

## ENVIRONMENTAL SETTING AND SITE DESIGN

### TABLE OF CONTENTS

<b>1.0</b>	<b>INTRODUCTION .....</b>	
1.1	Report Context .....	
1.2	Installation Details .....	
<b>2.0</b>	<b>SOURCE TERM CHARACTERISATION .....</b>	
2.1	The Development of the Installation .....	
	2.1.1 Historical Development .....	
	2.1.2 Proposed Development .....	
2.2	Installation Engineering .....	
	2.2.1 Groundwater Management .....	
	2.2.2 Basal Lining System .....	
	2.2.3 Side Slope Lining System .....	
	2.2.4 Capping System .....	
	2.2.5 Restoration and Aftercare .....	
2.3	Leachate Management and Monitoring Infrastructure .....	
	2.3.1 Leachate Monitoring .....	
2.4	Landfill Gas Management and Monitoring Infrastructure .....	
	2.4.1 Landfill Gas Generation .....	
	2.4.2 Landfill Gas Management .....	
	2.4.3 Landfill Gas Monitoring Infrastructure .....	
2.5	Surface Water Management System .....	
2.6	Groundwater Management and Monitoring .....	
	2.6.1 Groundwater Level and Quality Monitoring .....	
2.7	Post Closure Controls .....	
<b>3.0</b>	<b>PATHWAY AND RECEPTOR TERM CHARACTERISATION .....</b>	
3.1	Climate .....	
3.2	Geology .....	
3.3	Man-made Subsurface Pathways .....	
3.4	Hydrology .....	
3.5	Hydrogeology	
	3.5.1 Aquifer Characteristics	
	3.5.2 Groundwater flow	
	3.5.3 Groundwater quality .....	
3.6	Off-site Landfill Gas Monitoring .....	
3.7	Receptors and Compliance Points .....	

**4.0 SITE REPORT**

4.1 Introduction and Background Information .....

4.2 Objectives of this Assessment .....

4.3 Site Investigation (Data Collection) Details .....

4.4 Summary of Site Investigation and Analysis Findings.....

4.5 Data Interpretation .....

4.6 Conclusions.....

**TABLES**

Table ESSD1	Surrounding land uses
Table ESSD2	Residential Properties within 1km of the EP Boundary
Table ESSD3	Identified Receptors
Table ESSD4	NRW/EA Landfill Location
Table ESSD5	The nature and location of gas monitoring points.
Table ESSD6	Monitoring frequencies for Landfill Gas
Table ESSD7	Surface Water Monitoring
Table ESSD8	Groundwater Monitoring Borehole Locations
Table ESSD9	Groundwater Monitoring Parameters
Table ESSD10	Summary of metal concentrations in groundwater 2017-2018
Table ESSD11	Compliance Limits for Groundwater

## DRAWINGS

The site's conceptual model, environmental setting and installation design are presented as drawings. The drawings, maps or plans presented below have been used to minimise the total number of separate drawings produced to satisfy this requirement.

Dwg No	ESSD1	Scale	50,000	Title	Location
	Detail	Site location in relation to surrounding features			
Dwg No	ESSD2	Scale	10,000	Title	Environmental Site Setting
	Detail	Installation boundary			
		Residential areas			
		Schools			
		Recreational areas			
		Waterways			
		Water bodies			
		Agricultural areas			
		Urban sites			
		Flood risk map overlay			
		Roads, railways			
		Infrastructure (tanks, hard surfacing, quarantine areas)			
		Topography 500m outside site			
Dwg No	ESSD3	Scale	25000	Title	Cultural and Natural Heritage
	Detail	Natural heritage SSSIs, AONBs, National Parks cSACs, cSPAs, Ramsar sites Ancient Monuments			
Dwg No	ESSD4	Scale	2500	Title	Site Layout and Waste Deposition
	Detail	Site Infra Structure			
		Non Hazardous Waste Treatment			
Dwg No	ESSD5	Scale	2500	Title	Restoration
	Detail	Landscape planting proposals			
		Final Contours			

<b>Dwg No</b>	<b>ESSD6</b>	<b>Scale</b>	2500	<b>Title</b>	Site Phasing
Detail		Phases 1 to 8			
<b>Dwg No</b>	<b>ESSD7</b>	<b>Scale</b>	2500	<b>Title</b>	Landfill Gas Management
Detail		In waste monitoring points			
		Perimeter/external monitoring points			

<b>Dwg No</b>	<b>ESSD8</b>	<b>Scale</b>	50000	<b>Title</b>	Regional Geology
Detail		Regional geology (taken from BGS Geological Map)			
		Any appropriate regional cross sections			

<b>Dwg No</b>	<b>ESSD9</b>	<b>Scale</b>	12500	<b>Title</b>	Regional Hydrogeology
Detail		Aquifer classification			
		SPZs			
		Licensed and private abstractions from ground and surface water			
		Regional groundwater contours (for each ground water body)			
		Groundwater vulnerability			
		Off-site groundwater monitoring points (e.g. relevant EA Observation Wells etc)			

<b>Dwg No</b>	<b>ESSD10</b>	<b>Scale</b>	2500	<b>Title</b>	Local Hydrogeology and Hydrology
Detail		Groundwater monitoring points (constructional logs within an Appendix ESSD 7)			
		Groundwater contours			

<b>Dwg No</b>	<b>ESSD11</b>	<b>Scale</b>	2500	<b>Title</b>	Geological and Hydrogeological Cross Sections
Detail		Groundwater levels			
		Groundwater flow to discharge points			
		Inter-relationship between; site (base and sides), leachate levels, groundwater levels and relevant surface water features			

<b>Dwg No</b>	<b>ESSD12</b>	<b>Scale</b>	2500	<b>Title</b>	Source, Pathways, Receptors
		Met station location (if on site)			
		Receptors			
		Surface water Groundwater Amenity			
		Pathways			
		Air- include wind rose Surface water and surface water monitoring points Groundwater Drains- pipes etc Migration through surrounding strata			

**APPENDICES**

Appendix ESSD1	Historic Maps
Appendix ESSD2	Compaction Trial Report
Appendix ESSD3	Construction Quality Assurance Plan
Appendix ESSD4	Rainfall Data
Appendix ESSD5	Laboratory Certificates for tests carried out on the attenuative properties of the soils, tortuosity and sorption isotherms
Appendix ESSD6	BGS Aquifer Property Data
Appendix ESSD7	Groundwater Levels
Appendix ESSD8	Drill logs for Groundwater/Landfill Gas Monitoring Boreholes
Appendix ESSD9	Falling Head Tests and Dewatering Calculations
Appendix ESSD10	Groundwater Quality Data
Appendix ESSD11	Supporting data relating to the off-site monitoring of landfill gas
Appendix ESSD12	Envirocheck Soil Quality Data

## 1.0 INTRODUCTION

### 1.1 Report Context

White Rock Geo Environmental Limited were instructed by Mold Investments Limited (MIL), the Operator, to prepare an application for an Environmental Permit for Parry's Quarry Inert Landfill and Waste Transfer Station (WTS) in Mold, Flintshire under the Environmental Permitting (EP) (England and Wales) Regulations 2016.

This report provides a summary to the geological and hydrogeological setting of the site, the wider environmental setting and considers the operational impacts and installation design by inert landfill and the assessment demonstrates compliance the Environmental Permitting (England and Wales) Regulations 2016. Additional assessments include a Site Stability Assessment, Hydrogeological Risk Assessment, Landfill Gas Risk Assessment, and Amenity and Nuisance Assessment.

The site is situated within the existing Parry's Quarry in Alltami, Flintshire and bounded by the A494 to the south, A55 to the north and Pinfold Road to the west. The National Grid Reference (NGR) for the entrance to the site is SJ 27478 66278, presented at Figure 1 below and is detailed at Drawing ESSD 1.

