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# PLUMLEY AND CAPE OF GOOD HOPE PETROLEUM STORAGE DEPOTS
# CDOIF PHASE 1 SCREENING ASSESSMENT

RAMBOLL ENVIRON

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| Made by | **Jon Eudall** |
| Checked by | **Andy Goddard / Richard Hayes** |
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Ramboll Environ
Box House
Box
Wiltshire
SN13 8AA
United Kingdom
T +44 122 574 8420
www.ramboll-environ.com

# CONTENTS


| | | |
|---|---|---|
| **1.** | **INTRODUCTION** | **1** |
| 1.1 | Instruction | 1 |
| 1.2 | Objectives | 1 |
| 1.3 | Scope of Work | 1 |
| 1.4 | Reliance and General Limitations | 1 |
| **2.** | **DEPOT DESCRIPTION** | **3** |
| 2.1 | Depot Location | 3 |
| 2.2 | Depot Surrounds | 3 |
| 2.3 | Third Party Land | 3 |
| 2.4 | Cavern Storage | 3 |
| 2.5 | Depot Well Heads and Pipework | 4 |
| 2.6 | Depot Topography | 6 |
| 2.7 | Drainage Infrastructure | 6 |
| **3.** | **ENVIRONMENTAL BASELINE** | **9** |
| 3.1 | Introduction | 9 |
| 3.2 | Overview to Baseline | 9 |
| 3.3 | Designated Land / Water – International and National Sites | 9 |
| 3.4 | Designated Land / Water - National | 9 |
| 3.5 | Other Designated Land | 11 |
| 3.6 | Habitats | 11 |
| 3.7 | Historical Buildings | 12 |
| 3.8 | Groundwater / Surface Water Abstractions | 12 |
| **4.** | **GEOLOGY AND HYDROGEOLOGY** | **13** |
| 4.1 | Desk Based Information | 13 |
| 4.2 | Site Specific Geological Information – Plumley PSD | 13 |
| 4.3 | Site Specific Geological Information – CoGH | 15 |
| 4.4 | Hydrogeology | 16 |
| 4.5 | Third Party Information | 17 |
| 4.6 | Summary | 17 |
| **5.** | **HYDROLOGY AND FLOOD RISK** | **19** |
| 5.1 | Hydrology | 19 |
| 5.2 | Plumley PSD - Flood Risk | 19 |
| 5.3 | CoGH PSD – Flood Risk | 20 |
| **6.** | **CONCEPTUAL SITE MODEL** | **22** |
| 6.1 | Introduction | 22 |
| 6.2 | Methodology | 22 |
| 6.3 | Potential Environmental Hazards | 22 |
| 6.4 | Theoretical Loss Volumes | 22 |
| 6.5 | Fuel Properties | 24 |
| 6.6 | Pathways | 24 |
| 6.7 | Loss from Pipework at Well Head – Plumley PSD | 24 |
| 6.8 | Loss from Pipework at Well Head - CoGH PSD | 25 |
| 6.9 | Cavern Pipework | 26 |
| 6.10 | Receptors | 27 |
| 6.11 | Key Source, Pathway, Receptor Linkages | 28 |
| **7.** | **TOLERABILITY ASSESSMENT** | **30** |

| | | |
|---|---|---|
| 7.1 | Introduction | 30 |
| 7.2 | MATTE Assessment | 30 |
| 7.3 | Identification of MATTE | 30 |
| 7.4 | Establishment Risk Tolerability Matrix | 31 |

## APPENDICES

**Appendix 1**
Figures

**Appendix 2**
Ecology Baseline

**Appendix 3**
Geological Sequence Cross-Section and Borehole Logs

**Appendix 4**
Aquifer Mapping

**Appendix 5**
CDOIF Harm Criteria and Assessment

# 1. INTRODUCTION

## 1.1 Instruction

Ramboll Environ UK Ltd (Ramboll Environ) was commissioned by The Oil and Pipelines Agency (OPA) to undertake a qualitative CDOIF Phase 1 Screening Assessment of the Plumley and Cape of Good Hope (CoGH) Petroleum Storage Depots (PSD). The purpose of the assessment is to understand, using a screening approach, potential environmental risks associated with theoretical loss of containment scenarios from the storage of fuel products in salt caverns under 'steady state' conditions. The depots are classed as being 'Upper Tier' sites under the Control of Major Accident Hazard 1994 regulations and subsequent amendments).

## 1.2 Objectives

The objective of the assessment was to provide a screening assessment of likely environmental risks taking into account the Chemical and Downstream Oil Industries Forum Guideline on Environmental Risk Tolerability for COMAH Establishments (CDOIF Guidance).

Ramboll Environ has developed a process to screen Establishments for potential environmental risks using a qualitative approach where Ramboll Environ makes a professional judgement of the likely risk tolerability status for the Establishment taking into account the conceptual layout of the depot and its environmental setting.

## 1.3 Scope of Work

This report was originally prepared for Plumley PSD in 2015 and at the time the scope of works included:

- a visit and inspection of the depot in order to understand the context of the depot setting and infrastructure and, where present, identify surrounding receptors that could potentially be impacted by a theoretical fuel release event;
- an information review including:
  - a Landmark 'Envirocheck' Report: a radial search of information in respect of environmental setting and surrounding sensitive land uses including ecological designations and groundwater abstractions;
  - an online review of the 'Magic' website to identify species and habitat designations, ecological mapping within a defined radius and downstream via aquatic linear features (i.e. water courses); and
  - an online review of EA published flood risk mapping.
- development of a Conceptual Site Model to understand the potential release pathways to the environment; and
- completion of a Risk Tolerability Assessment for the Establishment.

The report has subsequently been updated in 2017 to include the CoGH PSD and a similar scope of works was undertaken in 2017 for CoGH PSD as completed for Plumley PSD in 2015.

## 1.4 Reliance and General Limitations

This environmental risk assessment has been prepared exclusively for use by the client, and such other persons or entities whose reliance is explicitly authorized in writing by Ramboll Environ.

The conclusions presented in this report represent Ramboll Environ's best professional judgment based upon the information available and conditions existing as of the date of the review. In performing its assignment, Ramboll Environ has relied upon publicly available information, information provided by the client and information provided by third parties. Accordingly, the conclusions in this report are valid only to the extent that the information provided to Ramboll

Environ was accurate and complete. This review is not intended as legal advice, nor is it an exhaustive review of depot conditions or facility compliance. Ramboll Environ makes no representations or warranties, express or implied, about the conditions of the depot. The assessment solely relates to environmental risks.

Ramboll Environ applied the principles of the CDOIF guideline using in-house expertise to determine the anticipated risk tolerability for a worst case hazard scenario at the depot. The conclusions drawn are based upon best professional judgement and taking into account the information presented in the depot's safety report.

# 2. DEPOT DESCRIPTION

## 2.1 Depot Location

The Plumley and CoGH PSD are located in the north-west of the UK, approximately 2 miles north-east of Northwich and 10 miles south-west of Manchester. The centre of Plumley PSD is located at grid reference SJ 726 739 and the Cape of Good Hope depot is located approximately at SJ 71304 73529. The Cape of Good Hope depot is located approximately 1km to the south-west of the Plumley depot. The location of the depots is shown on Figure 1, Appendix 1.

## 2.2 Depot Surrounds

The immediate surrounds of the depots are summarised below.

At Plumley PSD:

- the northern boundary of the site is formed by the Peover Eye, a stream that meanders from east to west. Beyond the stream there are residential properties on the outskirts of Plumley with the main village centre from 795m to the north-west;
- to the immediate south and west of the depot lies farm land. The CoGH depot is located 1km south-west of the Plumley depot and further to the south and west is Holford Brine Fields, the surface of which is given over to agriculture with caverns present at depth that are operated by Inovyn for gas and chemical storage; and
- to the east between Back Lane and the M6 there is a golf course, Fields Farm and Back Lanes Farm.

At CoGH:

- the land immediately surrounding CoGH is farm land with the buildings of the Cape of Good Hope farm located from approximately 50m to the south-east of the well heads and from 70m to the north buildings and equipment associated with Inovyn's off-site operations is present. The Crow Brook is located from approximately 185m to the south of the nearest CoGH well head T175. The wider surrounding farm land is part of the Holford Brine Fields (as discussed above).

## 2.3 Third Party Land

Inside of the Plumley PSD site boundary there is a parcel of land that includes infrastructure associated with cross country pipelines that are operated by a third party (CLH-PS Limited). There is also a fuel pipeline that crosses part of the PSD and provides aviation fuel to Manchester Airport – the Manchester Jet Line (operated by Manchester Jetline Limited). In the south-west of the PSD there are also farm buildings (Hall/Orchard Farm). No such third party infrastructure is present in the immediate vicinity of CoGH.

## 2.4 Cavern Storage

### 2.4.1 Plumley PSD

The Plumley depot consists of 35 solution-mined caverns that are located at depth in the bedrock. Based on the available information (see section 4) the caverns have been formed in a zone at depths between a minimum depth range of approximately 140m bgl to 215m bgl and a maximum depth range of approximately 205m bgl to 280m bgl. The caverns have an 'onion-shape' with a 76 m diameter at the widest section and a height of about 50 metres.

Twenty one of the caverns contain petroleum hydrocarbon products and fourteen contain only brine. The caverns range in size from 86,000m$^3$ to 107,000m$^3$. In total Plumley PSD provides a capacity of about 3.2 million cubic meters.

At the ground surface pipework is present at a well head that historically facilitated fuel transfer and removal. The pipework still contains fuel and brine.

According to third party information[1] :

- *"the caverns were created by a process of controlled brine pumping, where each cavity was developed using a triple-tubed borehole, with water or brine introduced into the cavern void and brine being continuously displaced through the central tube. The size, shape and halite dissolution of the caverns were carefully controlled by positioning the injection point. Stability and upward migration of each void were controlled by maintaining a compressed air blanket."*

Currently these salt cavities are classed as "in reserve" and hold fuel in 'steady state' conditions (fuel is not taken out or added to the caverns).

There is a long term intention to empty and decommission the caverns. However, this report is intended to inform the 'steady state' storage of fuel and therefore does not provide an assessment of fuel transfer or removal from the depot.

The substances stored in the caverns are as follows:

- hydrocarbon products described as crude oil and mid distillates;
- leaded petroleum spirit in one cavern (understood to be T33);
- leaded aviation fuel in one cavern (understood to be T1); and
- brine.

At ground level the depot is located on a working livestock farm. The cavern well heads are located across 65ha of grazing land. The majority of well heads are located in concrete pits in the ground with sliding metal covers known as 'cow sheds'.

Further information on the available spill kits, firewater system and out of hours call out details are presented in the safety report.

#### 2.4.2 CoGH

CoGH consists of two solution mined caverns that have been formed to a similar shape and in similar bedrock strata as the Plumley PSD caverns. The caverns are larger than at Plumley with each cavern holding approximately 250,000m$^3$. Both caverns hold crude oil. The surface well heads contain similar pipework as that present at Plumley PSD, although are contained in larger bund structures with an inner bund formed of brick and concrete and then a larger outer bund of a similar construction. The inner bund provides a capacity of approximately 25m$^3$ and the outer bund provides a capacity of approximately 400m$^3$.

As for the Plumley PSD caverns there is a long term intention to empty and decommission the caverns and this report informs the 'steady state' storage of fuel at CoGH only.

### 2.5 Depot Well Heads and Pipework

#### 2.5.1 Surface Well Head - Plumley

Each storage cavern has an associated well head comprising a concrete chamber that is accessed from the ground surface. The chamber itself is approximately 10m$^3$ with the base located approximately 3-4m below ground level. The chamber contains the fuel and brine pipework that would facilitate a transfer or removal of fuel from a cavern. The pipework still contains brine and

[1] URS Plumley Salt Caverns Assessment, prepared by URS Infrastructure & Environment UK Limited for Essar Oil UK Ltd, Ref. 47068571/MARP001rev4, Dated 13th December 2013.

fuel. Photograph 1 below shows a typical cow shed structure. The sliding cover for well head T4 is not present.

The only well head that is not located inside a concrete chamber is T1 where the pipework is located at the ground surface. It is understood that this wellhead will have increased primary containment in the future. The current infrastructure has been assessed in this report.

**Photograph 1: Typical Well Head Chamber**

The well heads are all located inside the bounds of the depot apart from T1, which is located in a separate parcel of land on the western side of Cheadle Lane, just to the south of Moss Farm.

2.5.2 Surface Well Head - CoGH

Each of the two caverns is located inside a bund structure that is formed of an inner and outer bund. Both the inner and outer bund are formed of a concrete floor and brick walls. In the corner of each outer bund there is a small concrete sump that previously facilitated the drainage of rainfall that had collected in the bund via a valve. The inner bund also had a drain line that ran into this sump directly. According to the depot manager (Mr. Robin Fanthom) both drains at the inner and outer bund were sealed with concrete and no longer provide a pathway for fluids to pass through either the inner or outer bund.

The brick and concrete elements of the bunds were reported by the depot manager to have been recently repaired and evidence of sealant sealing cracks was observed in certain parts of the bund. AN example of the inner bund at well head T175 is shown below.

**Photograph 2: Inner Bund and T175 Well Head at CoGH**

2.5.3 Below Ground Pipework – Plumley and CoGH

Below ground the pipework from the well head to the cavern runs in an outer 13-3/8" conductor casing to below the wet rock head level[2] . Inside the casing is a 10 3/4" pipe that contains fuel and the brine pipe; this 10 3/4" pipe continues down to the top of the cavern and then the 7" brine pipe continues further to the base of the cavern.

Fuel is present between the inner surface of the 10-3/4" pipe and the outer surface of the 7" brine pipe. For fuel to be released into the ground up to the wet rock head there would need to be a failure in the 10-3/4" pipe and the 13-3/8" conductor. Below this depth a failure of the 10-3/4" pipe would release fuel directly into the ground.

At the ground surface the pipework that runs between the well heads has been disconnected and emptied.

Previously at CoGH PSD a below ground fuel pipe ran from the CoGH depot to the Plumley depot. This pipeline has been capped and emptied, and is now no longer operational.

## 2.6 Depot Topography

According to publicly available topographic data (Google Earth™) the Plumley depot is located at elevations of approximately 30m AOD to 40m AOD. In general land at the depot slopes from the south-east (at approximately 40m AOD) to the north-west (at approximately 30m AOD). Surface water run-off from the depot is diverted in line with topography with the lowest point being at the interceptor in the north-west.

At the CoGH PSD the elevation of the land is at approximately 38m AOD and the surrounding land is generally flat and further to the south slopes down towards the Crow Brook, which lies at an approximate elevation of 32m AOD.

## 2.7 Drainage Infrastructure

2.7.1 Plumley Site Drainage

The majority of the depot is formed of agricultural fields drained by a network of land drains. The locations of the main land drains are shown on Figure 3.

The only areas observed to have engineered surface water drainage were from the roofs of the depot buildings (the main buildings being the administration block and former pumphouse). There are no drainage lines from the well head chambers to the depot interceptor. Run-off from

[2] The wet rock head is defined as the point where natural dissolution of salt in the underlying bedrock has ceased

buildings and all run-off from the agricultural land is reported to drain to the Plumley PSD interceptor.

### 2.7.2 Plumley PSD Interceptor

The Plumley PSD interceptor is located in the north-west corner of the PSD. It consists of four concrete lined trenches in two banks which are approximately 4.35m x 38m x 2.7m (~ 1,847m$^3$ capacity) in size, each trench can be operated independently from the other three. A bulk oil collection tank and a skimmer tank are located between each of the two banks for storing the fuel retained from the interceptor (if present). Each interceptor channel has a slotted skimmer pipe for removing oil floating on water (if present) to a central chamber.

There is a control valve on the interceptor outfall which can be closed off to prevent run-off leaving the site in the event of a pollution incident. There are currently no operational pollution probes or salinity detectors provided for the interceptor.

The interceptor discharges directly into the Peover Eye.

**Photograph 3: Site Interceptor (showing two of four channels)**

### 2.7.3 CoGH Site Drainage

Rainfall build-up within the inner and outer bunds previously drained directly to the Plumley PSD interceptor. However, since the drains have been sealed there is no direct pathway from the bund to the Plumley PSD interceptor. The depot staff now manually overpump water from the inner and outer bunds directly into the drainage run adjacent to each bund (via a manhole) that leads to the Plumley PSD interceptor. It was evident at the time of the site inspection in 2017 that surface water pooled on the surface of the outer bund and did not freely drain from the bund as shown below in Photograph 4.

The depot staff are also aware that beneath well head T175 a land drain runs from the agricultural fields to the north broadly from the north to the south beneath the well head that

discharges into the Crow Brook. There is no direct pathway for fuel to enter this drain from inside the bund.

**Photograph 4:** Pooled surface water build-up at the point of the blocked drain in the corner of the outer bund of T171.

# 3. ENVIRONMENTAL BASELINE

## 3.1 Introduction

This section describes the environmental baseline, including potential environmental receptors, designated sites and habitats within and surrounding the depots. The ecological setting has not been informed by specific field surveys. The geology and hydrology are presented in the following sections 4 and 5, respectively.

## 3.2 Overview to Baseline

In general the depot is located in an agricultural setting with surrounding fields predominantly used for livestock grazing. The wider surrounding area is part of the Cheshire Plain, an area of lowland that contains local natural depressions in the glacial drift. A number of these depressions form nationally and internationally important open water and peatland sites. These sites are referred to as 'Meres & Mosses' with the majority of designated sites within a 10km radius of this nature.

## 3.3 Designated Land / Water – International and National Sites

There are no internationally designated sites as SAC or SPA within 10km of the depot. Two RAMSAR sites have been identified and are described in Table 3.1.

