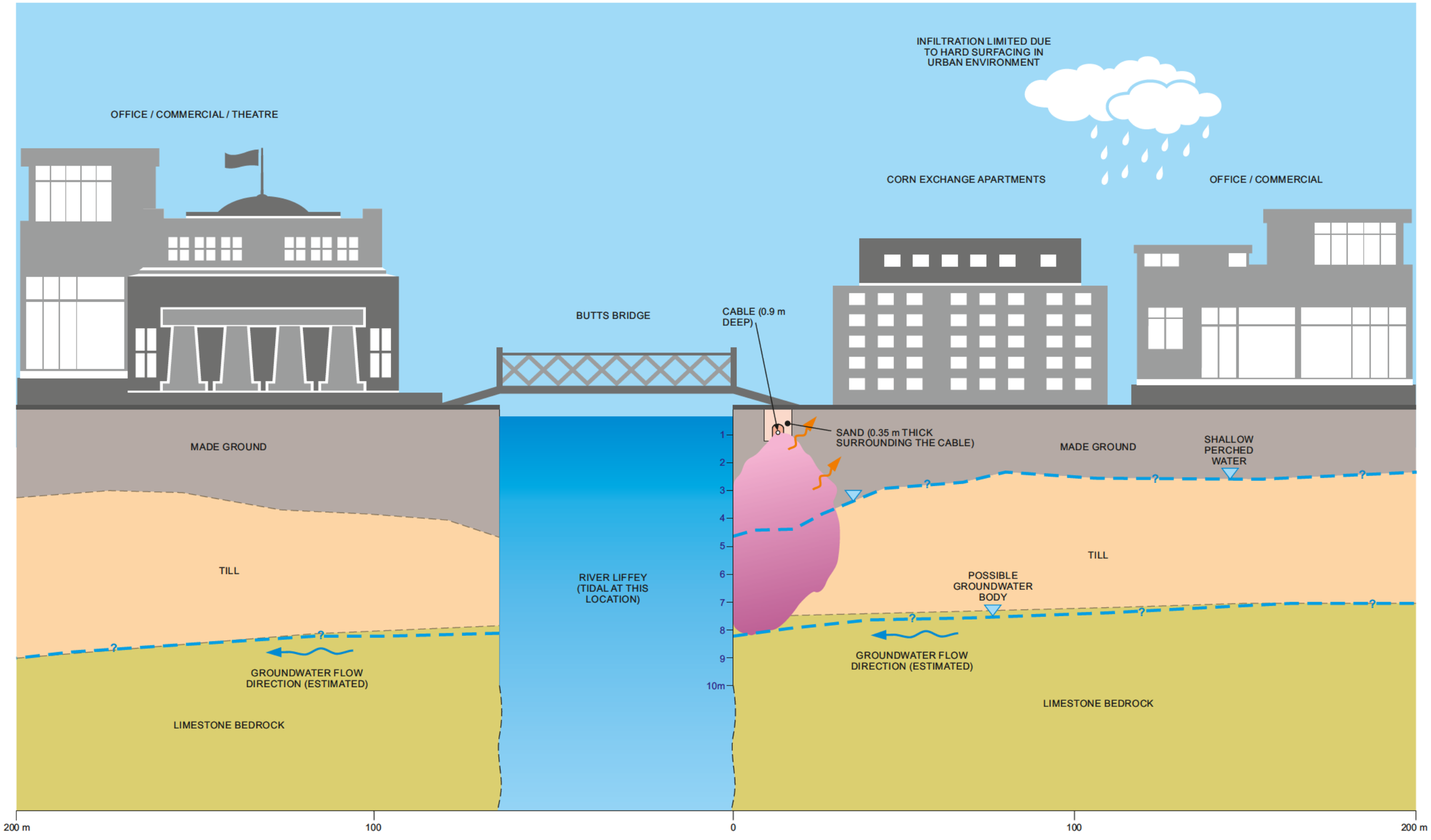
CONSULTANT
GOLDER

YYYY-MM-DD	2019 JUL 19
DESIGNED	KP
PREPARED	KP
REV EWED	TM
APPROVED	EMCA

PROJECT
ENVIRONMENTAL ASSESSMENTS OF ESB NETWORKS
HISTORIC FLUID FILLED CABLE LOSS

TITLE
PRELIMINARY SOURCE – PATHWAYS – RECEPTORS IDENTIFIED

PROJECT NO.	CONTROL	REV.	DRAWING
19126590	600-SW-035	B.0	1



LEGEND

- POTENTIAL PERCHED GROUNDWATER IN MADE GROUND
- VAPOUR MIGRATION

CLIENT
ESB

PROJECT
ENVIRONMENTAL ASSESSMENTS OF ESB NETWORKS HISTORIC FLUID FILLED CABLE LOSS

CONSULTANT
GOLDER

YYYY MM DD	2019 07 19
PREPARED	ECS
DESIGN	TM
REVIEW	TM
APPROVED	TM

SHEET TITLE
PRELIMINARY CSM (IDENTIFYING POLLUTANT LINKAGES) BEDFORD ROW, SHERIFF STREET (SITE 20)

PROJECT NO	CONTROL	REV	DRAWING
19126590	1001 EA 0021	A	2

APPENDIX A

Relevant Photographs Recorded During the Site Walkover

20-01 – Footpath appearing in good condition at the Site.

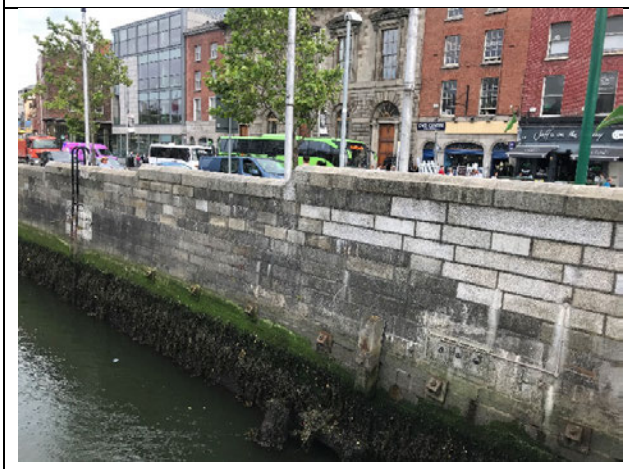
20-02 – Manhole present at Site on Burgh Quay.

20-03 – Immature trees noted along the Burgh Quay footpath, however some more mature trees were noted between O'Connell bridge and Rosie Hackett Bridge. Potential for developed and mature root systems interacting with underlying services.

20-04 – Going west along the cable length; towards O'Connell bridge and Aston Quay the road surfaces appeared in good condition.

20-04 – Going west along the cable length; towards O'Connell bridge and Aston Quay the road surfaces appeared in good condition.