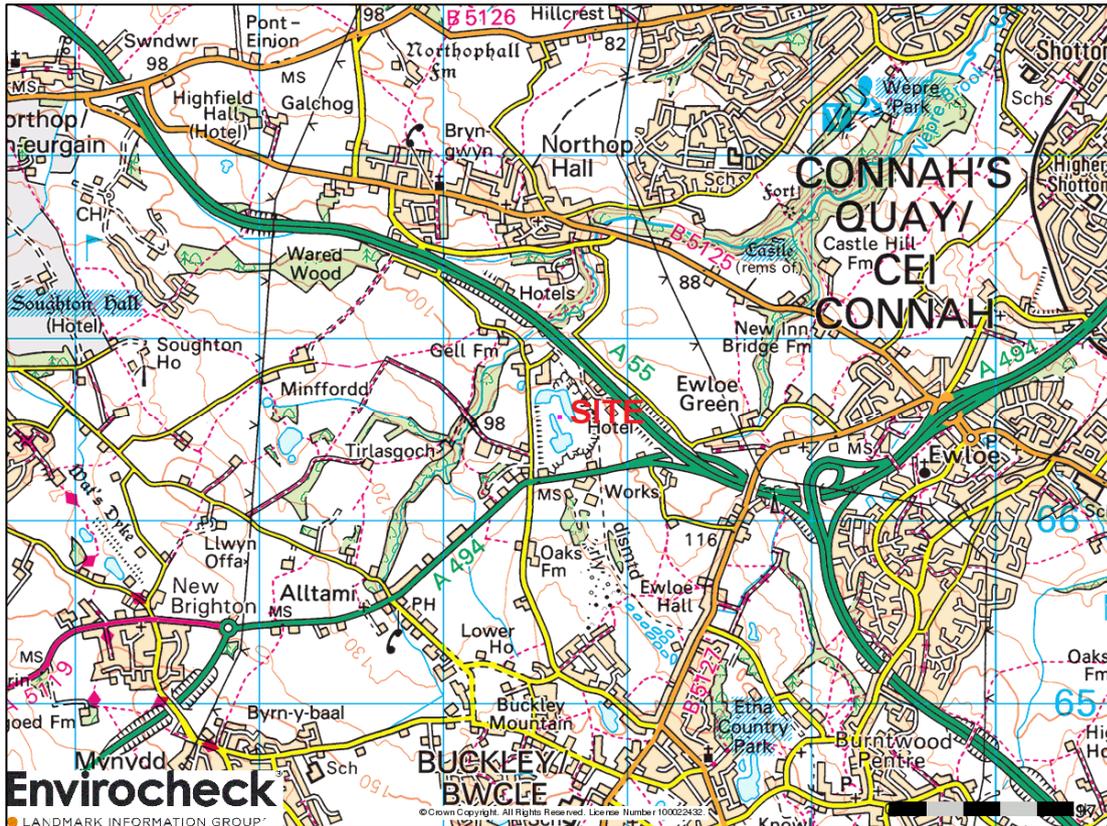
Access to the site is directly off Pinfold Lane through lockable steel security gates.

The site is currently operated as a brick clay quarry which covers an area of approximately 17 hectares. An area of the wider site holds an EP (Ref: EPR/TB3590HJ) for the transfer and reprocessing of inert waste. This EP application seeks to consolidate this activity within the overall landfill EP for the site.

The overall design is to now provide and engineering development platform using on site clays and crushed sandstone and the shortfall to be made up of imported inert waste which will then have a suitable engineering clean cover break over it which will comply with NHBC development protocols and requirements.

The site will be operated in two phases one based on hydraulic containment the second phase operated above the water table using an unsaturated zone to attenuate any pollution release beneath the geological barrier.

**Figure 1: Site Location**



## 1.2 Installation Details

The site is currently operated as a brick clay quarry which covers an area of approximately 17 hectares. An area of the wider site holds an EP (Ref: EPR/TB3590HJ) for the transfer and reprocessing of inert waste. This EP application seeks to consolidate this activity within the overall landfill EP for the site.

The proposed landfill operations will comprise the restoration of the quarry void space inert waste within fully engineered contained cells. The landfill will be below ground with the base of the cell and engineered containment being initially below the water table in Phase 1 and then raised above groundwater levels and Phase 2 will be operated above the water table.

The local topography is undulating and formed from a series of ridges and valleys. The site is situated at an elevation of circa 105mAOD on the site of the valley with the land to the south west rising up towards New Brighton at circa 145mAOD and falling away towards the north east towards the Wepre Brook, which is at an elevation of approximately 55mAOD. The wider topography is generally falling towards the River Dee Estuary which is at an elevation of circa 5mAOD approximately 4.5km to the north of site.

The permit application boundary is covered under the planning permission 04268 and the appeal APP/A6836/A/08/2068136.

**Figure 2: Aerial view of site**



The entire quarry perimeter is fenced with three strand barbed post and wire fence. The outer limit of the quarry has a hedgerow and tree planting. The site security fencing is considered adequate under the provisions of the Mines and Quarries Regulations 1999 in the location. The site has a substantial access to the site fitted with lockable gates. The site is within the entire ownership of Mold Investments Limited.

The gates at the site entrance are locked outside operating hours, and the site has offices and a wheelwash, inert treatment facility comprising a washing plant, mobile crusher and mobile screen.

All of the receptors have been identified on Drawing ESSD 2 and surrounding land uses are set out in Table ESSD1.

The site has an operational void capacity of 762,416m<sup>3</sup>.

**Table ESSD 1: Surrounding land uses.**

Boundary	Description
North	<p>Ewloe Wood House and commercial/industrial properties are located adjacent to the northern boundary beyond which lies the A55 and a service station (eastbound on the A55) including a petrol station, hotel and restaurant. Also, to the north of the site beyond the immediate surrounding is the residential conurbation of Northop Hall and the Northop Hall Country House Hotel. The outskirts of Northop Hall are located approximately 600m to the north.</p>
East	<p>To the east of the site is the westbound A55 Service Station, including an unnamed residential property, beyond which lies the A55 and agricultural land. The small town of Ewloe Green and the larger conurbation of Ewloe are located 550m and 1km respectively to the east.</p>
South	<p>Adjacent to the south of the site is an area of small woodland beyond which lies the A494. Beyond the A494 is a large building supply merchant and other commercial/industrial premises. The further surrounding land is predominately agricultural land with scattered residential buildings (farm houses) including Parrings Cottage and the Pottery Cottages.</p> <p>A further large commercial / industrial estate is located within 1km to the south.</p> <p>The south eastern edge of the site encompasses part of multi designated Buckley Claypits and Commons Site of Special Scientific Interest (SSSI) / Deeside and Buckley Newt Site Special Area of Conservation (SAC).</p>
West	<p>Pinfold Lane is located immediately to the west. A disused quarry is located off Pinfold Lane, beyond which lies predominately agricultural land and scattered residential/agricultural buildings, including Pinfold Cottage and Alltami House. The town of Alltami is located approximately 640m to the southwest.</p> <p>Also adjacent to the west and southwest of the site is numerous commercial/industrial premises.</p>

The closest residential properties and farms are detailed in Table ESSD 2 below and are indicated on Drawing ESSD 2.

**Table ESSD 2: Residential Properties within 1km of the EP Boundary**

Property Reference or Name	Direction from site	Approximate Distance from Boundary
Parrys Cottages	SE	20m
Pottery Cottages	SE	200m
Properties off Smithy Lane	SE	400m
Properties off A494	SE	550m
Unnamed property accessed via the service station	E	55m
The Box	N	80m
Ewloe House	N	120m
Pinfold House	NW	130m
Old Farm Cottages	N	360m
Penfold Cottage	NW	400m
Gell Farm	N	300m
Oak Farm	S	350m
Ewloe Green Farm	E	750m
Brook Park Farm	N	500m

### Ecology

The following information has been assessed in order to determine the ecological site setting:

- MAGIC Mapping Website<sup>1</sup>;
- NRW Designated Sites Tool<sup>2</sup>; and
- Woodland Trust's Ancient Tree Inventory<sup>3</sup>.

### European/International Sites

Searches on the MAGIC website confirm that there are no Special Protection Areas (SPA) or RAMSAR sites within 2km of the site's proposed EP boundary.

### Multi-Designated Site

An area of land located adjacent to the southern boundary of the site is designated as both a SAC and a SSSI. The SAC is known as the Deeside and

Buckley Newt Site and the SSSI is known as the Buckley Claypits and Common. The reasons for these designations are detailed below:

- Deeside and Buckley Newt SAC<sup>4</sup> supports a population of over 1000 adult great crested newts in 100 breeding ponds, a protected species under the Wildlife and Countryside Act 1981 and EC Habitats Directive 1994. The mixed mosaic of neutral and acid grasslands, lowland dry and wet heath and mature broad-leaved woodland provide the ideal habitat for various life stages of amphibians and other priority species. The SAC is primarily acidic oak woodland, dominated by Oak *Quercus spp.*, Ash *Fraxinus excelsior* and Sycamore *Acer pseudoplatanus*.
- Buckley Claypits and Commons SSSI has been designated for its; assemblage of amphibian species (newts), Great Crested Newt population; and its mixed mosaic of habitats including marshy, acidic and neutral grassland with a variety of wet heath, tall herb and scrub which provides an ideal range of habitats for amphibians to forage, shelter and overwinter at all life stages.

