Licence Reference No.	Risk Assessment Methodology Stage and Step	Report Version
N/A	Stage 1 (PSA)	A.2 Final for Client

REPORT

Site 60 Pembroke to Ringsend 38kv: Preliminary Site Assessment Report for Historic Fluid Filled Cable Loss

ESB Engineering and Major Projects

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Distribution List

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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 often 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 28,614 L of cable fluid (linear alkyl benzene) from a 38 kV section of cable between Pembroke and Ringsend (Site 60). The indicative leak location is in Pembroke Station.

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
- 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 are not considered necessary to assess the potential pollutant linkages identified in this report.

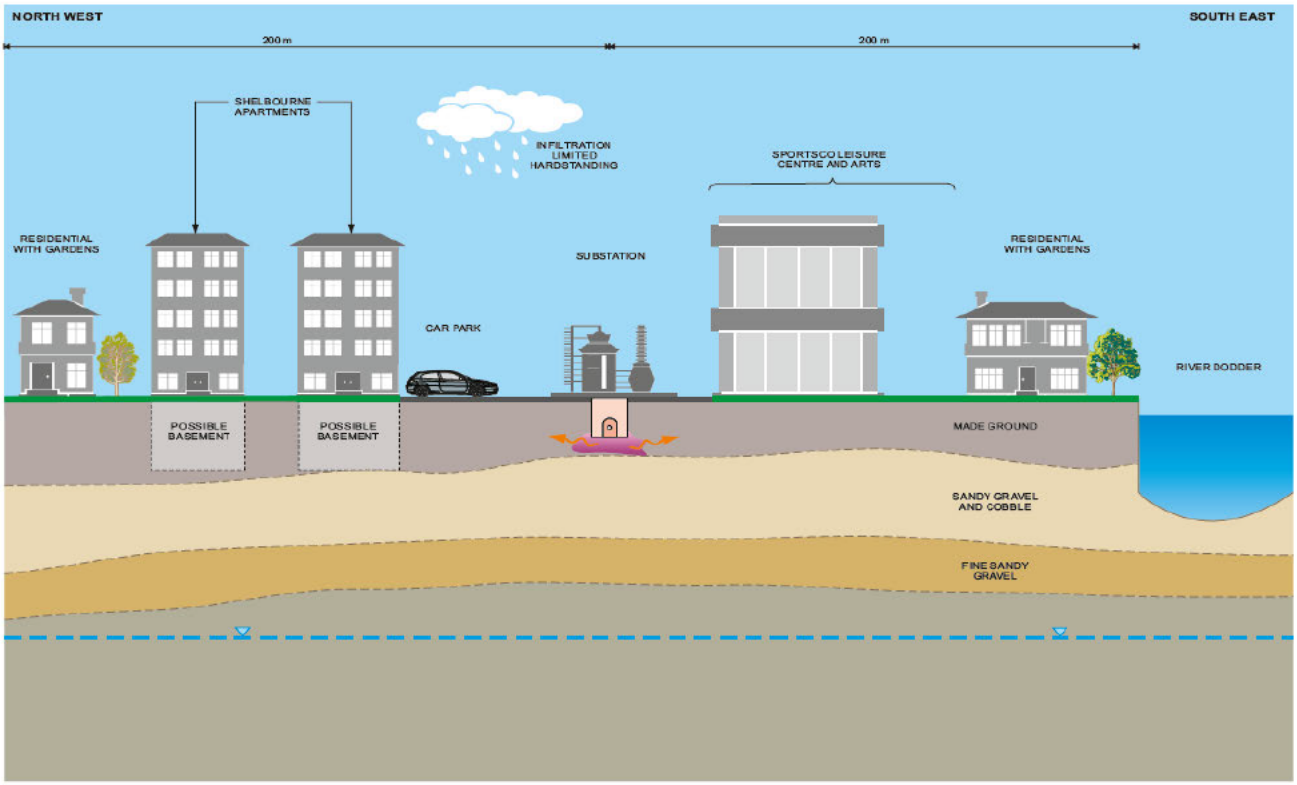

Figure 1: Preliminary CSM for Site 60 (Pembroke and Ringsend).

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	19126590.60.A.2	24 April 2020	A.2 Final for Client
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			
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. Golder does not provide specialist legal advice and the advice of lawyers will be required.

g) 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.

h) 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.

Table of Contents

TABLES

FIGURES

DRAWINGS

Drawing 1
Site Location – Site 60

Drawing 2
Not included

Drawing 3
Preliminary CSM (Identifying Pollutant Linkages) Pembroke to Ringsend (Site 60)

APPENDICES

APPENDIX A
Photographic record of site walkover

APPENDIX B
MSDS for T3788 (LAB)

APPENDIX C
CIRIA C522 Risk Analysis Definitions

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 (3 kV) cable run located between Pembroke and Ringsend ('Site 60') (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.

Golder has completed this work in accordance with the scope outline in proposal P19126590.P1.V0 dated 28 June 2019 and the revision P19126590.P1.V1 dated 3 July 2019, and the ESB Consultancy Services Agreement between ESB and Golder Associates Ireland Limited, dated 25 June 2019, and signed by Golder on 5 July 2019.

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 site 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 along the cable length from the cable leak are summarised in Table 1 and shown on Drawing 1. The cable was not inspected inside private property where no access was possible outside of ESB lands and public roadways.

Table 1: Site Location

	Leak Co-ordinates	200 m Cable Length Limit
Easting	317908	318060
Northing	233540	233617

The Site is located in Pembroke Station adjacent to residential areas of Dublin, approximately 160 m west of the River Dodder. The leak occurred in a basement of Pembroke substation.

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	60
Incident Title	30 Pembroke – Ringsend 38 kV – 2004
Circuit	Pembroke – Ringsend 38 kV
Leak Start Date	2004
Leak Repair Date	2004
Leak Duration (months)	11
Total Leakage (litres)	28,614
Leakage Rate (litres/month)	2,631
Volume of Circuit (litres)	5,757
Year Circuit Installed	1950
Voltage (kV)	38
Cable Length (km)	2.2
Leak Size Minus Circuit Volume (litres)	-120,552
Assumed Fluid	Linear alkyl benzene (LAB)
Comment	Post 1970 circuit. Leak size greater than circuit volume. Assume original fluid replaced.
Local Authority	Dublin City Council
Leak Location	In Pembroke Station
Fluid/Oil Type	Cable fluid
Chemical Information	Linear Alkyl Benzene
Brand Name	T 3788
CAS Number	67774-74-7

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 Site 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.

2.0 SITE DESCRIPTION

The Site walkover was completed on 5 July 2019. The Golder engineer walked along the length of the cable; 200 m from the leak location in each direction (shown on Drawing 1). It is noted that, as described below, the leak for this location occurred in a basement level of a substation. 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

Evidence of potential contamination from cable fluid/oily substances was observed in the basement level of the substation 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 total 200 m cable length (following the cable north of 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 Information Sources

- The Geological Survey of Ireland (GSI) online map viewer – dcenr.maps.arcgis.com, accessed 22 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 22 July 2019;
- Environmental Protection Agency (EPA) online map viewer - https://gis.epa.ie/EPAMaps/, accessed 22 July 2019;
- The National Monuments Service's Historic Environment Mapping Viewer - http://webgis.archaeology.ie/historicenvironment/, accessed 22 July 2019;
- The National Parks and Wildlife Service (NPWS) map data - https://www.npws.ie/maps-and-data, accessed 22 July 2019;
- The European Pollutant Release and Transfer Registers (E-PRTR) – http://prtr.ec.europa.eu, accessed 6 July 2019;
- The Geohive by Ordnance Survey Ireland – https://geohive/ie/, accessed 22 July 2019; and
- The Ireland Grid Reference - http://gridreference.ie/, accessed 22 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.