20-05 – Algae, seaweed, dirt and debris noted on quay wall (observed from opposite side of the river and Rosie Hackett Bridge). From a distance, no obvious inconsistent appearance on quay wall.



21-00 – Algae, seaweed, dirt and debris noted on quay wall (observed from opposite side of the river and Rosie Hackett Bridge). From a distance, no obvious inconsistent appearance on quay wall.

20-07 – Road surface at Beresford Place and Eden Quay in good condition.

20-08 – Telecom and others manhole covers north of site at Beresford Place and Eden Quay.

20-09 – Telecom and others manhole covers north of site at Beresford Place and Eden Quay.

20-10 – Tarmac patching and resurfacing noted in footpath along Butt Bridge.

20-11 – Tarmac patching and resurfacing noted in footpath along Butt Bridge.

APPENDIX B

MSDS for T 3788 (LAB) and Masse 106 Mineral Oil

MATERIAL SAFETY DATA SHEET

1: IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND OF THE COMPANY / UNDERTAKING

Product Name: T 3788

Application: Hollow-core Energy Cable Saturant

Company: H&R ESP Ltd.

Address: Matrix House
North 4th Street
Milton Keynes, MK9 1NJ
United Kingdom

Telephone: +44 (0)1908 351 111 Fax: +44 (0)1908 351122

2: COMPOSITION / INFORMATION ON INGREDIENTS

Composition: Low viscosity compound based on a blend of linear alkyl benzenes that have side alkyl chains of 10 – 13 carbon atoms in length.