**Table 3.1: Designated International Land / Water**

| Name and Distance | Designation Area | Description |
|---|---|---|
| Midlands Meres and Moses RAMSAR – 4.75km NE of Plumley and 6.50 km NE of CoGH | 510.88 ha | These two Meres & Mosses RAMSAR sites are part of a geographically discrete series of lowland open water and peatland sites in the north-west Midlands of England. These have developed in natural depressions in the glacial drift left by receding ice sheets which formerly covered the Cheshire/Shropshire Plain.<br>Both sites are designated as a RAMSAR under the following criteria:<br>• the sites provide a diverse range of habitats from open water to raised bog; and<br>• these sites support a number of rare species of plants associated with wetlands including five nationally scarce species together with an assemblage of rare wetland invertebrates. |
| Rostherne Mere RAMSAR – 9.1km N of Plumley and 10.49km N of CoGH | 79.76 ha | |

## 3.4 Designated Land / Water - National

The identified nationally designated sites within 10km of the depot are presented in Table 3.2 below.

| Table 3.2: Designated Land / Water - National | | |
|---|---|---|
| **Name and Distance** | **Designation Area** | **Description** |
| Plumley Lime Beds SSSI – 1.64km N of Plumley and 1.36km N of CoGH | 23.22 ha | Plumley Lime Beds is another calcareous soil habitat. A wide range of habitats also occurs including woodland, a pool and marshland and an area of soil deposited on part of the lime beds creating variable soil conditions. The ground flora contains various calcicole species including yellow-wort (*Blackstonia erfoliata*) and common centaury *Centaurium erthraea*. The woodland, scrub and reed beds provide a nesting habitat for a number of species of warbler including lesser whitethroat *Sylvia carruca* and reed warbler *Acrocephalus scirpaceus*. The open water attracts waders and wildfowl and the little ringed plover *Charadrius dubius* is known to have bred. |
| Tabley Mere SSSI – 1.63km NW of Plumley and 2.95km of CoGH N | 44.43ha | Tabley Mere has been selected to represent a mere type consisting of very nutrient rich water with a well-developed aquatic flora. The site also includes an area of acidic, marshy grassland and woodland.<br>There are two meres; the larger contains extensive stands of submerged plants, particularly autumnal starwort *Callitriche hermaphroditica* and Canadian pondweed *Elodea canadensis*. The smaller contains extensive cover of yellow water-lily Nuphar lutea with white water-lily Nymphaea alba scattered throughout. On the south side is an extensive area of lesser reedmace *Typha angustifolia* with some greater reedmace *T. latifolia* also present. |
| Witton Lime Beds SSSI – 5.74km W of Plumley PSD and 4.9km W of CoGH | 16.59 ha | Witton Lime Beds is a calcareous habitat. The lime beds are colonised by a wide range of plant species many of which are rare in Cheshire and more typical of dune 'slacks'. |
| River Dane SSSI – 8.14km SE | 295.2ha | The River Dane SSSI has four reaches that are considered to be important for fluvial geomorphology. They exhibit a well-developed modern meander belt and a complex sequence of Holocene terraces. |
| Tatten Mere SSSI – 4.75km NE of Plumley and 6.50km NE of CoGH | 90ha | Tatton Mere has an extensive community of submerged macrophytes including various pondweed species. A narrow disjunct fen is present with occasional tussocks of greater tussock sedge *Carex paniculata*, lesser pond sedge *Carex acutiformis* and bur-reed *Sparganium erectum*.<br>At the southern end of the mere is Knutsford Moor, one of the largest areas of fen and reedswamp dominated by common reed *Phragmites australis* in the county. |
| The Mere SSSI – 6.59km N of Plumley and 8.08km N of CoGH | 18.94ha | The Mere consists of two lakes -- The Mere and Little Mere. The lakes have been selected due to their diverse aquatic flora. |
| Rostherne Mere SSSI and National Nature Reserve – | 152.9ha | Rostherne Mere is the deepest and one of the largest meres. It lies in a deep hollow in glacial drift.<br>The Mere is nationally important for its birds. It acts as a winter roost for large numbers of ducks and holds nationally |

| Table 3.2: Designated Land / Water - National | | |
|---|---|---|
| **Name and Distance** | **Designation Area** | **Description** |
| 9.1km N of Plumley and 10.49km N of CoGH | | significant numbers of Pochard *Aythya ferina* and pintail *Anas acuta* as well as good numbers of all other common species associated with freshwater. Over 10,000 gulls regularly roost on the water and up to 90 cormorants *Phalacrocorax carbo* roost in the trees along the edge. Because of its size and depth it is the last freshwater body in the area to freeze in winter and is consequently an important refuge in severe weather. |
| Wimboldsley Wood 9.7km SW of CoGH PSD | 19.0ha | The site is situated on the eastern bank of the River Weaver and in two steep sided valleys. It contains a variety of woodland types and is particularly notable for an extensive wet area dominated by alder *Alnus glutinosa* and crack willow *Salix fragilis*. Areas of scrub, unimproved grassland, open water and a saliferous spring, a rare habitat nationally, are included in the designation. |
| Sandbach Flashes 9.95km S of CoGH PSD | 152.9ha | Sandbach Flashes is a site of physiographical and biological importance. It consists of a series of pools formed as a result of subsidence due to the solution of underlying salt deposits. The water varies from freshwater, chemically similar to other Cheshire meres, to highly saline. Inland saline habitats are extremely rare and are reported to be of considerable interest due to the unusual associations of plants and animals. |
| Pettypool Brook Valley 9.99km WSW of CoGH PSD | 47.02ha | The wetland communities at the head of Pettypool, and those downstream along the course of Pettypool Brook, comprise Cheshire's most extensive and diverse valley mire system. The mature woodland with its abundant dead wood, and the extensive peatland habitats, offer a diversity of refugia which are particularly attractive to a wide range of insects. The site supports populations of a number of national and county rarities, making it one of the county's foremost invertebrate sites. |

## 3.5 Other Designated Land

No Areas of Outstanding Natural Beauty (AoNB) or Biosphere Reserves have been identified within a 10km radius of the depots. The only Local Nature Reserve within 10km of the site is the Marshall's Arm Hartford reserve located 7.2km to the south-west of Plumley / 6.47km to the south-west of CoGH and providing woodland and meadow habitat and including a section of the River Weaver.

## 3.6 Habitats

The Plumley depot is part of a working livestock farm and is predominantly formed of grazed pastureland. No areas of the Plumley depot are classified as Priority Habitats, nor are any areas adjacent to the CoGH well heads.

Mapping available on the Magic website shows the following Priority Habitats within a 2km radius of the site:

- an area of Lowland Raised Bog is located from 220m to the west of the Plumley depot (700m north of CoGH);

- from 1.21km to the north-west of Plumley there is an area of Lowland Fens and from 1.33km to the north-west of Plumley an area of Lowland Calcareous Grassland; both of which are within the boundary of the Plumley Lime Beds SSSI (and lying further afield from CoGH); and
- there are numerous areas of Deciduous Woodland within 10km of the site. The closest habitats are located 165m to the east and 275m to the north of the Plumley depot (and lying further afield from CoGH).

The distribution of all habitats within a 10km radius of the depot is presented in Appendix 2.

### 3.7 Historical Buildings

No Grade I Listed Buildings have been identified in the immediate surrounds of the depots.

### 3.8 Groundwater / Surface Water Abstractions

A third party envirocheck database has been obtained for the location of Plumley and CoGH PSD. The only abstraction located in the immediate vicinity of the PSD is registered to Mr. R Williamson of the Grange Plumley for spray irrigation purposes, which appears to abstract from the section of the Peover Eye that lies immediately to the north of Plumley PSD. This is a commercial abstraction and is not classified as a receptor under the CDOIF guidance.

Information on the locations of private water supply abstractions within a 10km radius of the depot was requested from Cheshire East Council and the following abstractions were reported:

- Dairy House Farm, Chester Road, Over Tabley. Cheshire, WA16 0PN, grid reference 372392, 379538 (6.1km north) Spring supply, in use for commercial purposes
- Kermincham Hall, Forty Acre Lane, Swettenham, Cheshire, CW4 8DX, grid reference 379530, 367922 (9.97km south-east), spring supply of an unstated purpose.
- Brook Farm, Forty Acre Lane, Kermincham, Cheshire, CW12 2LJ, grid reference 379737,367573 (10.3km south-east), well supply used for commercial purposes.

The Council stated that until last year there was no legal requirement to register private water abstractions and therefore it cannot discount that

# 4. GEOLOGY AND HYDROGEOLOGY

## 4.1 Desk Based Information

### 4.1.1 Plumley PSD - Desk Based Geological Information

The British Geological Survey (BGS) 1:50,000 solid and drift geology maps of Macclesfield (England and Wales Sheet 110) shows the depot to be underlain by:

- across the majority of the site by superficial deposits consisting of Glacial Till with a thin band of River Terrace Gravels adjacent to the Peover Eye in the north of the site; overlying
- the Northwich Halite Member (formerly known as Lower Keuper Saliferous Beds) comprising halite stone (salt chloride) and calcareous mudstone (known as marl), with a maximum thickness of 286m.

From 50m to the west of Plumley PSD the BGS mapping shows the Sidmouth Mudstone Formation (formerly the Lower Keuper Marl Formation) to be present above the Northwich Halite Member.

The Sidmouth Mudstone Formation is predominantly mudstone and siltstone with thin beds of dolomitic siltstone and very fine-grained sandstone, interbedded with the mudstone at intervals throughout the formation. The Sidmouth Mudstone Formation is classified by the Environment Agency as a Secondary Aquifer (see section 4.3) and is not present beneath Plumley PSD (but does lie beneath CoGH, as discussed below). The Sidmouth Mudstone Formation is recorded to dip (i.e. to slope away from Plumley PSD) towards the south-west at approximately 7 degrees and appears to have been eroded from Plumley PSD.

### 4.1.2 CoGH PSD - Desk Based Geological Information

The aforementioned BGS map (Sheet 110) shows the depot to be underlain by Glacial Till and further underlain by the bedrock of the Sidmouth Mudstone formation, which then overlies the Northwich Halite Formation.

Further information on the geology beneath each depot is provided in the following sections based on the available geological borehole records.

## 4.2 Site Specific Geological Information – Plumley PSD

### 4.2.1 Superficial Deposits

The available borehole logs for Plumley PSD do not provide a description of the immediately underlying superficial deposits.

BGS borehole records (ref: SJ77SW 265, 268 & 266) are situated approximately 350m east of the depot and provide more detailed information on the Glacial Till deposits above the bedrock. The deposits at these off-site locations are expected to be broadly similar to the deposits held on-site.

The till is described as a sandy clay with gravel inclusions and many permeable glacial sand and gravel lenses. The Glacial Till was reported to become less fissured with depth. Groundwater appears to be present at varying depths suggesting the perched water is discontinuous within the sand and gravel lenses. Groundwater depths ranged between 6.5m bgl and up to a maximum depth of 17m bgl.

Based on the above description Ramboll Environ does not expect the superficial deposits to provide a pathway that may allow migration of a fuel loss beyond the Plumley PSD boundary if a

release occurred at the well head, albeit local migration may take place within the sand and gravel lenses.

### 4.2.2 On-Site Solid Geology

To provide further information on the bedrock borehole records have been reviewed for the depot. Ramboll Environ were provided with borehole records by the client and obtained further records from the British Geological Survey (BGS). The borehole locations coincide with the positions of each of the well heads.

The sequence encountered in boreholes excavated on the depot at well heads T1, T24 and T35 from the south-west and north-west of the site is described in Table 4.1 including an interpretation from Ramboll Environ.

**Table 4.1: Depot Borehole Records**

| SJ77SW117 – T24 South-West Corner | SJ77SW121 –T35 South-West Corner | SJ77SW47 - T1 North-West Corner | Ramboll Environ Interpretation |
|---|---|---|---|
| Sandy clay to 15.84m | Red clay over red clay and gravel 18.59m | Sandy clay and stones then boulders and clay to 16.15m | This is the Glacial Till. |
| Red and grey marl to 139m | Red and grey marl to 132m | Red and grey Marl to 145m | This appears to be the upper layers of the Northwich Halite that have had the salt leached out (the dry rockhead). |
| Salt or salt with marl to 323m | Salt or salt with marl to 329m | Ranges from bands of pure salt to marl with salt inclusions to 305m | This appears to be the Northwich Halite that has salt present (the wet rockhead). **The caverns are shown to have been formed in this sequence** (see below text). |
| Marl to 329m | Marl to 334m | Marl from 311m base not proven. | This is a band of marl within the Northwich Halite Formation that is known as the 'Thirty Foot Marl'. **The caverns are not shown to extend beyond this depth.** |
| Then salt to borehole end at 363m | Then salt to 365m | No record information. | Further salt of the Northwich Halite Fm. |

Note

*=The most detailed log records of the salt at this level are provided in borehole SJ77SW47. This describes the strata to range from bands of pure salt to bands of marl with salt inclusions.

All depths are metres below ground level.

A cross-section of the geological sequence on the depot has also been provided (production date unknown) that documents the position of the caverns in the geological sequence. The cross section shows the Dimension 'C' in feet that is assumed to represent the zone in which the caverns have been formed. It also shows the depth to the foot of the 10 3/4" pipe that is located at the top of the cavern.

Based on this information the depth of cavern excavation has taken place in a zone above the Thirty Foot Marl (a layer approximately 9m thick) that separates the upper Northwich Halite from the lower Northwich Halite beds. The cross section shows the depth to the rock to vary across the site. The caverns therefore appear to have been formed in a zone at depths between a minimum depth range of 140m bgl to 215m bgl and a maximum depth range of 205m bgl to 280m bgl. The original cross section and borehole records are shown in Appendix 3.

#### 4.2.3 Off-Site Solid Geology

Records have also been reviewed for the off-site sequence to the south-west. This is the area where the Sidmouth Mudstone Formation is reported to be present.

The records do not show any difference at the top of the rockhead that would differentiate the Sidmouth Mudstone Formation from the Northwich Halite Formation. A similar sequence of rock as that provided in Table 4.1 was identified, albeit that the depth to each layer increases moving to the south-west, in line with the dip of the rocks. The rock immediately adjacent to Plumley PSD is therefore also considered to be a low permeability salt and marl. Based on the available information it is not possible to tell if the Sidmouth Mudstone is present or not. This is discussed further below in the section on CoGH which mapping shows to be located directly on the Sidmouth Mudstone formation.

### 4.3 Site Specific Geological Information – CoGH

#### 4.3.1 Superficial Deposits

The BGS borehole records for the two wells at CoGH identified drift deposits to be present at a thickness of between 13m and 16m beneath the well heads. The superficial deposits are described as a red sandy clay or sandy clay with gravel. This appears to be similar strata to the Glacial Till encountered at Plumley PSD and that is present in the wider area.

#### 4.3.2 On-Site Solid Geology

The BGS records describe the underlying bedrock to be a grey or red marl up to depths of 46m bgl to 48m bgl at which point the marl contains bands of salt of varying thickness up to depths of 160m to 163m below ground level from which point mudstone is encountered that appears to extend down to the first evidence of salt beds at approximately 200m below ground level.

The BGS boreholes suggest that pilot holes were previously drilled to the top of the caverns (date unknown) that suggest the top of the cavern to be present at approximately 199.6m and 200.8m below ground level for T171 and T175, respectively. Further borehole records show the deeper sequence of rock in boreholes that were drilled before the caverns were formed. In these records salt is interbedded with salt and marl until approximate depths of 360m to 420m from which point further bands of marl are interbedded with the salt until the termination depths of the boreholes at approximately 450m below ground level.

It is not possible from these records to determine if and where the boundary between the Sidmouth Mudstone and the Northwich Halite formation exists on CoGH. For the purposes of this assessment it has conservatively been assumed that the shallow layers of marl that are shown on borehole logs to underlie CoGH PSD beneath the drift deposits could potentially be part of the

Sidmouth Mudstone formation that may include sandstone bands and that is designated as a Secondary Aquifer.

#### 4.3.3 Off-site Solid Geology

The immediate surrounding off-site solid geology is expected to be very similar to the site itself being underlain by Glacial Till and then expected to be underlain by the potential bedrock deposits of the Sidmouth Mudstone and at further depth the Northwich Halite Formation. Along the line of the Crow Brook superficial deposits of Alluvium and River Terrace Deposits are present from approximately 185m to the south of T175.

### 4.4 Hydrogeology

The Environment Agency (EA) groundwater designation maps (available on the EA website) provide the following aquifer designations for the strata on Plumley PSD:

- the superficial deposits of variably sandy and gravelly Glacial Till and River Terrace Gravels are classified as a Secondary Aquifer[3] with groundwater proven at depths between 6.5m bgl and 17.0 m bgl;
- the underlying bedrock of the Northwich Halite Formation is classified as Unproductive strata[4] which represent rock layers that are of low permeability and have negligible significance for water supply or river base flow; and
- the Sidmouth Mudstone Formation is classified as a Secondary Aquifer. The depth to groundwater is not known. It is assumed that groundwater is present within the more permeable sandstone bands of this unit that are not present within the Northwich Halite.

The distribution of the Sidmouth Mudstone aquifer is shown to encroach onto the boundary of the site in the south-west. Therefore for the purpose of this assessment the boundary of the Sidmouth Mudstone is assumed to be that shown by the EA on the Plumley PSD boundary rather than 50m off-site as shown on the BGS mapping.

The boundaries of the above aquifers are presented in Appendix 4.

On CoGH:

- the underlying Glacial Till are classed as a Secondary Aquifer.
- the Sidmouth Mudstone Formation is classed as a Secondary Aquifer (this is understood to be due to the potential for more permeable sandstone bands to be present in the upper layers of the bedrock).
- the Northwich Halite Formation is classified as Unproductive Strata.

With respect to the sensitivity of groundwater on-site and in the surrounds:

- the EA groundwater vulnerability map shows that neither Plumley or CoGH PSD are located within a designated groundwater source protection zone (SPZ); and
- the EA currently (August 2017) classifies groundwater in the superficial deposits (if present) directly underlying the depots under the Water Framework Directive as part of the Weaver and Dane Quaternary Sand and Gravel aquifers , which are classed as having a ‘good’ quantitative quality and ‘poor’ chemical quality.

[3] A secondary aquifer has predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures and weathering.

[4] Unproductive strata represent rock layers that are with low permeability that have negligible significance for water supply or river base flow.

### 4.5 Third Party Information

The URS report[5] provides further discussion on the properties of the rock salt for hydrocarbon storage. This stated that "r*ock salt exhibits important engineering properties for containment of hydrocarbons"* including:

- *low porosity,*
- *self-healing behaviour due to viscoelastic/ viscoplastic deformation of grains, causing the closure/ resealing of cracks, pores, fractures and microjoints that form over time; and*
- *lateral continuity and a sufficient thickness are also key properties in providing an effective seal. Little or no leakage will take place though a laterally continuous evaporite seal when the reservoired hydrocarbon is oil.*

### 4.6 Summary

In summary:

- shallow groundwater has been identified in sand and gravel lenses of the superficial deposits (up to 17m bgl) that is considered to be a receptor for shallow fuel loss and that is expected to be present on Plumley PSD and CoGH PSD. Due to their discontinuous nature, the sand and gravel bands are unlikely to represent a pathway through which fuel would migrate from well heads laterally off-site at Plumley PSD and would be expected to restrict the potential for significant in-ground migration away from the well heads at CoGH PSD;
- at both Plumley PSD and CoGH PSD beneath the superficial deposits mudstone is present to approximately 140m to 200m bgl:
  - At Plumley PSD the mudstone is considered to be the shallower layers of the Northwich Halite that have been leached of salt leaving only the mudstone. The well head to cavern pipe runs through this layer (as well as the superficial deposits). In general this is a low permeability deposit classed as Unproductive Strata that would restrict lateral fuel movement (if released from the pipework). However, it cannot be entirely discounted that weathered bands of mudstone may be present at shallow depths where the salt has been leached out that could provide a shallow lateral migration pathway;
  - At CoGH PSD the mudstone may be the Sidmouth Mudstone Formation. This is a more permeable mudstone than the upper layers of the Northwich Halite Formation as there are reported to be sandstone bands present in the Sidmouth Mudstone that may contain groundwater and therefore this strata is classified as a Secondary Aquifer by the Environment Agency. However, from the available borehole logs at CoGH PSD it is not possible to confirm whether this is or is not the Sidmouth Mudstone Formation (no sandstone bands are shown in the logs). For conservatism for the purpose of this assessment it has been assumed to be the Sidmouth Mudstone Formation and that sandstone bands and groundwater bodies may be present in the upper layers of the rock.
  - At CoGH and Plumley PSD beneath the mudstone from approximately 140m to 205m bgl the unweathered Northwich Halite Formation is present and formed of salt and marl layers with varying proportions of salt and marl. This is of low permeability and the caverns are formed into this rock. The URS information states that little or no leakage would be expected from the salt caverns;
- The Sidmouth Mudstone Formation is shown on geological mapping to surround CoGH PSD and extend up to the boundary with Plumley PSD The thickness of this formation at the boundary is not known, although it would be the basal units that would be present on or close to Plumley PSD and therefore would not be expected to be of a substantial thickness. If a

[5] URS Plumley Salt Caverns Assessment, prepared by URS Infrastructure & Environment UK Limited for Essar Oil UK Ltd, Ref. 47068571/MARP001rev4, Dated 13th December 2013.

release occurred from well head to cavern pipe at Plumley PSD, it is more likely that lateral flow of fuel towards the Sidmouth Mudstone would be restricted by the presence of the on-site Northwich Halite Formation.

# 5. HYDROLOGY AND FLOOD RISK

This section considers the potential impact of flooding on the site.

## 5.1 Hydrology

### 5.1.1 Plumley PSD

Plumley PSD is drained by a network of open land drains that cross the agricultural fields. The drains are not classified by the Environment Agency (EA) under its Water Framework Directive (WFD) scheme and as such are not considered to be receptors under the CDOIF guidance. All land drains are directed to the site interceptor that is discharged to the Peover Eye (a stream) located approximately 315m north of the depot.

The Peover Eye meanders to the north-west and after a confluence with the Smokers Brook becomes the Wyncham Brook (from 2.33km to the north-west). This flows broadly westwards joining the Wade Brook 5.5km to the west (near Northwich), before discharging into the River Weaver approximately 10km to the west. Along the route of the surface watercourses there are no designated sites downstream of the discharge point into the Peover Eye. As such there are no identified direct pathways to the designated sites via the nearby hydrological system.

The Peover Eye is considered to be a receptor and is currently classified by the EA under the WFD scheme as being of poor ecological quality and does not require assessment for chemical quality.