3.2 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
1864 (1:2,500)	■ Dominated by open spaces in Shelbourne Area/Triangle. ■ Appears to be man-made water courses (possibly canals) crosscutting the area - courses are very linear and sharp and lead from the Dodder. ■ Rope walk (recreational area along one of the water courses) is noted in what would be the current Shelbourne Park Stand area to the north. ■ A residential block is noted in the southwest and it appears canals lead to this area. ■ An iron foundry is noted on the eastern side of the Dodder, in line with the present day Shelbourne Park Stadium. ■ The electrical station is not present.
1907-1908 (1:2,500)	■ Shelbourne Park Stadium is not present. ■ Largely open space in the Shelbourne Area and residential areas are confined to the southwest and along roads in the greater area. ■ Electrical station in situ.
1935 (1:2,500)	■ Shelbourne Park still noted.

Date	Detail
	■ Electrical Station to the south of Shelbourne Park. ■ Pack Case factory is noted between Shelbourne Park and Electrical Station on this edition similar to Cassini map. ■ An elevated tank is noted on the Electrical Station Site. ■ A morgue is located to the southeast (east of present day ESB leisure Centre and adjacent to Dodder). ■ Area is largely residential along roads.
1970 (1:1,000)	■ The area is mixed use being residential along roads, open space (carparks/recreational) and recreational (stadium & recreational area - tennis courts). ■ Electricity Station noted on eastern side of South Lotts road (immediate west of area of interest along ESB line). ■ Three tanks noted on map associated with Electrical Station. ■ An additional area of tanks is noted further south within the ES site.
1988 (1:1,000)	■ The area is mixed use being residential along roads, open space (carparks/recreational) and recreational (stadium & recreational area - tennis courts). ■ Electricity Station noted on eastern side of South Lotts road (immediate west of area of interest along ESB line). ■ Three tanks noted on map associated with Electrical Station. ■ An additional area of tanks is noted further south within the ES site.
1994 (1:1,000)	■ The area is mixed use being residential along roads, open space (carparks/recreational) and recreational (stadium & recreational area - tennis courts). ■ Electricity Station noted on eastern side of South Lotts road (immediate west of area of interest along ESB line). ■ Three tanks noted on map associated with Electrical Station. ■ Note - Comparison with present Google aerials suggests the three tanks are gone and the area is now part of the carparking/internal road network.

4.0 CHEMICALS OF CONCERN

The information provided by ESB (summarised in Table 2) defines the chemical present in the cable fluid is Linear Alkyl Benzene (LAB) present in cable fluid T 3788 (CAS 67774-74-7). LAB is the Chemical 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 presents 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.

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

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 fluid, 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 of 0.001 – 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 (Reach Centrum, 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).

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 3 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	Shelbourne Park Apartments are located approximately 60 m north of the Site. Shelbourne Park greyhound racetrack is approximately 92 m north of the Site, beyond which is more residential buildings.

Direction from Leak Location	Description of Current Land Use
East	ESB Sportsco Leisure Centre lies approximately 20 m east of the Site. There is residential housing approximately 100 m east of Site.
South	The Site is bound to the south by ESB networks beyond which is residential housing with gardens.
West	The Site is bound to the west by ESB networks, beyond which is residential housing with gardens.

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

A review of the data available on the EPA online maps shows that there is an IPPC facility that holds an Industrial Emission license (IE) held by Van Leer Ireland Ltd. Approximately 505 m west of 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 South Dublin Bay and River Tolka Estuary SPA (004024) located approximately 1.15 km to the south east of the site. At this distance from the indicative leak location these sites are not considered a potential receptor as there is no viable pathway present. 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 Dodder located approximately 180 m east of Site. The River Liffey is located 700 m north of the Site. The Grand Canal is located approximately 385 m northeast of the Site.

5.1.6.2 Surface Water Quality

According to the Transitional Water Quality map 2010-2022, the section of the River Liffey north of site is considered unpolluted and is classified as being transitional in this area. The transitional Waterbody WFD status of the Liffey in this location is moderate. According to the EPA River Waterbodies Risk map, the River Dodder located approximately 180 m east of Site and the River Liffey, are at risk of deteriorating or being at less than 'Good' status. The River Waterbody WFD status of the River Dodder 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 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 shows a single flood event located approximately 20 m east of the Site at Sportsco which occurred on the 4 October 2011 due to surface water drainage following heavy rainfall in a short duration. The OPW flood maps do not indicate that the Site has a medium risk of flooding by rivers (1 in 100 chance of occurring or being exceeded in any given year). The Rainfall Flood Extents map indicates sections of the Site are at high probability (1 in 10 chance of occurring or being exceed in any given year) to be directly flood 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 is not listed as a specified pollutant 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 to a depth of approximately 3.5 m bGL (GSI reference R269/54134).

5.1.7.2 Superficial and Bedrock Geology

The GSI Subsoils (Quaternary Sediments) maps shows the subsoil to be 'urban'. A review of the Bedrock Geology 1:100,000 map (GSI) shows that the underlying bedrock geology to be Lucan Formation (dark limestone and shale) known as Calp. These form part of the Dinantian Upper Impure Limestones.

5.1.7.3 Faulting

The Bedrock Geology 1:500,000 map (GSI) Faults map 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 45 m south west from Site which was drilled to a depth of 7.5 m below Ground Level (bGL) (GSI reference R898/62380). The geology encountered was recorded as made ground to 2.6 m bGL, underlain by very soft, very sandy silt to 2.9 m bGL and compact fine to coarse sandy gravel to 7.5 m bGL. A depth to groundwater was recorded at 2.5 m bGL.

The GSI geotechnical viewer showed a borehole located approximately 40 m from Site which was drilled to a depth of 7.92 m bGL (GSI reference R269/54134). The geology encountered was recorded as Made Ground to 3.05 m bGL, underlain by sandy gravel cobbles and boulders to 6.1 m bGL and fine sandy gravel and cobbles to 7.92 m bGL. A depth to groundwater was recorded at 2.13 m bGL.

The nearest registered well is located approximately 400 m northwest of Site with a locational accuracy of 20 m (GSI name 2923SEW052). The well was drilled to 8.5 m and its yield class and use is unknown. At this depth in Dublin city centre this well is not considered to be for potable use. There are five more wells approximately 400 m northwest of Site two of which are for industrial use, and the other three being unknown. Two more wells are located 400 and 500 m southeast of Site by Aviva Stadium with a locational accuracy of 200 m (GSI name 2923SEW037 and 2923SEW028). The boreholes are listed as being drilled to 7.6 m bGL and 38 m bGL respectively.

5.1.9 Hydrogeology

5.1.9.1 Groundwater Vulnerability

The GSI Bedrock Aquifer map shows the Site and surrounds to have low vulnerability to groundwater contamination. Approximately 35 m south of the Site the groundwater vulnerability is moderate. 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 discharges to groundwater within 500 m of the Site.

5.1.9.3 Groundwater Abstractions

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.

The Dinantian Upper Impure Limestones are classed as a 'locally important' aquifer within the vicinity of the Site and the area across Dublin in general.