Synonyms: Linear Alkyl Benzenes
Alkyl C10-C13, benzenes
Benzene, C10-13-alkyl-deriv.
Detergent Alkylate

Composition	EINECS number	CAS number	Symbol letters	Risk numbers	Concentration range
C10 – C13 Linear Alkyl Benzenes	267-051-0	67774-74-7	Not regulated		100%

All constituents of this product are listed in EINECS (European Inventory of Existing Commercial Chemical Substances) or ELINCS (European List of Notified Chemical Substances) or are exempt.

3: HAZARDS IDENTIFICATION

Classification of preparation: This product is not classified as a dangerous substance / preparation in accordance with The Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 (CHIP3).

Physical and Chemical Properties: Not classified as flammable, but will burn. Avoid contact with strong oxidisers.

Health Effects

Skin:	Contact with the skin may cause irritation. Prolonged or repeated skin contact may cause drying of the skin, progressing to dermatitis. Symptoms may include itching, discolouration, swelling and blistering.
Eyes:	Contact with the eyes may cause irritation. Symptoms may include reddening, swelling and impaired vision.
Ingestion:	Ingestion of small amounts may cause nausea and vomiting.
Inhalation:	Due to low volatility, this product should not present an inhalation hazard under ambient conditions. Exposure to vapour or mineral oil mists may irritate the mucous membranes and cause dizziness, headaches and nausea.

Environmental Effects

No specific hazards under normal use conditions.

4: FIRST AID MEASURES

Inhalation:	Remove from further exposure. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance and call a doctor. If breathing has stopped, administer artificial respiration.
Skin contact:	Remove contaminated clothing and wash affected skin with soap and water. If persistent irritation occurs, obtain medical attention. If high pressure injection injuries occur, obtain medical attention immediately.
Eye contact:	Flush eye with copious quantities of water. If persistent irritation occurs, obtain medical attention.
Ingestion:	Wash out mouth with water and obtain medical attention. DO NOT INDUCE VOMITING.

5: FIRE FIGHTING MEASURES

Suitable extinguishing media:	Carbon dioxide (CO_2), dry chemical, foam or water spray.
Unsuitable extinguishing media:	Do not use water jets.
Special exposure hazards:	Combustion is likely to give rise to a complex mixture of airborne solid and liquid particulates and gases, including carbon monoxide, and unidentified organic and inorganic compounds.
Special protective equipment:	Proper protective equipment including breathing apparatus must be worn when approaching a fire in a confined space.

6: ACCIDENTAL RELEASE MEASURES

Personal Precautions:	Spilt product presents a significant slip hazard. Remove any sources of heat.
Environmental Precautions:	Prevent from spreading or entering into drains, sewers and watercourses by using inert absorbent material or other appropriate barriers. Inform local authorities if this cannot be prevented.
Methods for cleaning up:	Absorb liquid with inert absorbent material. Sweep up and remove to a suitable, clearly marked container for disposal in accordance with local and national regulations

7: HANDLING AND STORAGE

Handling:	Do not eat, drink or smoke whilst using this product. To avoid the possibility of skin disorders repeated or prolonged contact with products of this type must be avoided. It is essential to maintain a high standard of personal hygiene.
Storage:	Store in a cool place away from sources of heat and out of direct sunlight to avoid pressure build up. Do not store near oxidisers.

Handling and Storage Materials and Coatings

Suitable:	Carbon steel, baked epoxy or Phenolic coatings, aluminium.
Unsuitable:	Natural rubber, Butyl rubber

8: EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Limits:	Not established.
Engineering control measures:	Use of local exhaust ventilation is recommended whenever this product is used in a confined space, is heated above ambient temperatures, or is agitated.
Hygiene measures:	Wash hands before eating, drinking, smoking and using the toilet. Gloves should be washed before being removed.
Respiratory Protection:	Normally not required if adequate ventilation is in place. Where concentrations in air may exceed the limits given in this section, it is recommended to use a half mask respirator to protect from over exposure by inhalation. Suitable filter material depends on the amount and type of chemicals being handled, but filter material suitable for organic vapours may be considered for use.
Hand Protection:	When handling this product it is recommended to wear chemical resistant gloves. Suggested materials for protective gloves include: PVC, Neoprene or similar.
Eye Protection:	Wear eye protection such as safety glasses, chemical goggles, or face shield if engineering controls or work practices are not adequate to prevent eye contact. Have suitable eye wash water available.

Skin Protection:	Wear impervious protective clothing to prevent skin contact. Selection of protective clothing may include gloves, apron, boots, and complete facial protection depending on operations conducted.

