Wivenhoe Quarry Extension: Hydrogeological Impact Assessment

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Prepared for

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Issue	Date	Status	Author	Checker	Reviewer
1	06/04/2018	Draft report for external review	CDW	AWT	RCS
2	21/05/2018	Final Report	CDW	AWT	RCS

Executive Summary

Wivenhoe Quarry Eastern Extension: Site Summary		
Location	3.5 km south-east of Colchester, Essex.	
Geology and target mineral	Mineral is sand and gravel from Kesgrave Catchment Subgroup, this overlies Palaeogene Thames Group.	
Aquifer status	Sand and gravel is classified as Secondary A aquifer, Thames Group is non-productive.	
Designated sites	Upper Colne SSSI, located 800 m south-west, and the variously designated Colne Estuary, located 1 km south, are the closest water dependent sites.	
Neighbouring surface water Features	Sixpenny Brook (20 m east), ponds at Cockaynes Local Wildlife site (80 m south) & Alresford Angling Club fishing lakes (120 m south).	
Neighbouring abstractions	23 licenced and 18 private abstractions within 2 km	
Conceptual hydrogeology	Unconfined sand and gravel aquifer in hydraulic continuity with surrounding surface water features but isolated from Chalk by Thames Group including London Clay. Flow to west and south at the Site.	
Summary of proposal	Tarmac is proposing to extract sand and gravel from an area located east of the existing Wivenhoe Quarry. This is a logical extension to the existing quarry, and is allocated under the Essex Minerals Local Plan (2014). The Site is to be worked in a series of phases with progressive restoration using some inert restoration materials to nature conservation habitats including species-rich grassland and open water.	
Estimated dewatering requirements	Best estimate of up to 4,150 m^3/day	
Potential Impacts during Operation		
Impact	**Degree of Impact**	**Comment**
Impacts on neighbouring abstractions	**Major, negligible with mitigation**	Significant impact on some neighbouring water supplies and waterbodies. Mitigable to negligible with proposed mitigation measures.
Water quality impacts	**Major, negligible with mitigation**	Spillage of fuels and release of suspended solids easily mitigable to negligible with standard practice.
Impacts from quarry discharge, and on ground settlement.	**Negligible**	Provided conditions of discharge consent are followed
Potential Impacts following Restoration		
Impact	**Degree of Impact**	**Comment**
Long-term groundwater level impacts	**Negligible**	
Water losses from evaporation	**Negligible**	
Surface Water Flood risk	**Negligible**	Assessed in ESI (2018)

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1 Introduction

1.1 Background

Tarmac Services Limited (Tarmac) is submitting a planning application for the proposed eastern extension of the current sand and gravel extraction operation at Wivenhoe Quarry. Wivenhoe Quarry is located between Wivenhoe and Alresford in Essex. The proposed eastern extension area ("the Site") contains an estimated sand and gravel mineral resource of 4.0 x 10^6 tonnes which is proposed to be extracted over a 20 year period. It is proposed to work the sand and gravel mineral dry with dewatering required below the water table.

Figure 1.1 shows the location of the Site (shown in red) relative to the existing quarry (shown in purple) and surrounding area. The Site is currently greenfield and covers approximately 61.5 ha. Once the resource has been excavated, the Site will be variably restored to nature conservation habitat including areas of species rich grassland, woodland and water-based wildlife habitat. This restoration scheme includes provision of a small amount of imported inert restoration materials, in addition to the use of the soil, overburden and interburden materials found on site. Details of the proposed development and restoration are set out in the development and restoration plans in Appendix A and Appendix B respectively.

This report constitutes a Hydrogeological Impact Assessment (HIA) that has been prepared on behalf of Tarmac in support of the planning application to extract sand and gravel and restore the Site to nature conservation habitats and agriculture. A Flood Risk Assessment (FRA) also supports the planning application and this has been produced as a separate document (ESI, 2018).

1.2 Scope of Work

David L Walker Limited instructed ESI Limited (ESI) on behalf of Tarmac in February 2016 to undertake an HIA in support of the planning application for the Site. This report focusses on the hydrogeological and hydrological impacts of the mineral extraction and restoration at the Site and has been written in line with the National Planning Policy Framework (NPPF). ESI specialises in hydrogeology and water resource impact assessments.

The scope of work undertaken for this HIA includes the following:

- Review of the baseline hydrogeology and hydrology for the Site and surrounding area;
- Consideration of the Scoping Opinion adopted by the Mineral Planning Authority for the project;
- Identification of receptors and assessment of potential impacts;
- Recommendations for appropriate monitoring and mitigation measures; and
- Preparation of an HIA for the proposed development (this report).

1.3 Data Sources

The information and assessments in this report are predominantly based on secondary data analysis associated with both the Site itself and the surrounding land area. The main sources of data are summarised below:

- Proposed development and restoration plans provided by Tarmac (Appendix A and Appendix B respectively);
- A Site visit undertaken by ESI staff on 30 March 2016.
- British Geological Survey (BGS) mapping;

- Ordnance Survey mapping;
- Data on private groundwater abstractions from Colchester Borough Council and Tendring District Council;
- Groundwater monitoring data provided by Tarmac, as well as drilling data, and details on waste use at the current site; and
- Data from the Environment Agency (EA) including water quality, rainfall, landfill data, abstraction licences and discharge consents.

1.4 Report Outline

This report constitutes the HIA for the proposed mineral extraction, and includes the following:

- A review of the relevant baseline conditions and conceptual model for the Site (Section 2);
- An outline of the proposed quarry development, restoration and water management considerations (Section 3);
- An assessment of the potential impacts of the quarry development and recommendations for appropriate monitoring and mitigation measures as required (Section 4); and
- A summary of the results and key conclusions (Section 5).

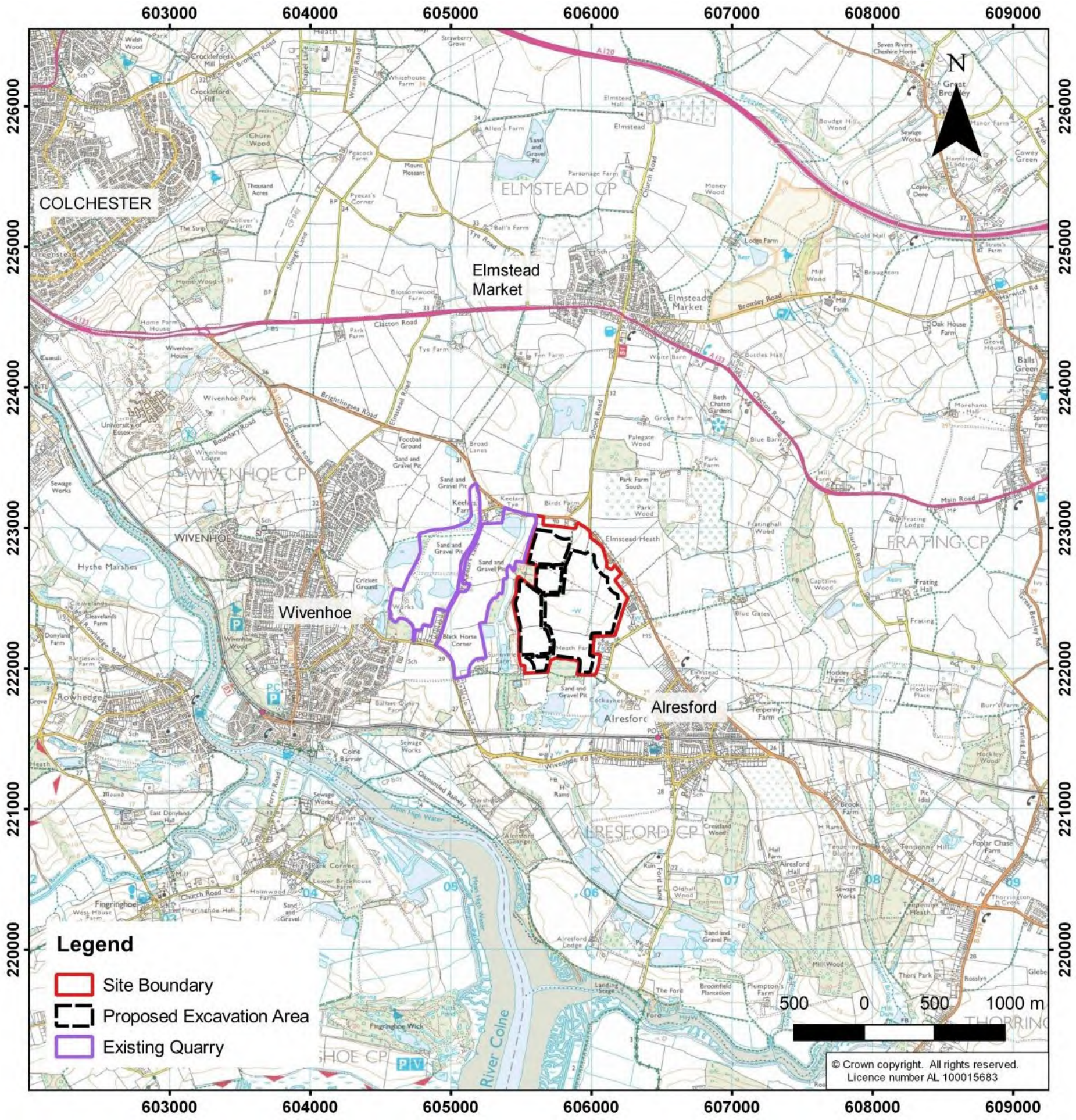

Figure 1.1 Map of the area surrounding the Site

2 Baseline Conditions

2.1 Site Setting

The Site is located approximately 3.5 km south-east of Colchester, 750 m east of Wivenhoe, and immediately south of the B1027 in Essex (NGR TM 04682281, nearest postcode CO7 9SR). Wivenhoe Quarry, which has been in operation for several decades, lies immediately west of the Site (Figure 1.1). The Site itself comprises approximately 61.5 hectares of land which is currently utilised for various agricultural purposes. A footpath ("Footpath 24") runs north-south through the Site

Sand and gravel extraction has been undertaken at the existing Wivenhoe Quarry for a number of years and Figure 1.1 shows the location of the existing planning boundary. Sand and gravel extraction at the current site is complete and the restoration operations are ongoing. The proposed extraction area covers most of the Site and is to be worked on a progressive basis in a series of phases. Further details on the proposed operation are outlined in Section 3.

Land use around the Site is a mixture of rural and agricultural land punctuated by various villages, areas of woodland and small settlements with some land used for industrial and quarrying use. A number of other active and restored sand and gravel quarries lie in the surrounding area including one located immediately south of the Site which is now used for recreational fishing and a local wildlife.

A number of small businesses are located around the Site boundaries. These include Alresford Garage, Shrublands Nursery and Mitchells Farm Shop which are all located immediately east and north-east of the Site. Cockaynes Wood lies immediately south of the Site, and the Sixpenny Brook bounds the Site to the west. The B1027 borders the Site to the north and north-east and the hamlet of Elmstead Heath lies along this road.

The closest major settlements to the Site are Alresford (550 m south-east of the Site), Wivenhoe (750 m west), Elmstead Market (1.4 km north) and Thorrington (3.2 km south-east). A number of farms and hamlets are located within 500 m of the Site. These include Elmstead Heath (immediately north-east), Heath Farm (immediately east), Sunnymead Farm (immediately west), Birds Farm (80 m north), Cockaynes (270 m south-east) and Keelars Farm (300 m west).

The River Colne, which is an important bird habitat, lies around 1.2 km to the south-west of the Site. The Colne Local Nature Reserve (LNR) is located 1.5 km to the west of the Site and the Upper Colne Marshes and Colne Estuary Site of Special Scientific Interest (SSSI), and Special Area of Conservation (SAC) lie 800 m to the south (see Figure 2.14).

Figure 2.1 shows a map of LiDAR topography at and around the Site, which is low-lying and broadly flat. At the Site, topography reaches a maximum elevation of around 30.5 m Above Ordnance Datum (m AOD) in the north-east and slopes gently towards the Sixpenny Brook west of the Site and the River Colne to the south. Elevations at the Site drop to around 24.5 m in the western part of the Site. Topography continues to rise slightly to the west of the Site before reaching the catchment divide between the Ten Penny Brook and Sixpenny Brook and declining gently towards the former.

In the surrounding area, topography is flat and subdued with the dominant features being a series of incised river valleys. The River Colne riverbed, which reaches < 0 m AOD, and the Tenpenny Brook are incised to the greatest degree. Isolated historical and existing mineral extraction sites also interrupt the flat topography.

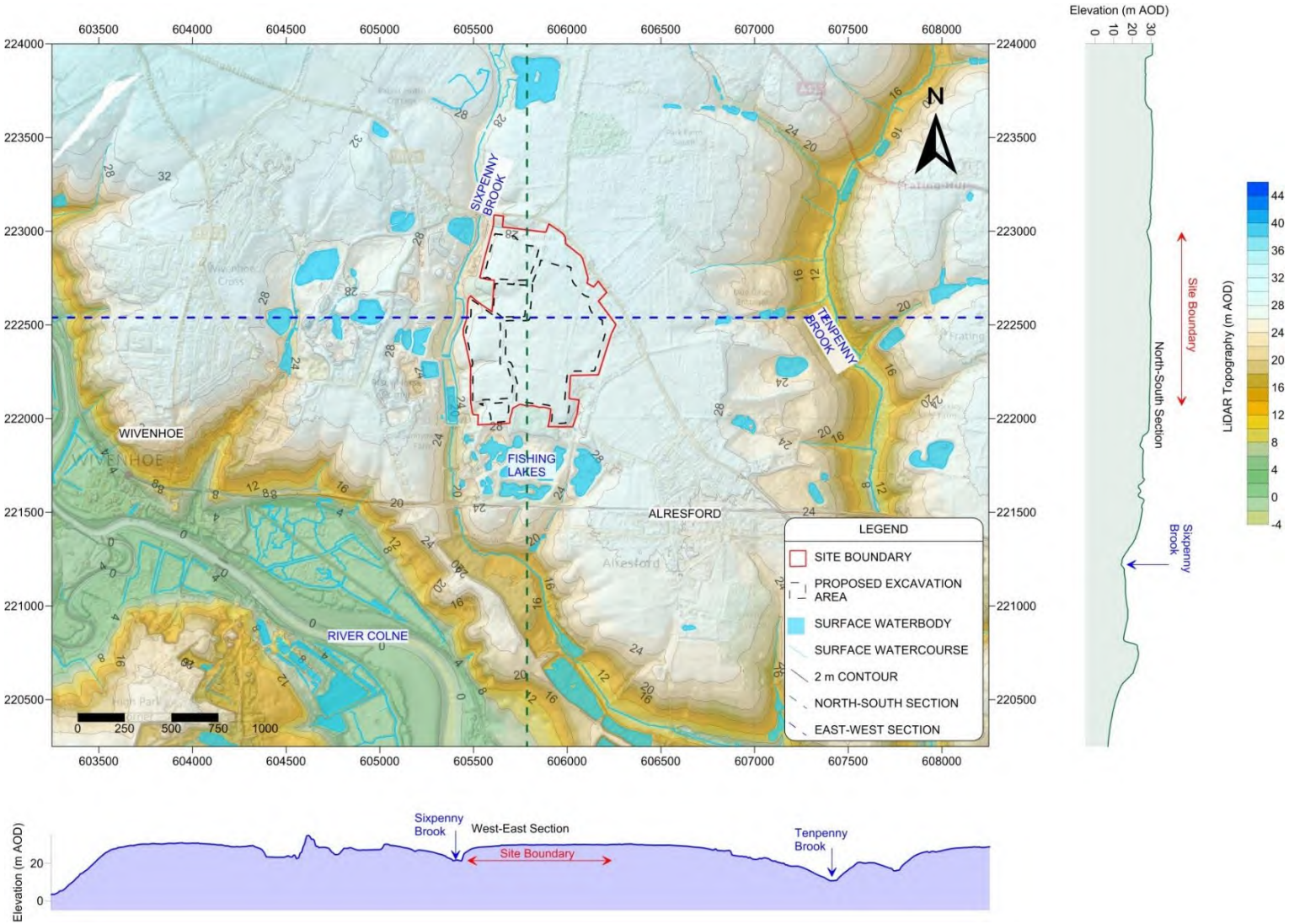

Figure 2.1 Topography at and around the Site

2.2 Geology

2.2.1 Regional geology

Bedrock

The bedrock geology of the area around the Site consists of Palaeogene and Cretaceous sedimentary deposits. The regional bedrock geology in the area around the Site has been taken from the 1:50,000 scale geological map of the area (BGS, 2010) and is summarised in Table 2.1.