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 shallow groundwater beneath the Site may flow in a generally eastern direction towards the River Dodder. The River Liffey approximately 700 m North of the Site is tidal in this area which may also affect groundwater flow direction. However, there is no Site-specific data available at this time to confirm this assumption.

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 Water Framework Directive (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. In Dublin City centre where this Site is located the utilisation of the GWB as a potable resource is considered to be low due to the availability of potable mains supply and the relatively poor yielding potential of the aquifer.

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 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.

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: 315731, Northing: 233067) (locations obtained from georeferenced ESB provided drawing, reference QD-354120-01-D460-001-011-001, dated 26 June 2019 (provided in Drawing 1). ESB estimate the total loss of cable fluid over the leak period as approximately 7,732 L. ESB has stated that the leak was repaired in February 2018.

A summary of the source (LAB) 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).

Additionally, a description of the leak event (provided by ESB), we understand that the leak occurred within a basement of the Poolbeg station limiting the potential for fugitive losses outside the station.

7.5 Description of the Receptors

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

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 on accessible lands, 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 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**
	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 (CSM)

Linkage Number	Source	Pathway	Receptor	Consequence of Risk Being Realised	Probability of Risk Being Realised	Risk Classification	Comments
1	Free-phase LAB 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	Unlikely	Low risk	1a) The spill was located inside ESB property which flowed to a containment sump. This sump was then periodically discharged to drainage. The potential for loses from this leak location along the cable route are unlikely. 1b) The nearest surface water receptor is 180 m east of the Site (Dodder) and is intersected by the cable run. However as noted the spill was contained inside ESB property and the potential for LAB to migrate to surface waters from this spill is unlikely.
2		Migration along other service trenches/pipes (including potential residue left in drainage system)	2a Groundwater and/or 2b surface water: direct contact or adjacent to the trench, likely to act as a LNAPL	Medium	Unlikely	Low Risk	2a) The spill was located inside ESB property which flowed to a containment sump. This sump was then periodically discharged to drainage. The potential for loses from this leak location along the cable route are unlikely. 2b) The nearest surface water receptor is 180 m east of the Site (Dodder) and is

Linkage Number	Source	Pathway	Receptor	Consequence of Risk Being Realised	Probability of Risk Being Realised	Risk Classification	Comments
							intersected by the cable run. However as noted the spill was contained inside ESB property and thee potential for LAB to migrate to surface waters from this spill is unlikely.
3			Mains water pipes	Minor	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 is not known to be aggressive to plastic or metal pipework, or cause leaching from plastic pipework.
4		Volatilisation and migration of vapours, accumulation in subsurface ducts, services, cellars, basements etc via inhalation	Residents or workers in basements exposed to vapours	Medium	Unlikely	Low Risk	The nearest residential buildings are located approximately 60 m north of site. However as mentioned the spill occurred within the ESB compound and was captured in a sump in a basement level. There is limited potential for LAB to migrate from this sump to off site receptors.
5	LAB in unsaturated soils from the cable leak	Vertical and lateral migration of LAB through the unsaturated zone	Direct contact with contaminated soil, inhalation and ingestion of dust	Minor	Unlikely	Very Low Risk	The spill was located inside ESB property which flowed to a containment sump. This sump was then periodically discharged to drainage. The potential for loses from this

Linkage Number	Source	Pathway	Receptor	Consequence of Risk Being Realised	Probability of Risk Being Realised	Risk Classification	Comments
			from recreational activities by public (e.g. children in playground and passers-by)				leak location along the cable route are unlikely. No surface breakouts of the COPC was observed along the section of interest within the ESB network compound, the Sportsco access road or in the adjacent car park.
6			Local residents (with gardens): plant uptake and consumption of homegrown produce	Minor	Unlikely	Very Low Risk	The spill was located inside ESB property which flowed to a containment sump. This sump was then periodically discharged to drainage. The potential for loses from this leak location along the cable route are unlikely. No surface breakouts of the COPC was observed along the section of interest within the ESB network compound, the Sportsco access road or in the adjacent car park.
7		Infiltration of rain, leaching of contaminants, and vertical/horizontal	Groundwater	Minor	Unlikely	Very Low Risk	The spill was located inside ESB property which flowed to a containment sump. This sump was then periodically discharged to drainage. The potential for loses from this

Linkage Number	Source	Pathway	Receptor	Consequence of Risk Being Realised	Probability of Risk Being Realised	Risk Classification	Comments
		migration of dissolved contaminants					leak location along the cable route are highly unlikely. No surface breakouts of the COPC was observed along the section of interest within the ESB network compound, the Sportsco access road or in the adjacent car park.
8		Volatilisation and migration of vapours, accumulation in subsurface ducts, services, cellars and basements etc via inhalation	Residents or workers in basements exposed to vapours	Minor	Unlikely	Very low Risk	The spill was located inside ESB property which flowed to a containment sump. This sump was then periodically discharged to drainage. The potential for loses from this leak location along the cable route are unlikely. No surface breakouts of the COPC was observed along the section of interest within the ESB network compound, the Sportsco access road or in the adjacent car park.

Notes: PPE = Personal Protective Equipment.

Drawing 3 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?
28,614L LAB from cable collected in sump at ESB site L LAB from cable approximately 0.9 m deep under Camden Lane (hotel basement)	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
28,614L LAB from cable collected in sump at ESB site	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
28,614L LAB from cable collected in sump at ESB site	Dermal contact (from near surface soils) – leak occurring approximately 0.9 m from surface (not in contact with surface soils) and no visual or olfactory signs noted during site walkover.Short-term Public (i.e. passers-by)	Short-term Public (i.e. passers-by, not workers)	Pathway linkage not viable
28,614L LAB from cable collected in sump at ESB site	Volatisation and migration of vapours, accumulation in underground ducts, services, cellars and basements	Ground 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	Short term exposure risks not examined in the PSA which deals with long term (chronic) risks to receptors

Source	Pathway	Receptor	Pollutant Linkage Identified?
		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.	
28,614L LAB from cable collected in sump at ESB site	Migration in groundwater - the closest protected sites are the South Dublin Bay SAC and the South Dublin Bay and River Tolka Estuary SPA. The groundwater flow direction is not defined for the Site; however, the distance from the source to these sites is approximately 1.15 km.	Protected Sites; South Dublin Bay SAC / pNHA and South Dublin Bay and River Tolka Estuary SPA	Pathway linkage not viable

8.0 RISK EVALUATION

Potential pollutant linkages that could impact human health and/or controlled water receptors have been not been identified in the Preliminary CSM assessment. Linkages are only 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 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 (if available).

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'.

Overall Golder consider that the leak location on ESB property was contained in a sump in the basement. The sump was then periodically discharged to the surface water drainage system on site. The leak occurred and was repaired in 2004 and in effect the leak was contained. Significant risks to workers or off-site receptors from the loss of cable fluid identified in this report were not identified in the preliminary risk assessment above. At present Golder consider that the loss of cable fluid identified above does not present a significant risk to on site or off-site receptors and that no further works are considered necessary in relation to this loss of cable fluid.

8.1 Conclusions

Golder completed a preliminary site assessment for the identified loss of cable fluid at site 60 within Pembroke Substation. The loss occurred in 2004 and was repaired at this time. The loss was captured in a sump on site and pumped form the sump to site surface water drainage. The risk assessment completed for this spill did not identify viable pollutant linkages. No further work is considered necessary for this site in relation to the loss of cable fluid in 2004 as identified in the report.