---

1. Multi-Agency Information for the Countryside – Available at: <http://www.magic.gov.uk>, accessed January 2018

2. NRW Designated Sites Tool, Available at <https://naturalresources.wales/guidance-and-advice/environmental-topics/wildlife-and-biodiversity/find-protected-areas-of-land-and-seas/designated-sites/?lang=en>, Accessed in June 2017

3 Woodland Trust Ancient Tree Inventory - <http://www.ancient-tree-hunt.org.uk/discoveries/interactivemap/>, Accessed in June 2017

4 This area is separate from the main quarry working area by a metal boundary fence designed to prevent newt migration into the site.

### **Sites of Special Scientific Interest**

There are a further two SSSI's within 2km of the site. The Connahs Quay Ponds and Woodlands SSSI is situated north east of the site at an approximate distance of 760m, whilst Maes y Grug SSSI is located 950m to the west.

- Connahs Quay Ponds and Woodland SSSI has been designated for its assemblage of amphibian species (newts), Great Crested Newt population and semi-natural broadleaved woodland.
- Maes y Grug SSSI has been designated for its populations of Great Crested Newts and mosaic of habitats including broadleaved woodland, mixed grassland, scrub and a range of hedgerows and waterbodies.

### **Other Ecological Receptors**

Searches on the MAGIC website have not identified any of the following ecological receptors within 2km of the permit boundary:

- Area of Outstanding Natural beauty (AONB);
- Registered Parks and Gardens;
- Local Nature Reserves;
- National Nature Reserves;
- Ancient Woodland;
- Biosphere Reserves; and
- National Parks.

### **Cultural and Heritage**

Information provided by NRW indicates numerous Listed Buildings and Scheduled Monuments within 2km of the site. The closest of each to the site is shown below:

- Listed Building: Greenbank Farm Farmhouse, 1.2km west; and
- Scheduled Monument: Site of Pinfold Lane Pottery, 740m south.

### **Identified Receptors**

Tables ESSD2 and ESSD3 and Drawings ESSD2 and ESSD3 identify the receptors which are considered to be potentially sensitive and could reasonably be affected by activities at the site.

**Table ESSD3: Identified Receptors**

Receptor Name	Receptor Type	Direction from Site	Approximate Distance from Site Boundary
<b>Environmental Site Setting within 1km of the EP boundary as shown on Drawing ESSD3</b>			
A494	Public Transport Network	South	Adjacent
Pinfold Lane	Public Transport Network	West	Adjacent
Commercial properties	Commercial	North	Adjacent
Woodland	Woodland	South	Adjacent
A55 Northop Services including Costa Coffee, UK Diner,	Service station	East	20
Disused Quarry	Industrial	West	20
Commercial/Industrial area including AH Plant Hire and Fire Doors	Commercial/Industrial	West	20
Flintshire County Council Offices and Depot	Council	West	20
A55 North Wales Expressway	Road Network	North, East	40
Thornccliffe Building Supplies	Commercial	South	75
Alltami Brook	Surface Water	Southwest, West, Northwest	250
Oaks Farm	Farm/Agricultural	South	260
Northop Services	Service Station	North	450
Werpe Brook	Surface Water	North	700
Northop Hall Bowling Club	Recreational	North	850

<b>Cultural and Natural Heritage identified receptors located within 2km of the EP boundary as shown on Drawing ESSD3</b>			
Deeside and Buckley Newt SAC	SAC	South	Adjacent
Buckley Claypits and Commons SSSI	SSSI	South	Adjacent
Site of Pinfold Lane Pottery	Scheduled Monument	South	740
Connahs Quay Ponds and Woodlands SSSI	SSSI	Northeast	760
Maes y Grug SSSI	SSSI	West	950
Greenbank Farm Farmhouse	Listed Building	West	1200

### **Landfill Classification**

The landfill is for acceptance of inert waste

### **Environmental Permit Boundary**

The EP Boundary and installation site layout is illustrated on Drawing ESSD2.

### **Site Security**

In order to prevent unauthorised access, a number of site security measures are already in place at the site and complement the operation of a landfill including:

- Fencing along the site boundary;
- Lighting;
- A CCTV system; and
- A gate located at the entrance to the site, which will be locked when the site is closed.

The site will be inspected at the commencement of each working day. Any defects or damage which compromises the integrity of the enclosure will be made secure by temporary repair by the end of the working day. Permanent repairs will be affected as soon as practicable.

All inspections, any defects, damage or repairs will be recorded in the site diary.

### **Compliance with NRW/EA Position of Location of Landfills**

NRW have adopted the same policy, in respect to the protection of groundwater at landfills, as the Environment Agency (EA) which is detailed in their updated 2018 guidance<sup>5</sup>. This guidance document details situations

where NRW would object to an application for a new landfill site if there were specific risks posed to groundwater due to the location. This position is detailed below in Table 1-5 and taken from Section E of the guidance.

**Table ESSD 4: NRW/EA Landfill Location**

E1 – Landfill Location
<p>The EA will normally object to any proposed landfill site in groundwater SPZ1.</p> <p>For all other proposed landfill site locations, a risk assessment must be conducted based on the nature and quantity of the wastes and the natural setting and properties of the location.</p>
<p>Where the risk assessment demonstrates that active long-term site management is essential to prevent long- term groundwater pollution, the EA will object to sites:</p> <p>Below the water table in any strata where the groundwater provides an important contribution to river flow, or other sensitive receptors.</p> <p>Within SPZ2 or 3.</p>

---

<sup>5</sup> The EA's approach to groundwater protection, February 2018, Version 1.2

Parry's Quarry Landfill is not located with a Source Protection Zone (SPZ), but is below the water table but is for inert waste and is not or within/on a principal aquifer.

The HRA prepared in support of this EP application, concluded that the development of the site will not pose a serious environmental risk. Therefore, it has been assumed that this development complies with NRW's Landfill Position Statement.

## 2.0 SOURCE TERM CHARACTERISATION

### 2.1 The Development of the Installation

The following section details the history of the area of land, and the proposed development.

#### 2.1.1 *Historical Development*

##### **1874 to 1964**

Historical maps indicate that the southern part of the site was being quarried prior to 1874 and is identified as a brick works with a clay pit, kilns and a railway track shown on the 1874 map. There is also a colliery (later identified as Elm Collieries) present in the south western corner which is now approximately the location of the current site entrance.

Between 1874 and 1912 historic maps show the development and expansion of the brickworks and colliery with a new brickworks identified as Castle Brickworks being developed in the northern half of the site. The quarry development identified above is in the western half of the current site as is visible in historic aerial photographs (Google Earth) from 1945 with the eastern half remaining as agricultural fields.

Historic Maps for the wider area, from 1900 onwards, show a number of brickworks having been developed to the south of the site with a small pit or pond shown immediately to the west of Pinfold Lane near the Castle Brickworks. The historic maps are presented at Appendix ESSD 1.

**Figure 3: Quarrying in 1945**



### 1964 to 1982

The original brickworks to the south are identified as disused on the 1964 map and the colliery is no longer shown but disused shafts are identified. By 1970 the former Colliery is identified as a works with industrial buildings having been erected. The Castle Brickworks to the north appears to still be in use in 1964 but over the years the scale of the buildings diminish and eventually it is shown as a workshop which is approximately half the size of the original buildings. The railway is still present on the 1963 map but is shown as dismantled on the 1970 map.

The former brick pits remain shown as disused throughout this period and the brickworks buildings to the south remain until the 1982 map when they are shown as having been removed.

### 1982 to 2004

The site remains identified as a disused quarry and on the 1988 map the A55 has been developed to the north east of the site. A hotel and filling station are shown on the 1991 Map in the location that is now the A55 services. The situation remains the same on the 2004 map with the exception of Ewloe Barns Industrial Estate being identified to the south.

### 2004 to Present

The situation as described in 2004 above remains the same with the exception that the small pit identified to the west of Pinfold Lane has now developed into a quarry which is identified as disused on 2015 Ordnance Survey data.

**Figure 4: Quarrying in 2006**



**Figure 5: Quarrying in 2011**



**Figure 6: Quarrying in 2020**



Remaining Etruria Marl deposits are clearly shown on the north, designated as Phase 2

### **2.1.2 Proposed Development**

This includes details relating to the following.

- The proposed waste types for the landfill area be inert non-reactive wastes which include Tax Qualifying Exempt Materials.
- A non-hazardous waste treatment facility will be operated to process construction and demolition wastes, other non-hazardous soils and to recovery secondary aggregates, which will also involve the use of crushers and screens and use of a barrel wash plant for road sweepings. The site will have a washing plant to process all excavated minerals. The detailed layout is presented at Drawing ESSD2.
- A skip will be located on site for load rejection.
- The site will have 2 operational phases to complete the landfill final landform. The time taken for all mineral extraction, lining, infilling and produce a development platform within 3 years.
- The site has valid planning permission until 2042.
- The final landform and end use is to create a development platform for commercial residential or commercial use.
- The site permit boundary requires an engineered geological barrier.
- Quarrying of clay and sandstone will continue across the site in tandem with inert landfill to complete the restoration of workings in a phased manner.
- The site is not within a Source Protection Zone and the site will be designed and operated on the principles of hydraulic containment.
- The proposed final landform is to form a surface with falls of approximately 1:20 which are suitable for residential and commercial development.