9: PHYSICAL AND CHEMICAL PROPERTIES

General Information

Appearance:	Clear, colourless liquid
Odour:	Mild petroleum odour

Health, safety and environmental information

pH:	Not determined
Boiling point/range:	280°C
Flash point:	>135°C
Flammability:	Non flammable
Explosive properties:	Not explosive
Oxidising properties:	Not applicable
Vapour pressure at 20°C:	<0.02 kPa
Density:	0.86 g/cm^{-3} at 20°C typical
Solubility in water:	Insoluble
Kinematic Viscosity at 20°C:	4.0 – 4.5 cSt (4.0 – 4.5 mm^2/s) typical
Vapour density (Air=1):	>1
Evaporation rate:	Not determined

Other information

Pour point:	-60°C typical
Expansion coefficient:	0.0007 /°C typical
Neutralisation value:	0.03 mg KOH g^{-1} maximum

10: STABILITY AND REACTIVITY

Chemical stability:	This material is considered stable under normal ambient and anticipated storage and handling conditions of temperature and pressure and will not polymerise.
Conditions to avoid:	Temperatures above 140°C
Materials to avoid:	Strong oxidising agents, such as liquid chlorine, concentrated oxygen, sodium hypochlorite, calcium hypochlorite, peroxides etc, as this may present an explosion hazard.
Hazardous decomposition products:	Carbon monoxide and irritant fumes may be generated if this product is burned in an enclosed space.

11: TOXICOLOGICAL INFORMATION

Basis for assessment:	Toxicological data have not been determined specifically for this product. Information given is based on a knowledge of the components and the toxicology of similar products.
Acute toxicity:	Oral LD50 expected to be >5000 mg/kg (rat) Inhalation LC50/4hr expected to be >1.8 mg/l (rat) Dermal LD50 expected to be >2000 mg/kg (rabbit)
Corrosivity/irritation:	
Eye:	May be slightly irritant
Skin:	May be slightly irritant
Respiratory tract:	If mists are inhaled, slight irritation of the respiratory tract may occur
Skin sensitisation:	Not expected to be a skin sensitiser
Repeated-dose toxicity:	Prolonged and/or repeated contact may lead to irritation and possibly dermatitis, especially under conditions of poor personal hygiene.
Mutagenicity:	Not expected to be a mutagen.
Carcinogenicity:	Not expected to be a carcinogen.
Reproductive toxicity:	The preparation has not been assessed at all for this end-point, so its hazardous property in this regard is not known.

12: ECOLOGICAL INFORMATION

Basis for assessment:	Ecotoxicological data have not been determined specifically for this product. Information given is based on a knowledge of the components and the ecotoxicology of similar products.
Ecotoxicity:	Poorly soluble mixture. Product is not expected to be ecotoxic to fish/daphinia/algae, or sewage bacteria. This preparation is expected to be removed in a wastewater treatment facility
Mobility:	Liquid under most environmental conditions. Floats on water. If it enters soil, it will adsorb to soil particles and will not be mobile.
Persistence and degradability:	Readily biodegradable. Soils degradation – half life approx. 15 days. Natural waters degradation – half life approx. 4 – 9 days.
Bioaccumulative potential:	May have the potential to bioaccumulate

13: DISPOSAL CONSIDERATIONS

Disposal must be in accordance with local and national legislation.

Unused Product:	Dispose of through an authorised waste contractor to a licensed site. May be incinerated.
Used/Contaminated Product:	Dispose of through an authorised waste contractor to a licensed site. May be incinerated.
Packaging:	Dispose of through an authorised waste contractor. May be steam cleaned and recycled.

14: TRANSPORT INFORMATION

This product is not classified as dangerous for transport.

15: REGULATORY INFORMATION

Classification/Symbol: Not Regulated

This preparation is not classified as Dangerous according to EU Directives

This safety data sheet is intended to assist in compliance with the following UK legislation:

- Chemicals (Hazard Information and Packaging for Supply) Regulations 2002
- Control of Substances Hazardous to Health Regulations 2002.
- Health and Safety at Work, etc. Act 1974.
- Environmental Protection Act 1990
- Environmental Protection (Duty of Care) Regs. 1991
- COSHH essentials: Easy steps to control chemicals. Control of Substances Hazardous to Health Regulations

Further Guidance
The following guidance notes are available from HMSO or HSE.