The Thames Group underlies the Site and the surrounding area. The Thames Group dates from the Eocene epoch of the Palaeogene and is comprised of the London Clay Formation and the Harwich Formation. The geological map for the area does not differentiate the Thames Group into these constituent units. Combined, the Thames Group is comprised of various fine grained marine sedimentary deposits including silty clay/mudstone, sandy silts and sandy clay.

The Thames Group is unconformably underlain by the Lambeth Group and Thanet Sand Formation which both date from the Palaeocene epoch of the Palaeogene. The Lambeth Group and Thanet Sand Formation outcrop east of Colchester around 4.1 km north-west of the Site. Again, the geological map of the area does not differentiate these units. These strata are comprised of clay, sand and silt with a discontinuous thin flint nodule bed at the base.

The Cretaceous White Chalk Subgroup unconformably underlies the Lambeth Group and Thanet Sand Formation. This unit is comprised of soft to hard white chalk with some flint-rich and marl layers. This unit is in turn underlain by the Grey Chalk Subgroup which is comprised of massively bedded grey chalk interbedded with thin marls. Together these units make up the Chalk Group which is thought to be around 270 m thick in this area.

These sedimentary bedrock units dip gently towards the south-east.

Table 2.1 Regional Bedrock Stratigraphy (BGS, 2010)

Period	Group	Sub-Group	Formation	Description	Thickness (m)
Palaeogene	Thames		London Clay	Clay, silty, blue-grey with thin sand and pebble beds	0 – 35
			Harwich	Clayey, silty with ashy layers and cementstone nodules and beds	15 - 20
	Lambeth		Various	Clay, sand and silt, colour mottled clays, grey brown and green sands and silts	15 - 30
	Montrose		Thanet Sands		
Cretaceous	Chalk	White Chalk		Soft to hard white chalk with flint-rich and marl flint-free layers and some hard bioclastic chalk beds	~ 225
		Grey Chalk		Grey massively bedded chalk with thin marls with a basal glauconitic marl bed	~ 45

Superficial

Figure 2.2 shows the regional superficial geology around the Site. Superficial deposits almost entirely cover the underling bedrock around the Site, being absent where they have been stripped away by previous quarrying activities. The Pleistocene Kesgrave Catchment Subgroup, which consists of mostly fluvial sands and gravels, but also comprises lacustrine silts and clays and organic peats, underlies the Site. It is this unit that comprises the economic mineral at the Site.

In the north-eastern corner, and north and east of the Site, the Kesgrave Catchment Subgroup is overlain by cover sand deposited in aeolian conditions. These deposits also contain layers of silt and clay. Along the main rivers, including the River Colne, Sixpenny Brook and Alresford Creek, alluvium is present (comprising various sands, silts and clays) and occasional areas of sand and gravel river terrace deposits outcrop.

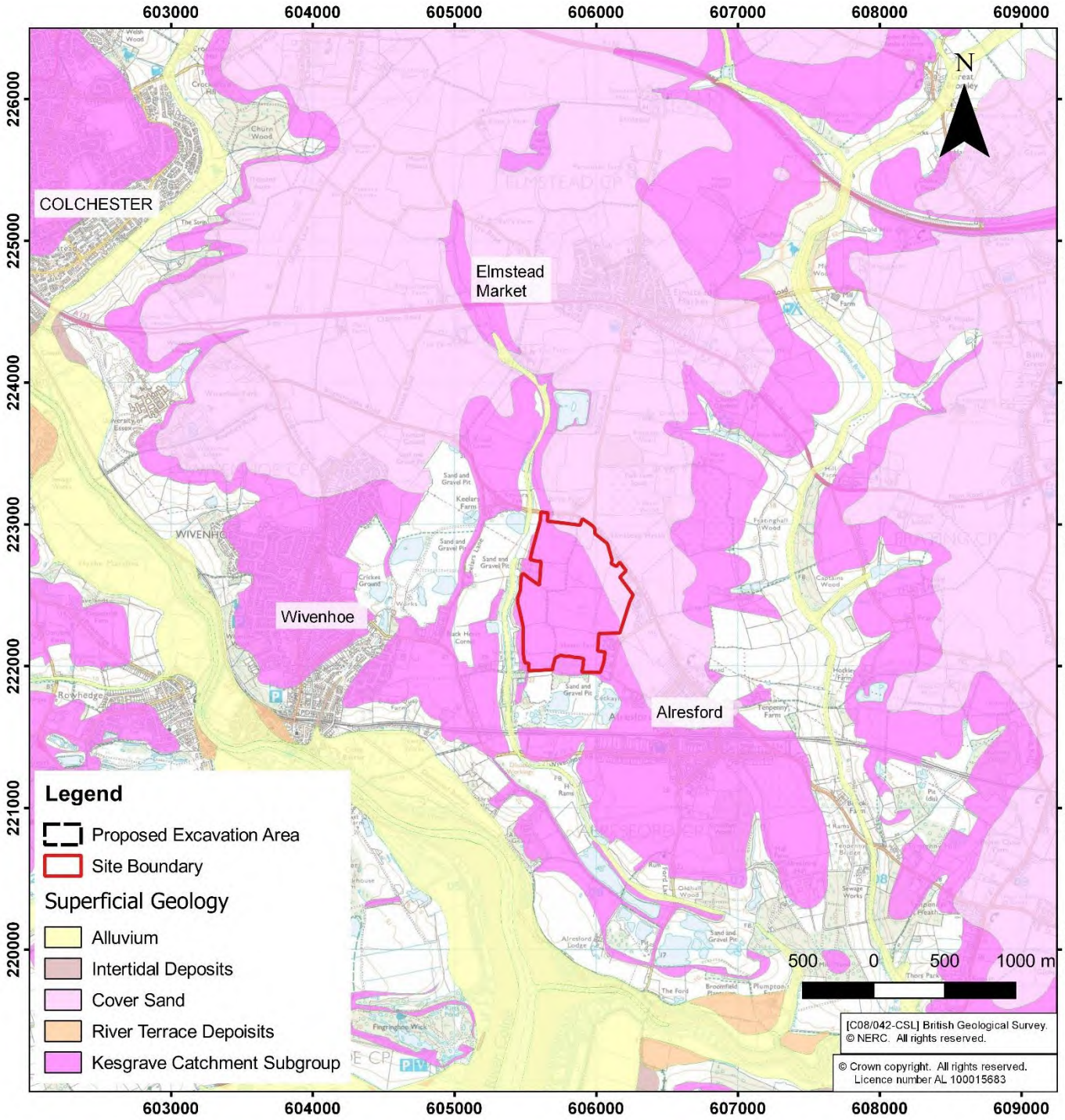

Figure 2.2 Regional superficial geology

2.2.2 Local geology

Information on the local geology in the vicinity of the Site has been obtained from the following sources:

- Exploration and monitoring well drilling undertaken at the Site;
- Previous reports written for the Site and surrounding areas;
- Publicly available geology maps; and
- Publicly available borehole logs including those sourced from the BGS.

Tarmac has drilled 101 boreholes at and around the Site (Appendix C). Borehole logs show that the Kesgrave Catchment Subgroup underlies topsoil at the Site and borehole drilling shows that Kesgrave Catchment Subgroup is comprised of four interbedded lithologies (presented as youngest to oldest):

- Overburden typically comprised of silty and/or sandy clay/silt with some gravel;
- Upper mineral comprised of fine to medium sand and gravels;
- Interburden typically comprised of silt or silty clay;
- Lower mineral typically comprised of fine to medium sand and gravels.

Whilst the above descriptions are what each layer is generally comprised of, the composition varies spatially across the Site.

Beneath these units is the Thames Group bedrock which was observed to be comprised of grey clay. The borehole logs indicate that overburden was identified in 40% of the 101 boreholes drilled. The upper mineral was observed in 19% of boreholes, whilst the lower mineral was logged in 95%. The interburden was only identified as being present where the upper mineral is also present. The lower mineral is therefore the principal economic resource at the Site.

A geological model has been built for the Site using the implicit geological algorithms in Leapfrog Works (Aranz Geo Limited, 2018). This model is based on Tarmac and neighbouring BGS borehole logs. For those borehole logs provided by Tarmac, it has been assumed that all of the boreholes terminated in Thames Group Bedrock that underlies the area. Soil and overburden have also been grouped together as one unit. The four lithologies outlined above have been modelled at the Site with the base of the model assumed to be bedrock.

Figure 2.3 shows contours of depth to bedrock. Depth to bedrock and the total mineral thickness decreases offsite towards the Sixpenny Brook in the west of the Site. Depth to bedrock is greatest in two areas in the eastern and western parts of the Site, being generally > 7.5 m in these areas. Elsewhere, the depth to the bedrock is typically around 5 m. Depth to bedrock varies across the Site with irregular thicker patches. The superficial thickness thins south of the Site where it has been removed by historical quarrying activities.

Total mineral thickness at the Site follows a similar trend to depth to bedrock. The extents of the upper mineral layer are limited as is shown in Figure 2.4. Upper mineral is mostly present in the south and east of the Site. Interburden is only present where the upper mineral is also present. The thickness of the lower mineral, which is the main economic mineral layer at the Site, follows the same patterns as bedrock depth.

Figure 2.5 shows a map of combined overburden and soil thickness at and around the Site. Overburden and soil thickness is mostly low across the Site being greatest along the western and south-eastern boundaries but is generally < 1 m thick across most of the Site

area.

The thickness of the Thames Group underlying the Site is uncertain. However, based on sections shown on the BGS geological map for the area, it is likely that the thickness of the bedrock units (Thames Group including Thanet Sands and Lambeth Group) overlying the Chalk is at least 40 m.