9.0 REFERENCES

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

Environmental Protection Agency (EPA) (2013) “Guidance on the Management of Contaminated Land and Groundwater at EPA Licenced Sites”.

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

European Commission Joint Research Centre (EC) (1997) *European Union Risk Assessment Report Volume 3: benzene, C_{10-13} alkyl derivatives risk assessment.* EUR 19011 EN. Final report, dated 30 June 1997.

F&G (1995) *Safety Data Sheet (93/112/EC)*. Dated October 1995.

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.

H&R ESP (undated) *Material Safety Data Sheet for T 3788.* MSDS Revision No. 00/09/05.

ReachCentrum (2012) https://www.reachcentrum.eu/consortium/linear-alkyl-benzene-lab-derivatives-reach-consortium-131.html# accessed 8 July 2019.

WHO (2008) Petroleum Products in Drinking-water, Background document for development of WHO Guidelines for Drinking-water Quality,

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Signature Page

Golder Associates Ireland Limited

[redacted]
Senior Hydrogeologist

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Geo Environmental Director

EMcA/TM/mb

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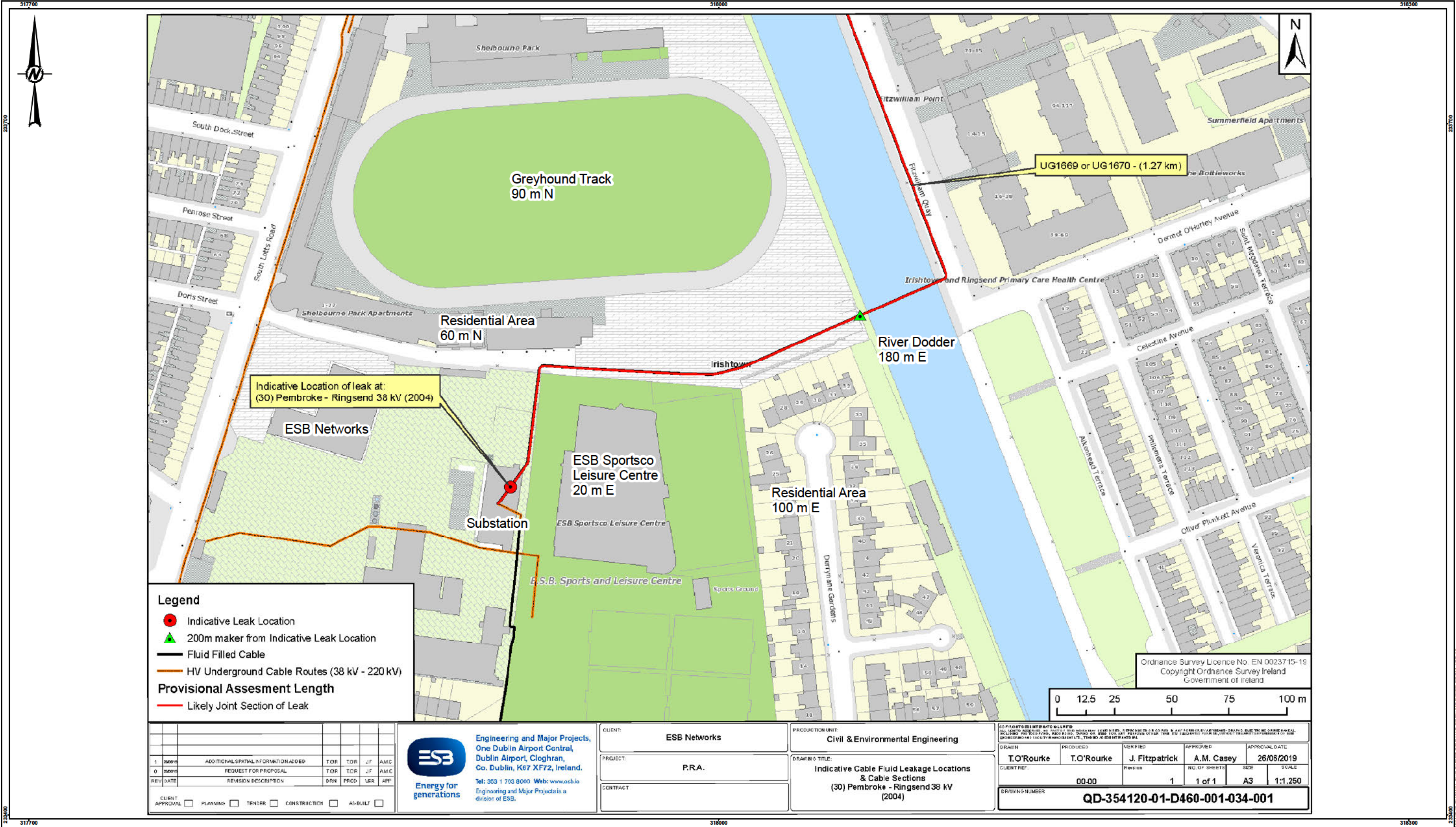
Town Centre House, Dublin Road, Naas, Co. Kildare, W91 TD0P, Ireland
Directors: S. Copping, A. Harris, DRV Jones
VAT No.: 8297875W

Drawing


Greyhound Track
90 m N
Residential Area
60 m N
River Dodder
180 m E
Indicative Location of leak at:
(30) Pembroke - Ringsend 38 kV (2004)
ESB Networks
ESB Sportsco
Leisure Centre
20 m E
Residential Area
100 m E
Substation
UG1669 or UG1670 - (1.27 km)
Shelbourne Park
South Dock Street
Penrose Street
Doris Street
South Lotts Road
Fitzwilliam Point
Fitzwilliam Quay
Summerfield Apartments
Dermot O'Hurley Avenue
Irishtown and Ringsend Primary Care Health Centre
Celestine Avenue
Derrynane Gardens
Oliver Plunkett Avenue
E.S.B. Sports and Leisure Centre
Legend
Indicative Leak Location
200m maker from Indicative Leak Location
Fluid Filled Cable
HV Underground Cable Routes (38 kV - 220 kV)
Provisional Assesment Length
Likely Joint Section of Leak
Ordnance Survey Licence No. EN 0023715-19
Copyright Ordnance Survey Ireland
Government of Ireland
0 12.5 25 50 75 100 m
Engineering and Major Projects, One Dublin Airport Central, Dublin Airport, Cloghran, Co. Dublin, K67 XF72, Ireland.
Energy for generations
CLIENT: ESB Networks
PRODUCTION UNIT: Civil & Environmental Engineering
PROJECT: P.R.A.
DRAWING TITLE: Indicative Cable Fluid Leakage Locations & Cable Sections (30) Pembroke - Ringsend 38 kV (2004)
DRAWN T.O'Rourke
PRODUCED T.O'Rourke
VERIFIED J. Fitzpatrick
APPROVED A.M. Casey
APPROVAL DATE 26/05/2019
CLIENT REF. 00-00
REVISION 1
NO. OF SHEETS 1 of 1
SIZE A3
SCALE 1:1,250
DRAWING NUMBER QD-354120-01-D460-001-034-001

Distance in Metres	Receptor Description	Direction from Leak Location
90	Residential area	S (GM)
275	South Dock Street Park	NW (EPA)
375	Health Centres Irish Town	NE (GH)
385	Grand Canal Dock	NE (EPA)
565	Technical Institute	NE (GH)
595	Naomh Padraig Boys School	NE (GH)
640	Ringsend College	NE (GM)
665	SN Paroiste Maitiu NFA	SE (GH)
675	Marion College	SE (GH)
700	River Liffey	N (EPA)
850	St Brigid's Convent National School	SW (GH)
850	Scoil Muire	SW (GH)
865	Canon O Memorial National School	SE (GH)
1000	The National Maternity Hospital	W (GM/EPA)
1240	SPA/SPC Area South Dublin Bay	SE (EPA)