Occupational exposure limits (EH 40). Effects of mineral oil on the skin (SHW 397).
Preventing dermatitis at work (INDG 233)
A step by step guide to COSHH assessment (HSG 97)
Assessing and managing risks at work from skin exposure to chemical agents (HSG 205)
The selection, use and maintenance of respiratory protective equipment: A practical guide (HSG 53)
Relevant EC Directives:

- Dangerous Substances Directive (DSD)
- Dangerous Preparations Directive (DPD)
- Safety Data Sheets Directive (SDSD)
- Health & Safety Framework Directive

16: OTHER INFORMATION

This data sheet was prepared in accordance with Commission Directive 2001/58/ECand SI 2002 No. 1689 (CHIP 3)

Key References:

- Chemicals (Hazard Information and Packaging for Supply) Regulations 2002
- The compilation of safety data sheets. Approved Code of Practice (third edition)
- Approved supply list (7th Edition). Information approved for the classification and labelling of substances and preparations dangerous for supply. Chemicals (Hazard Information and Packaging for Supply) Regulations 2002
- Approved classification and labelling guide. Chemicals (Hazard Information and Packaging for Supply) Regulations 2002. Guidance on regulations (Fifth edition).
- EH40/2005 Workplace Exposure Limits 2005
- COSHH essentials: Easy steps to control chemicals. Control of Substances Hazardous to Health Regulations
- European Inventory of Existing Commercial Substances (EINECS)

The data and advice given apply when the product is sold for the stated application or applications. The product is not sold as suitable for any other application. Use of the product for applications other than as stated in this sheet may give rise to risks not mentioned in this sheet. You should not use the product other than for the stated application or applications without seeking advice from us.

If you have purchased the product for supply to a third party for use at work, it is your duty to take all necessary steps to secure that any person handling or using this product is provided with the information in this sheet.

If you are an employer, it is your duty to tell your employees and others who may be affected of any hazards described in this sheet and of any precautions that should be taken.

We believe, in good faith and to the best of our knowledge that the preceding information is accurate. However, we give no guarantee or warranty in this respect. The information provided herein may not be adequate for all individuals and/or all situations. The purchaser/user of the product remains responsible for storing, using or dealing with the product safely and in accordance with all applicable laws and regulations.

Safety Data Sheet
(93/112/EC)

Date of edition: October 1995

1. Identification of Substance/Preparation and Company

Product name:
Masse 106
Supplier:
FELTEN & GUILLEAUME Energietechnik AG
Schanzenstraße 24-30
51063 Köln
Emergency telephone number: 0221/676-3333

2. Composition/Information on Ingredients

Blend of highly refined mineral oils and additives.
On the basis of available information, the components of this preparation are not expected to impart hazardous properties to this product.

3. Hazards Identifikation

Human Health Hazards

If swallowed, aspiration into the lungs may cause chemical pneumonitis.
Prolonged or repeated exposure may give rise to dermatitis.
No specific hazards under normal use conditions.

Safety hazards

The preparation contains mineral oil, for which an exposure limit for oil mist applies.

Environmental hazards

Avoid spillage.
The poduct is not readily biodegradable.

4. First Aid Measures

Inhalation

Remove to fresh air.
If breathing but unconscious, place in the recovery position.
If breathing has stopped, apply artificial respiration.
Medical attention is to be obtained immediately.

Skin

Remove contaminated clothing and wash affected skin with soap and water.

If high pressure injection injuries occur, obtain medical attention immediately.

Eye

Rinse immediately with plenty of water for ar least 10 minutes and seek medical advice.

Ingestion

Do not induce vomiting.
Aspiration into the lungs may occur directly or following ingestion. This can cause chemical pneumonitis which may be fatal.
If breathing but unconscious, place in the recovery position.
If breathing has stopped, apply artificial respiration.
Medical attention is to be obtained immediately.

Advice to physicians

Treat symptomatically

5. Fire Fighting Measures

Extinguishing media

Foam, dry chemical powder, carbon dioxide, sand or earth.

Safety Data Sheet
(93/112/EC)

Date of edition: October 1995

Product name: Masse 106

5. Fire Fighting Measures (continued)

Unsuitable extinguishing media

Do not use water in a jet

Specific hazards

- Combustion is likely to give rise to a complex mixture of gases and airborne particulates, including carbon monoxide, oxides of sulphur and unidentified organic and inorganic compounds.