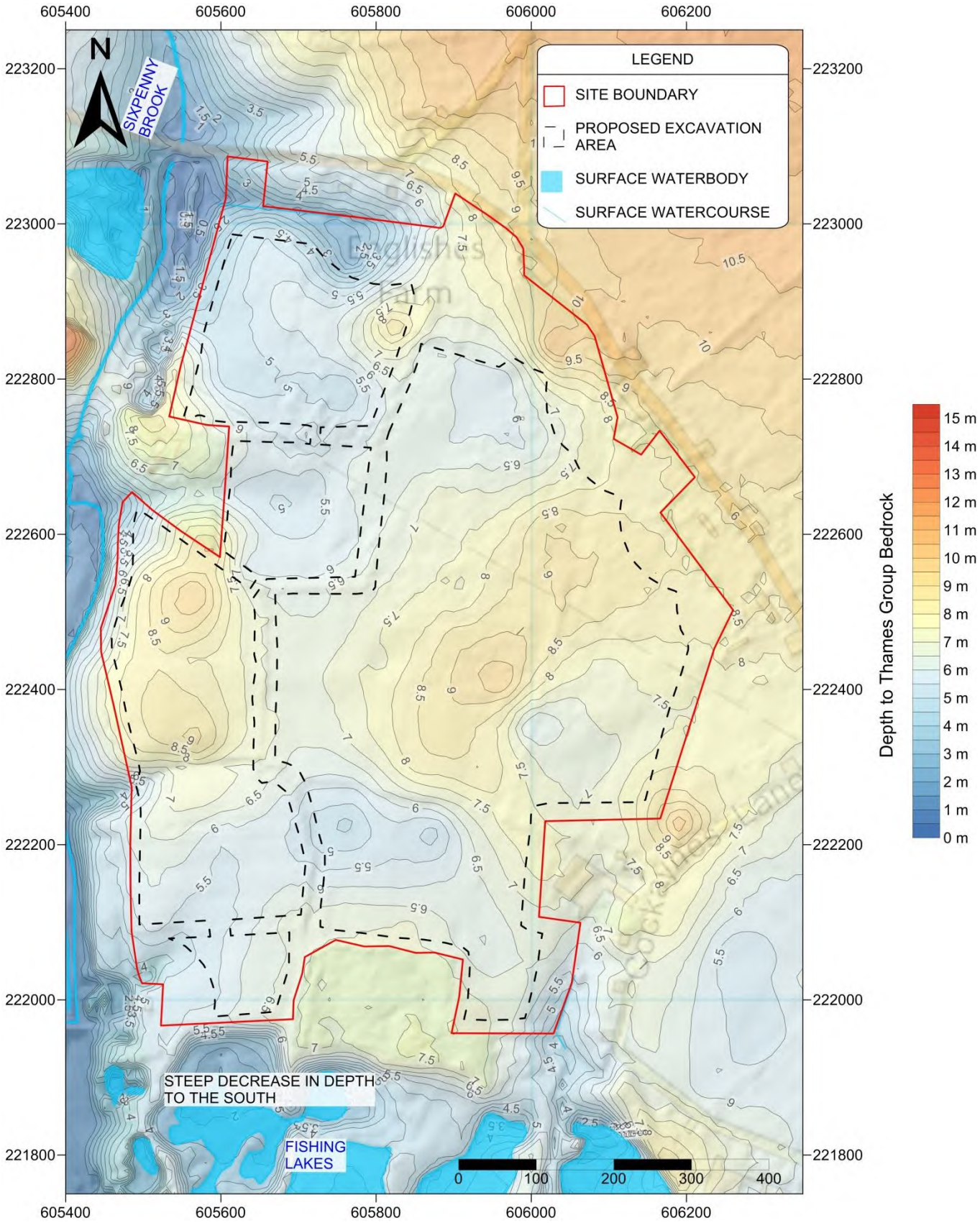

Figure 2.3 Depth to Thames Group bedrock

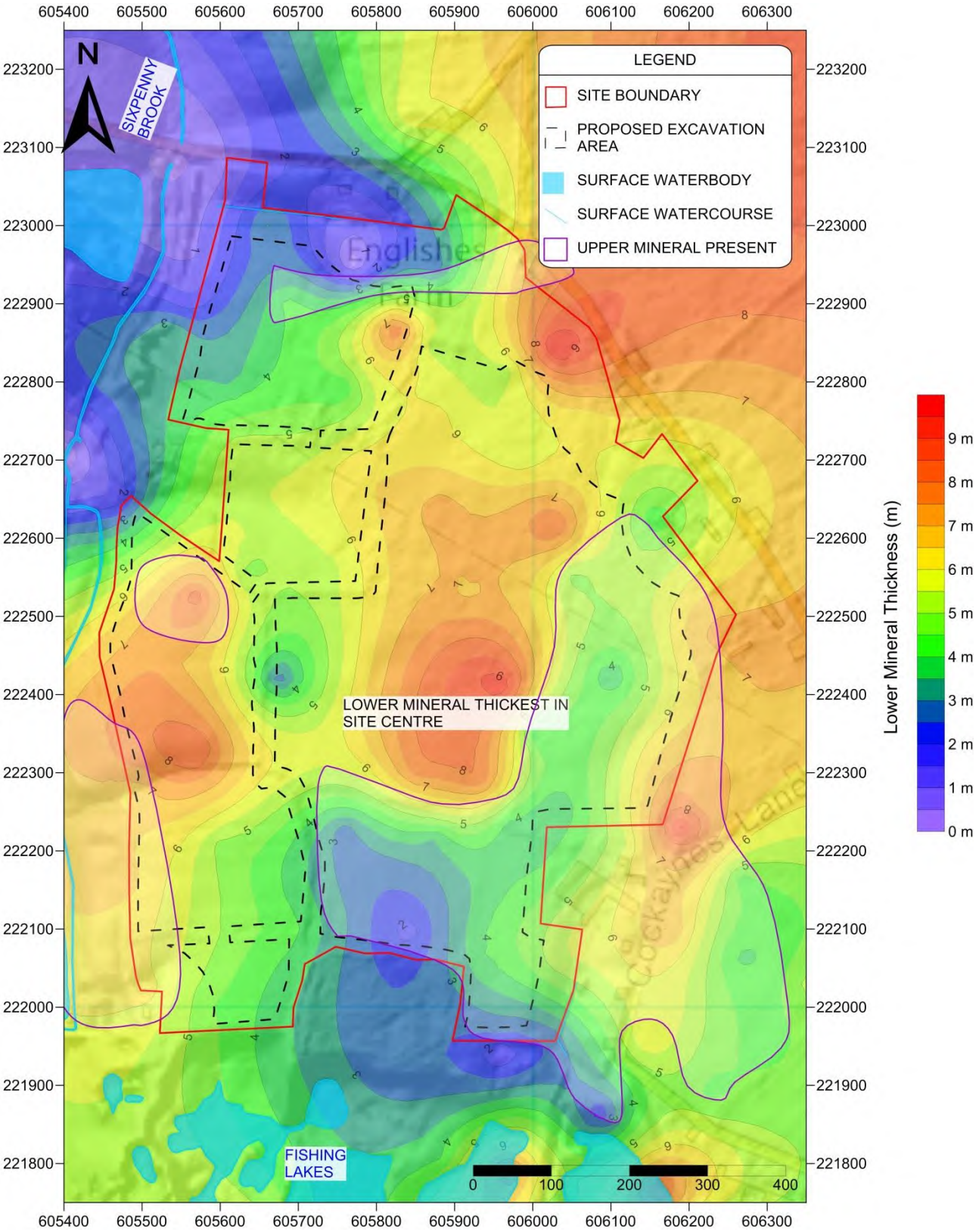

Figure 2.4 Lower mineral thickness and upper mineral extent at and around the Site

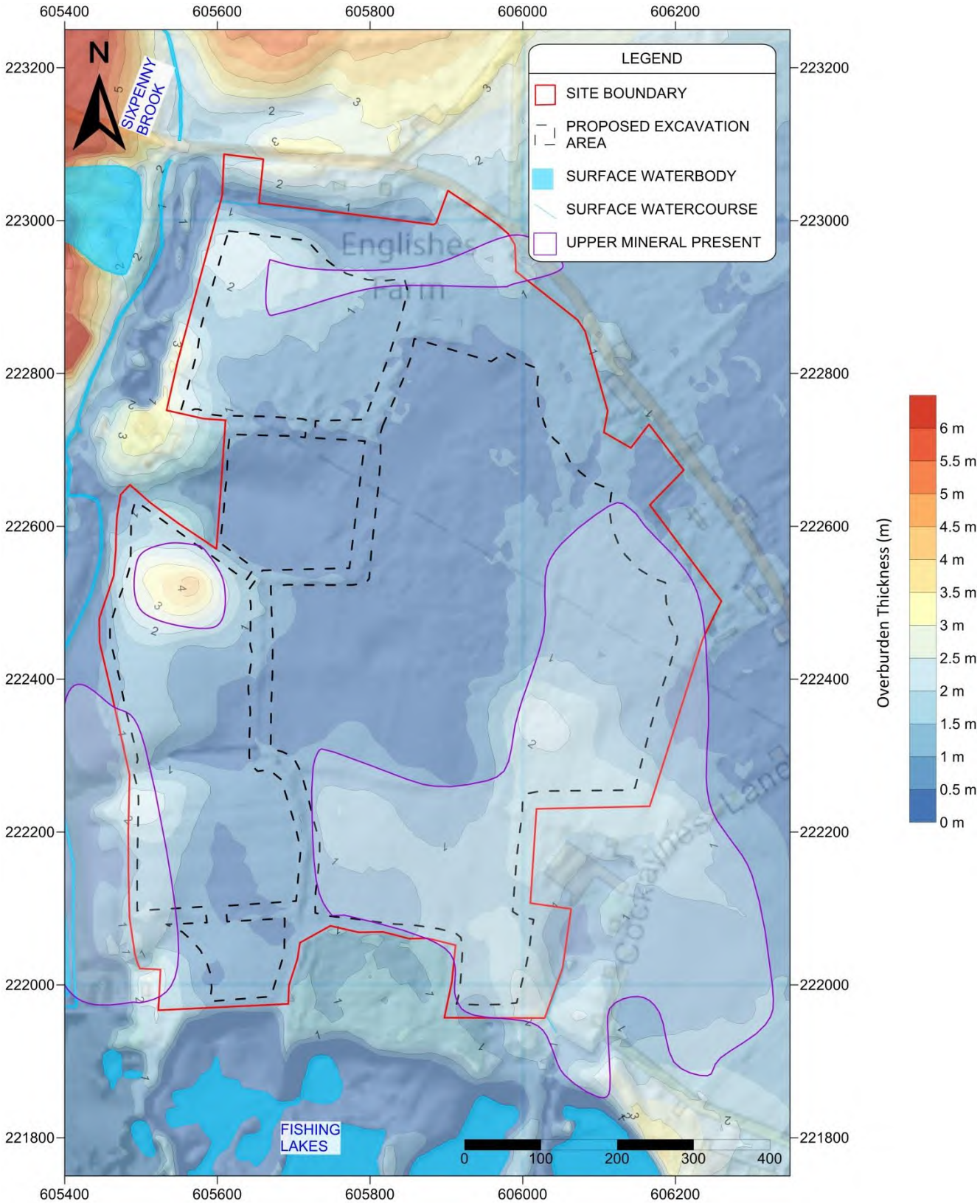

Figure 2.5 Overburden and soil thickness at and around the Site

2.2.3 Infilled ground/landfilling

Details of existing and historical landfills within 4 km of the Site have been obtained from the EA. Figure 2.6 shows authorised and historical landfill sites within 3 km of the Site.

There are three active landfills within 4 km of the Site. These active landfills are listed below:

- Wivenhoe Landfill Site, Elmstead Road, Wivenhoe, Active. Operated by Tarmac. Landfill accepting inert waste. Licence issued in 2005.
- Wivenhoe Landfill, The Gravel Pit, Elmstead Road, Wivenhoe, Active. Operated by Tarmac. Landfill taking non-biodegradable waste. Licence issued in 1977.
- Brightlingsea Inert Landfill, Moverons Lane, Brightlingsea. Operated by Brett Aggregates Limited. Landfill taking inert waste. Licence issued in 2016. (Located > 3 km away and not shown in Figure 2.6).

A further 14 historical landfills are located within 4 km of the Site. These sites are detailed in Table 2.2. The closest of these are located to the south-west of the Site in and around Wivenhoe and most details are unknown.

Table 2.2 Historical landfills within the Site vicinity

Landfill Name	Operator	Distance from Site	Type of waste(s) accepted	Site Active
Belle Vue Road	Unknown	1.1 km south-west	Unknown	Unknown
Ballast Quay Farm	Unknown	1.2 km south-west	Unknown	Unknown
The Shipyard	James W Cook and Company Wivenhoe Limited	1.3 km south-west	Industrial	1978 - 1988
Ballast Quay Road	Unknown	1.6 km south-west	Unknown	Unknown
King George Recreation Ground	Wivenhoe Urban District Council	1.8 km west	Commercial and household	1966 - 1974
Vanessa Drive	Unknown	1.6 km west	Unknown	Unknown
Ferry Road	Unknown	2.1 km south-west	Unknown	Unknown
Rowhedge Wharf	Unknown	2.1 km south-west	Unknown	Unknown
Poplars Chase Farm	Shairwood Contract Limited	2.3 km east	Inert, industrial & household	1978 - 1989
Thors Farm	Unknown	2.8 km south-east	Inert	1955 - 1975
Place Farm	Purle Waste Disposal	3.1 km west	Industrial	1966 - 1971
Haven Quay	Colchester Borough Council	3.2 km west	Unknown	Unknown
Fingringhoe Road Landfill	Fingringhoe Road Landfill	3.3 km west	Industrial, commercial and household	1983 - 2010
Molar Works	Moler Products Limited	3.6 km west	Inert and Industrial	1993 - 1999

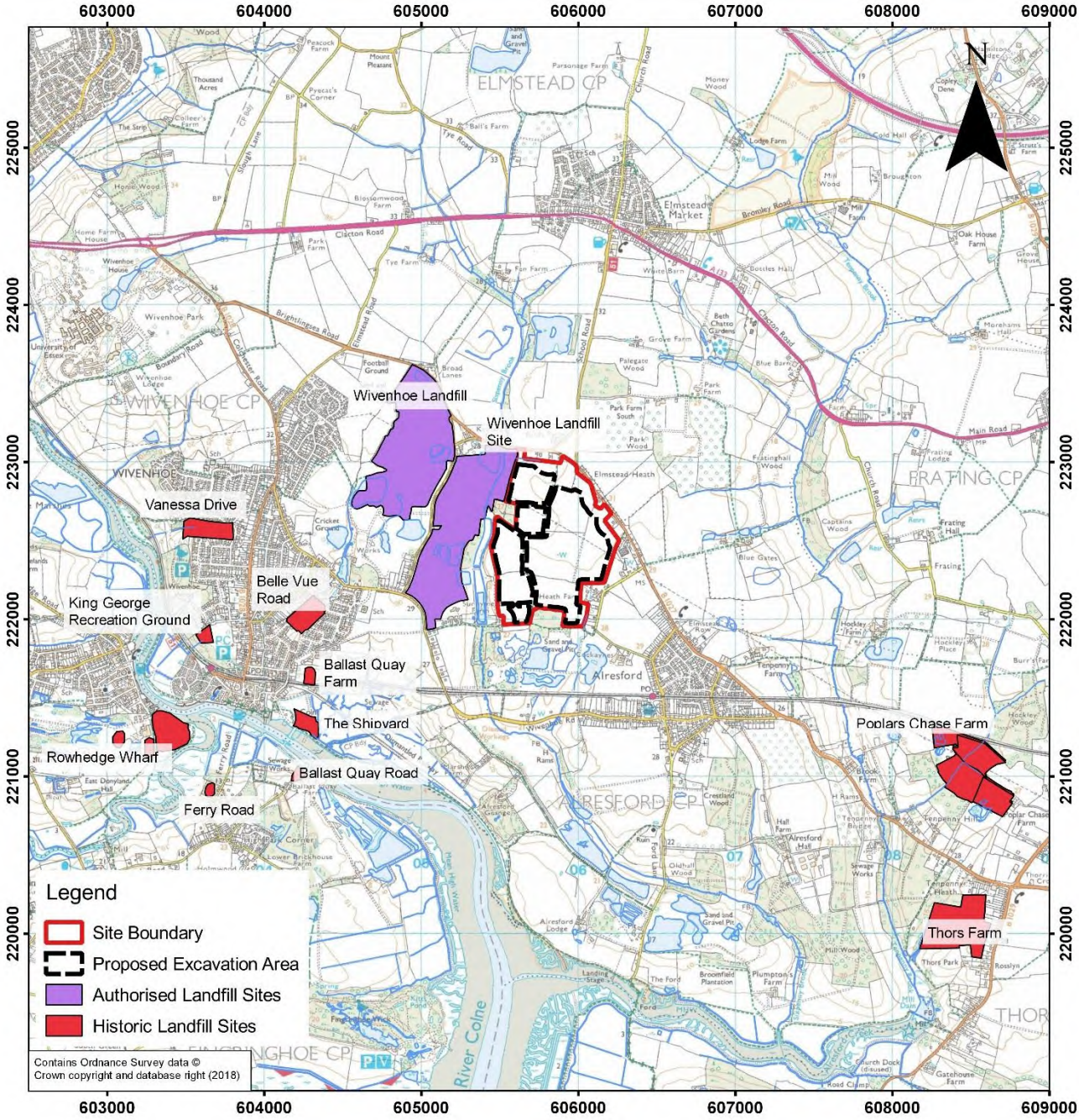

Figure 2.6 Authorised and historical landfills in proximity to the Site

2.3 Hydrology

2.3.1 Rainfall

Rainfall data are available from an EA rain gauge at Brightlingsea 4.4 km south-west of the Site (NGR: 607159, 217720) from 2000 to 2017. Table 2.3 summarises monthly mean rainfall values for this period. During this time, rainfall was typically highest during winter (namely October to January) and lowest over summer.

Mean annual rainfall for the period 2000 – 2017 based on mean monthly totals was 529 mm. Annual rainfall varied from 302 – 747 mm between 2000 and 2016. Rainfall was above average between 2012 and 2014 (inclusive) but has been below mean since 2015.

The Standard Average Annual Rainfall (SAAR) for the Site is 548 mm (HR Wallingford,

2017). This value is consistent with the rainfall data from Brightlingsea. Effective rainfall has been estimated in Section 2.3.3.

Table 2.3 Monthly rainfall data from Brightlingsea (2000 – 2017)

Month	Mean rainfall (2000 to 2017) (mm)
January[3]	50.7
February[3]	40.1
March[3]	32.4
April[3]	31.7
May[3]	47.0
June[3]	41.7
July[3]	40.6
August[1]	45.8
September[1]	35.7
October[1,2]	56.3
November[2]	59.8
December[2]	47.5
Annual	529

[1]Records for 2007 have been excluded as rainfall data for these times is incomplete
[2]Records for 2017 are incomplete for these times and have been excluded
[3]Records for 2000 have been excluded as rainfall data for these times is incomplete

2.3.2 Surface water features

Figure 2.7 shows surface waterbodies in the vicinity of the Site and Figure 2.8 shows hydrologic features close to the Site itself.