### 5.1.2 CoGH PSD

The Crow Brook is located from approximately 185m to the south of the nearest well head and is named as the Wade Brook further downstream. The Wade Brook flows to the west and eventually combines with the Peover Eye before discharging into the River Weaver near Northwich.

The Crow Brook is considered to be a receptor and is currently classified by the EA under the WFD scheme as being of poor ecological quality and failing chemical quality criteria.

## 5.2 Plumley PSD - Flood Risk

### 5.2.1 Fluvial and Tidal Flooding

The EA online Flood Map for Planning delineates areas considered by the EA to represent the ‘natural’ floodplain, in the absence of flood defences, structures or buildings.

The majority of the depot is not shown to be located within a formal flood plain area and is classified as being within Flood Zone 1 (low probability) with respect to fluvial flooding. This indicates that there is less than 0.1 percent (1 in 1,000) chance of flooding in any year. All of the well heads, depot buildings, the depot interceptor and the depot access road is located within Flood Zone 1. Therefore flooding from the stream is not expected to reach, and be able to affect, the depot infrastructure or operations.

The land either side of the Peover Eye watercourse (including land extending up to 45m into the depot) is recorded as being within either Flood Zone 2 (moderate probability) or Flood Zone 3 (high probability). At this location, Flood Zone 2 represents land assessed by the EA as being at risk of fluvial flooding during events with between a 1 in 100 and 1 in 1,000 annual probability. Flood Zone 3 represents land assessed as having greater than a 1 in 100 or greater annual probability of fluvial flooding. The areas of Flood Zones 2 and 3 associated with the Peover Eye are situated approximately 320m north of the nearest well head point. Therefore, flooding of such areas is not considered to be of consequence to the depot infrastructure. Furthermore the

increased probability of flooding does not affect the site access road such that flooding is not expected to inhibit or restrict site access.

#### 5.2.2 Reservoir Flooding

The Environment Agency mapping also indicates where there is a potential for flooding to occur should there be a reservoir failure event. Parts of the depot are shown to be at risk should a failure of the Redesmere Reservoir occur. The areas predicted by the EA to be at risk during such event broadly correlate with the extent of Flood Zone 2. As stated above, flooding of the land within Flood Zone 2 is not expected to affect the infrastructure or operations at Plumley PSD. Furthermore, reservoirs in the UK have an extremely good safety record. All large reservoirs must be inspected and supervised by reservoir panel engineers. It is assumed that these reservoirs are regularly inspected and essential safety work is carried out. Reservoir flooding therefore presents a minimal risk.

#### 5.2.3 Surface water Flooding

The EA online Flood Map for Surface Water shows the flood risk from surface water from the impact of heavy rainfall. The mapping delineates risk into the following four categories:

- Very Low - each year, this area has a chance of flooding of less than 1 in 1,000 (0.1%);
- Low - each year, this area has a chance of flooding of between 1 in 1,000 (0.1%) and 1 in 100 (1%);
- Medium - each year, this area has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%); and
- High - each year, this area has a chance of flooding of greater than 1 in 30 (3.3%).

The modelling undertaken by the EA in order to inform the surface water flood risk mapping specifically does not take account of drainage features such as the land drains present at Plumley PSD. The Environment Agency mapping shows the majority of the depot to be at Very Low risk of surface water flooding. There are areas of isolated areas of potential surface water flood risk in the east and the north of the depot, some of which coincide with the position of well heads. There is also a notable strip of potential surface water flood risk that runs along the length of a drain through the centre and south of the depot, extending up to the western boundary. However, it is noted that these areas of potential surface water risk appear to be disconnected from off-site areas by slightly raised ground along the depot boundary.

The surface water flood maps do not show the area of potential surface water ponding at the depot to extend beyond the depot boundary. This does not suggest that there is a pathway for any fuel release to be routed to off-site areas by surface flood waters in the event of a theoretical release event taking place at the same time as the flooding. It should also be noted that depot staff have confirmed that the depot drainage network is such that pooled surface water build-up, as shown on the EA maps, does not take place. Therefore, the potential for surface water rainfall to affect depot operations is considered to be managed by the presence of the depot drainage structures.

### 5.3 CoGH PSD – Flood Risk

#### 5.3.1 Fluvial and Tidal Flooding

The CoGH well heads are both shown to be located in Flood Zone 1 (low probability). The closest extent of Flood Zones 2 and 3 associated with the Crow Brook is shown on Environment Agency mapping to be approximately 120m to the south and therefore does not encroach into the location of the two well heads.

### 5.3.2 Reservoir Flooding

The predicted flood outline associated with a potential failure of the Redesmere Reservoir follows a similar profile to that of fluvial flood risks associated with the Crow Brook and does not encroach on the well head locations.

### 5.3.3 Surface water Flooding

The well heads and surrounding land are shown on the Environment Agency mapping to be largely surrounded by land considered to have a Very Low risk for surface water build-up. Locally adjacent to both well heads there are areas shown to have a potential Medium or High risk of surface water flooding. However, these areas are locally isolated and not located at the access points into the well heads. The well heads are contained structures and surface water collection in the bund structures is actively managed by the depot staff, as discussed in Section 2.5.2.

# 6. CONCEPTUAL SITE MODEL

## 6.1 Introduction

The conceptual site model presented in this section has been produced as the first step in identifying if the depot could cause a MATTE. This section provides an overview of where potential pollutant linkages may exist that could represent a risk to environmental receptors.

## 6.2 Methodology

The methodology used to assess environmental risk as required by the COMAH regulations is based on establishing a conceptual site model (CSM) and using the source(S)>pathway (P)>receptor(R) risk assessment concept.

This assessment method has followed this process involving the identification of:

- the environmentally hazardous materials and the release mechanisms that may lead to substance release (the sources);
- the means by which the sources may migrate upon release and reach the surrounding environment (the pathways); and
- the sensitivity of receiving environments or species (receptors) as identified from the collated baseline information.

The SPR approach requires all three elements of the SPR to be present for there to be a potential risk to a sensitive receptor in the form of a complete 'pollutant linkage'.

## 6.3 Potential Environmental Hazards

An environmental hazard is a process, activity, or hazardous substance/material that could potentially cause environmental harm.

The COMAH safety report for the depot has identified the following credible release scenarios:

- Loss from Pipework at Well Head; and
- Loss from Well Head to Cavern Pipework.

Based on the available evidence, cavern failure is not considered to be a plausible credible scenario. The justifications for this decision are presented in the safety report. The available information states that little to no leakage would take place from a salt cavern and so chronic release of fuel from the cavern has also been ruled out.

There is a record of a loss of fuel from a well head at COGH PSD in 2010 that entered the drainage and reached the Plumley PSD interceptor. The drainage lines have now been blocked and therefore there is no longer a direct pathway for releases at CoGH to reach the Plumley PSD interceptor. Under normal conditions the bund surrounding the well heads at Plumley PSD would be expected to contain a release. No drainage lines are present at the well heads on Plumley that could direct fuel directly to the interceptor.

There are no identified scenarios (e.g. fuel leak or fire) that may result in adverse impact to neighbouring operators (including the CLH compound and pipelines and the on-site farm).

## 6.4 Theoretical Loss Volumes

For the purposes of environmental harm assessment 'worst case' theoretical loss scenarios have been considered for the credible scenarios. This assumes the loss would be under abnormal conditions (for example on failure of containment/prevention measures or the absence of intervention by operators for a prolonged period).

As the caverns are stored under steady state conditions then the loss volumes calculated by the safety consultant are based on the maximum amount of fuel that could be lost from the pipework during storage, rather than any losses that could occur associated with a fuel transfer event (i.e. fuel being pumped through pipework such as when the caverns are emptied). Separate assessment of the environmental risks for removal of the fuel from the storage caverns would be required at that point.

In relation to loss from the well head pipework the following has been considered:

- the caverns are at thermal equilibrium, although it cannot be discounted that here may be some pressure at the wellhead due to thermal expansion and the vapour pressure of the fuel. The safety consultant has considered this potential to be low, although for the purpose of this assessment it has been assumed that a leak/failure at the wellhead could result in some loss of hydrocarbon. This would be of a short duration and limited volume; and
- if there were to be a failure of the pipe from the well head to the cavern, then fuel could be lost laterally, although the same limitations on the quantity to be released apply due to the low pressures in the system. Further mitigation would be provided at shallow depths due to the casing around the 10 3/4" pipework.

Potential loss volumes from pipework have been calculated at four different depths that are considered to be representative of the pipework infrastructure at depth. The four depths are:

1. Loss from the pipework into the concrete well head chamber i.e. near the ground surface.
2. Loss from the pipework at depth of shallow groundwater in the glacial till (at approximately 6.5m bgl - 17m bgl).
3. Loss from the bottom of the 13 3/8" casing (below the rock head).
4. Loss from releases at the bottom of the 10 ¾" tubing (near the entrance to the cavern).

The potential fuel loss from each of these pipe locations is presented in Table 6.1 below.

**Table 6.1: Loss Volumes from Pipework**

| Pipework Loss | Location | Volume ($m^3$) |
|---|---|---|
| 1. Wellhead chamber (ground surface). | Representative of a worst case loss to shallow ground. | $2m^3$ |
| 2. At the shallow water table (17m bgl). | Representative of a worst case loss to the shallow aquifer. | $2m^3$ |
| 3. Base the 13 3/8" casing (below the rockhead). | Representative of a loss in the bedrock at the top of the salt rock head. | $3.5m^3$ - 4.4 $m^3$. |
| 4. Bottom of the 10 ¾ tubing (near the entrance to the cavern). | Representative of a loss in the bedrock at the entrance to the cavern. | $4.9m^3$ – 6.2 $m^3$ |

The release volumes have been calculated by the safety consultant based on the volume of fuel that could be displaced by the brine column at the point of loss of contaminant of the fuel pipe, due to the difference in density of the two fluids. As the brine and the fuel are incompressible fluids, even if the brine is pressurised the final volume would not change (albeit the rate of loss would increase). Likewise the loss of brine from the pipe would not be greater than is presented in the tables above.

## 6.5 Fuel Properties

The petroleum products stored at the depot are reported to be leaded petrol, crude oil and mid distillates. The fuels would generally be insoluble and be expected to float on surface waters and groundwater, sorb to soils and coat and smother ecological receptors. The fuels would have a limited proportion of soluble products; primarily the smaller chain petroleum hydrocarbons and benzene, and for the leaded petrol it would also contain tetraethyllead (TEL). For the purpose of this assessment the brine has also been considered as a substance which could impact the environment due to its high salinity.

## 6.6 Pathways

A review of the potential pathways which could link an identified source to a receptor has been carried out. The plausible sources and pathways have been described below for each major accident hazard (MAH) scenario. For each scenario the following pathways have been considered:

- migration in the ground;
- migration in the drainage system;
- existing infrastructure pathways; and
- overland flow (including flow overland or on pooled water).

No plausible pathways have been identified which could allow migration of fuel from the depot to the wider designated sites and habitats.

## 6.7 Loss from Pipework at Well Head – Plumley PSD

### 6.7.1 T2-T35

The safety consultant has considered that a loss from the pipework inside the well head chamber could release up to $2m^3$ of fuel.

*Migration in the Ground*

There is a potential that fuel loss to ground could occur as evidence of groundwater ingress into the chambers was observed during the site inspection (i.e. there is a pathway between the chamber and the ground). However, the loss would be via thin cracks in the walls and at a relatively slow rate. Where fuel was lost it would be released into the superficial till deposits where the sand and gravel may provide a local pathway for migration of fuel on-site. Groundwater is present in the sand and gravel that is classed as a secondary aquifer (a receptor). There is a potential that shallow groundwater may be in continuity with nearby land drains on-site and provide a local migration pathway into the land drains. Most, if not all, free phase fuel is likely to be retained in the permeable soils, with only dissolved phase contaminants reaching the land drains.

*Migration via Drainage*

There is no drainage inside the cowshed structure that could provide a direct pathway to the site's interceptor. Wells heads T8, T14, T15, T19 and T28 are located close to land drainage that could provide a pathway via migration in the ground to the land drains, albeit it is not expected that significant fuel loss to ground could take place from the chamber.

*Infrastructure Pathways*

Decommissioned and emptied pipework runs in the ground between each of the wells heads. Potentially this could provide a pathway for migration within the bounds of the site if a fuel loss to ground took place. However it is not considered to be plausible that the pipework could

provide a pathway for migration of fuel beyond the site given the small theoretical release volumes that have been calculated.

*Overland Flow*

The majority of the well heads are located inside concrete chambers set into the ground (apart from T1 that sits at the ground surface). This would prevent direct overland flow taking place. There is a potential if the fuel was released as a spray that a limited proportion could spray outside of the cow shed at the edges of the cover. However, this would be a very small proportion of the overall loss that would sorb onto the immediate ground surface outside of the well head and not be expected to migrate far from the localised area of impact.

The potential for release of fuel from the well head chamber is increased if the chamber is full of ponded water. The Environment Agency surface water flooding plans show pooling of surface water could take place at the depot although this is not shown to provide a pathway for off-site migration. Furthermore depot staff have reported that surface water runoff is managed during rainfall events by the on-site drainage network that flows to the interceptor and that pooling of water as predicted in the Environment Agency mapping (which does not take into account on-site drainage networks) does not take place.

### 6.7.2 T1

*Overland Flow*

Well head T1 is located outside of the main depot boundary to the west of Cheadle Lane. This well head is located aboveground on the ground surface rather than in a concrete pit. As such, loss of fuel from the well head would flow directly overland impacting the shallow ground. The area around the well head is unsurfaced and not used for livestock grazing. Agricultural land lies to the south and west adjacent to the well head, which is a receptor.

*Migration in the Ground / Via Drainage / Infrastructure Pathways*

There is evidence of a land drain located approximately 60m to the north of the well head that then feeds to the Peover Eye, although it is unlikely that a release would reach this point via migration in the ground. As such migration in drainage, migration in the ground and infrastructure pathways are not considered to be plausible pathways to a receptor for this scenario.

## 6.8 Loss from Pipework at Well Head - CoGH PSD

*Migration in the Ground*

For both well heads the inner and outer bunds lie beneath the elevation of the surrounding land. The bunds have recently been repaired and there are no open penetrations or cracks that may provide a direct pathway for fuel to migrate from the bund into the ground. Nevertheless in line with the CDOIF guidance this assessment assumes a worst case scenario that at the time of a release that fuel could penetrate or escape the bund and enter into the underlying ground. Where fuel was lost it would enter the underlying Glacial Till deposits where the permeable layers of sand and gravel would provide a local pathway for lateral migration of fuel in the ground. However these lenses are expected to be discontinuous and therefore fuel would be expected to be entrained in the sand and gravel lenses close to the well head rather than flow directly towards the nearby Crow Brook.

*Migration via Drainage*

The inner and outer bunds previously directly drained to the Plumley PSD interceptor. However, these drains have since been decommissioned and there are no direct drainage pathways from the bunds to the interceptor. The bunds are now drained in line with the Containment Policy

requirement for bunds to be manually over-pumped and therefore it is not considered plausible that fuel entering the bunds can enter the drainage directly.

Of note a buried land drain runs beneath T175 in a broadly north – south orientation. This takes surface water run-off from the fields to the north and discharges to the Crow Brook to the south. The buried land drain represents a potential pathway if fuel was to enter the ground in this area and be able to penetrate the drain or to follow the drain it could provide a preferential pathway that would allow flow to occur towards the Crow Brook.

*Infrastructure Pathways*

Each well head is equipped with an oil and brine pipe that whilst not currently used continues to represent potential derelict infrastructure that provides preferential pathways for the migration of fuel if it was to enter the ground. The pipes run from each well head and then are routed directly towards Plumley PSD via the nearby location of a former 'Go Devil' pit. Based on the volume of fuel predicted to be released this pathway is not expected to provide a significant pathway for the long distance migration of fuel, although the depots emergency response arrangements should take account of the potential for flow along such derelict infrastructure.

*Overland Flow*

If a release was to occur under pressure there is a potential that fuel could be sprayed over the pit wall and locally flow overland. This is not expected to occur as the fuel is not expected to be heavily pressurised but is considered as a worst case scenario. The land surrounding each bund is relatively level and fuel would be expected to locally pool on the ground close to the bund with a potential that some of the fuel could enter the ground.

## 6.9 Cavern Pipework

6.9.1 Loss from Well Head to Cavern Pipework – Plumley and CoGH PSD

This section considers the plausible pathways that may exist for a fuel loss from the well head to cavern pipework at both PSDs. The pipework at each well head runs below ground from the base of the well head manifold chamber into the cavern at depth.

*Loss to Shallow Groundwater*

For this scenario the release would take place into the ground from the pipework above the shallow groundwater table. A loss volume of $2m^3$ has been calculated by the safety consultant.

At Plumley PSD there is a limited potential that fuel loss could migrate on shallow groundwater to reach the site drainage system as described above in Section 6.7.1. At CoGH PSD there is a potential given the close proximity of a land drain running beneath the T175 well head that fuel entering the ground immediately beneath the well head could migrate in sand and gravel lenses and enter or run alongside this drain.

The majority of fuel lost to the ground would be retained in the ground in more permeable sand and gravel layers that also contain shallow groundwater (a receptor). Due to the discontinuous nature of the lenses it is unlikely that fuel could migrate significant distance from the well heads in the sand and gravel lenses.

*Loss into the Bedrock at Depth*

For losses from the pipework at depth the fuel would be lost into the ground to the deeper bedrock. The following loss volumes have been considered:

- Base the of 13 3/8" casing - $3.5m^3$ - $4.4\ m^3$; and
- Base of the 10 3/4" pipework - $4.9m^3$ – $6.2\ m^3$.

At Plumley PSD the bedrock is formed of mudstone and rock salt. It is the low permeability of these geological units that make them suitable for fuel storage. Therefore, migration of fuel in the bedrock is not considered to be a plausible pathway. The loss volumes at these depths are also relatively small, so even if there were local fissures or weathered bands of mudstone (at shallow depth rather than in the actual salt) the fuel would not be expected to migrate significantly in a lateral direction beyond the point of loss. For Plumleu PSD given the low permeability of the bedrock it is unlikely that fuel would migrate laterally through the mudstone and halite into the Sidmouth Mudstone Aquifer, which is estimated to be 45m from the nearest well head.

At CoGH the underlying bedrock is classed as the Sidmouth Mudstone Formation that potentially includes sandstone bands. If a release occurred from the pipework at depth there is a potential that fuel could enter the sandstone bands (if present) and migrate laterally within that band. However, given the size of the release volumes that have been identified as plausible scenarios the fuel would not be expected to flow a significant distance from the pipework and would be expected to be entrained within the sandstone band close to the point of release.

## 6.10 Receptors

Following the identification of pathways to the environment screening of surrounding land the identified receptors have been summarised against CDOIF defined receptor categories in table 6.2 below:

| Table 6.2: Designated International Land / Water | |
|---|---|
| **CDOIF Receptor Category** | **Potential S-P-R Linkage** |
| 1) Designated Land/Water: National | No plausible pathway to designated sites. |
| 2) Designated Land/Water: International | No plausible pathway to designated sites. |
| 3) Other Designated Land | No plausible pathway to designated sites. |
| 4) Scarce Habitat | No plausible pathway to designated habitats. |
| 5) Widespread Habitat: Non-designated Land | **R1**: agricultural land adjacent to T1 of Plumley PSD. |
| 6) Widespread Habitat: Non-designated Water | No plausible pathway to water habitats. |
| 7) Source of Public and Private Drinking Water (Groundwater or Surface Water) | No receptors identified. |
| 8) Groundwater Body (non-public drinking water) | **R2:** on-site permeable sand and gravel bands in the till containing groundwater– a Secondary Aquifer. This is present at both Plumley PSD and CoGH PSD.<br>**R3:** potential for perched groundwater to lie in more permeable bands of the Sidmouth Mudstone Formation at CoGH PSD. |
| 9) Other groundwater. | Not relevant as a receptor. |
| 10) Soil and Sediment | None identified. |
| 11) Built Environment | None identified. |
| 13) Particular Species | The wider designated sites support populations of particular species. No pathway has been identified to these sites. |
| 14) Marine | No nearby marine habitats are present. |
| 15) Fresh and Estuarine Habitats | **R4** – The Peover Eye stream.<br>**R5** – The Crow Brook. |

### 6.11 Key Source, Pathway, Receptor Linkages

The key potential pollutant linkages based on the identified depot infrastructure, layout, topography and ground conditions can be summarised as below.