0 50 100
1:1,600 METRES

REFERENCE(S)
1. COORDINATE SYSTEM: TM65 IRISH GRID

CLIENT
ESB

PROJECT
ENVIRONMENTAL ASSESSMENTS OF ESB NETWORKS HISTORIC FLUID FILLED CABLE LOSS

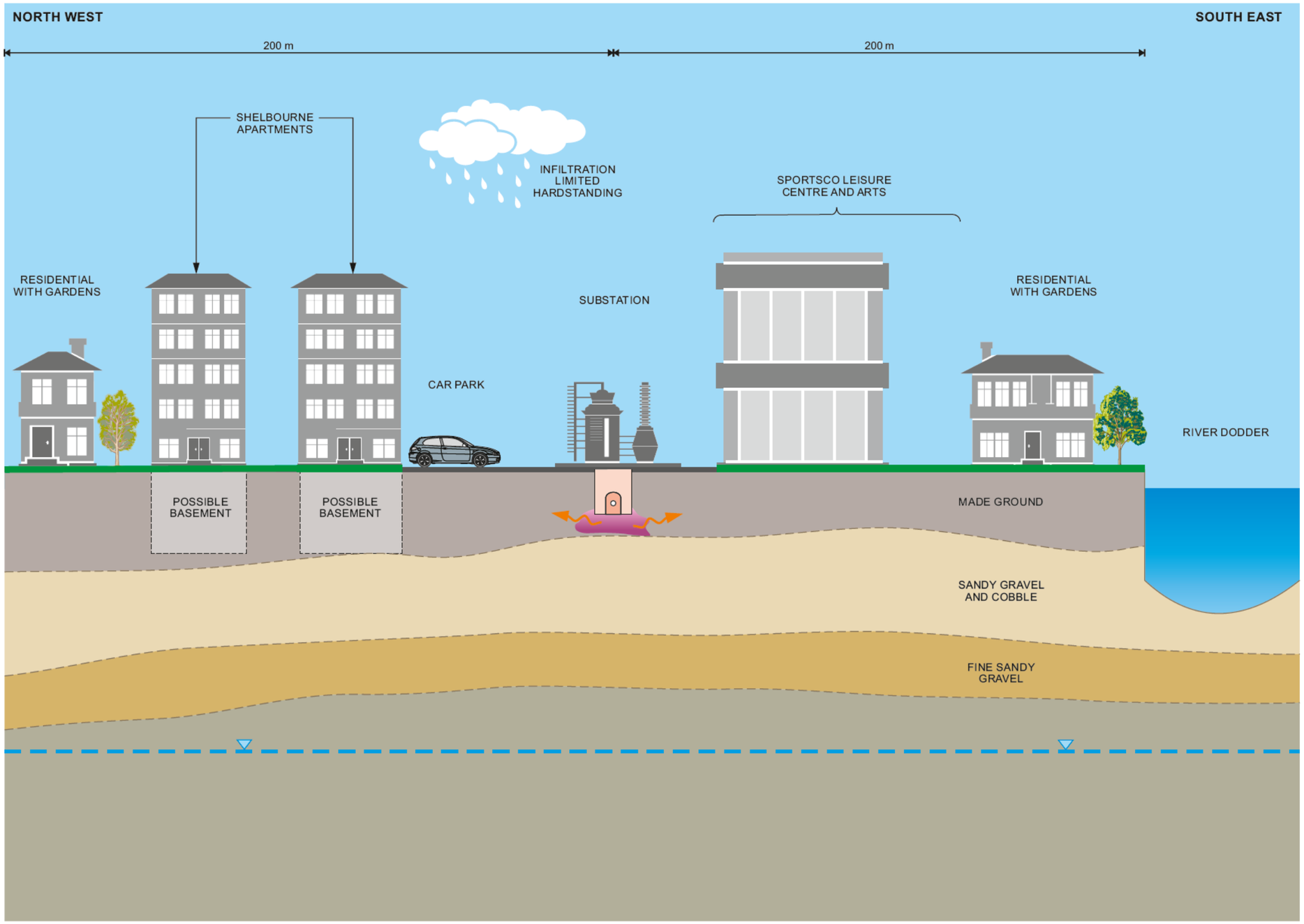
CONSULTANT

GOLDER

YYYY-MM-DD	2019 JUL 23
DESIGNED	KP
PREPARED	KP
REVIEWED	TM
APPROVED	EMCA

TITLE
PRELIMINARY SOURCE - PATHWAYS - RECEPTORS IDENTIFIED

PROJECT NO.	CONTROL	REV.	DRAWING
19126590	600-SW-029	B.0	1



LEGEND

- POTENTIAL WATER TABLE
- POTENTIAL GROUNDWATER FLOW
- VAPOUR MIGRATION

NOTES

1. DEPTHS IN METRES BELOW GROUND LEVEL (m bGL)
2. EXACT LEAK LOCATIONS UNKNOWN.
3. LEAKING OIL FOR ILLUSTRATIVE PURPOSES.

CLIENT
ESB

PROJECT
ENVIRONMENTAL ASSESSMENTS OF ESB NETWORKS HISTORIC FLUID FILLED CABLE LOSS

CONSULTANT
GOLDER

YYYY MM DD	2019 11 04
PREPARED	ECS
DESIGN	GF
REVIEW	GF
APPROVED	TM

SHEET TITLE
PRELIMINARY CSM (IDENTIFYING POLLUTANT LEAKAGES)
PEMBROKE TO RINGSEND 64 kV (SITE 60)

PROJECT NO	CONTROL	REV	DRAWING
19126590	1001 EA 0064	A	3

APPENDIX A

Relevant Photographs Recorded During the Site Walkover

60-01 – A sump was noted on the steps down to the basement level. The site representative noted that this sump drains liquids which may build up within the basement of the substationr. Oily material was noted in the sump, with staining around the sump.

60-02 – The outflow from the pump was found to lead to a surface water drain. It was not fully determined during the walkover whether an interceptor is linked to the site's surface water drainage system.

60-03 - The basement contains two bunds. The first bund on the left (closest to entrance door) contains a cable and two steel tanks. There were notable amounts of liquid in the bund and on the floor in front of the bund. Given the clear appearance of LAB it is difficult to differentiate from water pooling from a visual inspection, however due to the infrastructure within the bund and staining in that area it is highly likely that the majority of the liquid is oily material associated with the line and not water.

60-04 - Additional staining and liquid in one of the basement bunds.

60-05 - Additional staining and liquid in one of the basement bunds.

60-06 - Additional staining and liquid in one of the basement bunds.

60-07 – Oily staining was noted on the wall to the rear of the first bund.

60-08 – A second bund contained a similar amount of liquid build up as the first bund in its base and outside the bund.

60 -09 – The perimeter blocks of this bund had been removed in one area to accommodate three cable lines.

60 –10 – A further sump and pump were noted in another stairwell into the basement (northern side of the building). The sump contained a red rusty residue

60 –11 – Oily staining was noted in several other areas within the substation basement. Some staining was noted by the site representative to be bitumen, which was previously used as a type of insulation.