Surface watercourses

The Site is located within the River Colne catchment and is on the left bank of this main river.

The Sixpenny Brook is the closest watercourse to the Site (located 20 m west and a main river). The Sixpenny Brook rises west of Elmstead Market 2.2 km north of the Site and flows broadly southwards to its confluence with the Alresford Creek 2.8 km south-east of the Site.

Just west of the north-western corner of the Site, the Sixpenny Brook splits into two parallel watercourses as it flows past the Site. During the Site visit, flow was not observed in the western channel as it passes the agricultural reservoir west of the Site. South of Sunnymead Farm, these two watercourses merge and the Brook flows southwards as one watercourse to its confluence with the Alresford Creek.

Alresford Creek lies 2.1 km south of the Site at its closest approach. This river is formed from the Tenpenny Brook which flows southwards from its source 5.7 km north of the Site near Little Bromley and passes the Site 1.1 km to the east. Alresford Creek joins the River Colne 2.2 km south of the Site. The lowest reach of the Alresford Creek is tidal.

The River Colne is located approximately 1.2 km south-west of the Site and is tidal as far as Colchester. At its closest approach to the Site, the River Colne is around 68 m wide at low

tide and up to 310 m wide at high tide. South of the Site, the river flows south-south-eastwards to its estuary where it discharges to the North Sea at Brightlingsea Reach. Upstream of the Site, the River Colne passes through Colchester and is sourced from near the village of Stambourne around 38 km north-west of the Site.

Roman River is a tributary of the River Colne and the confluence is 2 km south-west of the Site. This river is sited on the right bank of the River Colne and flows eastwards from its source.

A number of small streams and farm drains flow into the major rivers discussed above. The closest of these is a small watercourse (labelled as “drain” on Figure 2.8) which rises immediately east of the Site south of Heath Farm. This flows southwards to a waterbody 650 m south of the Site south of Wivenhoe Road.

No major surface watercourses are present within the Site itself. However, during the Site visit a number of shallow ditches were observed. Four of these drain westwards towards the Sixpenny Brook. At the time of the Site visit, little flow was observed in the ditches and most were dry. A further ditch drains southwards along the south-eastern Site boundary near Heath Farm. This ditch conveys flow through the area occupied by the fishing lakes south of the Site (see below).

Surface waterbodies

There are no waterbodies located within the Site itself. There are numerous surface water bodies associated with the existing quarry and these are used as part of the water management system. Many of the other neighbouring waterbodies appear to be related to historical sand and gravel working. The closest of these are located around 150 m south of the Site.

Three fishing lakes are located close to the Site as part of the Orchard Complex owned by Alresford Angling Association. These lakes are as follows:

- Cox Lake (1.6 ha, located 120 m south-east); and
- Worcester Lake (1.4 ha, located 165 m south of the Site)
- Bramley Lake (1.4 ha, located 325 m south).

These lakes are associated with the historical sand and gravel extraction to the south of the Site. The base of Cox Lake and Worcester Lake are lined with clay and are fed by spring flows as well as direct rainfall and runoff (David L Walker Ltd, 2017). The springs enter the lakes above the clay liner level and flow mainly into the Cox and Worcester lakes, with the Bramley Lake mainly fed by overflow from the other two lakes and groundwater inflows. At Worcester Lake, one spring has been identified in the north-western part of the lake. An outfall from Worcester Lake provides inflows to Bramley Lake.

An outfall from Bramley Lake passes to a drain that runs north-south through the complex towards a small pond around 600 m south of the Site. This is the same drain described above as originating from Heath Farm. Immediately south-west of the Site lies Cockaynes Local Wildlife Site. This area includes a series of small ponds, the closest of which lies within 80 m of the Site, as well as a heavily vegetated former silt lagoon which has only a small depth of standing water (David L Walker Ltd, 2018). An outlet from the lake system conveys flows to the Sixpenny Brook. Bank conditions around the waterbodies include reedbeds and other vegetated habitats. These ponds are related to historical mineral extraction at the former Villa Quarry.

A rectangular waterbody is located 100 m west of the Site which is used as a reservoir for agricultural purposes. The level of this reservoir is above that of the Sixpenny Brook and

this waterbody is lined. The Sixpenny Brook splits into two parallel watercourse which flow either side of this waterbody. Other waterbodies associated with historical sand and gravel workings are located 580 m to the north and 725 m west of the Site.

A series of lakes is located 540 m east of the Site at Blue Gates Farm. Water from these lakes may be utilised for agricultural purposes.

Further waterbodies lie approximately 1 km south of the Site and these may also be former sand and gravel workings. The closest of these waterbodies is part of the Sixpenny Brook, receiving flows at its northern end with outflows at the southern end.

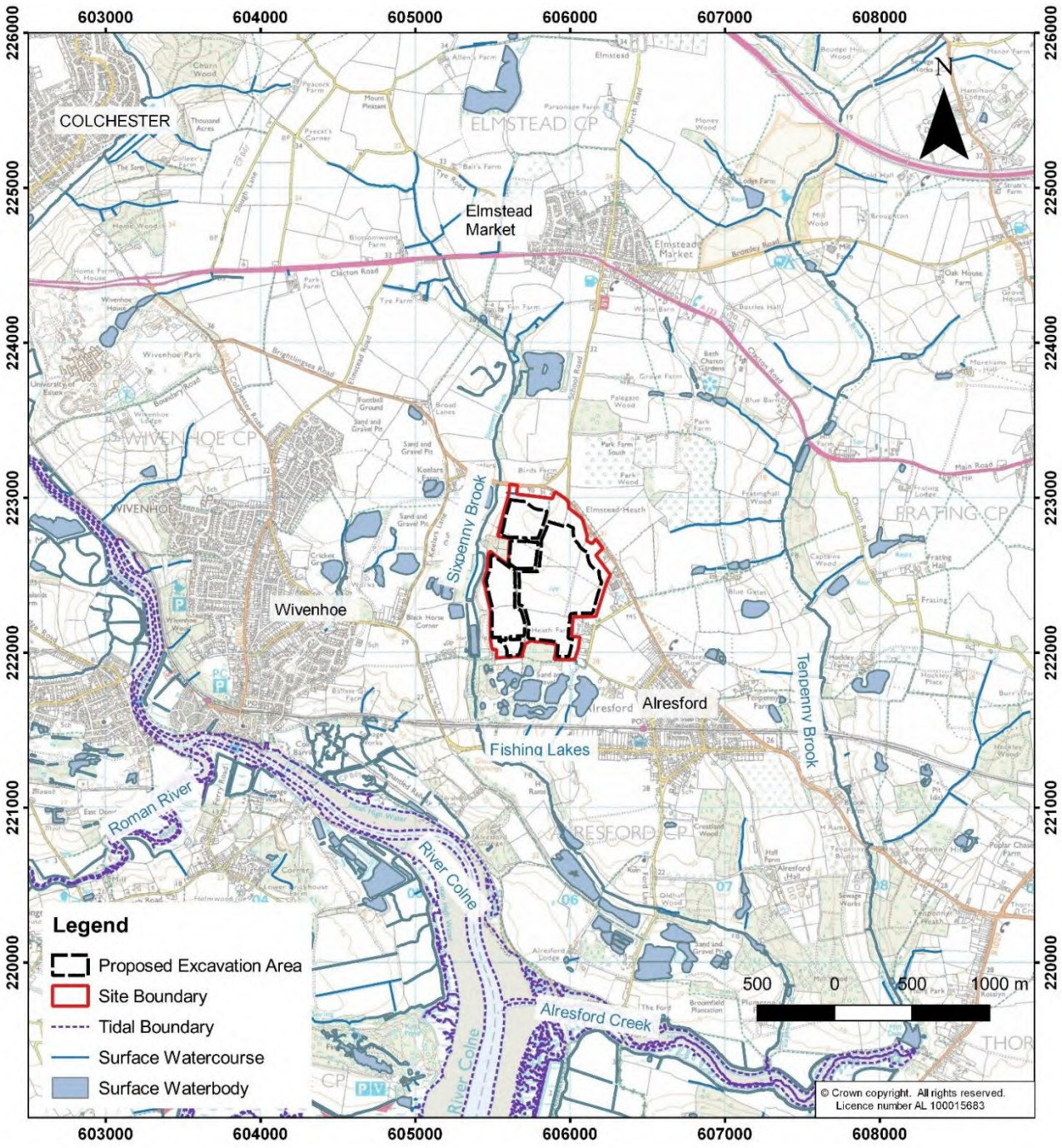

Figure 2.7 Surface water features around the Site

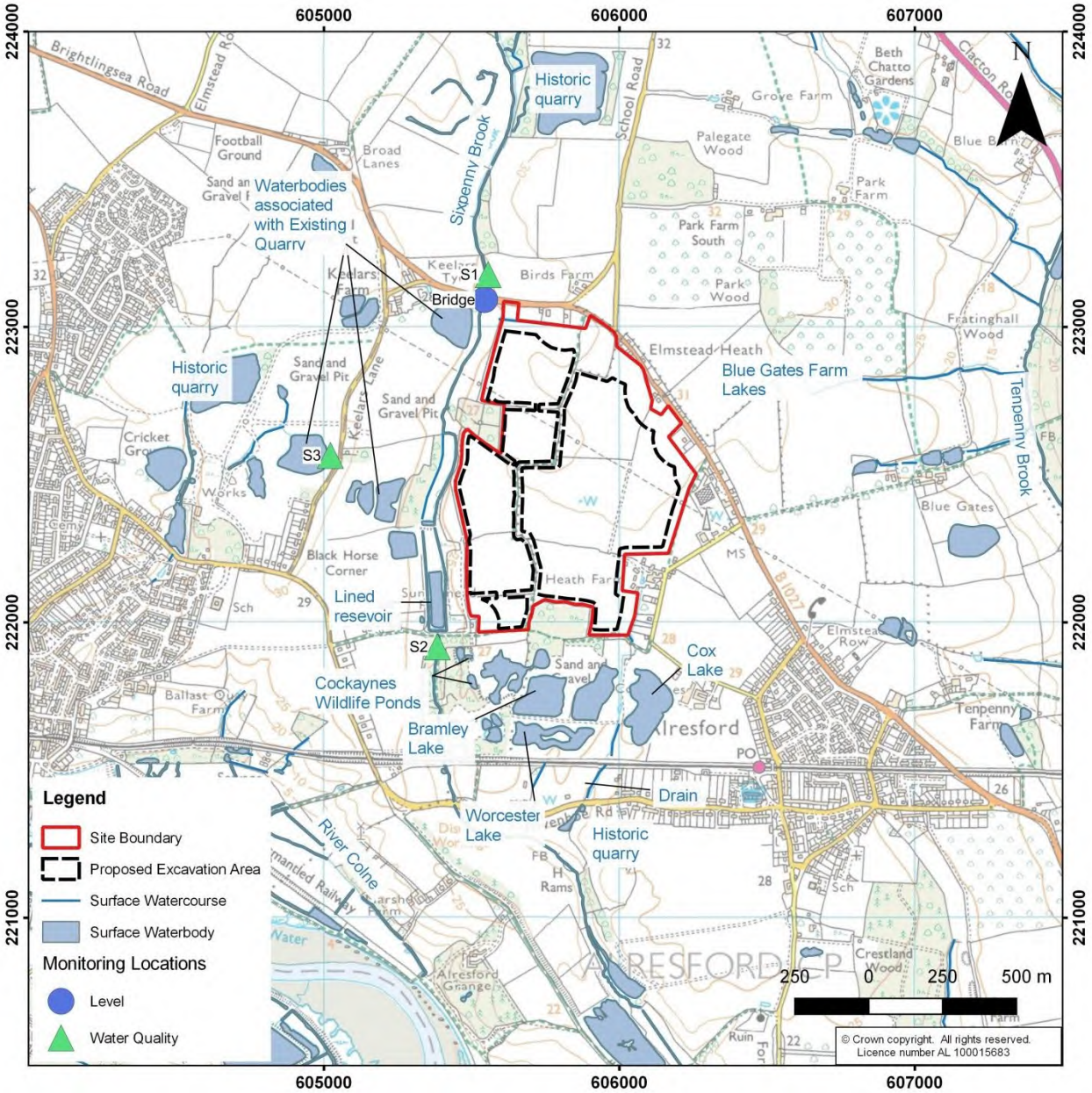

Figure 2.8 Local hydrology and surface water monitoring locations

2.3.3 Surface water flow and levels

Surface water flow data are available from (CEH, 2018) at the following locations:

- The Sixpenny Brook at Ship House Bridge (590 m south and downstream of the Site); and
- Tenpenny Brook at Tenpenny Bridge (2.4 km south-east).

Table 2.4 summarises the catchment characteristics and measured flows from each of these gauging locations. The baseflow indices for these watercourses indicate that the contribution to flow from groundwater in these catchments could be significant. As the Site is located upstream of the Sixpenny Brook gauging station, flows adjacent to the Site will likely be less than those presented here (unless the river is losing to groundwater).

Table 2.4 Flow statistics for neighbouring flow gauging locations (CEH, 2017)

Parameter	Sixpenny Brook at Ship House Bridge	Tenpenny Brook at Tenpenny Bridge
Available record	1960 - 1971	1961 – 1976
Location and distance from Site	590 m south	2.4 km south-east
Baseflow Index	0.658	0.664
Catchment area (km^2)	5.1	29
SAAR 1941 – 1970 (mm)	556	565
95% exceedance (m^3/s)	0.003	0.011
70% exceedance (m^3/s)	0.008	0.025
50% exceedance (m^3/s)	0.014	0.045
10% exceedance (m^3/s)	0.059	0.212
Mean flow (m^3/s)	0.025	0.085
Estimated mean annual effective precipitation (mm)	155	92

Mean flows of 0.025 m^3/s in the Sixpenny Brook imply an effective annual rainfall of 155 mm over the entire catchment. The SAAR for the catchment for 1941 – 1970 (i.e. consistent with the monitoring period) was 556 mm. This suggests an actual evapotranspiration of 401 mm/a. Using the same method for the Tenpenny Brook, similar values of 92 mm and 473 mm have been derived for annual effective rainfall and annual actual evapotranspiration respectively. These calculations only produce rough estimates and do not account for anthropogenic abstractions which could lower mean flows and therefore produce a lower estimated effective precipitation. There are a number of abstractions around these watercourses (Section 2.7) and, therefore, these estimates should be treated as lower bounds.

Tarmac monitors surface water levels in the Sixpenny Brook at Wivenhoe Bridge (marked as “Bridge” on Figure 2.8). Levels have been monitored since November 1997 and range from 23 – 23.55 m AOD with a mean level of 23.23 m AOD.