At Plumley PSD:

- a potential for fuel to flow overland from a loss of containment at T1 has been identified. This would affect nearby agricultural land used for crop production;
- it is plausible that fuel could be lost from pipework at and below the well head into the ground that may locally impact the on-site shallow groundwater (a Secondary Aquifer); and
- there is also a potential that fuel may enter the site's land drain network due to migration in the ground that could then enter the interceptor and be subsequently discharged to the Peover Eye.

At CoGH PSD:

- It is plausible that fuel could be lost from pipework inside the bunded well head that is then lost or enter the ground or be lost to ground directly from below the well head pipework. The

release could locally impact the on-site shallow groundwater (a Secondary Aquifer) in the Glacial Till.

- There is a potential that fuel lost at depth from the well head could directly impact the Sidmouth Mudstone Formation at the point of loss into the bedrock (a Secondary Aquifer).
- There is a potential that fuel could enter the land drain in the ground and migrate towards the Crow Brook.

# 7. TOLERABILITY ASSESSMENT

## 7.1 Introduction

Following the identification of key SPR linkages, the CDOIF guidance provides tolerability thresholds that can be used to determine whether a potential release may result in MATTE level harm depending on the predicted severity and the duration of the event.

The following section considers the potential effects of fuel release to the identified environmental receptors and whether the resultant effects may be considered to cause sufficient harm for the event to be determined as a MATTE.

Where an event is considered to be MATTE-level, a judgement is made on whether the risk tolerability of the Establishment to each receptor is either 'Broadly Acceptable', 'Tolerable if as low as reasonably practicable (TifALARP)' or 'Intolerable'

## 7.2 MATTE Assessment

The conceptual site model (CSM) has determined that plausible SPR linkages may exist at the depot. The potential harm that may be caused due to release events are considered in this section using the criteria set out in the CDOIF guidance to assess severity and duration of harm, in accordance with the criteria specified in Appendix 5 of the CDOIF guidelines.

The assessment of severity of harm and duration is presented in Appendix 5 for theoretical worst case MAH scenarios. The identified affected receptor types for the worst case scenario are categorised as per CDOIF guidance.

## 7.3 Identification of MATTE

Due to the relatively low predicted release volumes involved in the credible scenarios and proximity of environmental receptors, no MATTE level events are predicted.

Further discussion on the absence of MATTE level events is provided below for Plumley PSD:

- To cause a MATTE to the agricultural land a release would need to impact between 10 - 100ha of land to prevent the growing of crops or grazing of domestic animals. It is not considered plausible that the calculated release volume of 2m$^3$ could cause this level of impact.
- To cause a MATTE to the on-site groundwater between 1-100ha of groundwater would need to be affected. It is not considered plausible that the calculated release volume of 2m$^3$ could cause this level of impact.
- To cause a MATTE to the Peover Eye the Water Framework Directive chemical or ecological status would need to be lowered by one class for a period of a year for the event to be classed as a MATTE. Taking into account the relatively small initial release volumes being discussed (2m$^3$ at point of loss) and that the Peover Eye is a flowing stream that is continually replenished with clean water over the course of a year, it is not considered plausible that the calculated release volumes could cause this level of impact for a sustained period of a year.

A similar discussion is provided below for CoGH PSD:

- To cause a MATTE to the on-site groundwater of the Secondary Aquifers of the glacial till and Sidmouth Mudstone between 1-100ha of groundwater would need to be affected. It is not considered plausible that the calculated release volume of 2m3 to 4.4m3 could cause this level of impact.
- To cause a MATTE to the Crow Brook the Water Framework Directive chemical or ecological status would need to be lowered by one class for a period of a year for the event to be

classed as a MATTE. Taking into account the relatively small initial release volumes being discussed (2m3 at point of loss), the distance to the Crow Brook is over 150m and that the Crow Brook is a flowing stream that is continually replenished with clean water over the course of a year, it is not considered plausible that the calculated release volumes could cause this level of impact for a sustained period of a year.

## 7.4 Establishment Risk Tolerability Matrix

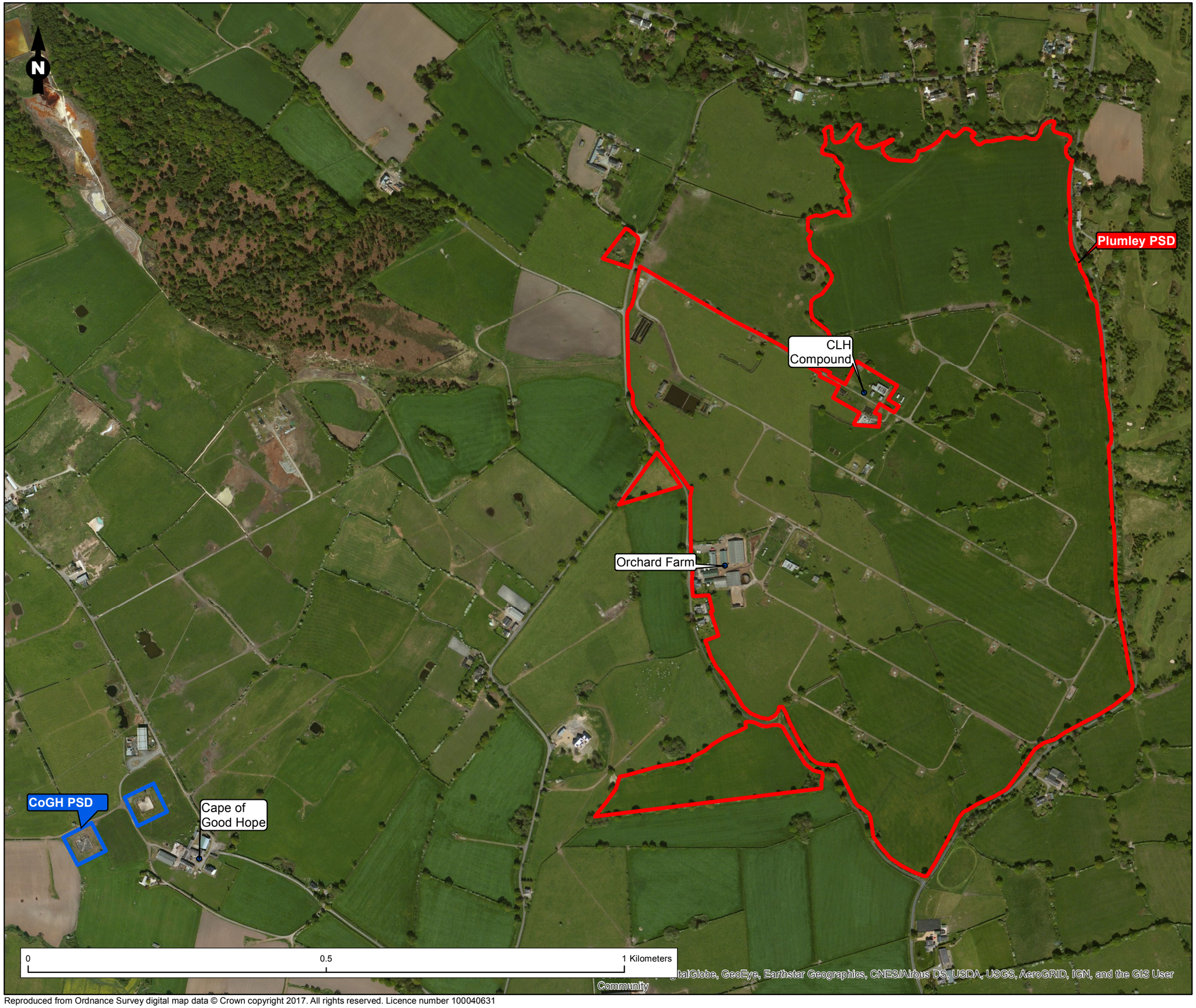
Table 7.1 shows the CDOIF risk tolerability matrix. Based on the above assessment the credible scenarios that could occur at the depot would not give rise to MATTE level impact and would sit within the 'sub-MATTE' region. Therefore, there is no 'X' shown within the Broadly Acceptable, Tif ALARP or Intolerable regions.

**Table 7.1: CDOIF Tolerability Matrix**

| | **Frequency per establishment per receptor per year** | | |
|---|---|---|---|
| **MATTE Consequence Level** | **Very Low Frequency** | **Low to Moderate Frequency** | **Moderate to High Frequency** |
| D-MATTE | Broadly Acceptable | | Intolerable |
| C-MATTE | | TifALARP | |
| B-MATTE | | | |
| A-MATTE | | | |
| **Sub MATTE** | **'X': The Plumley and CoGH PSD Establishments lies within this Sub-MATTE region of the matrix.** | | |

It should be noted that while the above assessment does not predict that a MATTE could take place with either depot under steady state storage conditions this does not remove the potential for a pollution incident to ground or surface water to take place if a failure of the pipework occurred. Overall the safety consultant considers that loss from pipework is likely to be a low frequency event and asset management takes place to ensure the pipework integrity is maintained.

# APPENDIX 1
# FIGURES



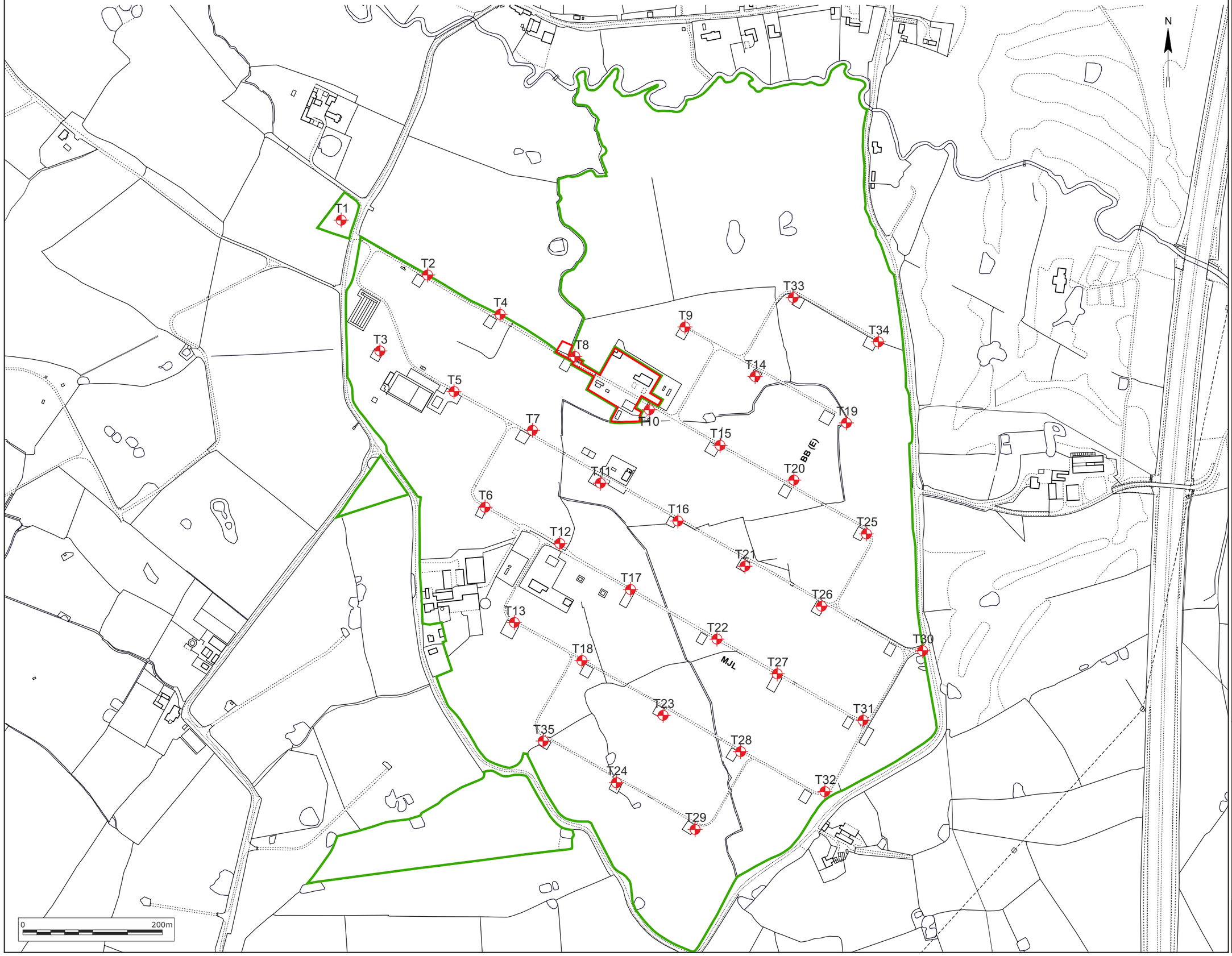

**Legend**

## Site Boundary

- Plumley PSD
- CoGH PSD - Well Heads

| | |
|---|---|
| Figure Title | Site Location |
| Project Name | Plumley |
| Project Number | UK14-21811 |
| Figure No. | 1 |
| Date | August 2017 |
| Prepared By | BM |
| Scale | 1:6,000 @A3 |
| Issue | 1 |
| Client | **Oil and Pipelines Agency** |

RAMBOLL ENVIRON




Key

- Site Boundary
- CLH Compound Boundary
- Well Head Location

| | |
|---|---|
| Title | Figure 2: Well Head Locations |
| Project No. | UK14-21811 |
| Site | Plumley PSD, Back Lane, Cheshire |
| Client | The Oil and Pipelines Agency |
| Date | August 2015 |
| Scale | 1:5,000 @ A3 |
| Issue | 1 |
| Drawn by | DM |

RAMBOLL ENVIRON

Peover Eye

Interceptor Discharge To Peover Eye

Depot Interceptor

Land Drains To Interceptor

BB (E)

MJL

N

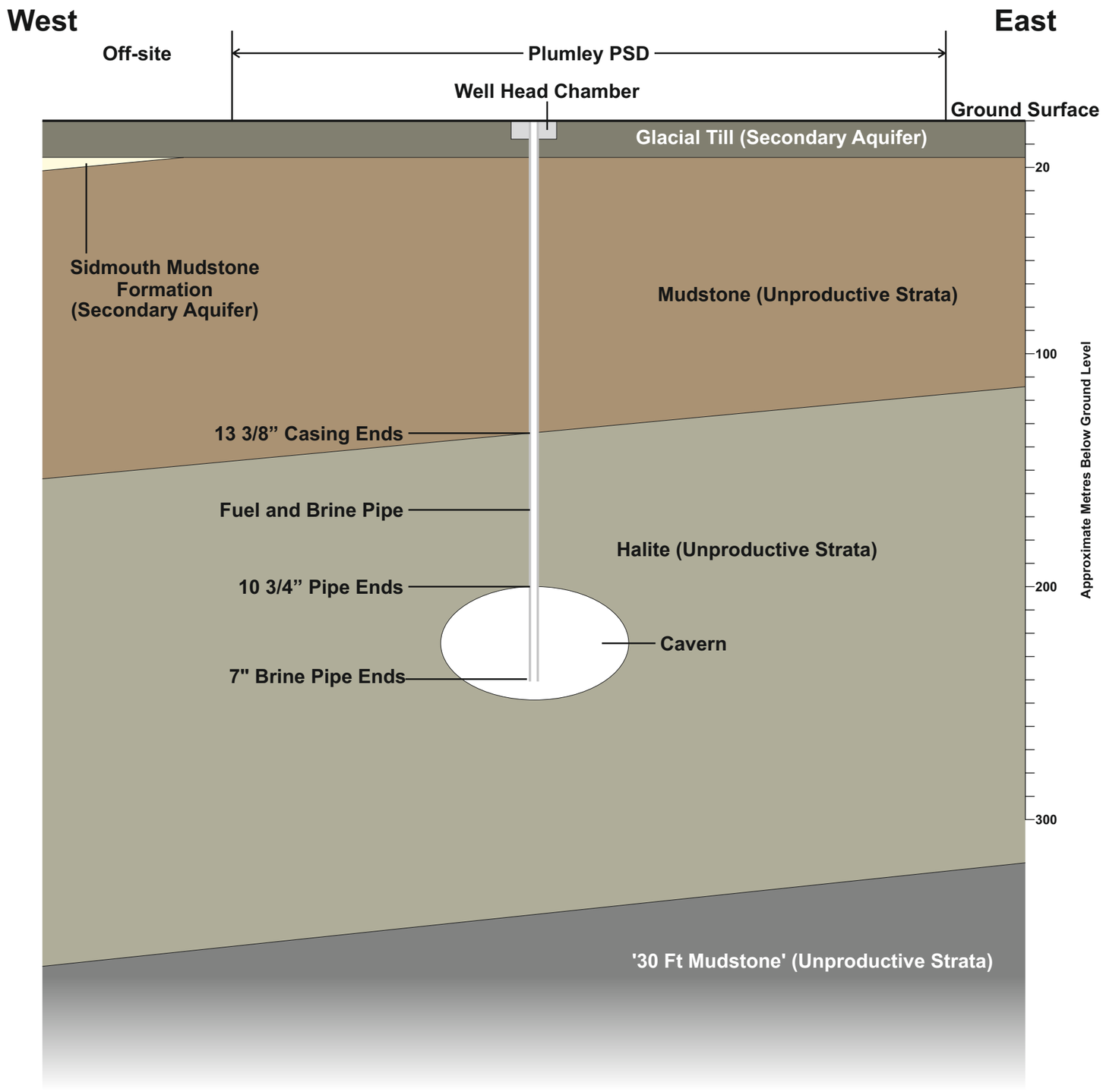
0 200m

Key

- Site Boundary
- CLH Compound Boundary
- Surface Water

| | |
|---|---|
| Title | Figure 3: Schematic Drainage Plan |
| Project No. | UK14-21811 |
| Site | Plumley PSD, Back Lane, Cheshire |
| Client | The Oil and Pipelines Agency |
| Date | August 2015 |
| Scale | 1:5,000 @ A3 |
| Issue | 1 |
| Drawn by | DM |