## **2.2 Installation Engineering**

### **2.2.1 Groundwater Management System**

Groundwater management is required during the operation of the site to ensure that groundwater is collected and directed to be removed during the infilling of Phase 1 and once above the rebound water table to stop pumping.

### **2.2.2 Basal Lining System**

It is proposed to re-work the exposed Etruria Marl to form the geological barrier by rolling. The returned cores from the compaction trial and previous lining have shown less than 5% air voids.

The compaction trial of the Etruria Marl is presented at Appendix ESSD 2.

The Construction Quality Assurance Plan is presented at Appendix ESSD 3 detailing the method of construction and the standards and testing frequency.

The cells construction shall consist of a basal and side wall seal constructed above the prepared formation level from suitable low permeability material placed and compacted in layers. The thickness of mineral lining shall be a minimum of 1.0m.

The lining material shall be free of unsuitable material and a summary of the design specification is required to meet the following requirements:

- i) Permeability  $\leq 1 \times 10^{-7}$  m/s BS: 1377: 1990: Part 6: Method 6
- ii) Plasticity Index  $< 65\%$  BS: 1377: 1990: Part 2: Methods 4.3 and 5.3
- iii) Plasticity Index  $> 10\%$  BS: 1377: 1990: Part 2: Methods 4.3 and 5.3
- iv) Clay Content (0.002mm)  $> 8\%$  BS: 1377: 1990: Part 2
- v) Percentage Fines  $> 20\%$  BS: 1377: 1990: Part 2
- vi) Maximum particle size  $> 187\text{mm}^*$  BS: 1377: 1990: Part 2
- vii) Percentage Gravel( $> 5\text{mm}$ )  $\geq 30\%$  BS: 1377: 1990: Part 2
- viii) Liquid Limit  $< 90\%$  BS: 1377: 1990: Part 2: Methods 4.3 and 5.3
- ix) Shear Strength  $> 50\text{kN/m}^2$  BS: 1377: 1990: Part 9

### **2.2.3 Side Slope Lining System**

It is proposed to re-work the Etruria Marl to form the geological barrier side wall seal which will be placed in accordance with the Construction Quality Assurance Plan placed in 270mm-300mm layers and compacted as per the Highways Specification. The returned cores have shown less than 5% air voids.

The Construction Quality Assurance Plan is presented at Appendix ESSD 3 detailing the method of construction and the standards and testing frequency.

The cells construction shall consist of a side wall seal constructed above the prepared formation level from suitable low permeability material placed and compacted in layers. The thickness of mineral lining shall be a minimum of 1.0m.

The lining material shall be free of unsuitable material and a summary of the design specification is required to meet the following requirements:

- i) Permeability  $\leq 1 \times 10^{-7}$  m/s BS: 1377: 1990: Part 6: Method 6
- ii) Plasticity Index  $< 65\%$  BS: 1377: 1990: Part 2: Methods 4.3 and 5.3
- iii) Plasticity Index  $> 10\%$  BS: 1377: 1990: Part 2: Methods 4.3 and 5.3
- iv) Clay Content (0.002mm)  $> 8\%$  BS: 1377: 1990: Part 2
- v) Percentage Fines  $> 20\%$  BS: 1377: 1990: Part 2
- vi) Maximum particle size  $> 187\text{mm}^*$  BS: 1377: 1990: Part 2
- vii) Percentage Gravel( $> 5\text{mm}$ )  $\geq 30\%$  BS: 1377: 1990: Part 2

viii) Liquid Limit <90% BS: 1377: 1990: Part 2: Methods 4.3 and 5.3

ix) Shear Strength >50kN/m<sup>2</sup> BS: 1377: 1990: Part 9

The side slope stability has been assessed as part of the Stability Risk Assessment for the permit application presented at Appendix C supporting the application.

### **2.2.3 Leachate Drainage System**

A leachate drainage system is not required at an inert landfill site.

### **2.2.4 Capping System**

An engineered capping system is not required at an inert landfill site.

### **2.2.5 Restoration and Aftercare**

The current final restoration of the site is to development platform which is suitable for residential or commercial development, see Drawing ESSD 5.

## **2.3 Leachate Management and Monitoring Infrastructure**

### **2.3.1 Leachate Generation**

Leachate monitoring is not a requirement at inert landfill sites. The site is designed as a fully hydraulically contained landfill within the saturated zone.

### **2.3.2 Leachate Management**

The Hydrogeological Risk Assessment has demonstrated that the site is unlikely to generate significant leachate that will have no detrimental impact on groundwater quality.

## **2.4 Landfill Gas Management and Monitoring Infrastructure**

### **2.4.1 Landfill Gas Generation**

The likelihood of gas production based on the Landfill Gas Risk Assessment is very low and it is recommended that internal gas monitoring points are constructed by retro drilling once each phase is completed.

There is no requirement for gas extraction due to the low organic fraction nature of the inert waste and therefore there will be little gas production and not enough gas for gas engines or flaring.

### 2.4.2 Landfill Gas Management

There is no proposed collection and extraction of landfill gas due to the inert nature of the waste and based on the Landfill Gas Risk Assessment.

There is no requirement for treatment and disposal of the landfill gas including the utilisation plant.

No gas will be flared or utilised on site. No landfill gas will emitted via sidewalls or the cap.

### 2.4.3 Landfill Gas Monitoring Infrastructure

Gas monitoring boreholes have been constructed around the outside of the landfill site and the locations are shown on Drawing ESSD 7. Gas monitoring will be carried out on a monthly basis at each of the external gas monitoring points using an infra-red gas analyser.

External gas monitoring is from the fourteen gas monitoring boreholes.

Internal gas monitoring points are presented on Drawing ESSD 7 and are based on 2 monitoring points per Phase due to the low risk proximity of the site in a rural surrounding.

Sampling will be undertaken by staff appropriately trained in environmental monitoring procedures, and who are familiar with the equipment and its limitations. The Company warrants that the personnel engaged in monitoring activities are trained to undertake the task. These will comprise the companies own technical personnel, the site manager or nominated deputy, following appropriate training by technical personnel. All monitoring staff undergo a period of job training and in addition external courses are used to supplement internal training. Results will be validated by the sampling personnel detailed above.

Gas monitoring boreholes and gas monitoring points are summarised in Table ESSD 4 below:

**Table ESSD 5: The nature and location of perimeter gas monitoring points**

<b>Phase 1</b>	<b>GMP1.1-1.9</b>	Monitoring Point in waste	Design detail on ESSD 7
<b>Phase 2</b>	<b>MP2.1-2.4</b>	Monitoring Point in waste	Design detail on ESSD 7
<b>Perimeter</b>	<b>BH G1-G14</b>	Monitoring Borehole outside waste. Combined gas and groundwater	Design detail on ESSD 7

#### 2.4.4 Gas Monitoring

The gas monitoring frequency and determined range has been developed based on the landfill gas risk assessment and is summarised below in Table ESSD 6.

**Table ESSD 6: Monitoring frequencies for landfill gas**

Determinands	Monitoring Frequencies	Units and Accuracies
Methane (CH <sub>4</sub> )	Quarterly	%v/v ±0.5%
Carbon Dioxide (CO <sub>2</sub> )	Quarterly	%v/v ±0.5%
Carbon Monoxide (CH <sub>4</sub> )	Quarterly	-
Oxygen (O <sub>2</sub> )	Quarterly	%v/v ±0.5%
Atmospheric Pressure	Quarterly	±1 mb
Differential pressure	Quarterly	±0.1 mb
Meteorological Data	Quarterly	-

#### 2.4.5 Making and submission of records

Records will be kept on site of determinands analysed, date of sampling, sampler, results, units.

A copy of the results of sampling and analysis will be forwarded to the Agency within 1 month of being carried out.

### 2.5 Surface Water Management System

During the operational phase, clean surface water which accumulates in the base of the quarry will be pumped to the surface water discharge point located along the north west boundary at NGR SJ 2746 6669. The discharge consent is regulated by NRW (EPR/CG0392101). The location of this discharge point, to Alltami Brook, is illustrated on Drawing ESSD10.

Surface water monitoring is to be carried out from sample points as indicated on Drawing ESSD10. SW1 is upstream and SW2 is down stream and is to be monitored until completion of the infill. Surface water monitoring is set out in Table ESSD6.