It is understood that levels in Cox Lake, Worcester Lake and the closest pond in Cockaynes Wildlife Site are due to be monitored on a regular basis however, no data have been collected to date. Anecdotal evidence indicates that levels in Cox Lake fluctuate by around 0.15 m between summer and winter.

2.4 Site Drainage and Water Management

2.4.1 Site water management plan

The Site does not have an existing surface water management plan. Surface water at the Site currently runs off to the shallow ditches that cross the Site or reaches the Sixpenny Brook directly. Details of the proposed surface water management for the Site are outlined in Section 3.

The existing Wivenhoe Quarry has a water management plan in place. A series of settlement lagoons are used to allow suspended solids to settle out of suspension within the mineral processing circuit prior to discharge to the Sixpenny Brook. Water within this circuit is topped up from quarry dewatering. This is governed by discharge licence PRENF-11541

which is appended in Appendix D and stipulates the following:

- The daily discharge rate will not exceed 3,928 m^3/day;
- The maximum instantaneous discharge rate will not exceed 45 l/s; and
- The discharge must contain no more than 30 mg/l of suspended solids.

Dewatering at Wivenhoe Quarry is currently minimal because the current excavation is not far below the water table and is of a relatively small area. Dewatering water is discharged under the conditions of PRENF-11541.

2.5 Hydrogeology

2.5.1 Groundwater classifications and systems

The Kesgrave Catchment Subgroup, river terrace deposits and alluvium are designated as Secondary A aquifers. Secondary A aquifers are permeable layers capable of supporting water supplies at a local rather than strategic scale, and can be an important source of base flow to rivers. Typically, these aquifers were formerly classed as minor aquifers. The cover sand and silt has been designated as a Secondary B aquifer. Secondary B aquifers are predominantly lower permeability strata which may have the ability to store and yield limited amounts of groundwater by virtue of localised features such as thin permeable horizons and weathering.

The Thames Group is designated as Unproductive. Unproductive denotes geological strata with low permeability that have negligible significant for water supply or river baseflow. The Cretaceous Chalk is designated as a Principal Aquifer. Principal Aquifers are layers of rock or drift deposits that have high intergranular and/or fracture permeability, meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. Mostly, Principal Aquifers were previously designated as major aquifers. At the Site, the underlying Chalk is confined and therefore will not support river base flow.

2.5.2 Groundwater levels

Available data

There are eleven groundwater level monitoring locations at the Site and the existing Wivenhoe Quarry. Monthly groundwater level data are available from December 1991 for some of these, with data for the full network being available from January 2012. Table 2.5 provides a summary of the monitoring locations and these are shown in Figure 2.9. Borehole logs are presented in Appendix C. Boreholes are generally screened in the lower sand and gravel layer or across both layers (including the interburden).

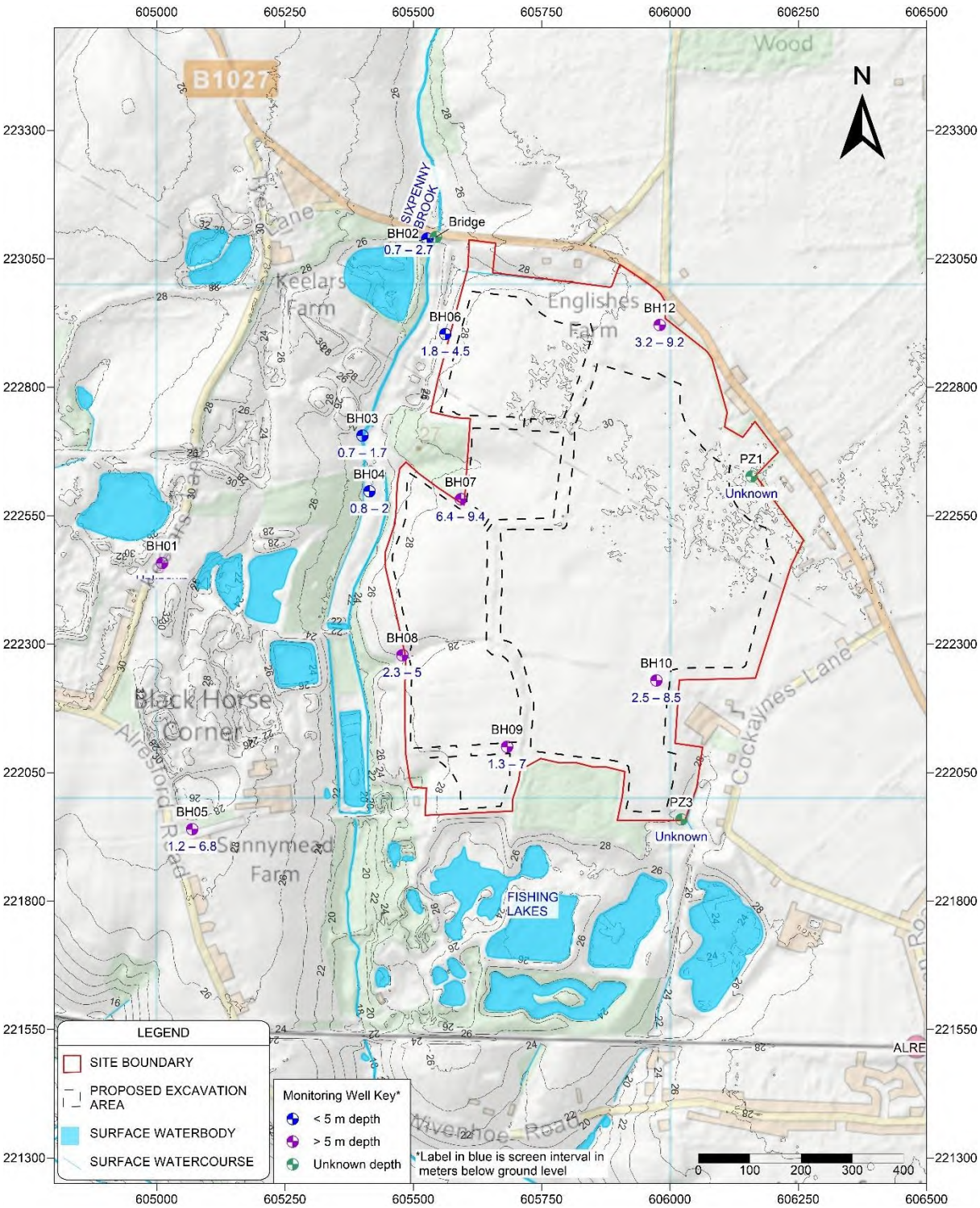

Figure 2.9 Monitoring locations at and around the Site

Table 2.5 Groundwater monitoring boreholes at and around the Site

Borehole	Easting	Northing	Screened interval (m bgl)	Screened unit	Data availability
BH01	605011	222457	Unknown	Clayey sand and silty gravel	Dec 91 – Jan 18
BH02	605527	223089	0.7 – 2.7	Sandy silty clay with medium gravels	Mar 1997 – Jan 18
BH03	605562	222904	0.7 – 1.7	Silty clay, fine-medium sand & gravel	
BH04	605593	222582	0.8 – 2	Fine-medium sand and gravel with silty clay	
BH05	605069	221940	1.2 – 6.8	Fine-medium sand with gravel	Mar 97 – Jan 18
BH06	605562	222904	1.8 – 4.5	Silty clayey gravel with silty clay	Jan 12 – Jan 18
BH07	605593	222582	6.4 – 9.4	Coarse sand and gravel & silty clay	
BH08	605478	222278	2.3 – 5	Fine-medium sand with gravel & silty clay	
BH09	605682	222100	1.3 – 7	Silty sand, fine-medium sand and gravel and silty clay	
BH10	605973	222229	2.5 – 8.5	Fine-medium sand with gravel and silt	
BH12	605980	222921	3.2 – 9.2	Fine-medium sand and gravel with silty clay	
PZ1	606159	222627	Unknown		Feb – May 16
PZ3	606022	221959	Unknown		

Groundwater Levels

A summary of the available groundwater level data is presented in Table 2.6. Mean groundwater levels vary from 21.3 m AOD (1.3 m bgl) at BH04 to 28.6 m AOD at BH12. Groundwater levels are shallowest at BH04 and deepest at BH07 (mean of 6.4 m bgl).

Table 2.6 Groundwater level data summary

Borehole	Groundwater Levels (m AOD)			Groundwater Levels (m bgl)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
BH01	23.3	24.8	26.6	7.55	5.99	4.25
BH02	22.0	23.4	24.2	2.79	1.40	0.52
BH03	21.5	21.9	22.4	1.98	1.56	1.09
BH04	20.2	21.3	22.1	2.41	1.33	0.47
BH05	23.7	25.3	28.2	5.77	4.10	1.24
BH06	23.8	25.0	25.2	3.54	2.34	2.06
BH07	22.9	23.5	25.1	7.06	6.40	4.77
BH08	23.4	25.7	26.2	3.68	1.41	0.91
BH09	26.1	27.2	28.7	3.67	2.57	1.11
BH10	27.1	27.9	29.3	3.31	2.51	1.11
BH12	27.9	28.6	29.9	3.32	2.62	1.36
PZ1	27.9	28.0	28.0	2.26	2.21	2.16
PZ3	25.8	25.9	25.8	1.71	1.69	1.68

Figure 2.10 shows groundwater level hydrographs for the monitoring locations at and around the Site. Seasonal fluctuations vary between locations but are typically not greater than 2 m. At BH03 fluctuations are much lower at around < 1 m and similar magnitudes of around 1 – 1.5 m are observed in BH02 and BH04. Fluctuations in these boreholes are likely dampened by the hydraulic connection with, and proximity to, the Sixpenny Brook. Longer term variations at some sites can be greater than 2 m although total variation in levels throughout the data period does not exceed 5 m.

Figure 2.10 also shows the monthly rainfall for the EA rain gauge at Brightlingsea. Peaks and troughs in groundwater levels correlate well with the rainfall data indicating that rainfall recharge is the primary control on groundwater levels.

Any drawdown due to dewatering at the existing Wivenhoe Quarry would be most expected in BH01 and BH05, which are located at the existing quarry. BH01 does not show any marked groundwater level decline which cannot be attributed to rainfall however, BH05 does show an approximately 1 m drawdown in levels between 2004 and 2006 followed by stabilisation. BH05 shows some recovery since 2015. This pattern of drawdown and recovery is coincident with the trend in the Cumulative Annual Mean Rainfall Residual (CAMRR) curve which can be used as a proxy for long term groundwater level trends where levels are primarily controlled by rainfall. This observed drawdown may therefore be natural. BH02, BH03 and BH04 do not show this trend implying that levels close to the Sixpenny Brook are moderated by water levels in the watercourse itself.

Since early 2017, most boreholes show a steady drop in groundwater levels. This correlates well with the rainfall data and can therefore be ascribed to natural variation in recharge.

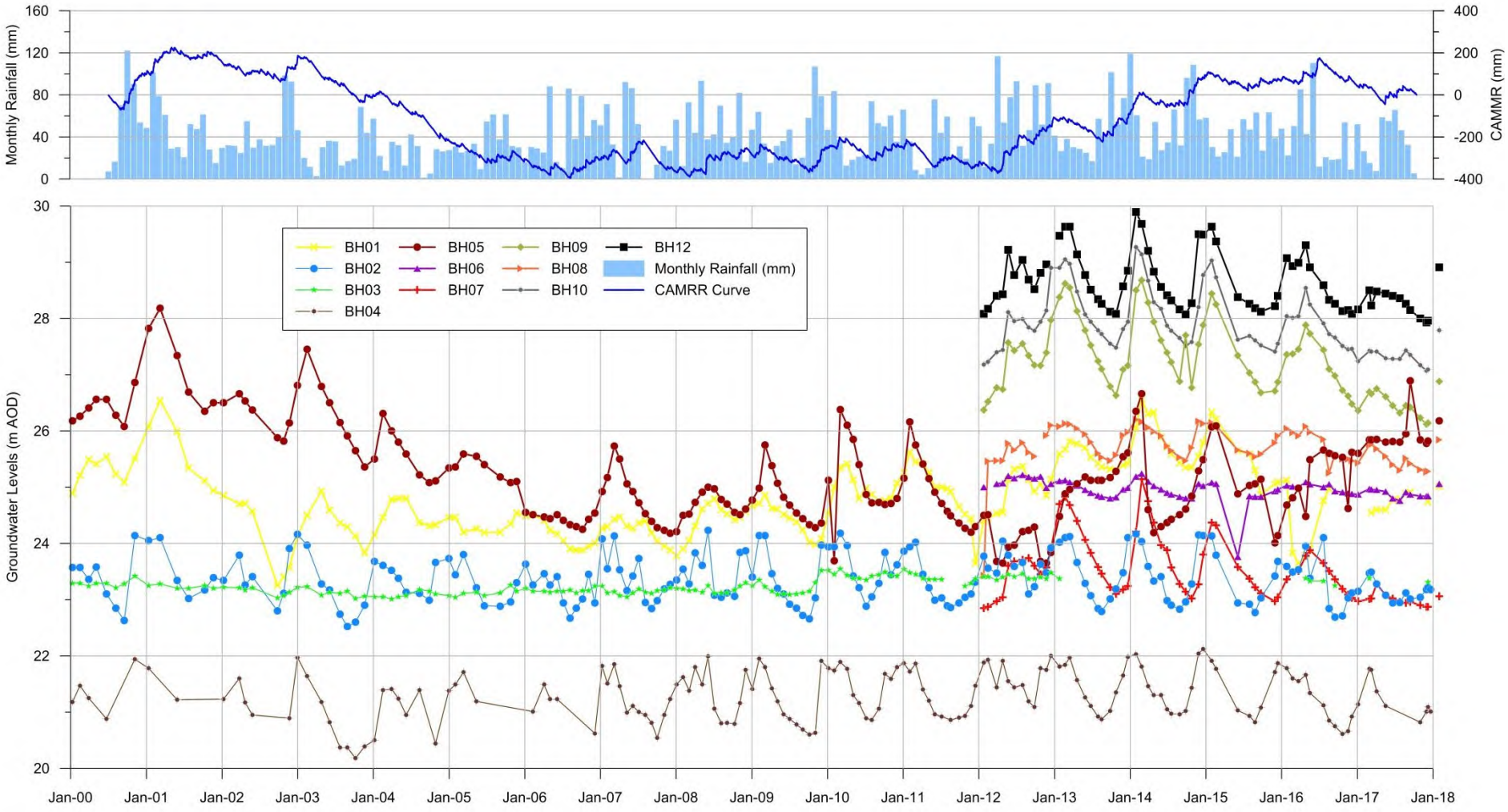

Figure 2.10 Groundwater level hydrographs

2.5.3 Groundwater flow

Groundwater levels are generally highest toward the eastern and northern boundaries of the Site and lowest toward the Sixpenny Brook. Figure 2.11 shows a groundwater level contour plan based on May 2016 levels (the most recent date for which levels are available at all points). An inferred groundwater level divide runs through the Site. Groundwater west of the divide discharges to the Sixpenny Brook west of the Site and the fishing lakes to the south, whilst that to the east will discharge to the Sixpenny Brook further downstream as well as other surface watercourse and waterbodies. David L Walker Limited reports that a number of springs have been observed which supply groundwater inflows to the fishing lakes to the south and it is therefore inferred that these act as local groundwater discharge locations. Based on the geological model, it is likely that these springs are above the Thames Group, but they may also be above the interburden layer.