RAMBOLL ENVIRON




Key

Title: Figure 4: Schematic Geological Cross-Section

Project No.: UK14-21811

Site: Plumley PSD, Back Lane, Cheshire

Client: The Oil and Pipelines Agency

Date: August 2015

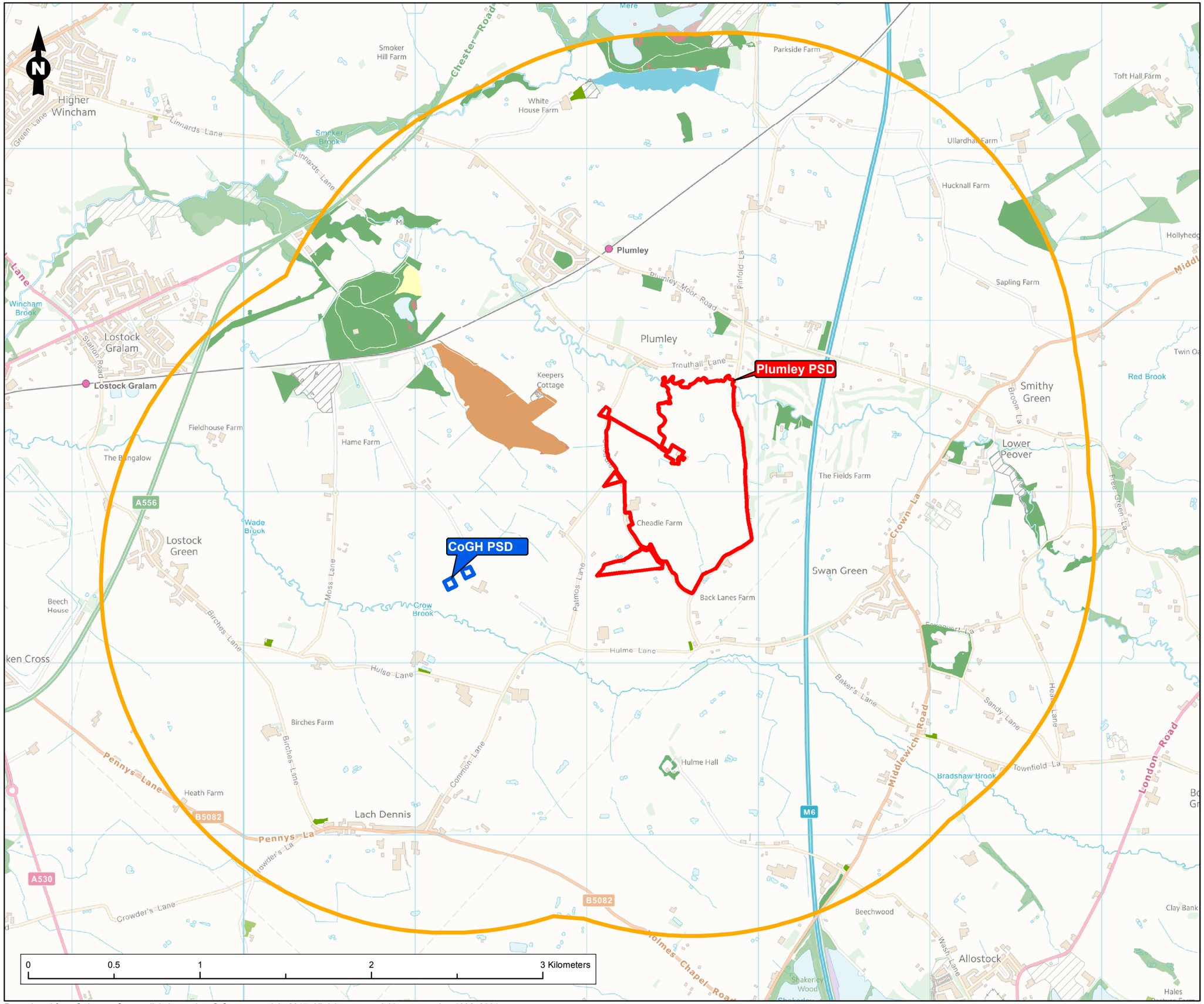
Scale: As shown

Issue: 1

Drawn by: DM

RAMBOLL ENVIRON

# APPENDIX 2
# ECOLOGY BASELINE




## Legend

- 2 km Buffer
- Deciduous Woodland
- Good Quality Semi-Improved Grassland
- Lowland Calcareous Grassland
- Lowland Fens
- Lowland Heathland
- Lowland Raised Bog
- Traditional Orchards
- No Main Habitat but Additional Habitat Present

### Site Boundary

- Plumley PSD
- CoGH PSD - Well Heads

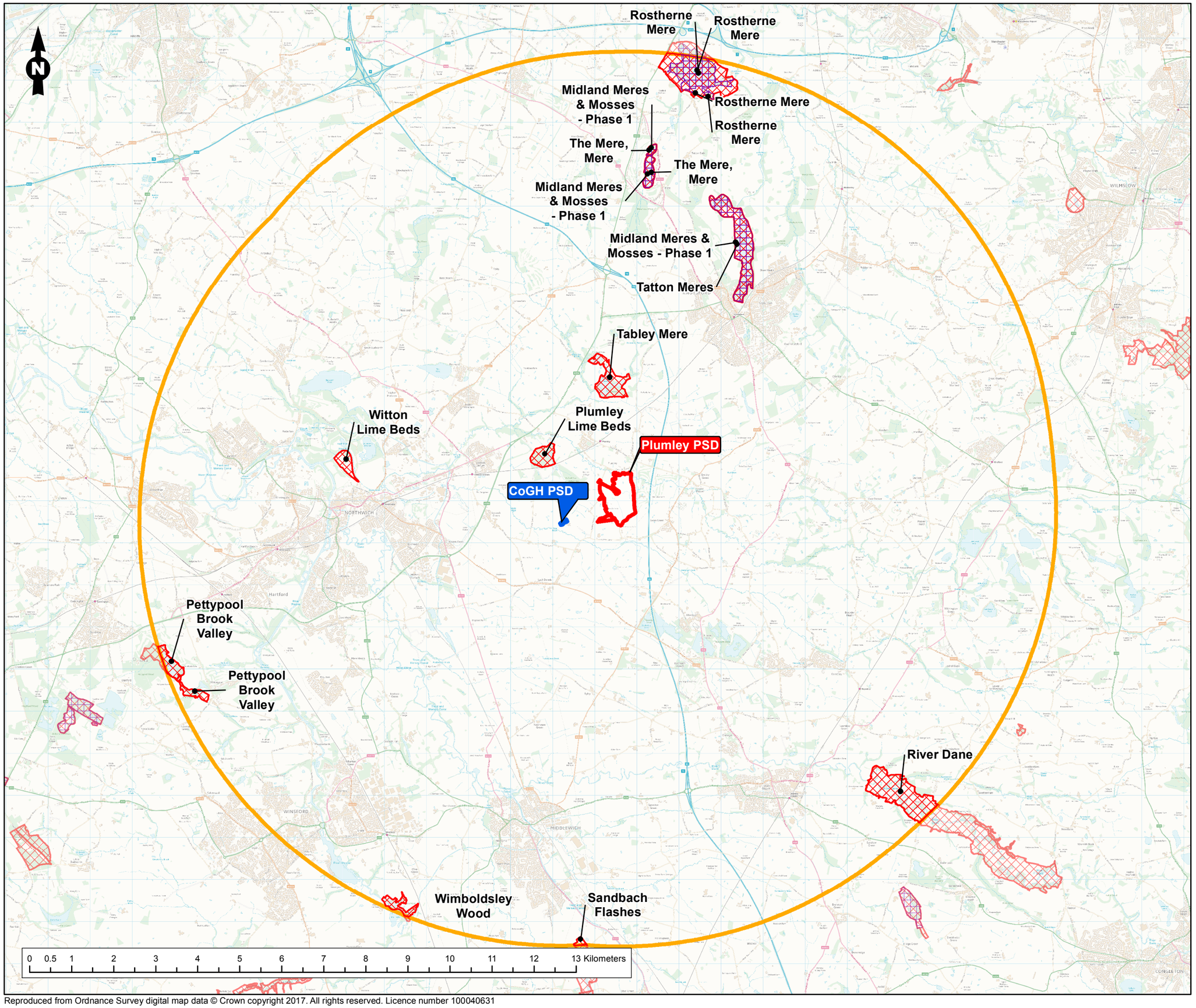
Figure Title
Proiority Habitats Within 2 km

Project Name
Plumley

| Project Number | Figure No. |
|---|---|
| UK14-21811 | 1 |
| **Date** | **Prepared By** |
| August 2017 | BM |
| **Scale** | **Issue** |
| 1:21,000 @A3 | 1 |

Client
**Client Name**

RAMBOLL ENVIRON






**Legend**

- RAMSAR
- Site of Special Scientific Interest
- 10 km Buffer

**Site Boundary**

- Plumley PSD
- CoGH PSD - Well Heads

Figure Title
Ramsar and SSSI Sites within 10km

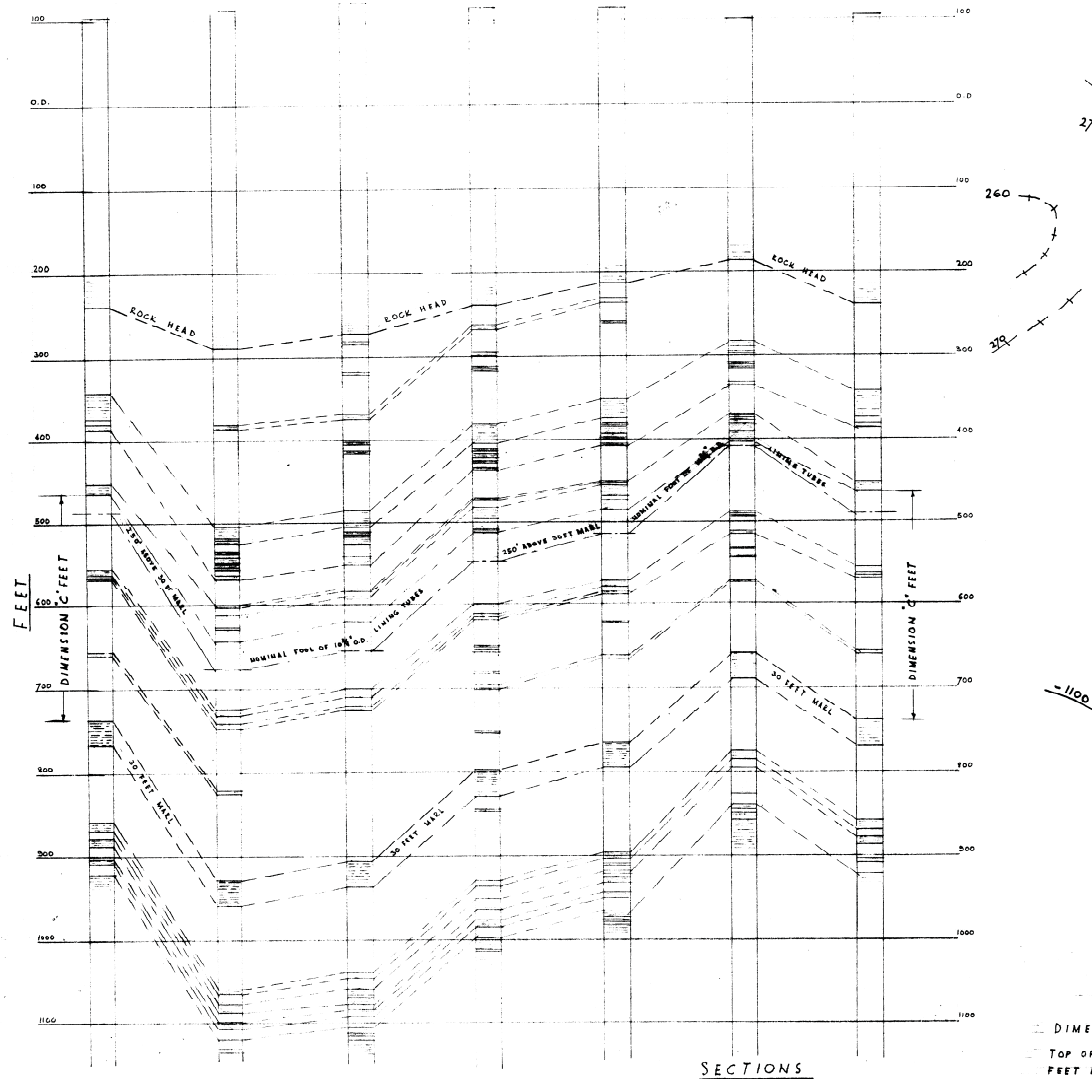
Project Name
Plumley

| Project Number | Figure No. |
|---|---|
| UK14-21811 | 1 |
| Date | Prepared By |
| August 2017 | BM |
| Scale | Issue |
| 1:85,000 @A3 | 1 |

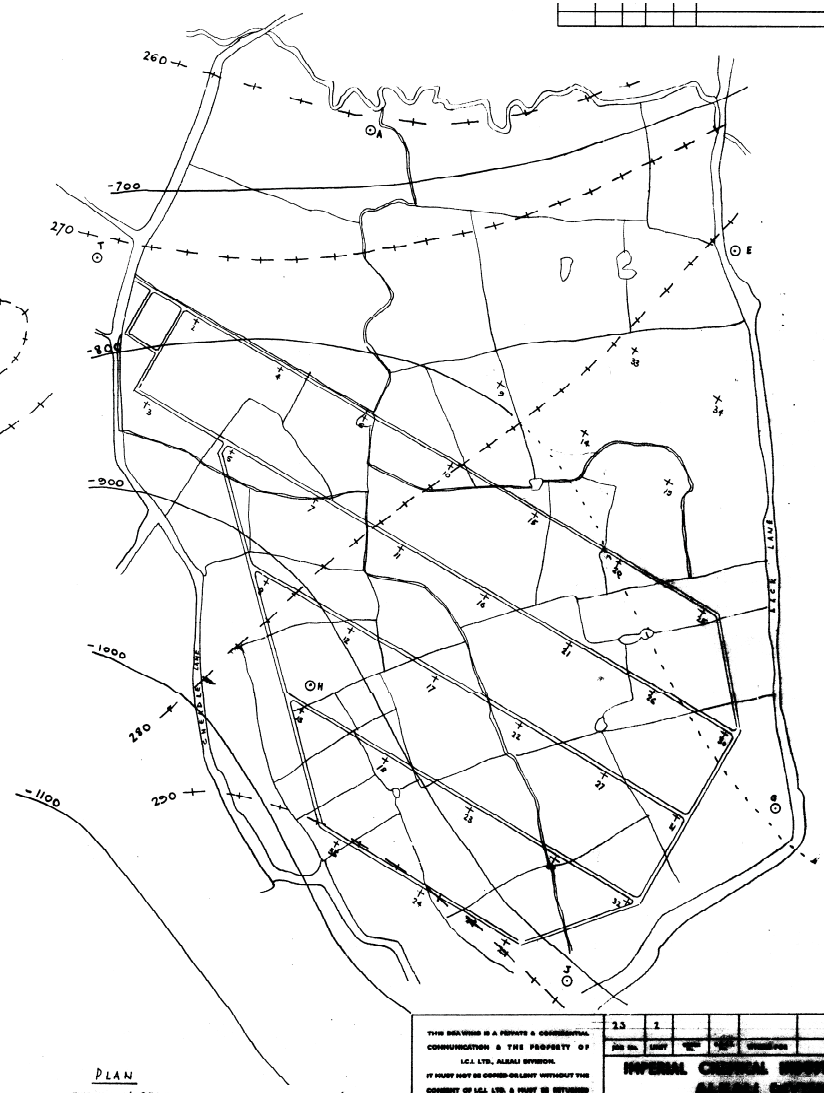
Client
**Client Name**

RAMBOLL ENVIRON

# APPENDIX 3
# GEOLOGICAL SEQUENCE CROSS-SECTION AND BOREHOLE LOGS




SECTIONS
SCALE 60 FT. TO 1 INCH.




PLAN
SCALE 1:2500

DIMENSION "C" THUS 270
TOP OF 30FT MARL
FEET BELOW O.D. THUS -900
PROBABLE —— DOUBTFULL ------



DRG Nº GC 35/65

SITE STRATIGRAPHY.

1063 Wt. 22438/0384 10m 7/45 (51) F.&S.

# RECORD OF SHAFT OR BORE FOR MINERALS

CONFIDENTIAL

CHESHIRE CONFIDENCE

(For Survey use only)
6inch Map Registered No. SJ 77 SW 121

Name and Number of Shaft or Bore P. SJ 77 SW

For Messrs. I.C.I.

Town or Village Nether Peover

County Six-inch quarter sheet

Exact site

Attach a tracing from a map, or a sketch-map, if possible.

6-inch Map Registered No. SJ77/138

Purpose for which made Salt (P.B. Scheme)

Level at which shaft bore commenced relative to O.D. c. 110' State if shaft bore is up, down, horizontal or inclined; in latter cases give angle of inclination and direction

Made by John Thom

Information from I.C.I. Date of Sinking 1952-3

Specimens

*Additional Notes in Space Overleaf*

| (For Survey use only) Geological Classification | Nature of Strata | Thickness | Depth |
|---|---|---|---|
| | Red clay | | 31 |
| | Red clay and gravel | | 58 |
| | Red ~~clay and~~ marl with grey | | 61 |
| | Grey marl | | 64 |
| | Red + grey marl | | 133 |
| | Red marl | | 160 |
| | Red + grey | | 193 |
| | Red | | 199 |
| | Red and grey | | 208 |
| | Red | | 217 |
| | Red + grey | | 274 |
| | Grey | | 295 |
| | Red | | 304 |
| | Red + grey | | 319 |
| | Grey | | 325 |
| | Red | | 331 |
| | Red + grey | | 355 |
| | Red | | 361 |
| | Red + grey | | 364 |
| | Grey | | 395 |
| | Red + grey | | 410 |
| | Grey | | 434 |
| | (Salt at 435/6) | | |
| | Salt- rock & grey marl | | 437 |
| | " | | 458 |
| | Salt- | | 476 |
| | No Samples | | 592 |
| | Salt | | 659 |

Continued Overleaf

| Geological Survey and Museum, South Kensington, | Date received | Correspondence File No. | 1" N.S. Map No. | 1" O.S. Map No. | Site marked (use symbol) on 1" Map | on 6" Map |
|---|---|---|---|---|---|---|
| | | | | | | |

(For Survey use only) GEOLOGICAL CLASSIFICATION

193

NATURE OF STRATA (Continued).

IN CONFIDENCE

SJ 77/138

| | THICKNESS | | | DEPTH | |
|---|---|---|---|---|---|
| | | | | | |
| Salt- + marl | | | | 677 | |
| Salt | | | | 683 | |
| Salt and marl | | | | 719 | |
| Salt- | | | | 737 | |
| Salt and marl | | | | 767 | |
| Marl | | | | 776 | |
| Salt and marl | | | | 791 | |
| Marl | | | | 797 | |
| Salt and marl | | | | 800 | |
| Salt- | | | | 869 | |
| Salt and marl | | | | 1007 | |
| Salt | | | | 1055 | |
| Salt and marl | | | | 1080 | |
| Coring. Red marl banded w. grey | | 2 | 9 | 1082 | 9 |
| Red and grey marl | | 4 | 7 | 1087 | 4 |
| Grey marl | | 3 | 2 | 1090 | 6 |
| Red marl | | 1 | 0 | 1091 | 6 |
| Red + grey marl | | 1 | 1 | 1092 | 7 |
| Grey banded w. red marl | | 2 | 10 | 1095 | 5 |
| Marly salt- | | 2 | 6 | 1097 | 11 |
| Red marl | | 2 | 5 | 1100 | 4 |
| end ! Salt- | | 25 | 8 | 1126 | 0 |
| Salt | | | | 1132 | |
| " | | | | 1200 | |

ADDITIONAL NOTES

1063 Wt. 22438/0384 10M 7/45 (51) F.&S.

CONFIDENTIAL

# RECORD OF SHAFT OR BORE FOR MINERALS

SJ77SW P.

(For Survey use only)
6 inch Map Registered No. CHESHIRE 34 SE 121

Name and Number of Shaft or Bore

For Messrs. I.C.I.

Town or Village Nether Peover

County Six-inch quarter sheet

Exact site

6-inch Map Registered No.

Attach a tracing from a map, or a sketch-map, if possible.