**Table ESSD6: Surface water monitoring**

Parameter	Landfilling Phase SW1, SW2		Closure/ Aftercare Phase SW2 only
	Quarterly	Annually	Six Monthly
pH	•	•	•
Visual Oil and Grease	•	•	
Suspended solids	•	•	
Electrical conductivity 20°C	•	•	•
Ammoniacal nitrogen	•	•	•

Parameter	Landfilling Phase SW1, SW2		Closure/ Aftercare Phase SW2 only
	Quarterly	Annually	Six Monthly
Chloride	•	•	•
Sulphate	•	•	•
Alkalinity	•	•	•
COD	•	•	•
BOD	•	•	•
TOC	•	•	•
Dissolved Oxygen	•	•	•

## 2.6 Groundwater Management and Monitoring

It is essential to monitor groundwater adjacent to the site for quality to assess the integrity of the performance of the site and to ensure that there is no impact on groundwater.

### 2.6.1 Groundwater Level and Quality Monitoring

Boreholes are located both up and down hydraulic gradient. Borehole locations are presented on Drawing ESSD 10. The nature and location of the groundwater monitoring boreholes is set out on Table ESSD 7.

**Table ESSD 7: Groundwater Monitoring Borehole Locations**

<b>Perimeter</b>	<b>BH C</b>	Perimeter Up Hydraulic Gradient	Level and Quality
<b>Perimeter</b>	<b>BH C1</b>	Perimeter Up Hydraulic Gradient	Level and Quality
<b>Perimeter</b>	<b>BH G</b>	Perimeter Down Hydraulic Gradient	Level and Quality
<b>Perimeter</b>	<b>BH H</b>	Perimeter Down Hydraulic Gradient	Level and Quality
<b>Perimeter</b>	<b>BH I</b>	Perimeter Down Hydraulic Gradient	Level and Quality

It is recommended that the compliance limits are reviewed on an annual basis or as appropriate. If, for example, the trigger levels are exceeded on three consecutive times, then this should be highlighted and discussed within any annual review of monitoring data. Such an occurrence may be the result of contaminant breakthrough or a change in the up-gradient groundwater quality.

The groundwater sampling regime is set out in Table ESSD 8 and is based on the Environment Agency Regulatory Position Statement-Landfill monitoring and reporting standards.

**Table ESSD 8: Groundwater Monitoring Parameters**

Parameter	Landfilling Phase		Closure/ Aftercare
	Quarterly	Annually	Annually
Water Level	•	•	•
pH	•	•	•
Electrical conductivity 20°C	•	•	•
Ammoniacal nitrogen	•	•	•
Chloride	•	•	•
Sulphate	•	•	•
Alkalinity	•	•	•
Sodium	•	•	•
Potassium	•	•	•
Calcium	•	•	•
Magnesium	•	•	•
Iron	•	•	•
Arsenic	•	•	•
Cadmium	•	•	•
Copper	•	•	•
Chromium	•	•	•
Lead	•	•	•
Nickel	•	•	•
Zinc	•	•	•
Phenol	•	•	
Napthalene	•	•	
Benzene	•	•	
Hazardous Substance Scan		Annual for first six years only from BHG,H,I	Six Yearly

Sampling will be undertaken by staff appropriately trained in environmental monitoring procedures, and who are familiar with the equipment and its limitations. The Company warrants that the personnel engaged in monitoring activities are trained to undertake the task. These will comprise the companies own technical personnel, the site manager or nominated deputy, following appropriate training by technical personnel. All monitoring staff undergo a period of job training and in addition external courses are used to supplement internal training. Results will be validated by the sampling personnel detailed above.

### **2.6.2 Submission of Data**

All data from the groundwater monitoring will be stored on the in house electronic database. This database will enable reports to be issued detailing trigger breaches and standard quarterly and annual reports plus laboratory reports.

Reports will be provided in a standard PDF format to the Environment Agency.

## 2.7 Post Closure Controls

### Groundwater and Leachate

Completion relating to hydrogeological risks will have been achieved when there is no unacceptable risk of pollution from the landfill, i.e. when the site can comply with the requirements of the Groundwater Regulations without the need for any active site management and during the three year post closure monitoring the results show the groundwater quality remains at or below the trigger levels.

The modelling has assumed 3 years of management.

Groundwater monitoring will continue for the period based on an annual sampling rounds from the eight boreholes and the downstream surface water monitoring point.

### Landfill Gas

Landfill gas utilisation and flaring is not considered necessary at the site long term based on the Landfill Gas Risk Assessment and again only requires monitoring for the three year post closure monitoring.

The nature of the waste should only allow for a nominal amount of settlement and the pre and post settlement levels are set as one and the same. Any low spots that form will be made good with importation of additional soils.

Gas monitoring will be carried out on a monthly basis for at least three years post closure.

### Stability and Settlement

The final surcharged and post-settlement restoration levels are shown in Drawing numbers ES5D 5 which is one and the same due to the inactive nature of the waste. A surcharge to accommodate settlement will therefore not be required.

The remainder of the post closure based on the risk assessments is for monitoring to ensure that the waste mass remains stable and that the leachate head does not increase above the design limit and therefore that no leachate removal is required.

Annual site surveys will be carried out using fixed settlement locations to measure settlement of the site once the site is completed.

### Mining Subsidence

Likelihood of mining related subsidence is not considered an issue and was reviewed as part of the Stability Risk Assessment.

### **Restoration, Aftercare and Completion Phase**

The site will be restored in accordance with the planning permission but is to be left as a development platform suitable for commercial or residential use and with a surface water pond which will be used long term for SUDS drainage from future development and the protected area for the GCN.

#### **Monitoring**

Features to be monitored for the purpose of closure include

Landfill Gas

Settlement Rate-Annual

Stability Observations

Groundwater Level

Groundwater Quality

### 3.0 PATHWAY AND RECEPTOR TERM CHARACTERISATION

#### 3.1 Climate

The site is located to the south of Meteorological Office Rainfall and Evaporation Calculation System (MORECS) square 104. The Meteorological Office has supplied long-term monthly averages for rainfall and hydrologically effective rainfall (HER) for the period 1971 to 2000.

Long-term average rainfall is c. 800mm per year. The highest monthly rainfall occurs in October and reduces to a minimum in May. The HER is 262mm per year. This is defined as the sum of rainfall less actual evapotranspiration, see Appendix ESSD 4.

Meteorological data for the site is available from Hawarden observation station located approximately 7km east- southeast of the site. Five consecutive years of hourly-sequential observation data from this location, covering the period 2012 – 2016, inclusive, have been obtained and presented as a windrose in Figure 1.

Wind roses from the Meteorological Office at Birmingham Airport are shown in Appendix ESSD 4. They indicate winds predominately from the south-west, which are particularly strong in winter.

#### 3.2 Geology

The site is situated within an outcrop of Carboniferous aged Coal Measures strata (predominately comprising mudstones with sub-ordinate sandstones, siltstones and coal beds). The geological succession is complicated by local structural controls; which has created a series of fault bounded blocks in the area and caused the various types of bedrock to locally become juxtaposed against each other.

The geological sequence at the site has previously been described as very complex (TerraConsult<sup>7</sup>, 2015); which is considered to reflect the rapid lateral and vertical changes in lithology due to the depositional nature of the sequence and post-depositional structural controls (i.e. dipping bedding and faulting). Attempts were made by TerraConsult to laterally correlate units observed at the site; evidently this was difficult due to the limitations of the available data (including that boreholes only provide a one-dimensional (vertical) record of the geological succession) and the complicated nature of the geology as outlined above. Nevertheless, based on published geological mapping, the following simplified geological sequence for local area has been identified:

- Etruria Formation<sup>8</sup> – comprising red, purple, brown, ochreous, green, grey and commonly mottled mudstone, with lenticular sandstones and conglomerates. The Etruria Formation includes the 'Buckley Blue' unit (a local and now obsolete name), which comprises a purple, black and grey mudstone, and was principally the clay that was excavated from the quarry

void;

- Pennine Middle Coal Measures Formation – comprising inter-bedded grey mudstone, siltstone, pale grey sandstone and coal seams. The upper part of the Coal Measures includes a sandstone unit referred to as the ‘Hollin Rock’ which immediately underlies the Etruria Formation; and
- Pennie Lower Coal Measures Formation – comprising inter-bedded grey mudstone, siltstone and pale grey sandstone, commonly with mudstones containing marine fossils in the lower part, and more numerous and thicker coal seams in the upper part.