Groundwater levels in BH02 are similar to those at the Wivenhoe Bridge surface water monitoring location (marked “bridge” on Figure 2.9) and it is likely that groundwater in the sand and gravel aquifer and the Sixpenny Brook is in hydraulic continuity. Levels in the watercourse are typically higher than groundwater levels during summer and lower during winter suggesting that the Sixpenny Brook at this location may lose to groundwater during the summer months and gain from groundwater in winter.

The groundwater contours show the Sixpenny Brook as gaining from groundwater despite levels in the brook being higher than groundwater. This is due to surrounding levels indicating that groundwater flow is towards, rather than away from, the brook. This is assumed to be the prevailing condition and the brook will only lose to groundwater during summer and, even during summer, losses will likely be only local. Recharge to groundwater will primarily be from rainfall rather than fluvial losses as is demonstrated by the responses of the groundwater hydrographs to incident rainfall.

Most of the monitoring boreholes are not screened where the interburden layer is present. Where boreholes are screened below the interburden layer, such as at BH07, groundwater levels are generally below the base of this unit indicating that they are unconfined. However, local areas of semi-confined groundwater may exist particularly in winter when levels are higher. Where the upper mineral is present, this could locally affect groundwater flow but, due to its greater thickness, the lower sand and gravel layer is considered to be the more important aquifer.

Vertical gradients will likely be present where there are two sand and gravel aquifer layers separated by a lower permeability interburden. This lower permeability layer will retard rainfall infiltration thereby causing local differences in groundwater levels across the interburden. This will mostly occur during winter when incident rainfall is generally greater. Around the Sixpenny Brook, there is an upwards gradient between BH02 and the bridge monitoring location, and a similar situation may also be evident at other neighbouring watercourses.

The Thames Group which underlies the sand and gravel aquifer forms the base of the aquifer due to its low permeability. It also acts to isolate the underlying Thanet Sands Formation and Chalk aquifer units.

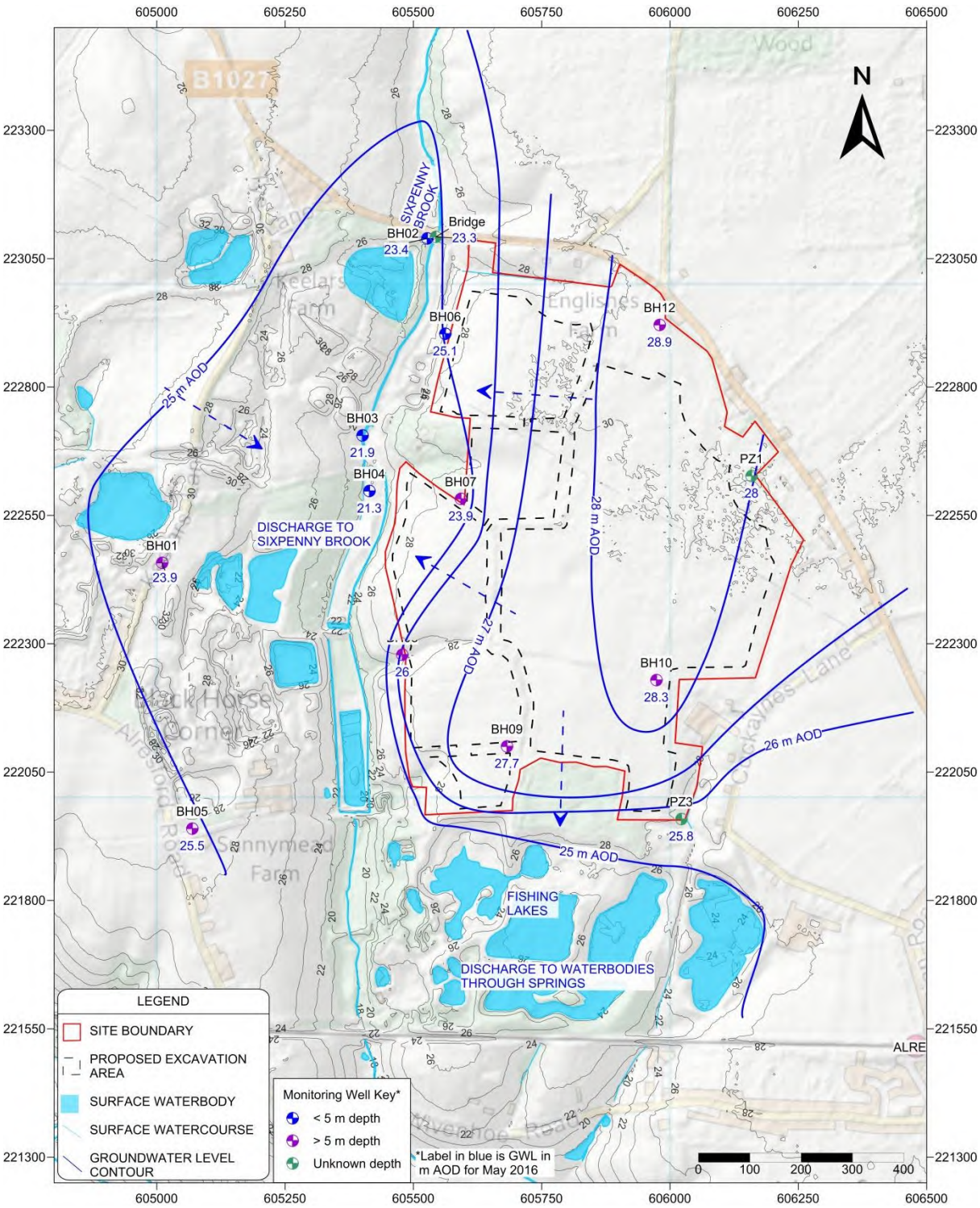

Figure 2.11 Groundwater levels and contour plan

2.5.4 Aquifer properties

Aquifer property testing has not been undertaken at the Site. However, estimates of the likely hydraulic properties can be made utilising the following sources of information:

- Borehole log descriptions of the encountered strata;
- Particle size distributions of samples taken during drilling;
- Recovery of groundwater levels following drilling; and

- Literature and previous investigations.

Superficial Deposits

Values for the hydraulic conductivity have been indirectly estimated based on particle size distributions, and geological descriptions. An approximate estimation of permeability from particle size distributions can be obtained using Equation 1 after (Hazen, 1893):

$$k = C \cdot (D_{10})^2 \quad (1)$$

Where: k is hydraulic conductivity (m/s);

D_{10} is the grain size at which 10% of particles in the sample are retained (mm); and

C is an empirical correlation factor.

A C value of 0.01 is typically used when grain size is in millimetres and hydraulic conductivity in m/s. Values derived from Equation 1 should be treated with caution, because they do not account for inherent heterogeneity or anisotropy (bedding planes, silty areas etc.) that might be present in the aquifer. Values estimated here have been used as a guide.

Hydraulic conductivity values have been estimated for ten intervals from five drilled exploration boreholes with the highest D_{10} values. This gives an upper estimate of the hydraulic conductivity of the sand and gravel aquifer. Table 2.7 presents the upper hydraulic conductivity estimates.

Table 2.7 Hydraulic conductivity estimates from particle size distributions

Borehole	Depth interval (m bgl)	D_{10} (mm)	Hydraulic Conductivity (m/s / m/day)
2	0.6 – 1.5	0.29	8.5×10^{-4} / 73.5
7	0.7 – 1.5	0.27	7.3×10^{-4} / 63
7	4.5 – 6	0.28	7.7×10^{-4} / 66.7
7	6 – 7.5	0.25	6.3×10^{-4} / 54
10	6 – 7.2	0.28	7.9×10^{-4} / 68.3
11	6 – 7	0.26	6.7×10^{-4} / 57.9
11	7 – 7.5	0.27	7.5×10^{-4} / 64.8
P1	0.4 – 1.5	0.28	7.9×10^{-4} / 68.3
P1	7.5 – 8.5	0.28	8.1×10^{-4} / 69.9

Although Equation 1 has yielded values consistent with those expected for a sand and gravel aquifer, there is likely to be some error in the results. Basing permeability on grain size alone does not account for macro scale heterogeneity in the aquifer that could influence the hydraulic conductivity. For samples with a D_{10} greater than the minimum particle size of 0.063 mm, estimated hydraulic conductivity ranges from 3.4 – 73.5 m/day with a mean of 29.2 m/day. Based on expert judgement, a value of 30 m/day is considered reasonable and

could be representative of the aquifer as a whole given the presence of a silty and clayey matrix within some of the sand and gravel strata.

The hydraulic conductivity of the overburden and interburden will be lower than the estimates outlined above. It is likely that the hydraulic conductivity of these layers will be < 1 m/day. Due to the presence of the interburden and overburden and lower permeability matrix sediments, the vertical hydraulic conductivity of the superficial aquifer as a whole will be lower than the horizontal hydraulic conductivity.

Thames Group

The Thames Group bedrock encountered beneath the superficial deposits at the Site is described as grey clay. It is expected that the hydraulic conductivity of this strata will be at least two orders of magnitude lower than that of the sand and gravel calculated above. The London Clay Formation was modelled with a hydraulic conductivity of 5 x 10^{-6} m/day in a groundwater model of the London Basin (Mott MacDonald, 2003). Given this low permeability, the Thames Group will confine underlying aquifers including the Chalk and Thanet Sands Formation.

2.6 Surface Water and Groundwater Quality

Groundwater quality is unavailable for monitoring boreholes at the Site. However, Tarmac does monitor surface water quality at the following locations (shown in Figure 2.8):

- SW1: Sixpenny Brook at Wivenhoe Bridge (Upstream of existing quarry) (100 m north-west);
- SW2: Sixpenny Brook south of Alresford Road (downstream of existing discharge location) (145 m south-west); and
- SW3: A settlement lagoon (430 m west).

Table 2.8 summarises the data provided by Tarmac which covers five sampling events in 2017. Surface water quality is generally good and exceedances of Environmental Quality Standards (EQS) are rare. There are a number of nickel exceedances, but these are compared to the bioavailable standard and the results obtained are for total nickel which will be greater than that which is bioavailable. There is one exceedance of the ammoniacal nitrogen Drinking Water Standard (DWS) at the settlement lagoon, but this recorded concentration is an outlier.

The two monitoring locations on the Sixpenny Brook are located upstream and downstream of the existing discharge location. Data from these locations can therefore be used to assess whether there is any deterioration in water quality of this watercourse that could be attributed to the existing quarry.

Based on the data provided, mean concentrations of iron, nickel, zinc and suspended solids are all higher at the downstream location compared to the upstream location. Iron concentrations are generally twice as high at the downstream location. However, concentrations of nickel, zinc and suspended solids fluctuate at both locations and are not consistently higher at the downstream location compared to the upstream location. Taking the water quality data as a whole, there are no consistent differences between the upstream and downstream locations.

Table 2.8 Summary of surface water quality data provided by Tarmac

Determinand	EQS (mg/l)	SW1: Sixpenny Brook U/S			SW2: Sixpenny Brook (D/S)			SW3: Settlement Lagoon		
		Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Ammoniacal nitrogen as N (mg/l)	0.39[1]	0.2	0.06	0.14	0.192	0.08	0.34	0.232	<0.05	0.61
Calcium (mg/l)	-	75.9	53	100	73.6	33	98	78.4	57	99.0
Chloride (mg/l)	250	66.9	56	88	68.6	39	81	60.2	41	72.0
Electrical Conductivity (µS/cm)	-	643	630	750	614	340	720	632	480	740
Iron (mg/l)	1	0.027	0.007	0.04	0.042	0.011	0.082	0.02	0.012	0.031
Manganese (mg/l)	0.123	0.010	0.006	0.067	0.0061	<0.001	0.016	0.0032	0.001	0.006
Nickel (mg/l)	0.004	0.008	0.004	0.018	0.0118	0.01	0.015	0.0026	0.001	0.004
Sodium (mg/l)	-	36.0	29.0	46.0	34.4	21	41	37	29	44.0
Sulphate (mg/l)	400	85.5	83.0	100	75.2	40	88	90.6	65	100
Suspended Solids (Total) (mg/l)	-	20.1	<10	48	30.2	<10	89	13.2	<10	40.0
pH (-)	-	7.87	7.60	8.00	7.76	7.5	8.00	8.04	7.80	8.30

[1]Drinking water Standard (DWS)

Water quality data for the Sixpenny Brook at Ford Lane in Alresford, 1.7 km south-east of the Site, has been provided by the EA. Data are available from May 2014 to April 2016 and summary statistics are presented in Table 2.9. Runoff from surrounding agricultural land will likely be responsible for the relatively high nitrate concentrations however, these do not exceed DWS. Relatively high nitrate and nitrite is suggestive of oxidising conditions indicating that water quality is, on the whole, good. The maximum results for ammoniacal nitrogen and nitrite exceed DWS however, this occurred on only one occasion for both determinands.

Table 2.9 Surface water quality for Sixpenny Brook at Ford Lane, Alresford

Determinand	DWS (mg/l)	Statistic		
		Minimum	Mean	Maximum
pH (-)	-	7.49	7.74	7.99
Electrical Conductivity (µS/cm)	-	453	639.5	719
Ammoniacal Nitrogen as N (mg/l)	0.39	0.03	0.06	0.421
Nitrate as N (mg/l)	11.3	1.92	8.21	10.8
Nitrite as N (mg/l)	0.02	0.04	0.0088	0.257

2.7 Potential Receptors

2.7.1 Surface water features

The following surface water features could potentially be affected by the proposed development:

- Sixpenny Brook;
- Tenpenny Brook;
- Ponds at Cockaynes Wildlife Site;
- Fishing lakes to the south of the Site including:
    - Cox Lake;
    - Worcester Lake; and
    - Bramley Lake.
- Waterbodies at Blue Gates Farm; and
- Other smaller watercourses and waterbodies in the area around the Site.

2.7.2 Licenced water abstractions

Licenced abstractions located within 2 km of the Site are shown in Figure 2.12 and detailed in Table 2.10. Appendix E contains a full list of all licenced abstractions around the Site.

Groundwater

Twelve (12) licenced groundwater abstractions are located within 2 km of the Site. These abstractions are mostly utilised for spray irrigation purposes reflecting the surrounding

predominantly agricultural land use. Some of the abstractions in Table 2.10 are from more than one location and the distances to each are listed in the table.

The closest licenced abstraction is from a borehole within the Site boundary (J Tinneveld) and this supply is utilised for direct spray irrigation. A further two abstraction locations for the same licence are sited 745 m west of the Site from gravel pits at the existing Wivenhoe Quarry. Tarmac also abstracts groundwater for mineral washing from the quarry under licence 8/37/25/*G/0028.

The closest Brett Aggregates abstraction is for the historical quarry to the south of the Site which has now been restored. It is understood that this abstraction is therefore no longer utilised and will not be affected by the proposed development.