6. Accidental Release Measures

Personal precautions

Ventilate contaminated area thoroughly.

Minimise contact with skin.

Environmental precautions

Prevent further leakage or spillage and prevent from entering drains.

Prevent from spreading or entering into drains, ditches or rivers by using sand, earth or other appropriate barriers.

Clean-up methods

Absorb or contain liquid with sand, earth or spill control material.

Shovel into a suitable, clearly marked container for disposal or reclamation in accordance with local regulations.

7. Handling and Storage

Handling

When using do not eat or drink.

When handling product in drums, safety footwear should be worn and proper handling equipment should be used

Prevent spillages.

Storage

Keep container tightly closed and in a well ventilated place. Avoid direct sunlight, heat sources and strong oxidising agents.

Recommended materials: mild steel, high density polyethylene for containers or container linings.

8. Exposure Controls/Personal Protection

Engineering control measures

Use only in well ventilated areas.

Occupational exposure standards

Component name	Limit type	Value/Unit	Other information
Oil mist	8 h TWA	5 mg/m³	ACGIH
	10 min STEL	10 mg/m³	ACGIH

Respiratory Protection

Not normally required.

If oil mist cannot be controlled, a respirator fitted with an organic vapour cartrige combined with a particulate prefilter should be used.

Hand Protection

PVC or nitril rubber gloves if splashes are likely to occur and if applicable.

Eye Protection

Safety spectacles

Body Protection

Minimise all forms of skin contact.

Safety Data Sheet
(93/112/EC)

Date of edition: October 1995

Product name: Masse 106

8. Exposure Controls and Personal Protection (continued)

Hygiene measures

Don't keep oily rags in your pockets.
Wash hands before eating and drinking.

9. Physical and Chemical Properties

form	liquid	
colour	yellow	
pourpoint	< -60°C	DIN ISO 3016
flashpoint	145°C	DIN 51758
flammability - lower limit (vol%)	0,6	
flammability - upper limit (vol%)	6,5	
vapour pressure (20°C)	< 0,01 hPa	
density (15°C)	888 kg/m³	DIN 51757
solubility in water (20°C)	negligible	
n-octanol/water partition coeff.	na	
kinematic viscosity (40°C)	8,5 mm²/s	DIN 51562

10. Stability/Reactivity

Stability

stable under normal use conditions

Materials to avoid

strong oxidising agents

Hazardous decomposition products

Hazardous decomposition products are not expected to form during normal storage.

11. Toxicological Information

Toxicological Data:

Acute toxicity - oral

LD 50 is expected to be > 2000 mg/kg.

Irritation of skin, irritation of eye

The product is expected to be slightly irritant.

Sensitisation of skin

The produkt is not expected to be a skin sensitiser.

Prolonged and/or repeated contact

Prolonged/repeated contact may cause defatting of the skin, which can lead to dermatitis and may make the skin more susceptible to irritation and penetration by other materials.

Carcinogenicity

Product is based on mineral oils of types shown to be non-carcinogenic in animal skin-painting studies. Other components are not known to be associated with carcinogenic effects.

Other information

Aspiration into the lungs may occur directly or following ingestion. This can cause chemical pneumonitis which may be fatal.
Information given is based on a knowledge of the toxicology of similar products.

Safety Data Sheet
(93/112/EC)

Date of edition: October 1995

Product name: Masse 106

12. Ecological Information

Basis for assessment

Information given is based on data on the components and the ecotoxicology of similar products.

Mobility

Product floats on water. It is liquid under most environmental conditions.
If it enters soil, it will be adsorbed to soil particles and will not be mobile.
Product has the potential to bioaccumulate.

Ecotoxicity

Product is expected to be practically non-toxic to aquatic organisms, LC/EC50 > 100 mg/L.

13. Disposal Considerations

Product

Precautions: Dispose to licensed disposal contractor.
Waste disposal Nr. (D): 54106

Container disposal

Drain container thoroughly.
Dispose to licensed disposal contractor.

Recomanded cleaning procedure

Cleaning by disposal contractor

14. Transport Information

Product is not dangerous for conveyance under UN, IMO, ADR/RID and IATA/ICAO codes. (According ADR/RID regulations from 1.1.1995)

15. Regulatory Information

Classification

The Product is not classified as dangerous under EC criteria.