Purpose for which made Salt (P.B. Scheme)

Level at which shaft bore commenced relative to O.D. c 110' State if shaft bore is up, down, horizontal or inclined; in latter cases give angle of inclination and direction

Made by John Thom

Information from I.C.I. Date of Sinking 1952-3

Specimens

*Additional Notes in Space Overleaf*

| (For Survey use only) Geological Classification | Nature of Strata | Thickness | Depth |
|---|---|---|---|
| | Red clay | | 31 |
| | Red clay and gravel | | 58 |
| | Red ~~clay and~~ light grey marl | | 61 |
| | Grey marl | | 64 |
| | Red + grey marl | | 132 |
| | Red marl | | 160 |
| | Red + grey | | 193 |
| | Red | | 199 |
| | Red and grey | | 208 |
| | Red | | 217 |
| | Red + grey | | 274 |
| | Grey | | 295 |
| | Red | | 304 |
| | Red + grey | | 319 |
| | Grey | | 325 |
| | Red | | 331 |
| | Red + grey | | 355 |
| | Red | | 361 |
| | Red + grey | | 364 |
| | Grey | | 395 |
| | Red + grey | | 410 |
| | Grey | | 434 |
| | (Salt at 435/6) | | |
| | Salt rock & grey marl | | 427 |
| | " | | 458 |
| | Salt | | 476 |
| | No Samples | | 592 |
| | Salt | | 659 |

Continued Overleaf

| Geological Survey and Museum, South Kensington, London, S.W.7. | Date received | Correspondence File No. | 1" N.S. Map No. | 1" O.S. Map No. | Site marked (use symbol) on 1" Map | on 6" Map |
|---|---|---|---|---|---|---|
| | | | | | | |





[SJ77SW BJ 121 .]

| (For Survey use only) Geological Classification | 193 NATURE OF STRATA (*Continued*) | Thickness | | | Depth | |
|---|---|---|---|---|---|---|
| | Salt- + marl | | | | 677 | |
| | Salt | | | | 683 | |
| | Salt and marl | | | | 719 | |
| | Salt- | | | | 737 | |
| | Salt and marl | | | | 767 | |
| | Marl | | | | 776 | |
| | Salt and marl | | | | 791 | |
| | Marl | | | | 797 | |
| | Salt and marl | | | | 800 | |
| | Salt- | | | | 869 | |
| | Salt and marl | | | | 1007 | |
| | Salt | | | | 1055 | |
| | Salt and marl | | | | 1080 | |
| coring | Red marl banded W. grey | | 2 | 9 | 1082 | 9 |
| | Red and grey marl | | 4 | 7 | 1087 | 4 |
| | Grey marl | | 3 | 2 | 1090 | 6 |
| | Red marl | | 1 | 0 | 1091 | 6 |
| | Red + grey marl | | 1 | 1 | 1092 | 7 |
| | Grey banded W. red marl | | 2 | 10 | 1095 | 5 |
| | Marly salt- | | 2 | 6 | 1097 | 11 |
| | Red marl | | 2 | 5 | 1100 | 4 |
| ends | Salt- | | 25 | 8 | 1126 | 0 |
| | Salt | | | | 1132 | |
| | " | | | | 1200 | |

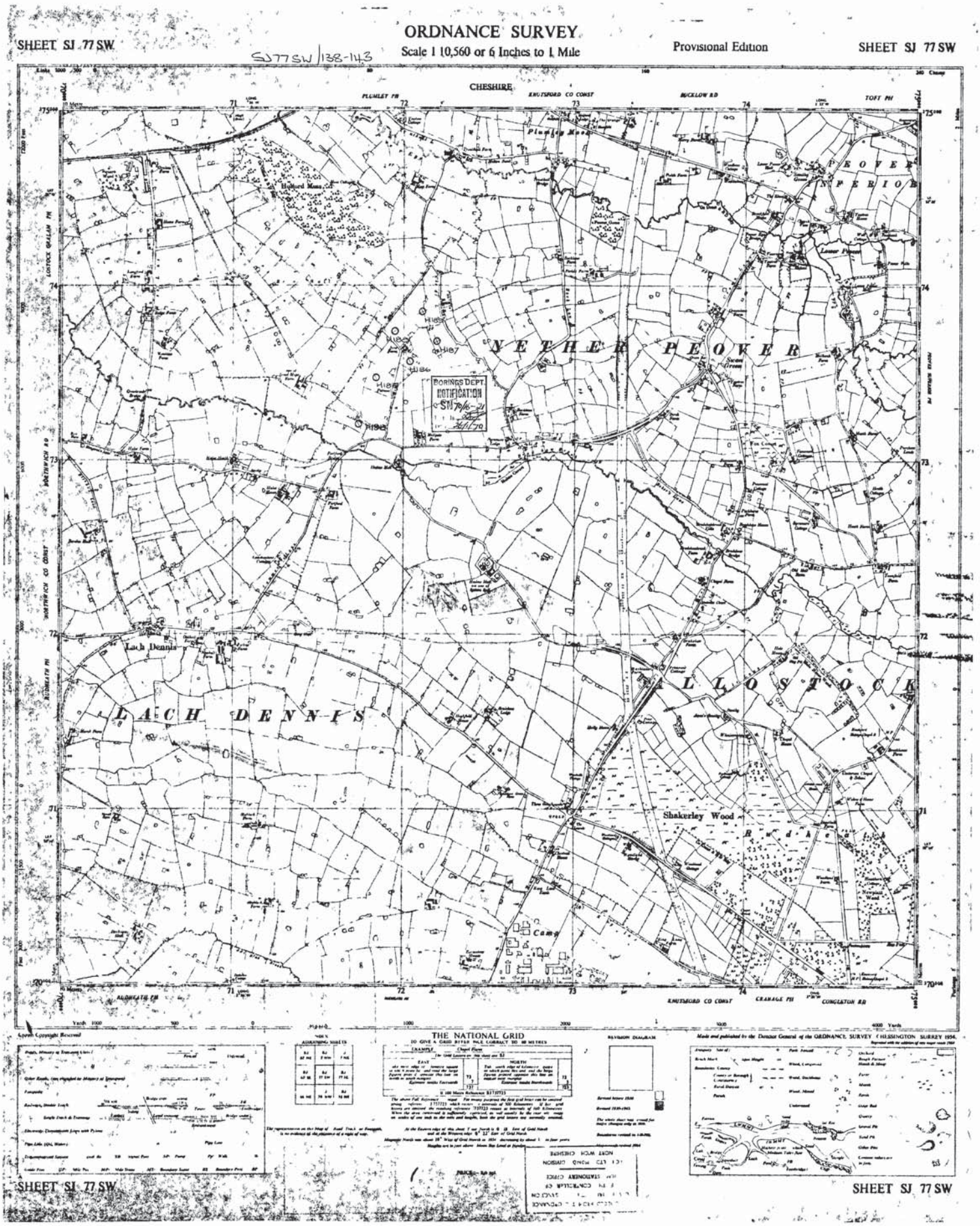
ADDITIONAL NOTES

SJ 77 SW / 138-143

CONFIDENTIAL

| Borehole | H 198 / 138 | | H 185 / 139 | | H 186 / 140 | | H 187 / 141 | | H 188 / 142 | | H 189 / 143 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Description of Strata | Thickness Ft | Depth F B S | Thickness Ft | Depth F B S | Thickness Ft | Depth F B S | Thickness Ft | Depth F B S | Thickness Ft | Depth F B S | Thickness Ft | Depth F B S |
| Glacial Drift | 14 | 14 4·27m | 38 | 38 11·58m | 40 | 40 12·19m | 38 | 38 11·58m | 40 | 40 12·19m | 38 | 38 11·58m |
| Red and Grey Marl (Middle Keuper Marl) | 661 | 675 205·74m | 531'6" | 600'6" 183·03m | 512 | 552 168·35m | 450 | 488 148·74m | 470'9" | 510'9" 155·68m | 425 | 463 141·12m |
| Rock Salt with occasional Marl Bands Zones H I J | | | | | | | | | | | | |
| Rock Salt with massive Marl Bands Zone G | | | | | | | | | | | | |
| Rock Salt with Marl Bands Zones D, E, F | | 1345 409·96m | | 1278 389·53m | | 1211 369·11m | | 1139 347·17m | | 11746" 357·99m | | 1114 339·55m |
| Marl (30 Ft Marl Band) Zone C | 37 | 1382 421·23m | 29 | 1307 398·37m | 32 | 1243 378·87m | 31'6" | 1170'6" 356·77 | 30'6" | 1205 367·28m | 29 | 1143 348·29 |
| Bottom of Borehole | 33 | 1415 | 53 | 1360 | 57 | 1300 | 53'6" | 1224 | 45 | 1250 | 41 | 1184 |
| | | 431·29m | | 414·53m | | 396·24m | | 373·08m | | 381·00m | | 360·88m |

Confidential.








[SJ77SW BJ 141 .]

IN CONFIDENCE SJ77/132

140 34 SE/13

(1932) Wt.80370/0370 10,000 9/39 A.& E.W.Ltd. Gp.685

# RECORD OF SHAFT OR BORE FOR MINERALS SJ77SW

SJ 7130 7355

Name and Number of Shaft or Bore given by Geological Survey:

Name and Number given by owner (if different from above): H. 171

Town or Village Holford Date of sinking

Exact site

County CHESHIRE

6" Quarter Sheet 34 SE

1" N.S. Geol. Map 110

1" O.S. Geol. Map

Whether Confidential CONFIDENTIAL

A sketch-map or tracing from a large-scale map is desirable.

Purpose for which made

Level at which bore commenced relative to O.D. 119.4 If not down bore, state if horizontal or up

Made by for Messrs. ICI alkali Division

Information from I.C.I Date received 6 Jan 1950

Specimens Dip of strata

| Geological Classification | Description | Thickness | | | Depth | | |
|---|---|---|---|---|---|---|---|
| | Drift | | 44 | | | 44 | |
| | Marl | | | | | 626 | |
| | Salt Rock | | | | | 704 | |
| | Salt + Marl | | | | | 724 | 6 |
| | Salt | | | | | 849 | |
| | Red + blue marl | | | | | 855 | |
| | Salt and marl | | | | | 868 | 6 |
| | Marl | | | | | 881 | |
| | Salt & gypsum | | | | | 918 | |
| | Rock salt | | | | | 954 | |
| | Salt + marl | | | | | 964 | |
| | Red and blue marl | | | | | 975 | |
| | Salt and marl | | | | | 1001 | 6 |
| | Salt | | | | | 1059 | 6 |
| | Dirty salt | | | | | 1083 | 6 |
| | Red and blue marl | | | | | 1091 | |
| | Salt rock (dirty) | | 13 | 6 | | 1104 | 6 |
| | Marl | | 1 | | | | |
| | Dirty rock salt | | 79 | 6 | | 1185 | |
| | Marl | | 4 | | | | |
| | Salt | | | | | 1285 | |
| | Marl | | 2 | | | | |
| | Salt | | 1 | 6 | | | |
| | Red and grey marls | | | | | 1321 | 7 |
| | Salt rock | | 111 | 5 | | 1433 | |
| | Marls. | | | | | 1446 | |

Cheshire SJ77SW 1/132

Brine & Water Works,
Holford.

## 171 Pilot Hole 'B' - Strata

Nr Coach & Bromyte cavity

| Description of Strata | Thickness | Depth from Surface |
|---|---|---|
| Dugwell | 3'0" | 3'0" |
| Red Sandy Clay | 27'0" | 30'0" |
| Red Sandy Clay and Gravel | 21'0" | 51'0" |
| Grey Marl and Gravel | 6'0" | 57'0" |
| Red Marl | 6'0" | 63'0" |
| Red and Grey Marl | 6'0" | 69'0" |
| Grey Marl | 6'0" | 75'0" |
| Red and Grey Marl | 9'0" | 84'0" |
| Red Marl | 9'0" | 93'0" |
| Red and Grey Marl | 6'0" | 99'0" |
| Grey Marl | 6'0" | 105'0" |
| Red Marl | 15'0" | 120'0" |
| Red and Grey Marl | 30'0" | 150'0" |
| Red and Grey Marl with Gypsum | 3'0" | 153'0" |
| Red and Grey Marl with Gypsum | 12'0" | 165'0" |
| Red and Grey Marl | 18'0" | 183'0" |
| Red Marl | 6'0" | 189'0" |
| Red and Grey Marl | 3'0" | 192'0" |
| Red and Grey Marl with Gypsum | 24'0" | 216'0" |
| Red and Grey Marl | 6'0" | 222'0" |
| Red Marl | 3'0" | 225'0" |
| Red and Grey Marl | 12'0" | 237'0" |
| Red Marl | 3'0" | 240'0" |
| Red and Grey Marl with Gypsum | 9'0" | 249'0" |
| Red and Grey Marl | 21'0" | 270'0" |
| Red and Grey Marl with Gypsum | 6'0" | 276'0" |
| Red and Grey Marl | 9'0" | 285'0" |
| Red and Grey Marl with Gypsum | 15'0" | 300'0" |
| Red and Grey Marl | 9'0" | 309'0" |
| Red and Grey Marl with Gypsum | 9'0" | 318'0" |
| Red Marl | 3'0" | 321'0" |
| Red and Grey Marl | 3'0" | 324'0" |
| Red and Grey Marl with Gypsum | 42'0" | 366'0" |
| Red and Grey Marl | 18'0" | 384'0" |
| Grey Marl | 3'0" | 387'0" |
| Red and Grey Marl | 12'0" | 399'0" |
| Red and Grey Marl with Gypsum | 21'0" | 420'0" |
| Red and Grey Marl | 117'0" | 537'0" |
| Grey Marl | 3'0" | 540'0" |
| Red and Grey Marl | 3'0" | 543'0" |
| Red Marl | 6'0" | 549'0" |
| Red and Grey Marl | 12'0" | 561'0" |
| Red Marl | 3'0" | 564'0" |
| Red and Grey Marl | 6'0" | 570'0" |
| Grey Marl | 6'0" | 576'0" |
| Red and Grey Marl | 9'0" | 585'0" |
| Grey Marl | 3'0" | 588'0" |
| Red and Grey Marl | 6'0" | 594'0" |
| Red Marl | 3'0" | 597'0" |
| Red and Grey Marl | 3'0" | 600'0" |
| Grey Marl | 59'0" | 659'0" |

This hole bored near site of H 171. by the cavity

(1932) Wt.30370/0370 10,000 9/39 A.& E.W.Ltd. Gp.685

# RECORD OF SHAFT OR BORE FOR MINERAL

SJ77SW

34 SE/13

115

County CHESHIRE

6" Quarter Sheet 34 SE

1" N.S. Geol. Map 110

1" O.S. Geol. Map

Whether Confidential

CONFIDENTIAL

Name and Number of Shaft or Bore given by Geological Survey :

Name and Number given by owner (if different from above) : H. 171

Town or Village Holford Date of sinking

Exact site

A sketch-map or tracing from a large-scale map is desirable.

Purpose for which made

Level at which bore commenced relative to O.D. 119.4 If not down bore, state if horizontal or up

Made by for Messrs. Imp Alkali Division

Information from I C I Date received 6 Jan 1950

Specimens Dip of strata

| Geological Classification | Description | Thickness | | | Depth | | |
|---|---|---|---|---|---|---|---|
| | Drift | | 44 | | | 44 | |
| | Marl | | | | | 626 | |
| | Salt Rock | | | | | 704 | |
| | Salt + Marl | | | | | 724 | 6 |
| | Salt | | | | | 849 | |
| | Red + blue marl | | | | | 855 | |
| | Salt and marl | | | | | 868 | 6 |
| | Marl | | | | | 881 | |
| | Salt w. gypsum | | | | | 918 | |
| | Rock salt | | | | | 954 | |
| | Salt + marl | | | | | 964 | |
| | Red and blue marl | | | | | 975 | |
| | Salt and marl | | | | | 1001 | 6 |
| | Salt | | | | | 1059 | 6 |
| | Dirty salt | | | | | 1083 | 6 |
| | Red and blue marl | | | | | 1091 | |
| | Salt rock (dirty) | | 13 | 6 | | 1104 | 6 |
| | Marl | | 1 | | | | |
| | Dirty rock salt | | 79 | 6 | | 1186 | — |
| | Marl | | 4 | | | | |
| | Salt | | | | | 1285 | |
| | Marl | | 2 | | | | |
| | Salt | | 1 | 6 | | | |
| | Red and grey marls | | | | | 1321 | 7 |
| | Salt rock | | 111 | 5 | | 1433 | |
| | Marls. | | | | | 1446 | |

Geological Survey and Museum,
South Kensington,
London, S.W.7.

| G.S.M. Office File No. | Site marked on 6" Map by | Site marked on 1" Map by |
|---|---|---|
| | | |





[SJ77SW BJ 115 .]

Brine & Water Works,
Holford.

## 171 Pilot Hole 'B' - Strata

Not Cored & Bored to carry

| Description of Strata | Thickness | Depth from Surface |
|---|---|---|
| Dugwell | 3'0" | 3'0" |
| Red Sandy Clay | 27'0" | 30'0" |
| Red Sandy Clay and Gravel | 21'0" | 51'0" |
| Grey Marl and Gravel | 6'0" | 57'0" |
| Red Marl | 6'0" | 63'0" |
| Red and Grey Marl | 6'0" | 69'0" |
| Grey Marl | 6'0" | 75'0" |
| Red and Grey Marl | 9'0" | 84'0" |
| Red Marl | 9'0" | 93'0" |
| Red and Grey Marl | 6'0" | 99'0" |
| Grey Marl | 6'0" | 105'0" |
| Red Marl | 15'0" | 120'0" |
| Red and Grey Marl | 30'0" | 150'0" |
| Red and Grey Marl with Gypsum | 3'0" | 153'0" |
| Red and Grey Marl with Gypsum | 12'0" | 165'0" |
| Red and Grey Marl | 18'0" | 183'0" |
| Red Marl | 6'0" | 189'0" |
| Red and Grey Marl | 3'0" | 192'0" |
| Red and Grey Marl with Gypsum | 24'0" | 216'0" |
| Red and Grey Marl | 6'0" | 222'0" |
| Red Marl | 3'0" | 225'0" |
| Red and Grey Marl | 12'0" | 237'0" |
| Red Marl | 3'0" | 240'0" |
| Red and Grey Marl with Gypsum | 9'0" | 249'0" |
| Red and Grey Marl | 21'0" | 270'0" |
| Red and Grey Marl with Gypsum | 6'0" | 276'0" |
| Red and Grey Marl | 9'0" | 285'0" |
| Red and Grey Marl with Gypsum | 15'0" | 300'0" |
| Red and Grey Marl | 9'0" | 309'0" |
| Red and Grey Marl with Gypsum | 9'0" | 318'0" |
| Red Marl | 3'0" | 321'0" |
| Red and Grey Marl | 3'0" | 324'0" |
| Red and Grey Marl with Gypsum | 42'0" | 366'0" |
| Red and Grey Marl | 18'0" | 384'0" |
| Grey Marl | 3'0" | 387'0" |
| Red and Grey Marl | 12'0" | 399'0" |
| Red and Grey Marl with Gypsum | 21'0" | 420'0" |
| Red and Grey Marl | 117'0" | 537'0" |
| Grey Marl | 3'0" | 540'0" |
| Red and Grey Marl | 3'0" | 543'0" |
| Red Marl | 6'0" | 549'0" |
| Red and Grey Marl | 12'0" | 561'0" |
| Red Marl | 3'0" | 564'0" |
| Red and Grey Marl | 6'0" | 570'0" |
| Grey Marl | 6'0" | 576'0" |
| Red and Grey Marl | 9'0" | 585'0" |
| Grey Marl | 3'0" | 588'0" |
| Red and Grey Marl | 6'0" | 594'0" |
| Red Marl | 3'0" | 597'0" |
| Red and Grey Marl | 3'0" | 600'0" |
| Grey Marl | 59'0" | 659'0" |

This hole bored near site of
H 171. to the cavity

IN CONFIDENCE

5577/14

(1932) Wt.30370/0870 10,000 9/39 A.& B.W.Ltd. Gp.685

# RECORD OF SHAFT OR BORE FOR MINERALS

SJ 7119 7348

SJ 77 SW

Name and Number of Shaft or Bore given by Geological Survey:

Name and Number given by owner (if different from above): H175

Town or Village Holford Date of sinking

Exact site

County CHESHIRE

6" Quarter Sheet 34 SE

1" N.S. Geol. Map 110

1" O.S. Geol. Map

Whether Confidential

CONFIDENTIAL

A sketch-map or tracing from a large-scale map is desirable.

Purpose for which made

Level at which bore commenced relative to O.D. 119·8 If not down bore, state if horizontal or up

Made by for Messrs. ICI Alkali Division

Information from ICI Holford Date received Jan 6 1956

Specimens Dip of strata

| Geological Classification | Description | Thickness | | | Depth | | |
|---|---|---|---|---|---|---|---|
| | Drift | | 55 | | | | |
| | Marls | | | | | 654 | |
| | Salt | | | | | 757 | |
| | Rock and marl | | 9 | | | | |
| | Salt | | | | | 803 | |
| | Salt and marl | | 12 | | | | |
| | Salt | | | | | 877 | |
| | Salt and marl | | 5 | | | | |
| | Red and blue marls w. gypsum | | 4 | | | 907 | |
| | Salt | | 10 | | | | |
| | Red and blue marls | | 8 | 6 | | | |
| | Salt and marls | | | | | 948 | |
| | Salt | | | | | 986 | |
| | Salt and marl | | 11 | 6 | | | |
| | Marls w. gypsum and salt | | | | | 1029 | 6 |
| | Salt | | | | | 1132 | |
| | Salt and marl | | | | | 1145 | |
| | Salt | | | | | 1194 | |
| | Rock salt with marl | | | | | 1239 | |
| | Salt rock | | | | | 1259 | |
| | Salt and marl | | 8 | | | | |
| | Salt | | | | | 1311 | |
| | Salt and marl | | | | | 1322 | |
| | Salt rock | | | | | 1341 | |
| | Red marl | | 30 | | | 1371 | |
| | Blue marl w. salt | | 2 | | | | |
| | Red marl | | 4 | | | | |
| | Salt w. marl | | 4 | | | | |
| | Salt rock. | | | | | 1489 | 6 |

GEOLOGICAL SURVEY AND MUSEUM, [illegible]

| G.S.M. Office File No. | Site marked on 6" Map by | Site marked on 1" Map by |
|---|---|---|

193 SJ77SW CONFIDENCE Cheshire 3 SJ77/6 11/133

Brine & Water Works,
Holford.