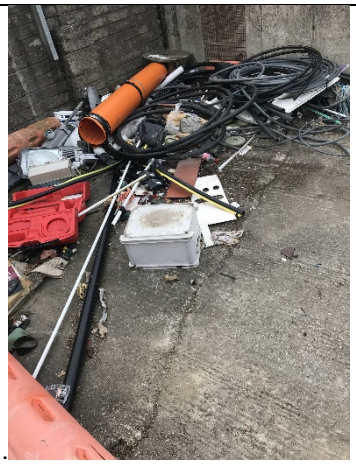
60 –12 – Additional oily staining within the substation basement.

60 –13 – Additional oily staining within the substation basement.

60 –14 – A fill point similar to the tanks in the first basement bund was found externally on the northeast corner of the substation building. Staining was not noted on the external sides of the tanks or on the hardcore surface, however staining was evident on the pipework and the wall behind the pressure valves.

60–15 – From the mapping it appears that the section of interest runs northwards within the ESB networks property, under a waste storage area. This area has a patched concrete base.

60 –16 – Additional patched concrete base under a waste storage area.



60 –17 – Additional patched concrete base under a waste storage area.

60 –18 – From the mapping it appears that the section of interest turns east after it leaves the ESB networks property. This turn is under the Sportsco access road. The section of interest then runs under a tarmac cark park east towards the River Dodder. The carpark surface was noted to generally be in good condition with only one patch noted in the general vicinity of the cable route.

60 –19 – Concrete storage bays and a shipping container are located above the section of interest prior to the end of this section at the River Dodder.

APPENDIX B

MSDS for T 3788 (LAB)

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

T 3788

CAS No: 67774-74-7

EC No: 267-051-0

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture

ES1 - Industrial use of intermediates.
Sector of uses [SU]:
SU3: Industrial uses: Uses of substances as such or in preparations at industrial sites
Environmental release categories [ERC]:
ERC 6a: Use of intermediate
Process categories [PROC]:
PROC 2: Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
ES2 - Formulation & (re)packing of substances and mixtures - Industrial uses
Sector of uses [SU]:
SU3: Industrial uses: Uses of substances as such or in preparations at industrial sites
Environmental release categories [ERC]:
ERC 2: Formulation into mixture (mixtures)
Process categories [PROC]:
PROC 1: Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions
PROC 2: Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions
PROC 3: Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition
PROC 4: Mixing or blending in batch processes
PROC 5: Mixing or blending in batch processes
PROC 8a: Transfer of substance or mixture (charging and discharging) at non-dedicated facilities
PROC 8b: Transfer of substance or mixture (charging and discharging) at dedicated facilities
PROC 9: Transfer of substance or mixture into small containers (dedicated filling line, including weighing)
PROC 15: Use as laboratory reagent.
ES03 - Use in cable oil - industrial use
Sector of uses [SU]:
SU3: Industrial uses: Uses of substances as such or in preparations at industrial sites
Environmental release categories [ERC]:
ERC 5: Use at industrial site leading to inclusion into/onto article
ERC 7: Use of functional fluid at industrial site
Process categories [PROC]:
PROC 13: Treatment of articles by dipping and pouring

Uses advised against

none

1.3. Details of the supplier of the safety data sheet

Company name: H&R ChemPharm (UK) Limited
Street: Dudley Road
Place: GB-DY4 8EH Tipton, West Midlands
Telephone: +441215220100 Telefax: +441215220116
e-mail: info.uk@hur.com
Responsible Department: Technical/Commercial Enquiries

1.4. Emergency telephone number: +44(0)2078580111

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Regulation (EC) No 1272/2008

Hazard categories:
Aspiration hazard: Asp. Tox. 1
Hazard Statements:
May be fatal if swallowed and enters airways.

2 2 Label element

Regulation (EC) No. 1272/2008

Signal word: Danger

Pictograms:

Hazard statements

H304 May be fatal if swallowed and enters airways.

Precautionary statements

P301+P310 IF SWALLOWED: Immediately call a POISON CENTER/doctor.
P331 Do NOT induce vomiting.
P501 Dispose of contents/container to local/regional/national/international regulations.

2.3. Other hazards

This substance does not meet the PBT/vPvB criteria of REACH, Annex XIII.

SECTION 3: Composition/information on ingredients

3.1. Substances

Hazardous components

CAS No	Chemical name			Quantity
	EC No	Index No	REACH No	
	Classification according to Regulation (EC) No. 1272/2008 [CLP]			
67774-74-7	Benzene, C10-13-alkyl derivs.			100 %
	267-051-0			
	Asp. Tox. 1; H304			

Full text of H and EUH statements: see section 16.

SECTION 4: First aid measures

4.1. Description of first aid measures

General information

In case of accident or unwellness, seek medical advice immediately (show directions for use or safety data sheet if possible).

After inhalation

In case of accident by inhalation: remove casualty to fresh air and keep at rest. In all cases of doubt, or when symptoms persist, seek medical advice.

After contact with skin

After contact with skin, wash immediately with plenty of water and soap. Take off immediately all contaminated clothing. In case of skin irritation, consult a physician.

After contact with eyes

Rinse immediately carefully and thoroughly with eye-bath or water. In case of troubles or persistent symptoms, consult an ophthalmologist.

After ingestion

Do NOT induce vomiting. Rinse mouth thoroughly with water. Let water be drunken in little sips (dilution effect). Observe risk of aspiration if vomiting occurs. Never give anything by mouth to an unconscious person or a person with cramps. When in doubt or if symptoms are observed, get medical advice.

4.2. Most important symptoms and effects, both acute and delayed

If swallowed or in the event of vomiting, risk of entering the lungs.

4.3. Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media

Sand. Foam. Carbon dioxide (CO_2). Extinguishing powder. In case of major fire and large quantities: Water spray jet. Water mist.

Unsuitable extinguishing media

Full water jet

5.2. Special hazards arising from the substance or mixture

Burning produces heavy smoke.
Can be released in case of fire: Carbon monoxide Carbon dioxide (CO_2) Sulphur dioxide (SO_2) Nitrogen oxides (NO_x)

5.3. Advice for firefighters

In case of fire and/or explosion do not breathe fumes. In case of fire: Wear self-contained breathing apparatus.

Additional information

Collect contaminated fire extinguishing water separately. Do not allow entering drains or surface water.
Co-ordinate fire-fighting measures to the fire surroundings.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Wear personal protection equipment (refer to section 8).
Ventilate affected area.
Special danger of slipping by leaking/spilling product.

6.2. Environmental precautions

Do not allow to enter into surface water or drains. Prevent spread over a wide area (e.g. by containment or oil barriers). Do not allow to enter into soil/subsoil.

6.3. Methods and material for containment and cleaning up

Absorb with liquid-binding material (e.g. sand, diatomaceous earth, acid- or universal binding agents).
Treat the recovered material as prescribed in the section on waste disposal.
Clean contaminated articles and floor according to the environmental legislation.

6.4. Reference to other sections

No information available.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Advice on safe handling

Wear suitable protective clothing. (See section 8.)
Avoid formation of oil dust.

Advice on protection against fire and explosion

Usual measures for fire prevention. Keep away from sources of ignition - No smoking.
Fire class B

Further information on handling

Do not breathe vapour/aerosol.
Avoid contact with eyes and skin.
Advices on general occupational hygiene: See section 8.

7.2. Conditions for safe storage, including any incompatibilities

Requirements for storage rooms and vessels

Keep container tightly closed in a cool, well-ventilated place. Only use containers specifically approved for the substance/product.