Available geological mapping (British Geological Survey (BGS) (2018), as shown on Drawing ESSD8, and at Figure 7 below indicates that sandstones of the Etruria Formation are present across the eastern two thirds of the Site (and extend to the area immediately to the east); mudstones, sandstones and conglomerates of the Etruria Formation are present across the western third of the Site. The Middle Coal Measures are then present further to the west. This includes the Hollin Rock Member which is identified beyond a north-south faulted boundary (with an apparent 50m downthrow) present along the western boundary of the Site.

The Lower Coal Measures Formation are present c. 50m to the east of the Site beyond another approximately north-south faulted boundary.

Mapping of the superficial geology, as shown on Drawing ESID10, also shows that glacial till is present above bedrock across much of the area surrounding the site. The TerraConsult report shows that it is c. 2m in thickness and comprises a sandy clay with sandstone fragments. Superficial deposits are absent along the route of Alltami Brook where it is closest to the site (i.e. 250m to the northeast). Elsewhere however, alluvium is present along the course of the brook to the south (i.e. up-stream); and alluvium and glacio-fluvial (sand and gravel) deposits are present on both Alltami and Wepre brooks to the north (i.e. down-stream).

The mapping shows that superficial deposits are absent from across much of the site; this is due to the development that has taken place (i.e. initially a brickworks, followed by quarry extraction). Furthermore, the southern quarter of the site; the areas immediately to the north and to the south of the site; and several other areas in the vicinity are identified as artificial ground. Again, this relates to the former uses of these areas.

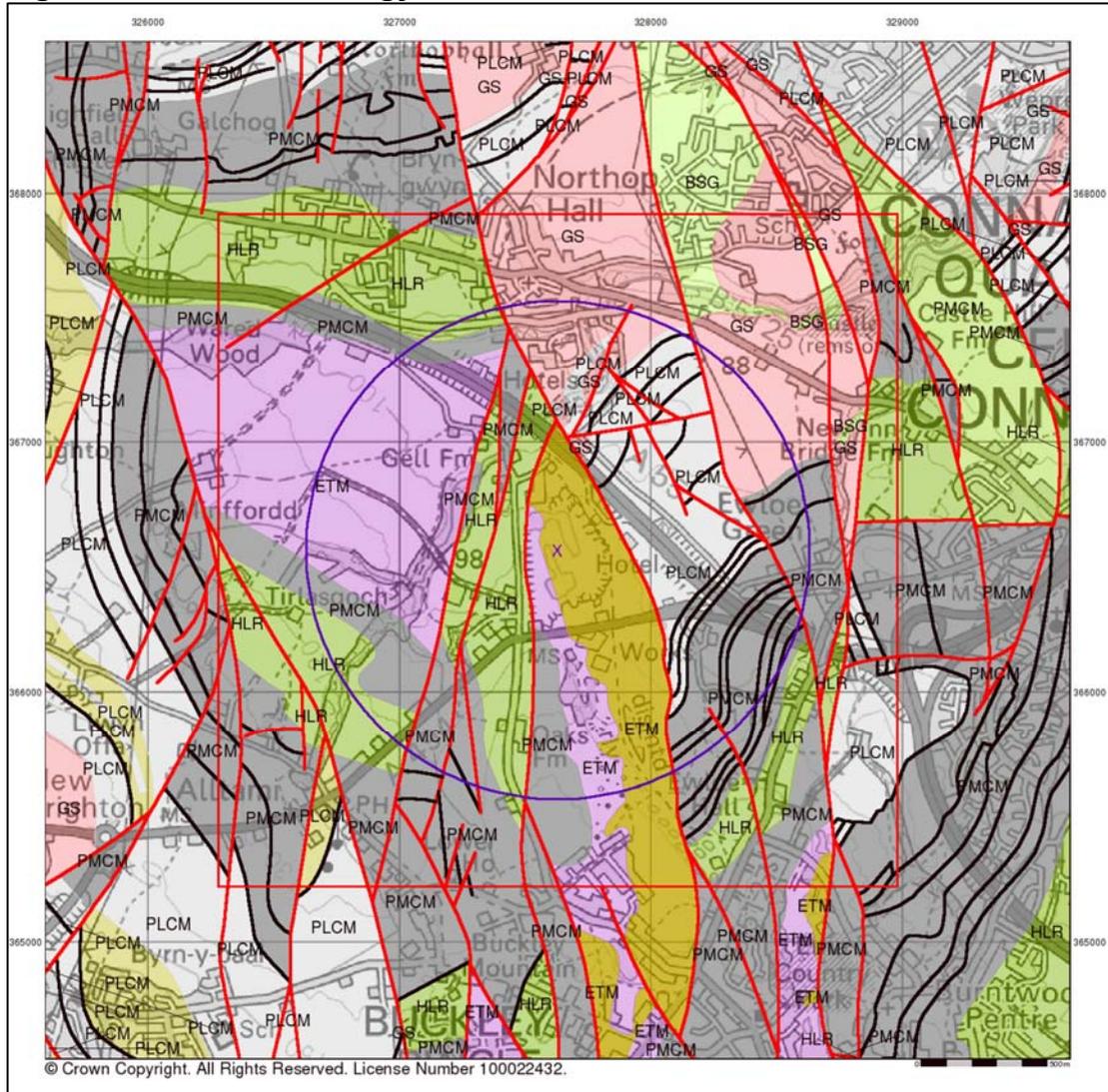
---

<sup>7</sup> Terraconsult, 2015. Parrys Quarry Landfill Site. Hydrogeological Risk Assessment. December 2015. Report: 2434-R05

<sup>8</sup> Note that the Etruria Formation is used here in preference to the term Etruria Marl as was adopted by TerraConsult (2015) since this is the current name for this unit given by the BGS (2018).

The Local bedrock geology is also presented at Figure 7 for reference below. The solid geological map is presented at Drawing ESSD 8.

**Figure 7: Bedrock Geology**



### 3.3 Man-made Subsurface Pathways

The Coal Measures in the local area are known to have been worked historically; and Coal Authority (2018) records indicate that this includes workings associated with the former Elm Colliery which was located immediately to the south-west of the site (on the area now occupied by the FCC depot). Former workings may have become preferential groundwater flow pathways.

Three former shafts are identified in this area; which were worked until the colliery was closed in 1934. However, the shafts and workings are understood to have been between 150m and 31m below ground level. Coal Authority (2018) records indicates that worked seams present beneath the site were all below -63m AOD. Coal Authority records also indicates that the closest dewatering works are at Harwarden (which is located c. 4km to the south-east). The depth

and distances to the seams suggest that they are unlikely to affect groundwater at the site.

### 3.4 Hydrology

The site lies within the catchment area of the River Dee. The nearest water course to the site is Alltami Brook which is situated to the west of the site; flowing from southwest to northeast. At its closest point it is 250m to the northwest of the site; it flows onwards and converges with Wepre Brook 700m to the north of the site. Wepre Brook flows from west to the east and is a tributary to the River Dee c. 4km to the northeast of the site. New Inn Brook, another tributary to Wepre Brook, is present 900m to the east of the site.

Identified flood risk zones associated with Wepre Brook and Alltami Brook are confined to their respective river channels and, as such, at their closest they are approximately 250m to the northeast of the site.

The area immediately to the south of the site includes several ponds and is part of the Deeside and Buckley Newt Sites designated SSSI and SAC. This relates to the presence of four protected amphibian species which were identified on the site mid-1990s. The owner of the site at that time (Hanson Brick Ltd) relocated these species from an area of planned mineral extraction and established a dedicated conservation area (which were subsequently designated as part of the SSSI and SAC).

#### Discharge Consents

There is an active discharge consent for the site held by Mold. This allows trade discharges (e.g. surface water) from a point on the north-western boundary of the site to Alltami Brook. It is understood that the discharge is limited to a maximum of 14 l/s. There is a similar discharge consent for trade discharges from the adjacent quarry between Pinfold Lane and Alltami Brook.

There are two discharge consents for treated sewage effluent into a tributary of the Alltami Brook, c. 350 m southwest (and upstream) of the Site associated with the FCC depot. There are also a group of discharge consents for treated sewage effluent from domestic properties to the same tributary immediately upstream of this point. There is another group of discharge consents, primarily relating to sewage discharges from a water company to Wepre Brook c. 700 m to the north of the Site.