CONFIDENTIAL

175 Pilot Hole No.2 - Strata

N. cover Boring to cavity

| Description of Strata | Thickness | Depth from Surface |
|---|---|---|
| Dugwell | 3'6" | 3'6" |
| Red Sandy Clay | 20'6" | 24'0" |
| Red Sandy Clay and Gravel | 24'0" | 48'0" |
| Red Marl | 9'0" | 57'0" |
| Red and Grey Marl | 6'0" | 63'0" |
| Red Marl | 3'0" | 66'0" |
| Red and Grey Marl | 60'0" | 126'0" |
| Red and Grey Marl with Gypsum | 32'0" | 158'0" |
| Red and Grey Marl with Gypsum | 60'0" | 218'0" |
| Red and Grey Marl with Gypsum | 82'0" | 300'0" |
| Red and Grey Marl with Gypsum | 66'0" | 366'0" |
| Red and Grey Marl | 12'0" | 378'0" |
| Grey Marl | 8'0" | 386'0" |
| Red and Grey Marl with Gypsum | 17'0" | 403'0" |
| Red and Grey Marl | 30'0" | 433'0" |
| Red and Grey Marl with Gypsum | 77'0" | 510'0" |
| Red and Grey Marl | 9'0" | 519'0" |
| Grey Marl | 15'0" | 534'0" |
| Red and Grey Marl | 9'0" | 543'0" |
| Grey Marl | 6'0" | 549'0" |
| Grey Marl | 3'0" | 552'0" |
| Red and Grey Marl | 44'0" | 596'0" |
| Grey Marl | 7'0" | 603'0" |
| Red and Grey Marl | 8'0" | 611'0" |
| Red and Grey Marl | 44'0" | 655'0" |

This hole bored at site of
H.175 to cavity

(7832) Wt.30370/0370 10,000 9/89 A.& H.W.Ltd. Gp.685

# RECORD OF SHAFT OR BORE FOR MINERALS

SJ77SW 34 SE/14 14

116

County CHESHIRE

6" Quarter Sheet 34 SE

1" N.S. Geol. Map 110

1" O.S. Geol. Map

Whether Confidential

CONFIDENTIAL

Name and Number of Shaft or Bore given by Geological Survey:

Name and Number given by owner (if different from above): H175

Town or Village Holford Date of sinking

Exact site

A sketch-map or tracing from a large-scale map is desirable.

Purpose for which made

Level at which bore commenced relative to O.D. 119·8 If not down bore, state if horizontal or up

Made by for Messrs. ICI Alkali Division

Information from ICI Holford Date received Jan 6 1956

Specimens Dip of strata

| Geological Classification | Description | Thickness | | | Depth | |
|---|---|---|---|---|---|---|
| | Drift | 50 | | | | |
| | Marls | | | | 654 | |
| | Salt | | | | 757 | |
| | Rock and marl | 9 | | | | |
| | Salt | | | | 803 | |
| | Salt and marl | 12 | | | | |
| | Salt | | | | 877 | |
| | Salt and marl | 5 | | | | |
| | Red and blue marls w. gypsum | 4 | | | 907 | |
| | Salt | 10 | | | | |
| | Red and blue marls | 8 | 6 | | | |
| | Salt and marls | | | | 948 | |
| | Salt | | | | 986 | |
| | Salt and marl | 11 | 6 | | | |
| | Marls w. gypsum and salt | | | | 1029 | 6 |
| | Salt | | | | 1132 | |
| | Salt and marl | | | | 1145 | |
| | Salt | | | | 1194 | |
| | Rock salt with marl | | | | 1239 | |
| | Salt rock | | | | 1259 | |
| | Salt and marl | 8 | | | | |
| | Salt | | | | 1311 | |
| | Salt and marl | | | | 1322 | |
| | Salt rock | | | | 1341 | |
| | Red marl | 30 | | | 1371 | |
| | Blue marl w. salt | 2 | | | | |
| | Red marl | 4 | | | | |
| | Salt w. marl | 4 | | | | |
| | Salt rock. | | | | 1459 | 6 |

Geological Survey and Museum,
South Kensington,
London, S.W.7.

| G.S.M. Office File No. | Site marked on 6" Map by | Site marked on 1" Map by |
|---|---|---|
| | | |

Cheshire 34 SE 26

1953 SJ77SW 116

Brine & Water Works,
Holford.

CONFIDENTIAL

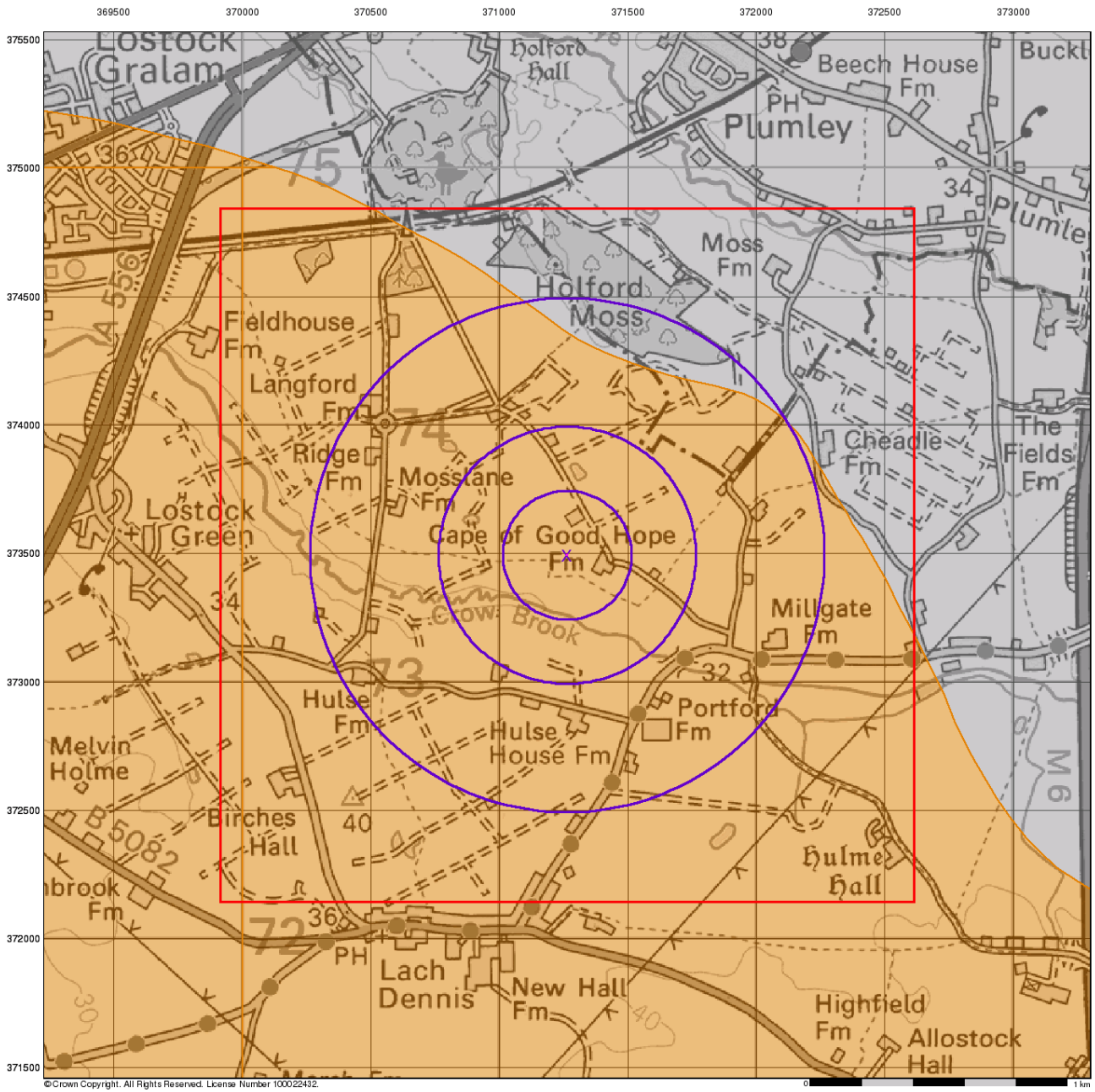
175 Pilot Hole No.2 - Strata

N. core Boring to cavity

| Description of Strata | Thickness | Depth from Surface |
|---|---|---|
| Dugwell | 3'6" | 3'6" |
| Red Sandy Clay | 20'6" | 24'0" |
| Red Sandy Clay and Gravel | 24'0" | 48'0" |
| Red Marl | 9'0" | 57'0" |
| Red and Grey Marl | 6'0" | 63'0" |
| Red Marl | 3'0" | 66'0" |
| Red and Grey Marl | 60'0" | 126'0" |
| Red and Grey Marl with Gypsum | 32'0" | 158'0" |
| Red and Grey Marl with Gypsum | 60'0" | 218'0" |
| Red and Grey Marl with Gypsum | 82'0" | 300'0" |
| Red and Grey Marl with Gypsum | 66'0" | 366'0" |
| Red and Grey Marl | 12'0" | 378'0" |
| Grey Marl | 8'0" | 386'0" |
| Red and Grey Marl with Gypsum | 17'0" | 403'0" |
| Red and Grey Marl | 30'0" | 433'0" |
| Red and Grey Marl with Gypsum | 77'0" | 510'0" |
| Red and Grey Marl | 9'0" | 519'0" |
| Grey Marl | 15'0" | 534'0" |
| Red and Grey Marl | 9'0" | 543'0" |
| Grey Marl | 6'0" | 549'0" |
| Grey Marl | 3'0" | 552'0" |
| Red and Grey Marl | 44'0" | 596'0" |
| Grey Marl | 7'0" | 603'0" |
| Red and Grey Marl | 8'0" | 611'0" |
| Red and Grey Marl | 44'0" | 655'0" |

This hole bored at Sid
H. 175 ft. cavity

# APPENDIX 4
# AQUIFER MAPPING




RAMBOLL ENVIRON

# Bedrock Aquifer Designation

## General

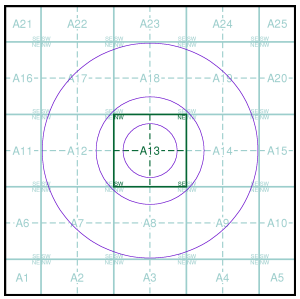
Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

## Agency and Hydrological

**Geological Classes**

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown
- Unknown (Lakes and Landslip)

## Site Sensitivity Context Map - Slice A



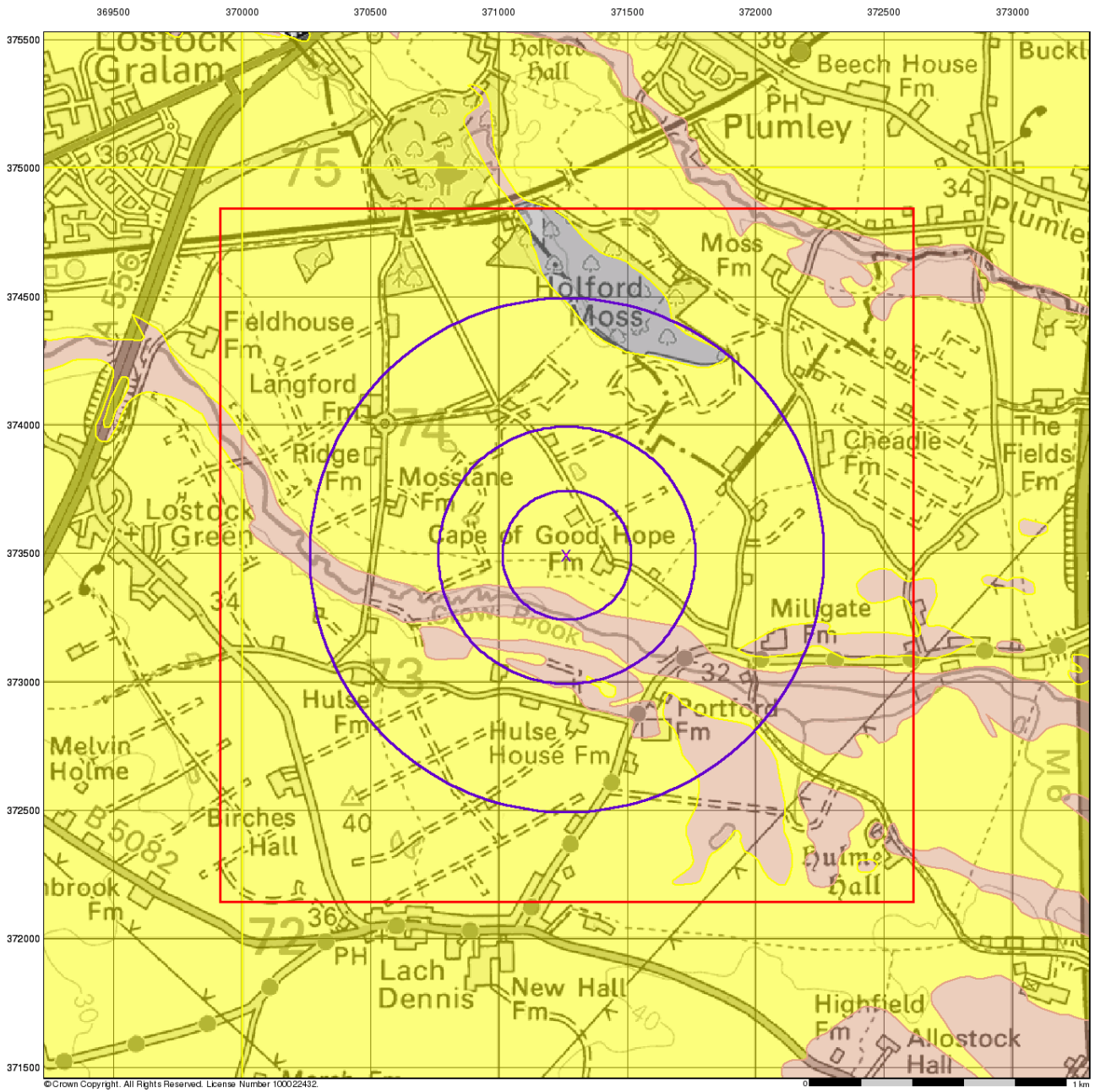

## Order Details

| | |
|---|---|
| Order Number: | 137361940_1_1 |
| Customer Ref: | UK1421811 CoGH |
| National Grid Reference: | 371260, 373490 |
| Slice: | A |
| Site Area (Ha): | 0.01 |
| Search Buffer (m): | 1000 |

## Site Details

Site at, Plumley, Cheshire


Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk




RAMBOLL ENVIRON

## Superficial Aquifer Designation

### General

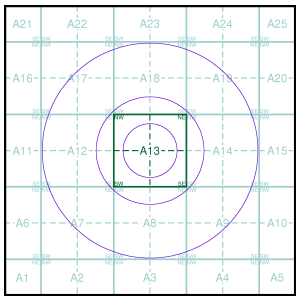
Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

### Agency and Hydrological

**Geological Classes**

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown
- Unknown (Lakes and Landslip)

### Site Sensitivity Context Map - Slice A



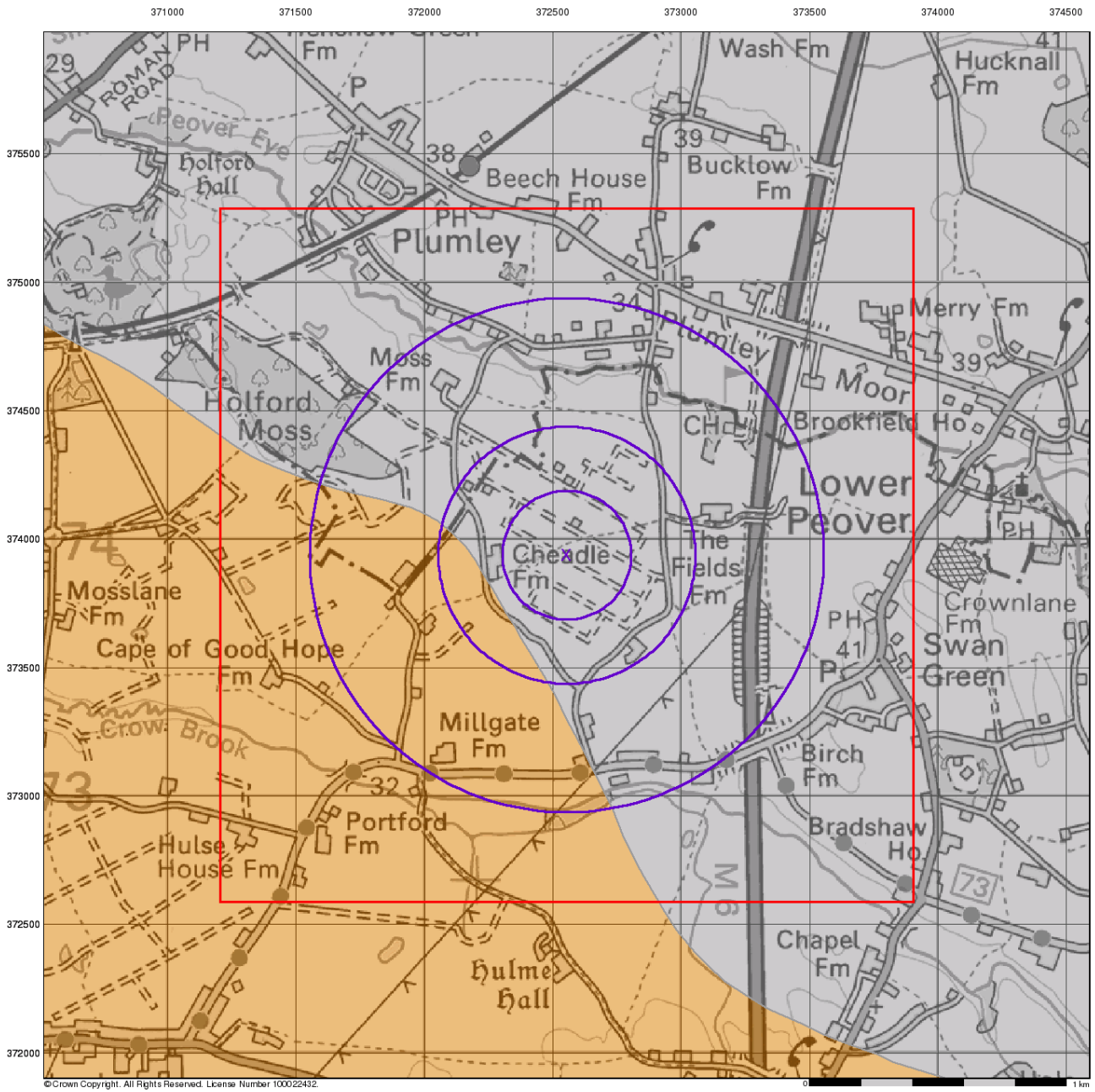

### Order Details

| | |
|---|---|
| Order Number: | 137361940_1_1 |
| Customer Ref: | UK1421811 CoGH |
| National Grid Reference: | 371260, 373490 |
| Slice: | A |
| Site Area (Ha): | 0.01 |
| Search Buffer (m): | 1000 |

### Site Details

Site at, Plumley, Cheshire

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk




RAMBOLL ENVIRON

# Bedrock Aquifer Designation

## General

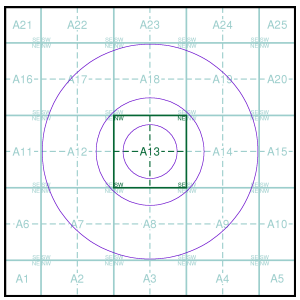
Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