Advice on storage compatibility

Do not store together with: Gas. Explosives. Radioactive substances. Infectious substances

Further information on storage conditions

Temperature control required. Protect from light. Keep container tightly closed. Do not allow contact with air.

7.3. Specific end use(s)

refer to chapter 1.

SECTION 8: Exposure controls/personal protection

8 1 Control parameter

DNEL/DMEL values

CAS No	Substance			
DNEL type		Exposure route	Effect	Value
67774-74-7	Benzene, C10-13-alkyl derivs.			
Worker DNEL, long-term		inhalation	systemic	7 mg/m³
Worker DNEL, long-term		inhalation	local	7 mg/m³
Worker DNEL, long-term		dermal	systemic	9,6 mg/kg bw/day
Consumer DNEL, long-term		inhalation	systemic	1,8 mg/m³
Consumer DNEL, long-term		inhalation	local	1,8 mg/m³
Consumer DNEL, long-term		dermal	systemic	4,8 mg/kg bw/day
Consumer DNEL, long-term		oral	systemic	0,5 mg/kg bw/day

PNEC values

CAS No	Substance	
Environmental compartment		Value
67774-74-7	Benzene, C10-13-alkyl derivs.	
Freshwater		0,001 mg/l
Freshwater (intermittent releases)		0 mg/l
Marine water		0 mg/l
Freshwater sediment		1,65 mg/kg
Marine sediment		0,165 mg/kg
Micro-organisms in sewage treatment plants (STP)		14,2 mg/l
Soil		0,329 mg/kg

Additional advice on limit values

Air limit values::
Possibility of exposure to Aerosol
Limit value = 5 mg/ m3 - Source: ACGIH

8.2. Exposure controls



Appropriate engineering controls

Provide adequate ventilation.

Protective and hygiene measures

Clean skin thoroughly after working.
Do not put any product-impregnated cleaning rags into your trouser pockets.
When using do not eat, drink or smoke.

Eye/face protection

Safety goggles with side protection. In case of increased risk add protective face shield. DIN EN 166

Hand protection

Use safety gloves of following materials: NBR (nitrile) / neopren / viton (permeationslevel 5 - 6), Cat. II according to norm EN 347/EN 388.
The quality of the protective gloves resistant to chemicals must be chosen as a function of the specific working place concentration and quantity of hazardous substances.
For special purposes, it is recommended to check the resistance to chemicals of the protective gloves mentioned above together with the supplier of these gloves.

Skin protection

Oil-resistant and hardly inflammable protective clothing.

Respiratory protection

With correct and proper use, and under normal conditions, breathing protection is not required.
Respiratory protection necessary at:
-aerosol or mist formation
-exceeding exposure limit values
Suitable respiratory protection apparatus: Respiratory equipment in case of nebulosity or aerosol: Use a mask with a filter type A2, A2/P2 or ABEK.
The filter class must be suitable for the maximum contaminant concentration (gas/vapour/aerosol/particulates) that may arise when handling the product. If the concentration is exceeded, self-contained breathing apparatus must be used.

Environmental exposure controls

No information available.

SECTION 9 Phy ical and chemical propertie

9.1. Information on basic physical and chemical properties

Physical state:	Liquid
Colour:	colourless
Odour:	characteristic

		Test method
pH-Value:	No information available.	
Changes in the physical state		
Melting point:	-39 °C	
Initial boiling point and boiling range:	>260 °C	
Sublimation point:	No information available.	
Softening point:	No information available.	
Pour point:	> -60 °C	ASTM D 97-66
Flash point:	>130 °C	ASTM D 93
Sustaining combustion:	No data available	
Flammability		
Solid:	No information available.	
Gas:	No information available.	
Explosive properties		
none		
Lower explosion limits:	No information available.	
Upper explosion limits:	No information available.	
Ignition temperature:	No information available.	
Auto-ignition temperature		
Solid:	No information available.	
Gas:	No information available.	
Decomposition temperature:	No information available.	
Oxidizing properties		
none		
Vapour pressure: (at 25 °C)	0,013 hPa	ASTM D 323
Vapour pressure: (at 50 °C)	No information available.	
Density:	0,85-0,88 g/cm³	ASTM D 1298
Bulk density:	No information available.	
Water solubility:	Immiscible	
Solubility in other solvents		
No information available.		
Partition coefficient:	No information available.	
Viscosity / dynamic:	No information available.	
Viscosity / kinematic: (at 40 °C)	4,0-4,5 mm²/s	ASTM D 445

Flow time:	No information available.
Vapour density:	No information available.
Evaporation rate:	No information available.
Solvent separation test:	No information available.
Solvent content:	No information available.

9.2. Other information

Solid content:	No information available.

SECTION 10 Stability and reactivity

10.1. Reactivity

No information available.

10.2. Chemical stability

Stable at ambient temperature.

10.3. Possibility of hazardous reactions

No hazardous reactions known.

10.4. Conditions to avoid

No information available.

10.5. Incompatible materials

Oxidising agent, strong

10.6. Hazardous decomposition products

No hazardous decomposition products known.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Toxicocinetics, metabolism and distribution

No information available.

Acute toxicity

Based on available data, the classification criteria are not met.

CAS No	Chemical name				
	Exposure route	Dose	Species	Source	Method
67774-74-7	Benzene, C10-13-alkyl derivs.				
	oral	LD50 > 5000 mg/kg	Rat	ECHA Dossier	EEC Directive 67/548
	dermal	LD50 > 2000 mg/kg	Rat	ECHA Dossier	OECD Guideline 402

Irritation and corrosivity

Based on available data, the classification criteria are not met.

Sensitising effects

Based on available data, the classification criteria are not met.

May cause sensitisation especially in sensitive humans.

Carcinogenic/mutagenic/toxic effects for reproduction

Based on available data, the classification criteria are not met.
Reproductive toxicity:
Method: OECD Guideline 416 (Two-Generation Reproduction Toxicity Study)
Species: Rat
Result: NOEL = 50 mg/kg (P0), 50 mg/kg (F1), 50 mg/kg (F2); Literature information: ECHA Dossier
Developmental toxicity/teratogenicity: Method: OECD Guideline 414 (Prenatal Developmental Toxicity Study);
Species: Rat; Result: NOAEL = 125 mg/kg (embryotoxicity); Literature information: ECHA Dossier; Reproductive toxicity:

STOT-single exposure

Based on available data, the classification criteria are not met.

STOT-repeated exposure

Ba ed on available data, the cla ification criteria are not met

A piration hazard

May be fatal if wallowed and enter airway (Benzene, C10 13 alkyl deriv)

Practical experience

Other observations

Frequent contact specially if dried out may cause skin and eye irritations.

SECTION 12: Ecological information

12.1. Toxicity

If this product contains phenol, dodecyl, branched (EC No. 310-154-3), this product is not to be classified as dangerous for the environment. Raw materials containing this substance have not been classified by our suppliers as hazardous to the environment on the basis of test data, expert judgement or analogy assessments.

CAS No	Chemical name					
	Aquatic toxicity	Dose	[h] | [d]	Species	Source	Method
67774-74-7	Benzene, C10-13-alkyl derivs.					
	Acute algae toxicity	ErC50 >0,1* mg/l	72 h	Desmodesmus subspicatus	ECHA Dossier	*The substance is not soluble in water OECD Guideline 201
	Acute crustacea toxicity	EC50 > 0,041* mg/l	48 h	Daphnia magna	ECHA Dossier	*The substance is not soluble in water. - EU Method C.2
	Fish toxicity	NOEC >0,0577 8* mg/l	21 d	Danio rerio	ECHA Dossier	*The substance is not soluble in water. - OECD Guideline 203
	Crustacea toxicity	NOEC >0,007* mg/l	21 d	Daphnia magna	ECHA Dossier	*The substance is not soluble in water.