16. Other Information

Additional informations

Concawe Report 5/87 Health Aspects of Lubricants.

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should therefore not be construed as guaranteeing any specific property of the product.

APPENDIX C

CIRIA C522 Risk Analysis

6.3 RISK EVALUATION

The purpose of risk evaluation is to decide whether or not risks are acceptable and to determine the need for remedial action. The acceptability of identified risks may depend on who is considering the risks (see Chapter 7). Ultimately, the decision on acceptability of a risk is a balance of the technical reasoning, practicality, perception and cost-benefit.

This stage involves:

- collation and review of the risk-based information for the site
- addressing uncertainty and its effect on judgements regarding risk estimates
- identification of those risks that are considered unacceptable.

6.3.1 Collating and reviewing risk-based information

At this stage it is useful to summarise all the risk-based information for the site and relate the receptors to the relevant contaminants. In effect, this involves a re-examination of the conceptual model in light of new information. For large sites it may be that the site is subdivided into several zones for clarity and ease of assessment.

6.3.2 Addressing uncertainty

Uncertainty should be considered in terms of:

- whether enough data exists to estimate the risks with an acceptable level of confidence
- identification of assumptions and safety factors used in the assessment.

The assumptions and safety factors incorporated into a risk estimation should be examined, and if uncertainty is considered unacceptable then the risk estimation stage is repeated (ie the collection of more site investigation data, see Section 5.3). The cost and benefit of additional risk estimation needs to be balanced against the need for certainty. For some sites, uncertainty may be acceptable, and the costs of additional risk estimation deemed unnecessary. However, further site investigation data and risk assessment may be necessary to achieve a cost-effective remediation strategy.

6.3.3 Identification of unacceptable risks

The following methodology has been developed from an in-house procedure used by Enviros Aspinwall (not published), submitted during the course of this research. This methodology was in turn developed from the "Guide to Risk Assessment and Risk Management for Environmental Protection" (DoE, 1995) and *Draft Statutory Guidance on Contaminated Land* (DoE, 1996). The method presented is an updated and modified version of the Enviros Aspinwall procedure and represents one possible methodology for presenting and evaluation the results of risk estimation.

This method for risk evaluation is a qualitative method of interpreting the output from the risk estimation stage of the assessment. It involves the classification of the:

- magnitude of the potential **consequence** (severity) of risk occurring (Table 6.3)
- magnitude of the **probability** (likelihood) of the risk occurring (Table 6.4).

Table 6.3 *Classification of consequence*

Classification	Definition	Examples
Severe	Short-term (acute) risk to human health likely to result in "significant harm" as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. Catastrophic damage to buildings/property. A short-term risk to a particular ecosystem, or organism forming part of such ecosystem (note: the definitions of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000).	High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water. Explosion, causing building collapse (can also equate to a short-term human health risk if buildings are occupied.
Medium	Chronic damage to Human Health ("significant harm" as defined in DETR, 2000). Pollution of sensitive water resources (note: Water Resources Act contains no scope for considering significance of pollution). A significant change in a particular ecosystem, or organism forming part of such ecosystem. (note: the definitions of ecological systems within Draft Circular on Contaminated Land, DETR , 2000).	Concentrations of a contaminant from site exceed the generic, or site-specific assessment criteria. Leaching of contaminants from a site to a major or minor aquifer. Death of a species within a designated nature reserve.
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ("significant harm" as defined in the *Draft Circular on Contaminated Land*, DETR, 2000). Damage to sensitive buildings/structures/services or the environment.	Pollution of non-classified groundwater. Damage to building rendering it unsafe to occupy (eg foundation damage resulting in instability).
Minor	Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc). Easily repairable effects of damage to buildings, structures and services.	The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discoloration of concrete.

Table 6.4 *Classification of probability*

Classification	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place, and is less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term

These classifications are then compared to indicate the risk presented by each pollutant linkage. It is important that this classification is only applied where there is a possibility (which can range from high likelihood to unlikely) of a pollutant linkage existing.

This method can be applied with or without site investigation data and can be used to assess the results of either qualitative or quantitative assessment. **It is recommended that the amount of data and basis of classifications are made clear when reporting such an assessment**. It is often possible to undertake this risk evaluation following the Phase 1 stage of the risk assessment. If site investigation and further risk estimation are then undertaken the evaluation can be revised.