## Agency and Hydrological

### Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown

## Site Sensitivity Context Map - Slice A



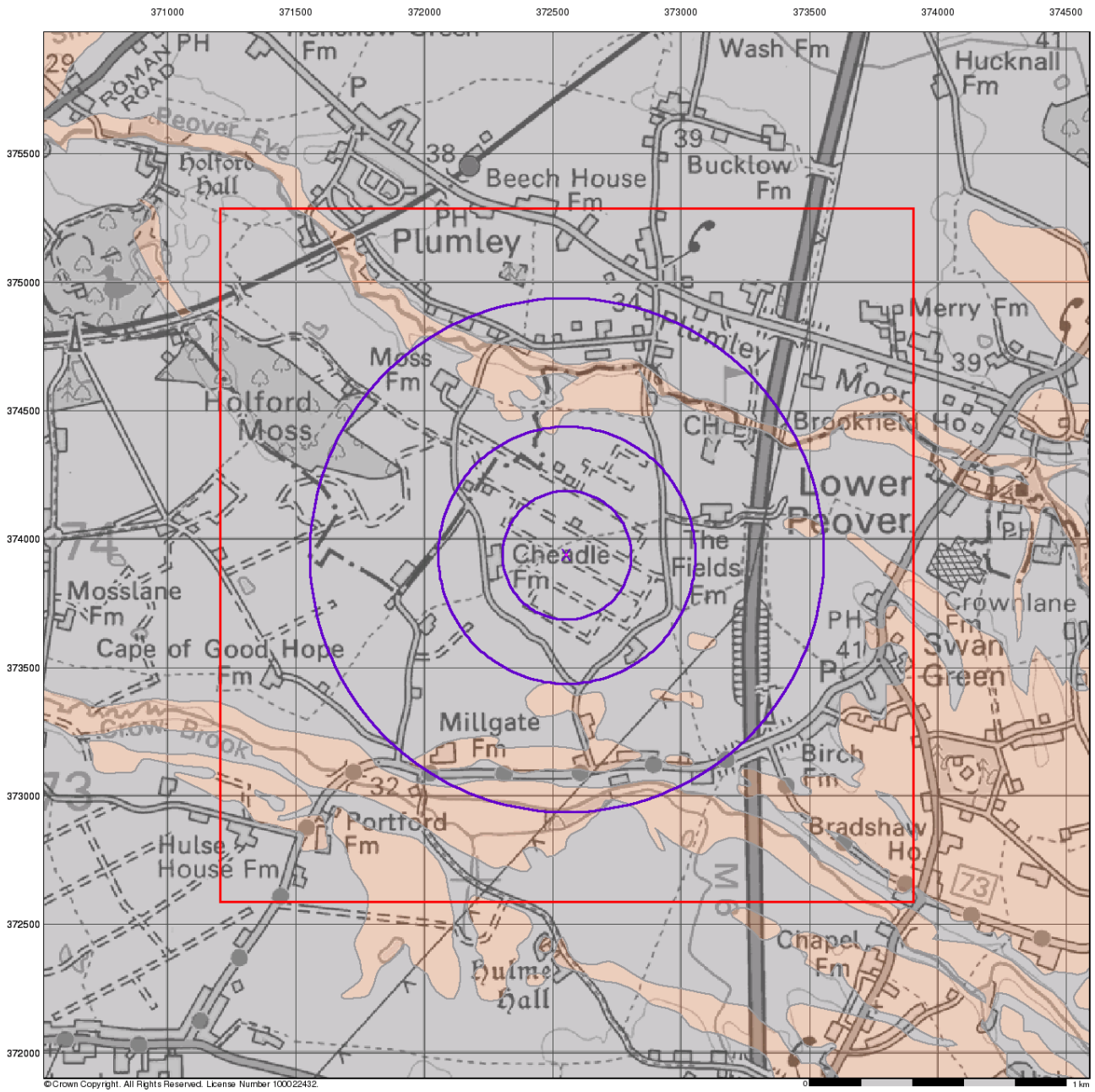

## Order Details

| | |
|---|---|
| Order Number: | 70247091_1_1 |
| Customer Ref: | uk14-21811 |
| National Grid Reference: | 372550, 373940 |
| Slice: | A |
| Site Area (Ha): | 0.01 |
| Search Buffer (m): | 1000 |

## Site Details

Site at, Plumley, Cheshire

Landmark Information Group
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk




RAMBOLL ENVIRON

## Superficial Aquifer Designation

### General

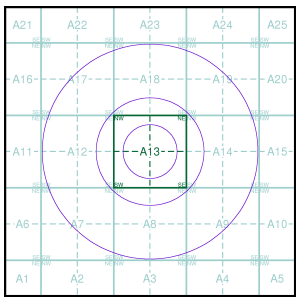
Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

### Agency and Hydrological

**Geological Classes**

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown

### Site Sensitivity Context Map - Slice A



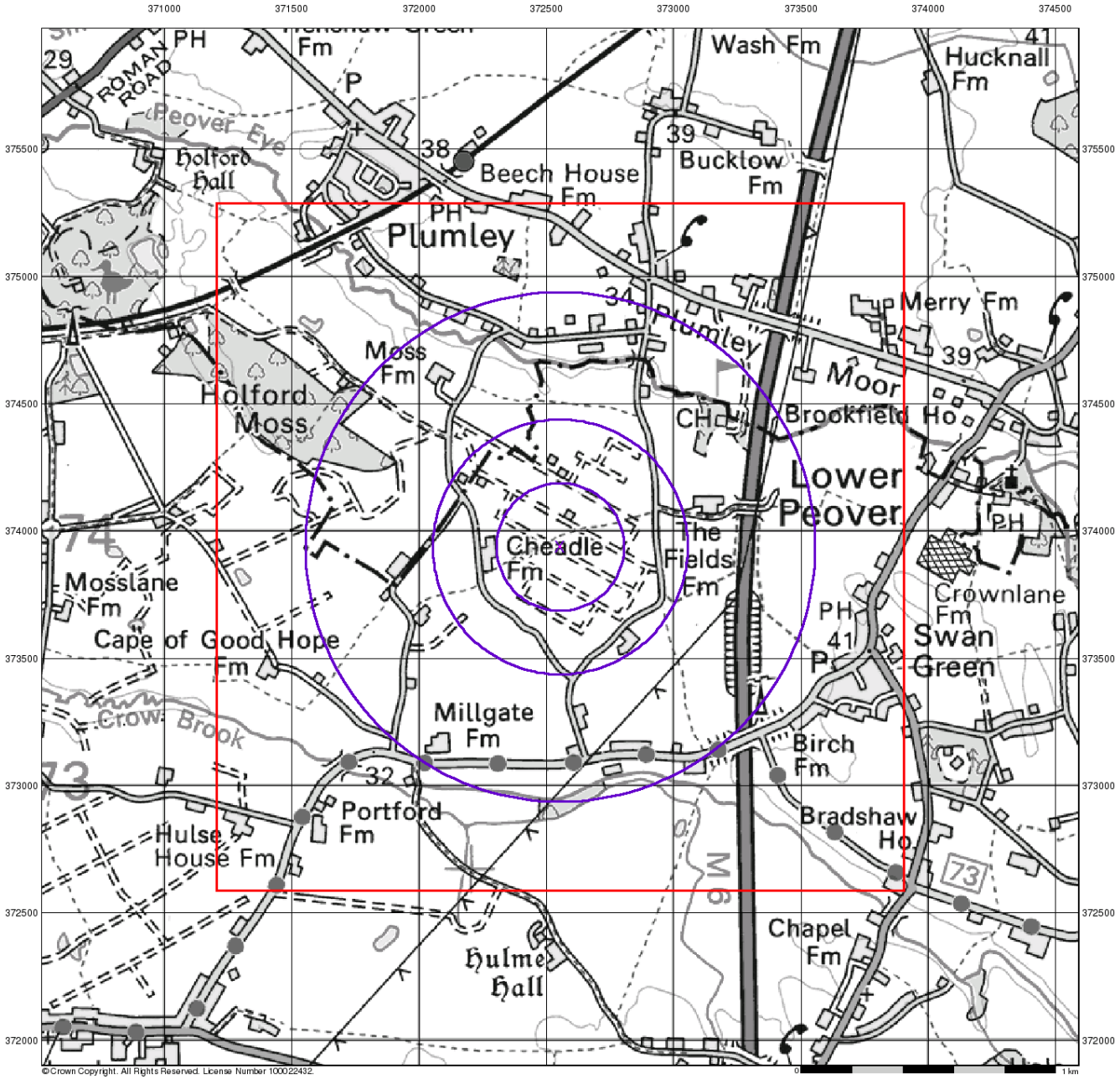

### Order Details

| | |
|---|---|
| Order Number: | 70247091_1_1 |
| Customer Ref: | uk14-21811 |
| National Grid Reference: | 372550, 373940 |
| Slice: | A |
| Site Area (Ha): | 0.01 |
| Search Buffer (m): | 1000 |

### Site Details

Site at, Plumley, Cheshire

Landmark Information Group
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk




RAMBOLL ENVIRON

## Source Protection Zones

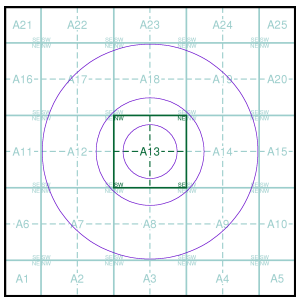
### General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

### Agency and Hydrological

- Inner zone (Zone 1)
- Inner zone - subsurface activity only (Zone 1c)
- Outer zone (Zone 2)
- Outer zone - subsurface activity only (Zone 2c)
- Total catchment (Zone 3)
- Total catchment - subsurface activity only (Zone 3c)
- Special interest (Zone 4)
- Source Protection Zone Borehole

### Site Sensitivity Context Map - Slice A




### Order Details

| | |
|---|---|
| Order Number: | 70247091_1_1 |
| Customer Ref: | uk14-21811 |
| National Grid Reference: | 372550, 373940 |
| Slice: | A |
| Site Area (Ha): | 0.01 |
| Search Buffer (m): | 1000 |

### Site Details

Site at, Plumley, Cheshire

Landmark Information Group
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

# APPENDIX 5
# CDOIF HARM CRITERIA AND ASSESSMENT

| **Table A.5.1: Identified Receptor Summary** | | | | | |
|---|---|---|---|---|---|
| **CDOIF Receptor Category** | **Description** | **Severity Criteria** | | | |
| | | **Significant (1)** ***While this level of harm might be significant pollution, it is not considered a MATTE*** | **Severe (2)** | **Major (3)** | **Catastrophic (4)** |
| 1 | Designated Land / Water Sites (Nationally Important) | Impact below that of Severity Level 2. | >0.5ha or 10-50% of site area, associated linear feature or population | >50% of site area, associated linear feature or population | N/A |
| 2 | Designated Land/Water Sites (Internationally important) | Impact below that of Severity Level 2. | >0.5ha or 5-25% of site area or 5-25% of associated linear feature or population | 25-50% of site area, associated linear feature or population | >50% of site area, associated linear feature or population |
| 3 | Other Designated Land | Impact below that of Severity Level 2. | 10-100ha or 10-50% of land | >100ha or >50% of land | N/A |
| 4 | Scarce Habitat | Impact below that of Severity Level 2. | 2-20ha or 10-50% of habitat | >20ha or >50% of habitat | N/A |
| 5 | Widespread Habitat – Non Designated Land | Impact below that of Severity Level 2. | Contamination of 10 – 100 ha of land, preventing growing of crops, grazing of animals or renders the area inaccessible to the public because of possible skin contact with dangerous substances. Alternatively contamination of 10ha or more of vacant land. | 100 – 1,000 ha (applied as per text under 'severe') | >1,000 ha (applied as per text under 'severe') |

| **Table A.5.1: Identified Receptor Summary** | | | | | |
|---|---|---|---|---|---|
| **CDOIF Receptor Category** | **Description** | **Severity Criteria** | | | |
| | | **Significant (1)** ***While this level of harm might be significant pollution, it is not considered a MATTE*** | **Severe (2)** | **Major (3)** | **Catastrophic (4)** |
| 6 | Widespread Habitat – Non-Designated Water | Impact below that of Severity Level 2. | Contamination of aquatic habitat which prevents fishing or aquaculture or renders is inaccessible to the public. | N/A | N/A |
| 7 | Source of Public or Private Drinking Water (Groundwater or Surface Water) | Impact below that of Severity Level 2. | Interruption of drinking water supply from a ground or surface water source where persons affected x duration in hours (at least 2) is >1,000, or 1 ha or more of a SPZ where drinking water standards are breached. | $1 \times 10^7$ person hours interruption of drinking water (a town of ~100,000 loosing supply for a month or 10 – 100 ha SPZ drinking water standards breached. | $1 \times 10^9$ person hours interruption of drinking water (a town of ~1 million loosing supply for a month or >100 ha SPZ drinking water standards breached. |
| 8 | Groundwater Body (non- Drinking Water Source) | Impact below that of Severity Level 2. | 1-100ha of groundwater body where the WFD status has been lowered | 100-10,000ha | >10,000ha |
| 9 | Other Groundwater (outside of groundwater bodies) | Where groundwater is a pathway to another receptor, assess against the relevant criteria for that receptor. | | | |
| 10 | Soil or sediment (i.e. as receptor | Impact below that of Severity Level 2. | Contamination of 10ha or more land etc. as per Widespread Habitat; or | Contamination of 100 – 1,000 ha or more land etc. as per Widespread Habitat; | Contamination of >1,000 ha or more land etc. as per |

| **Table A.5.1: Identified Receptor Summary** | | | | | |
|---|---|---|---|---|---|
| **CDOIF Receptor Category** | **Description** | **Severity Criteria** | | | |
| | | **Significant (1)** ***While this level of harm might be significant pollution, it is not considered a MATTE*** | **Severe (2)** | **Major (3)** | **Catastrophic (4)** |
| | rather than purely a pathway) | | contamination of 10ha or more of land by substances, preparations, organisms micro-organisms that results in a significant risk of adverse effects on human health. | or contamination rendering the soil immediately hazardous to hums (e.g. skin contact) or the living environment, but remediation is available. | Widespread Habitat; or contamination rendering the soil immediately hazardous to hums (e.g. skin contact) or the living environment, but remediation difficult or impossible. |
| 11 | Built Environment (limited to Grade 1 / Cat A Listed Buildings, scheduled monuments, conservation area etc. | Impact below that of Severity Level 2. | Damage sufficient for designation of importance to be withdrawn. | Feature of built environment subject to designation of importance entirely destroyed. | N/A |
| 12 | *Various Receptors (as per DETR 1999 Table 9* | Not applicable under the guidelines issued by CDOIF, and is not used to identify a MATTE. | | | |
| 13 | Particular Species | Impact below that of Severity Level 2. | Loss of 1-10% of animal or 5-50% of plant ground cover | Loss of 10-90% of animal or 50-90% of plant ground cover. | Total loss (>90%) of animal or plant ground cover. |
| 14 | Marine | Impact below that of Severity Level 2. | 2 – 20ha of littoral or sub-littoral zone, 100 – | 20 – 200 ha of littoral or sub-littoral zone, 1,000 – | >200 ha of littoral or sub-littoral zone, |

| **Table A.5.1: Identified Receptor Summary** | | | | | |
|---|---|---|---|---|---|
| **CDOIF Receptor Category** | **Description** | **Severity Criteria** | | | |
| | | **Significant (1)** ***While this level of harm might be significant pollution, it is not considered a MATTE*** | **Severe (2)** | **Major (3)** | **Catastrophic (4)** |
| | | | 1,000 ha of benthic community, or 100 – 1,000 dead sea birds (500 – 5,000 gulls), or 5 - 50 dead / significantly impaired sea mammals. | 10,000 ha of benthic community, or 1,000 – 10,000 dead sea birds (5,000 – 50,000 gulls), or 50 - 500 dead / significantly impaired sea mammals. | >10,000 ha of benthic community, or >10,000 dead sea birds (>50,000 gulls), or >500 dead / significantly impaired sea mammals. |
| 15 | Fresh and Estuarine Habitats | Impact below that of Severity Level 2. | WFD Chemical or ecological status lowered by one class for 2-10km of watercourse or 2-20ha or 10-50% area of estuaries or ponds. Plus interruption of drinking water supplies, as per DETR Table 6 | WFD Chemical or ecological status lowered by one class for 10-200km of watercourse or 20- 200ha or 50-90% area of estuaries and ponds. Plus interruption of drinking water supplies, as per DETR Table 6 | WFD Chemical or ecological status lowered by one class for >200km of watercourse or >200ha or >90% area of estuaries and ponds. Plus interruption of drinking water supplies, as per DETR Table 6 |

| **Table A.5.2: Duration of Harm Criteria** | | | | |
|---|---|---|---|---|
| **Description** | **Short Term (1)** **(Harm with such short recovery is not considered a MATTE)** | **Medium Term (2)** | **Long Term (3)** | **Very Long Term (4)** |
| Harm Duration Category | 1 | 2 | 3 | 4 |
| Land | ≤3 years | > 3 years or > 2 growing seasons for agricultural land | > 20 years | > 50 years |
| Surface Water | ≤1 year | > 1 year | > 10 years | > 20 years |
| Groundwater body or surface water public or private drinking water source | N/A | Harm affecting non-public drinking water source. | Harm affecting public drinking water source or SPZ. | N/A |
| Built Environment | Can be repaired in < 3 years, such that its designation can be reinstated | Can be repaired in > 3 years, such that its designation can be reinstated | Feature destroyed, cannot be rebuilt, all features except world heritage site | Feature destroyed, cannot be rebuilt, world heritage site |

The determined severity and harm categories are used to determine the consequence level in accordance with the following matrix.

**Table A.5.3: Consequence Determination Matrix**

| Severity of Harm | | Consequence Level | | | |
|---|---|---|---|---|---|
| | 4 | Sub Matte | C | D | D |
| | 3 | | B | C | D |
| | 2 | | A | B | C |
| | 1 | Sub Matte | | | |
| | | 1 | 2 | 3 | 4 |
| | | Harm Duration Category | | | |

| **Table A.5.4: Identified Receptor Summary** | | | | |
|---|---|---|---|---|
| **CDOIF Receptor Category** | **Receptor** | **Severity** | **Duration / Recovery Criteria** | **Consequence Level** |
| 1) Designated Land/Water: National | No pathway. | **-** | **-** | - |
| 2) Designated Land/Water: International | No pathway. | **-** | **-** | - |
| 3) Other Designated Land | No pathway. | **-** | **-** | - |
| 4) Scarce Habitat | No pathway. | **-** | **-** | - |
| 5) Widespread Habitat: Non-designated Land | **R1** – agricultural land adjacent to T1. | **Significant (1):** Impact below that of Severity Level 2. | **Short Term (1):** <1 year. | Sub-MATTE |
| 6) Widespread Habitat: Non-designated Water | No pathway. | **-** | **-** | - |
| 7) Source of Public and Private Drinking Water (Groundwater or Surface Water) | No receptor. | **-** | **-** | - |
| 8) Groundwater Body (non-public drinking water) | **R2:** on-site sand and gravel bands in the till– Secondary Aquifer**.** | **Significant (1):** Impact below that of Severity Level 2. | **Short Term (1):** <1 year. | Sub-MATTE |
| | **R3:** Sidmouth Mudstone Formation. | **Significant (1):** Impact below that of Severity Level 2. | **Short Term (1):** <1 year. | Sub-MATTE |
| 9) Other groundwater | No receptor. | **-** | **-** | - |
| 10) Soil and Sediment | No receptor. | **-** | **-** | - |
| 11) Built Environment | No receptor. | **-** | **-** | - |
| 13) Particular Species | No pathway to designated sites. | - | - | - |
| 14) Marine | No receptor. | **-** | **-** | **-** |

| **Table A.5.4: Identified Receptor Summary** | | | | |
|---|---|---|---|---|
| 15) Fresh and Estuarine Habitats | **R4** – The Peover Eye stream is a receptor. | **Significant (1):** Impact below that of Severity Level 2. | **Short Term (1):** <1 year. | Sub-MATTE |
| | **R5:** The Crow Brook is a receptor. | **Significant (1):** Impact below that of Severity Level 2. | **Short Term (1):** <1 year. | Sub-MATTE |