12.2. Persistence and degradability

The product is slightly soluble in water. It can be largely eliminated from the water by abiotic processes, e.g. mechanical separation.

CAS No	Chemical name			
	Method	Value	d	Source
	Evaluation			
67774-74-7	Benzene, C10-13-alkyl derivs.			
	OECD Guideline 301 F	64%	28	ECHA Dossier
	Easily biodegradable (concerning to the criteria of the OECD)			

12.3. Bioaccumulative potential

No indication of bioaccumulation potential.

Partition coefficient n-octanol/water

CAS No	Chemical name	Log Pow
67774-74-7	Benzene, C10-13-a kyl derivs.	6,4

BCF

CAS No	Chemical name	BCF	Species	Source
67774-74-7	Benzene, C10-13-alkyl derivs.	35		Environmental Toxico

12.4. Mobility in soil

No information available.

12.5. Results of PBT and vPvB assessment

This substance does not meet the PBT/vPvB criteria of REACH, Annex XIII.

12.6. Other adverse effects

No information available.

SECTION 13 Di po al con ideration

13.1. Waste treatment methods

Advice on disposal

Dispose of waste according to applicable legislation. Consult the appropriate local waste disposal expert about waste disposal. Non-contaminated packages may be recycled. The allocation of waste identity numbers/waste descriptions must be carried out according to the EEC, specific to the industry and process.

Waste disposal number of contaminated packaging

150110 WASTE PACKAGING; ABSORBENTS, WIPING CLOTHS, FILTER MATERIALS AND PROTECTIVE CLOTHING NOT OTHERWISE SPECIFIED; packaging (including separately collected municipal packaging waste); packaging containing residues of or contaminated by hazardous substances; hazardous waste

Contaminated packaging

Handle contaminated packages in the same way as the substance itself.

SECTION 14: Transport information

Land transport (ADR/RID)

14.1. UN number: No dangerous good in sense of this transport regulation.

14.2. UN proper shipping name: No dangerou good in en e of thi tran port regulation

14.3. Transport hazard class(es): No dangerou good in en e of thi tran port regulation

14.4. Packing group: No dangerou good in en e of thi tran port regulation

Inland waterways transport (ADN)

14.1. UN number: No dangerous good in sense of this transport regulation.

14.2. UN proper shipping name: No dangerous good in sense of this transport regulation.

14.3. Transport hazard class(es): No dangerous good in sense of this transport regulation.

14.4. Packing group: No dangerous good in sense of this transport regulation.

Marine transport (IMDG)

14.1. UN number: No dangerous good in sense of this transport regulation.

14.2. UN proper shipping name: No dangerous good in sense of this transport regulation.

14.3. Transport hazard class(es): No dangerous good in sense of this transport regulation.

14.4. Packing group: No dangerous good in sense of this transport regulation.

Air transport (ICAO-TI/IATA-DGR)

14.1. UN number: No dangerous good in sense of this transport regulation.

14.2. UN proper shipping name: No dangerous good in sense of this transport regulation.

14.3. Transport hazard class(es): No dangerous good in sense of this transport regulation.

14.4. Packing group: No dangerous good in sense of this transport regulation.

14.5. Environmental hazards

ENVIRONMENTALLY HAZARDOUS: no

14.6. Special precautions for user

Information for afe handling ee chapter 7

Information for per onal protective equipment ee chapter 8

14.7. Transport in bulk according to Annex II of Marpol and the IBC Code

not relevant

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

EU regulatory information

2010/75/EU (VOC): No information available

2004/42/EC (VOC): No information available.

Information according to 2012/18/EU (SEVESO III): Not ubject to 2012/18/EU (SEVESO III)

Additional information

Observe in addition any national regulations!

National regulatory information

Employment restrictions: Observe restrictions to employment for juvenils according to the 'juvenile work protection guideline' (94/33/EC).

Water contaminating class (D): 1 - slightly water contaminating

Additional information

none

15.2 Chemical Safety Assessment

not applicable.

15.2. Chemical safety assessment

For this substance a chemical safety assessment has been carried out.

SECTION 16: Other information

Changes

Rev. : 1,0 - 08.05.2018

Abbreviations and acronyms

ADR: Accord européen sur le transport des marchandises dangereuses par Route

CAS Chemical Abstracts Service
DNEL: Derived No Effect Level
IARC: INTERNATIONAL AGENCY FOR RESEARCH ON CANCER
IMDG: International Maritime Code for Dangerous Goods
IATA: International Air Transport Association
IATA-DGR: Dangerous Goods Regulations by the "International Air Transport Association" (IATA)
ICAO: International Civil Aviation Organization
ICAO-TI: Technical Instructions by the "International Civil Aviation Organization" (ICAO)
GHS: Globally Harmonized System of Classification and Labelling of Chemicals
GefStoffV: Gefahrstoffverordnung (Ordinance on Hazardous Substances, Germany)
LOAEL: Lowest observed adverse effect level
LOAEC: Lowest observed adverse effect concentration
LC50: Lethal concentration, 50 percent
LD50: Lethal dose, 50 percent
NOAEL: No observed adverse effect level
NOAEC: No observed adverse effect level
NTP: National Toxicology Program
N/A: not applicable
OSHA: Occupational Safety and Health Administration
PNEC: predicted no effect concentration
PBT: Persistent bioaccumulative toxic
RID: Règlement international concernant le transport des marchandises dangereuses par chemin de fer (Regulations Concerning the International Transport of Dangerous Goods by Rail)
SARA: Superfund Amendments and Reauthorization Act
SVHC: substance of very high concern
TRGS Technische Regeln fuerGefahrstoffe
TSCA: Toxic Substances Control Act
VOC: Volatile Organic Compounds
VwVwS: Verwaltungsvorschrift wassergefaehrdender Stoffe
WGK: Wassergefaehrdungsklasse

Relevant H and EUH statements (number and full text)

H304 May be fatal if swallowed and enters airways.

Further Information

Classification according to Regulation (EC) No 1272/2008 [CLP] - Classification procedure:
Health hazards: Calculation method. ; H304: On basis of test data.
Environmental hazards: Calculation method.
Physical hazards: On basis of test data.

The above information describes exclusively the safety requirements of the product and is based on our present-day knowledge. The information is intended to give you advice about the safe handling of the product named in this safety data sheet, for storage, processing, transport and disposal. The information cannot be transferred to other products. In the case of mixing the product with other products or in the case of processing, the information on this safety data sheet is not necessarily valid for the new made-up material.

Identified uses

No	Short title	LCS	SU	PC	PROC	ERC	AC	TF	Specifica ion
1	Industrial use of intermediates.	-	0	-	2	6a	-	-	
2	Formulation & (re)packing of substances and mixtures - Industrial uses	F	0	-	1, 3, 4, 5, 8a, 8b, 9, 15	2	-	-	

LCS: Life cycle stages
SU: Sectors of use
PC: Product categories
PROC: Process categories
ERC: Environmental release categories
AC: Article categories
TF: Technical functions

APPENDIX C

CIRIA C522 Risk Analysis Definitions

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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