Once the consequence and probability have been classified, these can then be compared (see Table 6.5) to produce a risk category, ranging from "very high risk" to "very low risk". The actions corresponding with this classification is given in Table 6.6. A worked example is presented in Box 6.10.

Table 6.3 shows the classification of consequence. To classify the consequence it is important to bear in mind that the classification does not take into account the probability of the consequence being realised (this is considered in Table 6.4). Therefore, for a particular pollutant linkage it may be necessary to classify more than one consequence. For example, the risk from methane build-up in a building presents a risk of harm both to the building and to human health. Both would be classified as *severe*, but the probability, addressed in the next stage of this methodology, may vary (for example, the building may be unoccupied for most of the time, with only occasional visits – eg a pumping station).

The classification of *severe* relates to short-term (acute) risks only. The *medium* classification relates to chronic harm, which can be classed as "significant harm" (if the assessment is carried out for Part IIA purposes. The *mild* classification also relates to significant chronic harm but applies to less-sensitive receptors. The *minor* classification relates to harm which, while not considered "significant", may have a financial implication (eg phytotoxic effects of contaminants on development landscaping).

It is worth noting that, in theory, both a *severe* and *medium* classification can result in death. The differentiation between the two categories is that *severe* relates to a short-term risk whilst *medium* relates to a long-term risk. Therefore the classification of *severe* should indicate that urgent action is required (urgent action may also be required under the *medium* classification, but usually longer-term actions are sufficient).

The classification gives a guide as to the severity and consequence of identified risks when compared with other risk presented on the site. It is not possible to classify an identified risk as presenting "no-risk", rather "very low risk". This is important, as the acceptability of risk may depend on the viewpoint of the stakeholder concerned. It may be necessary to take action to deal with a risk even if classified as "very low", although these actions may not necessarily be required urgently.

Table 6.5 *Comparison of consequence against probability*

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High likelihood	**Very high risk**	**High risk**	**Moderate risk**	Moderate/ low risk
	Likely	**High risk**	**Moderate risk**	Moderate/ low risk	Low risk
	Low likelihood	**Moderate risk**	Moderate/ low risk	Low risk	Very low risk
	Unlikely	Moderate/ low risk	Low risk	Very low risk	Very low risk

Table 6.6 *Description of the classified risks and likely action required*

Very high risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High risk	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the longer term
Moderate risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, if is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term
Low risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very low risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

Box 6.10 *Example of risk evaluation*

A site is used for car parking. The surface is mainly hardstanding, but the quality is not sufficient to prevent infiltration of rainwater. Site investigation has shown that, underlying the hardstanding, the made ground and groundwater (minor aquifer) beneath the made ground contain raised concentrations of toxic metals. The site investigation also encountered several areas of fly-tipped wastes with very high cyanide content (enough to present short-term risks to human health). One such area, bordered by housing, is used for informal recreation, mainly by children.

Therefore the contaminant-pathway-receptor relationship can be summarised as below.

Contaminant	Pathway	Receptor	Consequence of risk being realised	Probability of risk being realised	Risk classification	Risk management action taken
Fly-tipped material with high cyanide content	Direct contact	Humans, mainly children playing on site	Severe	High likelihood	Very high	Immediate removal of fly-tipped material to suitable landfill facility
Toxic metals, for example arsenic and cadmium	Leaching to groundwater (minor aquifer)	Minor aquifer, no local abstractions	Medium	High likelihood	High	Further groundwater monitoring, including perimeter and removal of hotspots of contamination.
Toxic metals, for example arsenic and cadmium	Direct contact	Site workers and visitors during remediation	Medium	Likely	Moderate	Site health and safety plan made allowance for contamination. Site workers were supplied with personal protective equipment and damping down of the site during dry periods was undertaken during remediation.
Toxic metals, for example arsenic and cadmium	Dust	Site workers Residential properties next door to site Site workers and visitors during remediation	Medium	Likely	Moderate	It was considered that damping down of site was sufficient to break this pollutant linkage. Dust monitoring was undertaken on site and at site boundaries to prove this.

Note

The pollutant linkage for residential properties was not assessed in detail, as the measures to address the risk to site workers from contaminated dust were considered sufficient to protect nearby residents.

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