The next closest licenced abstractions are all > 500 m away and include three groundwater boreholes at Elmstead Hall Farm, and a borehole at Fen Farm. Other than the closest Tinneveld abstraction (6,342 m^3/day) and the Tarmac abstraction, the next closest abstraction with the greatest rate is that operated by Fen Farm (3,300 m^3/day). Other surrounding licenced groundwater abstractions are typically for up to < 1,000 m^3/day. Abstractions from surface water are generally licenced for much greater quantities.

It is uncertain which aquifer the groundwater abstractions target. Those from quarry voids will be from shallow and permeable superficial deposits however, some of the other larger abstractions could target bedrock aquifers underlying the Thames Group.

None of the abstractions within 4 km of the Site are associated with a Source Protection Zone (SPZ) and there are no SPZs within 4 km of the Application Site.

Surface Water

Eleven (11) licenced surface water abstractions are located within 2 km of the Site. All of these abstractions are utilised for spray irrigation purposes.

The closest surface water abstraction is operated by Sunnymead Farm and is from a lined reservoir along the Sixpenny Brook 170 m west of the Site. This reservoir is used to store water presumably for use during the summer months. It is assumed that this license to top up the reservoir is from the Sixpenny Brook and that water is abstracted from the Brook mostly during winter.

The next closest surface water abstractions are from three reservoirs supplied by the Tenpenny Brook at Blue Gates Farm. It is expected that a similar arrangement to that at Sunnymead Farm is in place at this location. Information from David L Walker indicates that the Grove Farm surface water abstraction (1 km north-east of the Site) is from a series of four reservoirs situated east of Grove Farm of which the most westerly is spring fed and unlined.

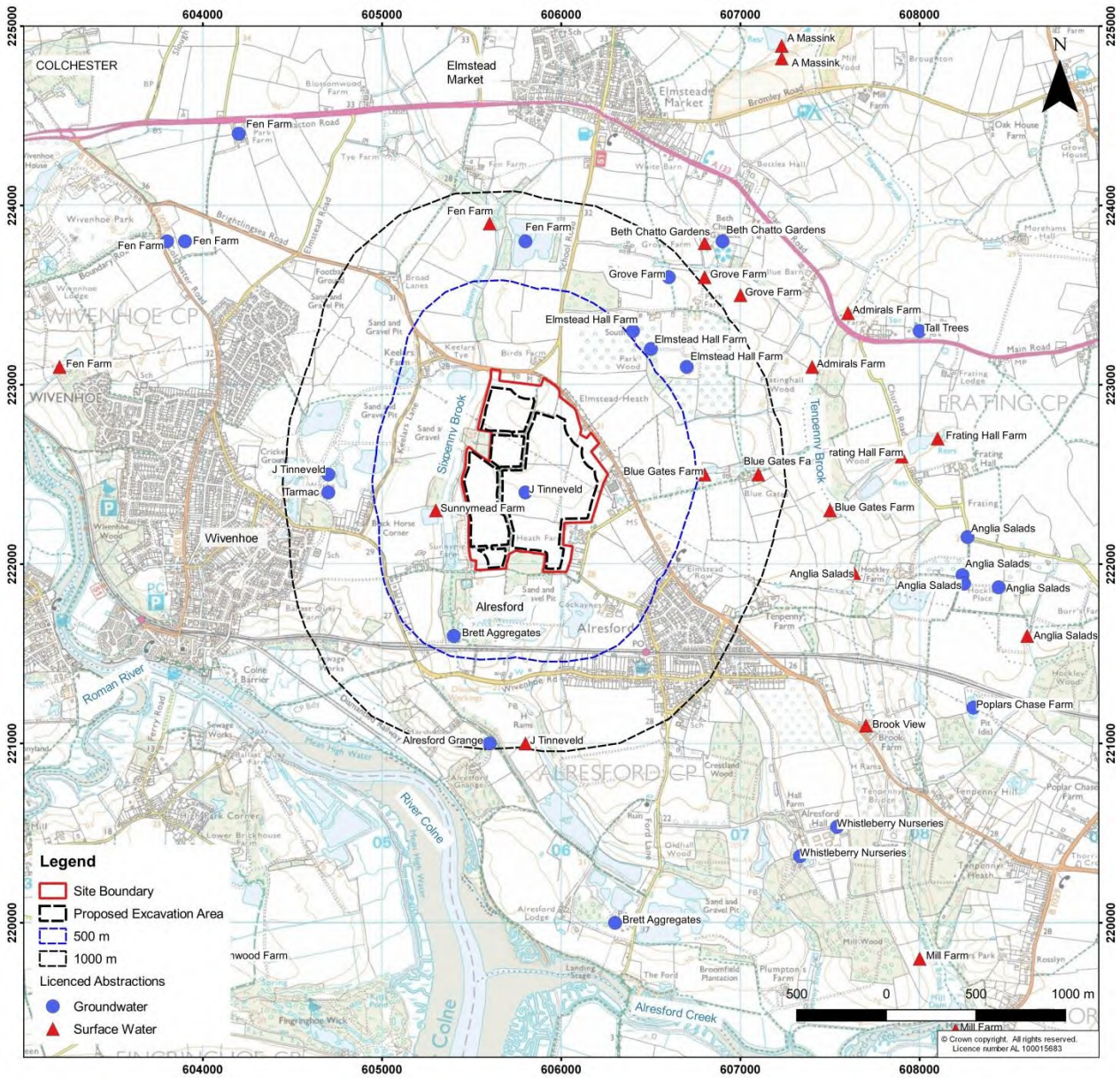

Figure 2.12 Licenced abstractions around the Site

Table 2.10 Licenced abstractions within 2 km of the Site

Name	Licence No.	Distance from Site	Use	Daily Limit (m^3/day)	Comments
Groundwater					
J Tinneveld	8/37/25/*G/0093	At the Site & 745 m west	Spray Irrigation – direct & frost protection	6,342	3 abstractions from gravel pits and borehole
Brett Aggregates	8/37/25/*G/0188	400 m south	Mineral washing	650	
Elmstead Hall Farm	8/37/25/*G/0014	520 m, 540 & 645 m north-east	Spray irrigation – direct	682	Abstraction from three boreholes
Fen Farm	8/37/25/*G/0282	720 m north	Spray irrigation – direct	3,300	
Tarmac	8/37/25/*G/0028	750 m west	Mineral washing	2,100	Abstraction from quarry voids
Grove Farm	8/37/25/*G/0170	870 m north-east	Spray irrigation – direct	480	
Alresford Grange	8/37/25/*G/0089	975 m south	General farming and domestic	21	
Beth Chatto Gardens	8/37/25/*G/0302	1.2 km north-east	Spray irrigation – direct	100	
Fen Farm	8/37/25/*G/0179[1]	1.9 km north-west	Spray irrigation – direct	874	Two borehole locations
Tall Trees	8/37/25/*G/0105	1.9 km north-east	Spray irrigation - direct	95	
Brett Aggregates	8/37/25/*G/0110	2.0 km south	Mineral Washing	36	
Brett Aggregates	8/37/25/*G/0112	2.0 km south	Mineral washing	136	
Surface Water					
Sunnymead Farm	8/37/25/*S/0222	170 m west	Spray Irrigation, storage	22,700	Abstraction from lined reservoir
Blue Gates Farm	8/37/25/*S/0127	540 m & 840 m	Spray irrigation – direct	455	Abstraction from three reservoirs fed by

Name	Licence No.	Distance from Site	Use	Daily Limit (m^3/day)	Comments
					Tenpenny Brook
J Tinneveld	8/37/25/*S/0041	975 m south	Spray Irrigation – direct	683	Reservoir on Sixpenny Brook
Grove Farm	8/37/25/*S/0015	1 km & 1.1 km north-east	Spray irrigation – direct	656	Reservoir on Tenpenny Brook
Beth Chatto Gardens	8/37/25/*S/0280	1.2 km north-east	Spray irrigation – direct	91	Tributary of Tenpenny Brook
Admirals Farm	8/37/25/*S/0241	1.3 km east	Spray Irrigation – storage	2,030	Tenpenny Brook
Blue Gates Farm	8/37/25/*S/0291	1.3 km east	Spray Irrigation – storage	12,100	Tenpenny Brook
Anglia Salads Limited	AN/037/0025/005/R01	1.5 km east	Spray Irrigation – storage	960	Tenpenny Brook
Admirals Farm	8/37/25/*S/0196	1.6 km north-east	Spray Irrigation – storage	680	Tenpenny Brook
Fraiting Hall	8/37/25/*S/0198	1.6 km & 1.8 km east	Spray irrigation – direct & storage	336	Tributaries of Tenpenny Brook
Brook View	8/37/25/*S/0230	1.9 km south-east	Spray irrigation - direct	1,640	Tenpenny Brook

[1]Licence includes transfer licence between sources

2.7.3 Private Water Supplies

Information was provided by Tendering District Council and Colchester Borough Council in March 2018 on private water supplies in the surrounding area.

Further information on known private water supplies where records are not held by either council has been provided by David L Walker Limited and has been sourced from OS mapping. David L Walker Limited has undertaken a letter drop in the area around the Site to obtain these further records. Records for the OS map wells were not corroborated by the letter drop survey and it is assumed that these no longer exist however, for completeness, these records have been included.

Figure 2.13 shows a map of known private water supply locations around the Site and Table 2.11 summarises the available information for these supplies. Appendix F contains details of all known private water supply records obtained. Only those within the jurisdiction of Tendering District Council are located within 2 km of the Site.

All known private water supplies are sourced from groundwater and are utilised for domestic and gardening purposes. Knowledge of four of the five closest private water supplies has been obtained from David L Walker Limited. It is uncertain which aquifer most of these water supplies target but, given the expected small abstraction rates, it is expected that the supplies are sourced from the shallow superficial deposits. The closest Furzedown borehole is understood to be 4 m deep and will likely be typical of many of the boreholes in this area.

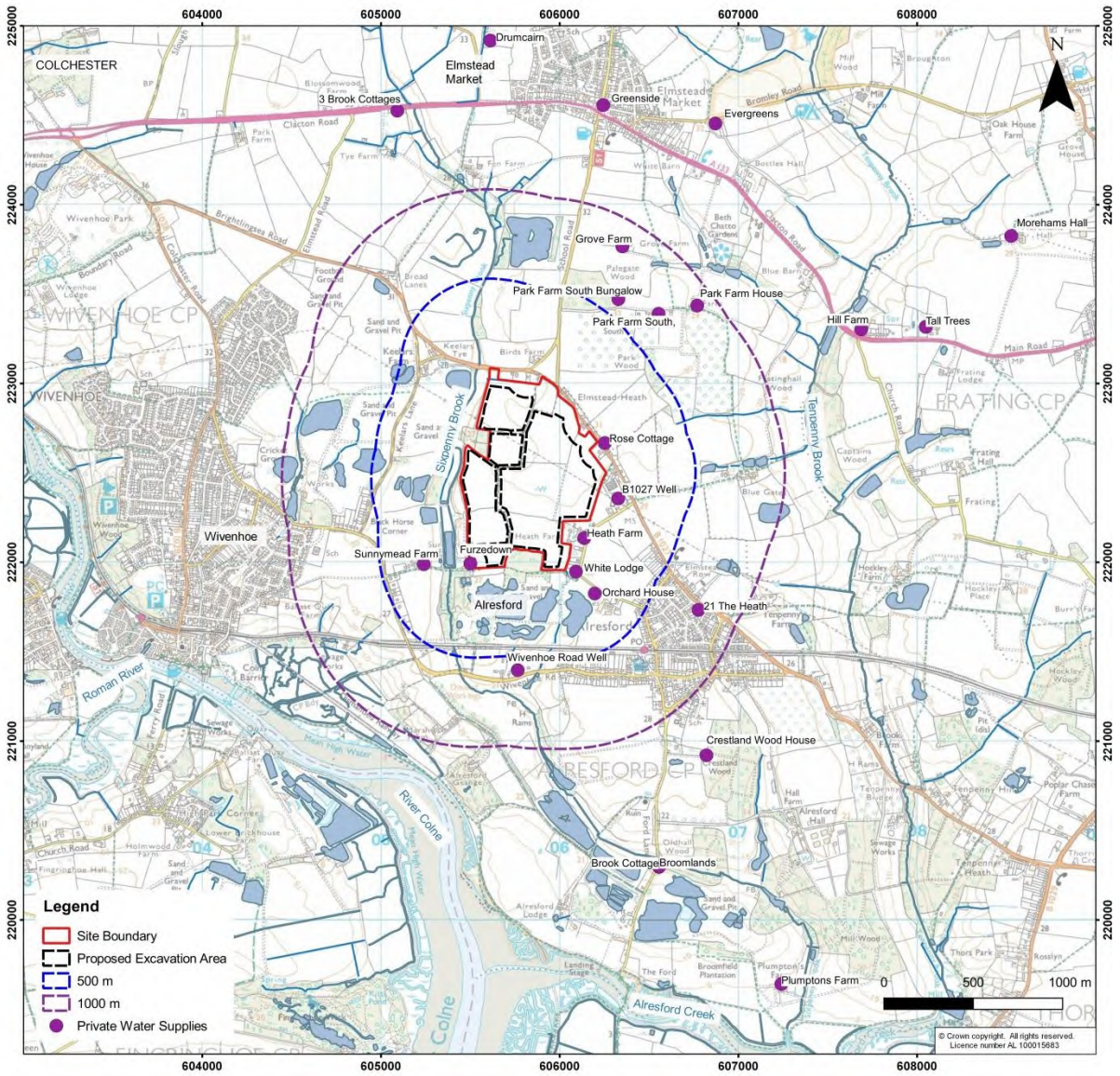

Figure 2.13 Private water supplies in the surrounding area

Table 2.11 Known private water supplies within 2 km of the Site

Name	Distance from Site	Source	Data Source
Furzedown	Immediately west	GW	David L Walker Ltd
Rose Cottage	50 m east	GW	
White Lodge	60 m east	GW	
Heath Farm	85 m east	GW	
B1027 Well	115 m east	GW	OS mapping
Orchard House	220 south-east	GW	David L Walker Ltd
Sunnymead Farm	260 m west	GW	
Wivenhoe Road	560 m south	GW	OS mapping
Park Farm South Bungalow, Elmstead	600 m north-east	GW	Tendering District Council
Floral Cottage	690 m east	GW	David L Walker Ltd
Park Farm South, Elmstead	700 m north-east	GW	Tendering District Council
21 The Heath	790 m east	GW	David L Walker Ltd
Grove Farm	860 m north	GW	
Park Farm House, Elmstead	920 m north-east	GW	Tendering District Council
Crestland Wood House, Alresford	1.3 km east	GW	
3 Brook Cottages, Elmstead	1.5 km north	GW	
Greenside, Elmstead	1.6 km north	GW	
Hill Farm, Frating	1.6 km east	GW	
3 Brook Cottages, Alresford	1.7 km south-east	GW	
Broomlands, Alresford	1.7 km south-east	GW	
Evergeens, Elmstead	1.7 km north	GW	
Drumcairn, Elmstead	1.8 km north	GW	
Tall Trees, Frating	1.9 km east	GW	

2.7.4 Designated environmental sites

Figure 2.14 shows the location of neighbouring designated sites in relation to the Site. Table 2.12 provides a summary of these sites and the reasons for the designation. The closest designated site is the Wivenhoe Gravel Pit SSSI which is not water-dependent and therefore is not a potential receptor.