### 3.5 Hydrogeology

#### 3.5.1 Aquifer Characteristics

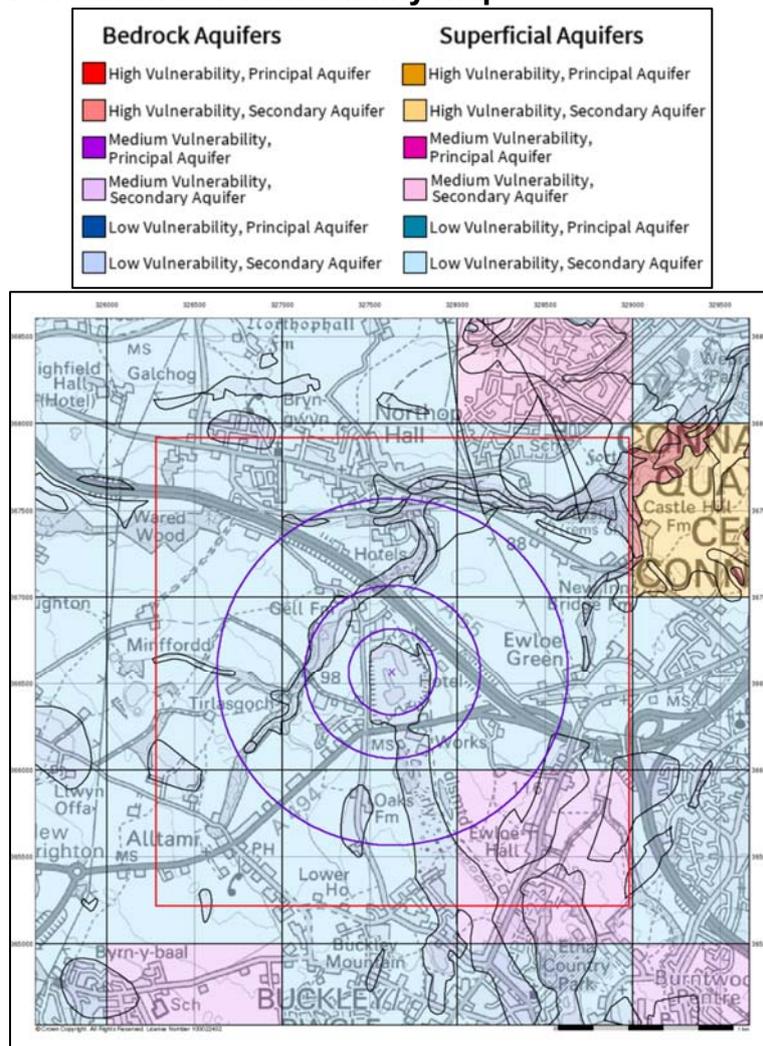
From 1st April 2010 new aquifer designations replace the old system of classifying aquifers as Major, Minor and Non-Aquifer. This new system is in line with our Groundwater Protection Policy (GP3) and the Water Framework Directive (WFD) and is based on British Geological Survey mapping.

The Coal Measures and surrounding bedrock are classified as a Secondary A Aquifer. Jones *et al.* (2000) describe how these strata are expected to behave as a multi-layered aquifer system in which lower permeability mudstones act as aquicludes between sandstone aquifer horizons. Both the mudstones and sandstones (which are well cemented) possess minimal primary porosity. Groundwater flows predominately occur within joints and fractures within the sandstone strata to depths of up to 250m; transmission of groundwater will depend on how locally well connected these hydrogeological units are. Lateral recharge is considered likely to be limited as the hydraulic continuity of the aquifer is disrupted by the faulting which effectively splits the aquifer units into isolated blocks. Locally, the hydrogeology can be modified by the presence of mine shafts and inter-connecting mine workings.

The superficial deposits (alluvium and glacio-fluvial) locally present along Alltami Brook and Wepre Brook are classified as Secondary A Aquifer. The Glacial Till is classified as unproductive strata.

Figure 8 shows the groundwater vulnerability mapping which is designated as low for and around the site.

**Figure 8: Groundwater vulnerability map**



The site is not within a Source Protection Zone.

### **3.5.2 Groundwater Flow**

In general, the groundwater flow direction within the Coal Measures is expected to follow the overall topography towards the north; however local variations in flow directions (and hence piezometric head differences between separate or poorly connected hydrogeological units present within the Coal Measures) are also likely to be apparent.

TerraConsult (2015) previously undertook a detailed review of available groundwater level data at the site. However, limitations were recognised with the available data set including borehole records were not available for all monitoring points (i.e. so there was no knowledge of which hydrogeological units were being monitored); and rather than targeting discrete water bearing units, the groundwater monitoring points tended to have been installed with long response zones that intersect multiple, higher and lower, permeability units. As a result, the water levels may provide an 'average' water level for all the units; including some at higher elevations where groundwater flows may actually be negligible. Other limitations included the frequency and duration of available groundwater level monitoring data; and identifying the influence of groundwater dewatering that had been undertaken historically at the Site and in a neighbouring quarry.

For these reasons, it was decided that a new network of groundwater monitoring points was required at the site. This resulted in borehole drilling and the installation of 14 dedicated groundwater monitoring locations around the perimeter of the site in early 2017 (TerraConsult, 2017).

A programme of a groundwater level monitoring has been undertaken since these new groundwater monitoring points have been installed. The results are discussed in further detail in the HRA and are summarised below:

- The groundwater level monitoring that has been undertaken between January 2017 and November 2018 suggests that a relatively consistent piezometric surface is present which falls from c. 98 to 100mAOD in the south-east to c. 87 to 90mAOD in the west and north-west of the site.
- With the exception of one monitoring location (2016-C) the variation in groundwater levels that has been observed over this period is on average c. 2m but variations of up to a maximum of c. 4m have been identified.
- The recent groundwater monitoring data suggests that despite the identified small scale geological complexity, individual water bearing units appear to be relatively well connected at the scale of the site and so appear to combine to act as a single aquifer unit with a broadly consistent and identifiable piezometric surface across the site.

As described above, Alltami Brook, is located c. 250m to the north-west of the site. It is down topography from the site (where it is situated in a valley at an elevation of between c. 80 and 90mAOD; compared to the elevation of the site at around 110mAOD). Given that groundwater levels within the Coal Measures are typically between 87 and 90mAOD on the north-western boundary of the Site it is considered likely that there is hydraulic connection between

groundwater and the brook down hydraulic gradient of the site (TerraConsult, 2015).

### 3.5.3 Groundwater Quality

A review of available groundwater quality at the site was undertaken as part of the previous permit application. As with the groundwater level data set identified above, issues and uncertainties were identified with this groundwater quality data set.

Following the installation of the new groundwater monitoring points in early 2017 groundwater quality monitoring has also been undertaken between early 2017 and March 2018. The result from this monitoring are discussed below with, where relevant, reference and commentary on the observations regarding groundwater level that were made by TerraConsult (2015):

- TerraConsult (2015) identified that chloride concentrations in groundwater generally remained below <90 mg/l with the exception of those monitoring points positioned along the western perimeter of the Site. Here, TerraConsult (2015) identified chloride concentrations up to 1,250mg/l and concluded that groundwater quality was influenced by the leaching of road salt which is stored at the Flintshire County Council depot.
  - In general, the results from the recent monitoring programme support these observations with mean chloride concentrations <90mg/l in nine of the 14 monitoring points. Four of the five remaining monitoring points (BHH, BHI, BHJ and BHK) are located along the western perimeter of the site (the mean concentrations observed in these points were between 147 and 395mg/l). The final monitoring point (BHC) (where the mean concentration was 168mg/l) is, in contrast, located to the south-east of the Site. For comparison the UK Drinking Water Standard (DWS) for chloride is 250mg/l.
  - It is notable that chloride concentrations in BHC were consistently less than 100mg/l throughout 2017; after which they rose to almost 400mg/l. The cause of this rise and the origin of the chloride in this location is not known (however, as described below, elevated sodium and sulphate concentrations are also observed in BHC so it is considered that they may also originate from road salt).
  - It is also notable that the chloride concentrations in BHK1 were appreciably lower than in BHK (mean concentrations of 61mg/l and 327mg/l respectively). Whilst these monitoring points are both located to the south-west of the Site they monitor vertically separate sandstone units; with the screened section of BHK1 monitoring at the higher elevation of 74.7 to 76.1mAOD compared to BHK which monitors at 63.9 to 70.0mAOD.
  - As TerraConsult (2015) note, the presence of chloride in groundwater that likely originates from nearby anthropogenic source(s), means that due consideration should be given to the use of chloride to assess the long-term performance of a non-hazardous landfill.

The observations made by TerraConsult (2015) regarding the likely origin of the chloride from road salt are supported by the sodium concentrations observed during the recent monitoring programme. Sodium concentrations show a very similar pattern to chloride; with elevated concentrations (i.e. typically above 50mg/l) only observed in BHC, BHH, BHI, BHJ and BHK.

- TerraConsult (2015) reported that outside the salt influenced area that sulphate concentrations were typically in the range 100 to 400mg/l (compared to concentrations of over 500mg/l within this area). As with the sodium concentrations, elevated sulphate concentrations (i.e. in excess of the UK DWS of 250mg/l) were only observed in those monitoring points where elevated chloride concentrations were also observed (i.e. BHC, BHH, BHI, BHJ and BHK).
- The pattern of ammoniacal nitrogen concentrations observed from the recent monitoring programme contrast to chloride, sulphate and sodium. Apart from BHH, ammoniacal nitrogen concentrations have largely remained below the UK DWS of 0.39mg/l as N and no trends or patterns are readily identifiable. Concentrations in excess of 1mg/l as N were detected in BHH at the start of 2017 and increased to 2mg/l as N in May 2017; however, since that time they have fallen appreciably. Since early 2018 they have remained around 0.1 mg/l as N.
- A summary of metal and minor ion concentrations from the recent monitoring programme is presented in Table 3-2. The table includes current UK DWS and shows that only the observed concentrations of iron, manganese, nickel and cyanide exceed these standards (as marked in bold).

**Table ESSD10: Summary of metal concentrations in groundwater (2017 to 2018)**

Analyte	Units	Nr	Nr>LOD	Minimum	Maximum	Mean	UK DWS
Cadmium	mg/l	98	36	<0.0001	0.0008	0.00025	0.005
Calcium	mg/l	138	138	16	289	118.2	-
Chromium	mg/l	98	27	<0.002	0.013	0.0053	0.05
Copper	mg/l	98	86	<0.001	0.038	0.0063	2
Iron	mg/l	138	138	0.04	<b>7.96</b>	<b>0.38</b>	0.2
Lead	mg/l	98	1	<0.001	0.002	-	0.01
Magnesium	mg/l	138	138	3	166	45.1	-
Manganese	mg/l	138	132	<0.003	<b>10.5</b>	<b>2.0</b>	0.05
Mercury	mg/l	98	0	<0.001	<0.001	-	0.001
Nickel	mg/l	98	90	0.001	<b>0.032</b>	0.010	0.02
Potassium	mg/l	138	138	1	21	8.6	-
Zinc	mg/l	98	98	0.002	0.279	0.027	-
Cyanide (total)	mg/l	98	12	<0.03	<b>1.38</b>	<b>0.27</b>	0.05

- As TerraConsult (2015) identified, the Coal Measures and Etruria Marl are a readily available source of iron and manganese, hence their presence in groundwater at elevated concentrations at the site is not unsurprising. Furthermore, they will therefore be less useful as a means of assessing the long-term performance of the landfill.
- Detailed inspection of the data from nickel shows that the UK DWS is only exceeded in four monitoring points (in all 7 times nickel was analysed in BHF1; in 5 of the 7 times in BHJ; twice in BHK; and once in BHI).

In accordance with the requirements for compliance levels as defined in Paragraph 4(c) of Annex III of the Landfill Directive, control and compliance limits have been established for all non-hazardous substances, with compliance limits set for hazardous substances.

The groundwater quality assessment and compliance limits presented in Table 5.6 are proposed to allow performance of the landfill to be monitored. Limits have been set for the two groundwater monitoring points (BH-G and BH-I) located on the down-gradient boundary of the Site.

Limits have been set for ammoniacal nitrogen, chloride and nickel based on available background groundwater monitoring data (SLR, 2019a). Limits for arsenic, naphthalene, phenol and benzene will be set once sufficient background groundwater quality data have been collected for these substances.

Groundwater quality data collected at the selected monitoring points have been analysed and used to derive the limits (see Appendix B). Assessment levels have been set at the mean concentration plus two standard deviations, and Compliance limits are either set at the mean concentration plus three standard deviations or at the respective EALs.

**Table ESSD11: Proposed groundwater compliance limits**

Determinand	Unit			
		BHG	BHH	BH1
Ammoniacal Nitrogen	mg/l	0.39	2.8	0.55
Chloride	mg/l	250	433.2	555.5
Zinc	mg/l	0.5	0.5	0.5
Phenol	mg/l	0.5	0.5	0.5

### 3.6 Off-site Landfill Gas Monitoring

Natural background gas concentrations have been carried out over a period of time from the outside groundwater monitoring boreholes to establish a baseline concentration. The boreholes have shown presence of carbon dioxide at HIGH levels, most likely associated with the former coal mining activities and some landfilling and general earthworks with burying of top soils at depth.

Carbon dioxide has been recorded in all of the boreholes. The current data sets will be supplemented during the permit process to obtain trigger levels in accordance with the Industry Code of Practice.

Off-site gas monitoring details are presented at Appendix ESSD 10.

### 3.7 Receptors and Compliance Points

This section details the specific receptors identified and compliance points that have been set in the various risk assessments.

#### Groundwater

For Hazardous Substances, the receptor/compliance point will need to be the point at which the substance will enter the groundwater below or adjacent to the site. This can be monitored from Boreholes G, H and I which are all down hydraulic gradient. Compliance limits have been set and are summarised in Table ESSD 10.

For Non-Hazardous Polluting Substances, the primary receptor/compliance point will normally be the downstream boundary of the site at Boreholes G and I. Compliance limits have been set and are presented at Table ESSD 10.

#### Surface Water

Surface water is discharged from site via the current discharge consent which will be consolidated into the new permit.

#### Landfill Gas

The site will accept inert waste which produces extremely low concentrations of methane and low concentrations of carbon dioxide. The global impact is therefore considered as negligible from the waste mass.

Key receptors have been identified and gas monitoring boreholes have been located near to identified receptors based on level of risk.

## 4.0 SITE REPORT

The Environmental Permit Regulations require that a permit application must be accompanied by a (Baseline) Site Condition Report, which describes the condition of the whole site, not just the landfill. Operators are required in particular to “*identify any substances in, on, or under land which may constitute a pollution risk*”

This Site Report gives a factual “baseline” account of the land. A Site Condition Report (SCR) has been prepared in accordance with the NRW H5 Guidance Note on Site Condition Reports<sup>9</sup> and is included in this EP application, as.

### Site Details

All details relating to the site are included in Section 1.0 of this ESSD report.

### Outline of Proposed Development

All details relating to the proposed development of the site are included in Section 1.0 of this ESSD report.

### Former Land Uses

All details relating to former land uses are included in Section 2.2 of this ESSD report and the SCR included in Section 12 of this EP application.

### Geology and Hydrogeology

All details relating to the geology, hydrology and hydrogeology of the site are included in Section 3.2, 3.3 and 3.6 respectively of this ESSD report and the SCR included in this EP application.

### Potential Contaminants and History of Incidents

All details relating to potential contaminants are included in Section 2.2 of this ESSD report and a history of pollution incidents in Section 3.5. Typical soil values are presented at Appendix ESSD11.

### Objectives of this Assessment

The objective of the SCR is to record and describe the condition of the land at the time of the permit application and prior to work beginning. This provides baseline environmental data and a point of reference so that upon surrender of the permit it can be demonstrated that there is no deterioration of the land as a consequence of the proposed operations and ensure that the condition of the land is in a ‘satisfactory state’ on surrender of the permit.

An SCR is not a requirement for the permanent deposit of waste (the proposed landfill) therefore the SCR only focuses on the areas of land contained within the EP boundary not subject to the infilling of waste. The installation site layout is detailed on Drawing ESSD2, which illustrates the areas that this SCR relates to.

Sections 1 to 3 of NRW's SCR template have been completed in the preparation of this document, which comprises the following:

- Site details;
- Condition of the land at permit issue;
  - Geology;
  - Hydrology;
  - Hydrogeology;
- Pollution history;
- Evidence of historic contamination; and
- Permitted activities.

Sections 4 to 7 of the SCR template will be maintained during the life of the permit and Sections 8 to 10 will be completed and submitted in support of the application to surrender the permit.

### **Areas of the Site Considered**

Those areas of the Site which will not be subject to the permanent deposit of waste are as follows:

- Access roads;
- Wheel wash area;
- Waste reception area and weighbridge;
- Fuel storage area;
- Surface water attenuation lagoon;
- Landfill gas control compound;
- Leachate control compound; and
- WTS.

### **Conclusions**

The information presented within Sections 1.0, 2.0 and 3.0 of this ESSD report and the SCR establishes the landfill source, pathway and receptor term characterisation for the installation, and defines the baseline site conditions, in terms of the geology, surface water and groundwater conditions and their sensitivity.

This section of the ESSD report is considered to have provided the necessary information on the potential source term characterisation for the non-landfill areas of the installation and should be read in conjunction with the remaining sections of the ESSD report.

---

<sup>9</sup> Natural Resources Wales – Environmental Permitting Regulations, Guidance for applicants; H5 Site Condition Report – guidance and templates, October 2014, Version 5.0.