The Upper Colne Marshes SSSI is the closest water-dependent designated site. This is part of a series of designated sites along the River Colne and its estuary. These are variably designated as SSSI, Ramsar, Special Area of Conservation (SAC) and Special Protection Area (SPA) and are comprised of important estuarine, wetland and intertidal habitats for various bird species. A Local Nature Reserve (LNR) is located further upstream along the River Colne.

Cockaynes Wood is immediately adjacent to the Site to the south is a designated Ancient

Woodland. This wood is defined as ancient and semi-natural woodland and covers an area of 5.49 ha. Coakynes Wood forms part of Cockaynes Wildlife site. The restored minerals workings at Cockaynes Wildlife site to the south, whilst holding nature conservation value, are not understood to be designated at this time.

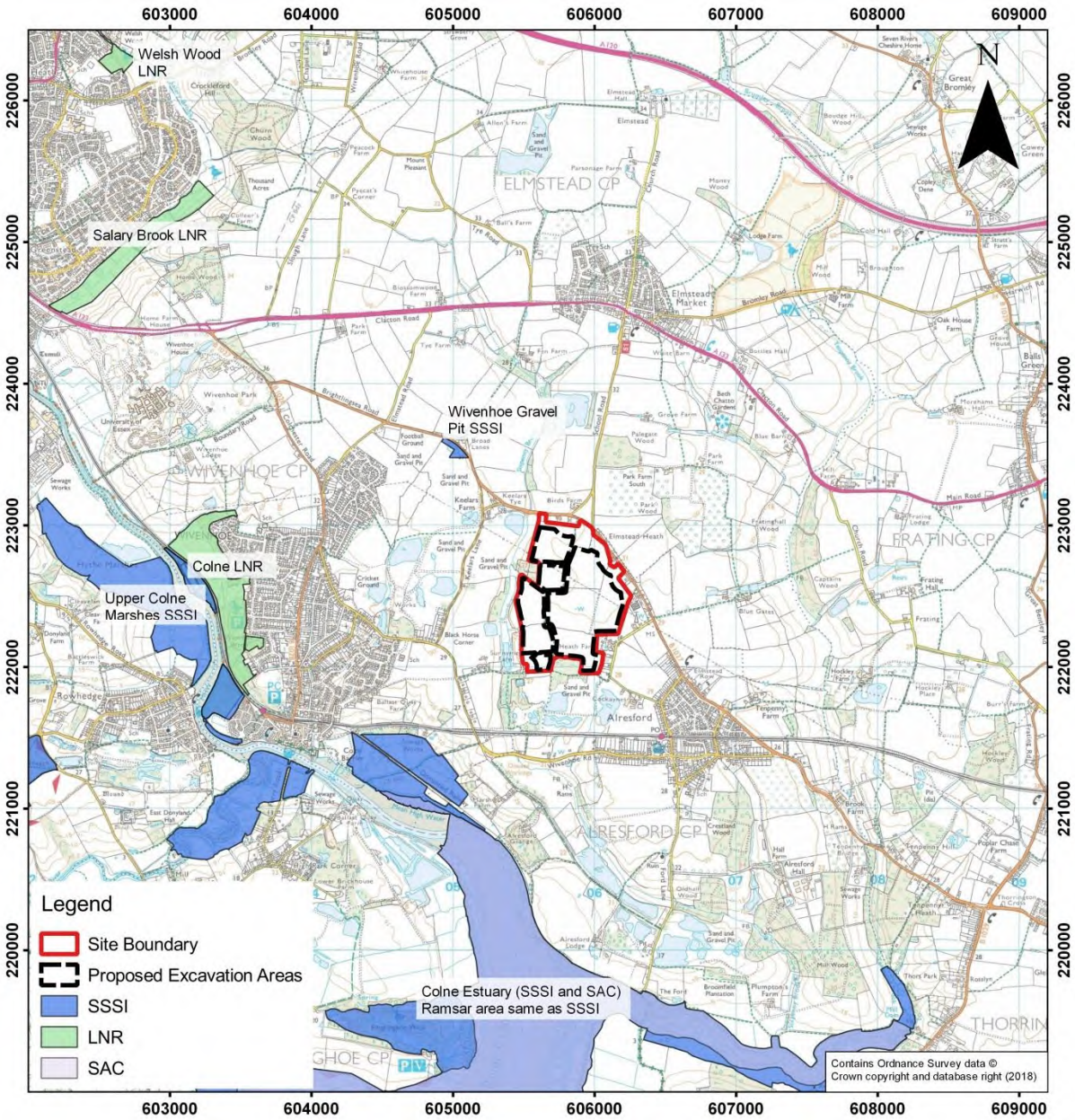

Figure 2.14 Designated sites in the surrounding area

Table 2.12 Designated sites within 4 km of the Site

Name	Designation	Distance from Site	Designation	Water Dependent
Cockaynes Wood	Ancient woodland	Immediately south	Ancient and semi-natural woodland	Yes
Wivenhoe Gravel Pit	SSSI	650 m north-west	Interglacial sediments containing well preserved fossils	No
Upper Colne Marshes	SSSI	800 m south-west	Assemblage of nationally scarce plants and diverse brackish ditch-types. The site also provides habitats for terrestrial and aquatic invertebrates and breeding and wintering birds.	Yes
Colne Estuary	SSSI/Ramsar	1 km south	Variety of salt marsh and estuarine habitats supporting important vegetation and bird species.	Yes
Essex Estuaries	SAC			
Colne Estuary	SPA			
Colne	LNR	1.8 km west	Marsh, woodland and grassland habitats.	Yes
Salary Brook	LNR	3.2 north-west	Marsh, wet grassland and wetland habitats	Yes
Roman River	SSSI	3.4 km south-west	Woodland, grassland and fen habitats supporting various bird and insect species.	Yes

2.8 Conceptual Model

Superficial strata at the Site are underlain by the Thames Group bedrock comprised of grey clay. The economic sand and gravel mineral is within the superficial Kesgrave Catchment sub-group. This unit is comprised of four distinct units; a clay/silt dominated overburden, an upper sand and gravel layer, a silty/clayey interburden and a lower sand and gravel layer.

The upper sand and gravel layer is not continuous at the Site, whilst the lower layer is continuous and is much thicker. Interburden is found between the upper and lower mineral layers where the upper mineral is present. The mineral is thickest (> 7.5 m) in the western and central parts of the Site. The mineral thins to the south of the Site where it has been removed by historical quarrying activities and a series of waterbodies now occupy these voids. Overburden is typically < 1 m thick in the centre of the Site but thickens to the east and west (but is still < 2 m thick).

Several small ditches being either ephemeral or conveying very small flows drain the Site. The Sixpenny Brook is the closest watercourse lying 20 m west of the Site at its closest

approach. A number of small ponds are present at Cockaynes Wildlife site (80 m south) and a series of fishing lakes are also present (120 m south) and these waterbodies occupy historical quarry voids. Springs have been observed around these waterbodies indicating that they receive discharge from groundwater, likely to be in continuity with the Kesgrave Group.

Based on groundwater levels recorded in boreholes at the Site and the existing Wivenhoe Quarry, the Sixpenny Brook is inferred to be in hydraulic continuity with groundwater in the sand and gravel aquifer. Groundwater flow appears to be towards the Sixpenny Brook in the west of the Site, towards the fishing lakes in the south of the Site and towards lower reaches of the Sixpenny Brook and other surrounding waterbodies in the east of the Site. Groundwater levels shows typical seasonal fluctuations of around 2 m except towards the Sixpenny Brook which appears to dampen these changes. Groundwater levels indicate that the sand and gravel aquifer is unconfined, but it may become locally confined over the winter months when levels are particularly high.

The deeper Chalk aquifer is inferred to be confined by the low permeability Thames Group unit. The Thames Group strata isolate the Chalk from the sand and gravel aquifer and therefore the two are not considered to be in hydraulic continuity.

There are many licenced and private abstractions in the area. In the absence of evidence to the contrary, it is assumed that groundwater abstractions (both licenced and private) in the surrounding area take water from the shallow sand and gravel layers rather than the deeper Chalk.

3 Proposed Development

3.1 Operational Stage

Sand and gravel mineral is to be excavated at the Site in a series of seven phases. Each phase will extend to approximately the base of the lower sand and gravel deposit. Appendix A contains the operational plans for the Site and full operational plans are provided in the Environmental Impact Assessment which this report forms part of.

An outline of the proposed development for each of the phases is provided below. Access to the Site will be via a surfaced access road in the northern part of the Site from the B1027.

Phase 1 is located in the north-western part of the Site and, following extraction, a low-level Processing Plant, Site office, freshwater lagoon and processed mineral stockpiles will be sited at this location. Two silt lagoons are to be created in the southern part of the Phase 1 void separated by a retained hedgerow and therefore mineral..

After Phase 1 has been excavated, subsequent phases will be excavated and then restored as excavation begins at the next phase. Overburden, interburden, topsoil and subsoil will be used where required to form screening bunds around each phase at the start of operations, or will be directly placed in support of the restoration of preceding extraction phases. Once extraction in each phase is complete, the quarry voids are to be restored using a combination of material from the screening bunds, overburden, soils and interburden from the next phase and imported inert restoration materials. Voids at phases 2, 3, 4 and 5 will be at least partially filled with inert restoration materials. .

Table 3.1 summarises the proposed phasing, restoration materials and mineral depths for each phase. The depth to the base of mineral varies across each phase, and this has been estimated using the geological model described above.

Table 3.1 Proposed phases, restoration materials and mineral depths for each phase

Phase	Depth to base of lower mineral (m)	Restored using
1	4 – 8.7	Phase 1 and 2 interburden and overburden
2	4.8 – 7.4	Imported inert restoration materials, Phase 2 and 3 interburden and overburden
3	4 – 9.9	Imported inert restoration materials and Phase 3 interburden and overburden
4	5.7 – 9.1	Imported inert restoration materials and Phase 4 and Phase 5 interburden and overburden
5	6.3 – 9.7	Imported inert restoration materials and Phase 5 and Phase 6 interburden and overburden
6	6 - 9	Phase 6 and Phase 7 interburden and overburden
7	4.4 – 7.9	Phase 7 interburden and overburden

Footpath 24, which currently runs north-south through the Site, will be maintained during the operation. Prior to commencing extraction at phases 4 to 7, a tunnel is proposed to be constructed beneath footpath 24. Excavated mineral would be transported from phases 4 to 7 using this tunnel to the processing plant. A 15 m standoff distance is to be maintained between the Phase 2 and Phase 7 excavation area and Cockaynes Wood during operations.

It is proposed to work each phase dry. Groundwater and surface water would be pumped from a sump in each phase to the silt lagoons under the provision of a Transfer Licence. Water will be discharged to the Sixpenny Brook under the terms of a discharge consent. There will be a requirement for consumptive water usage for the purposes of wheel washing, dust suppression and mineral processing. This water would be abstracted from the clean water lagoon and would be governed by an abstraction licence.

3.2 Restoration Stage

Appendix B contains the proposed restoration plan for the Site. Phases 4, 5 and 6 in the east of the Site are to be restored to a lake with marginal reedbed habitats. The remainder of the Site is to be restored to species-rich grassland with areas of woodland. The existing footpath 24 will remain and additional permissive footpaths are also proposed. An outlet is proposed to the restored lake, and this will drain through a small watercourse to two ponds in the Phase 7 area. An outlet is proposed from these ponds to a further watercourse conveying flow south of the Site.

3.3 Estimate of Inflows to the Excavations

3.3.1 Groundwater inflows

This section includes the theoretical analytical calculations of groundwater drawdown and inflows to the Site associated with operational dewatering.

Radius of Influence

The radius of influence of an abstraction can be estimated using the Sichardt formula (Equation 2).

$$R_0 = C \cdot s \cdot \sqrt{k} \quad (2)$$

Where: R_0 is the radius of influence (m);

s is drawdown (m);

k is hydraulic conductivity (m/s); and

C is an empirical factor

For radial flow, a C value of 3000 is typically used (Environment Agency, 2007). This method includes a number of assumptions and therefore the calculated values should be treated with caution.

Saturated thickness of the sand and gravel aquifer varies around the Site due to the variability of the base of the sand and gravel unit and groundwater levels. Assuming that each phase will be excavated to the underlying Thames Group bedrock and that dewatering will be undertaken to the base of each phase, drawdown has been estimated. This has been done by subtracting the maximum depth to the Thames Group bedrock from the approximate mean groundwater level. Table 3.2 contains these drawdown estimates. Estimated drawdown varies from 5.2 – 8 m between the phases.

Table 3.2 Depth to bedrock, mean groundwater levels and drawdown in each phase

Phase	Depth of bedrock (m AOD)	Mean groundwater level (m AOD)	Estimated drawdown (m)
1	21.3 - 26	26.5	0.5 - 5.2
2	20.5 – 23.9	27	3.1 - 6.5
3	19 – 22.5	26	3.5 - 7
4	20.8 – 24.5	28.5	4 - 7.7
5	20 – 23.5	28	4.5 - 8
6	20.7 – 23.5	28	4.5 - 7.3
7	21.8 - 25	27.5	2.5 - 5.7

The largest prospective quarry void area is Phase 5, and this also has the largest estimated drawdown. The mean base elevation of the sand and gravel mineral is around 21.5 m AOD in this area, and mean groundwater levels are approximately 28 m AOD. This gives an estimated mean drawdown of 6.5 m. This value has been used in the subsequent calculations.

Based on estimates and discussion of hydraulic conductivity in the sand and gravel aquifer (Section 2.5.4), a range of hydraulic conductivity values has been used in the equations. A hydraulic conductivity range of 3 to 75 m/day has been attributed to the aquifer. A best estimate of 30 m/day has been used based on mean hydraulic conductivities derived from particle size distributions. Using this hydraulic conductivity range and Equation 2, estimates of the radius of influence have been made and are presented in Table 3.3. A range in radius of influence of 115 – 575 m is calculated, but is most likely to be around 447 m.

Table 3.3 Results of radius of influence calculations

Hydraulic conductivity (m/day)	Radius of influence (m)
3 (estimated minimum)	115
30 (best estimate)	363
75 (estimated maximum)	575

Radii of influence presented in Table 3.3 are likely to be upper bounds. This is because the sand and gravel aquifer is limited in a real extent to the south and east of the Site where the unit is now absent.

Groundwater Inflows

Total groundwater inflow to the quarry voids during dewatering has been estimated using the Dupuit-Theim equation (Equation 3) for steady-state flow to a well in an unconfined aquifer (Kruseman & de Ridder, 1990).

$$Q = \pi \cdot k \cdot \left(\frac{h_1^2 - h_2^2}{2.3 \cdot \log\left(\frac{r_e + R_0}{r_e}\right)} \right) \quad (3)$$

Where: Q is the groundwater inflow per unit width of the aquifer (m^3/day/m);

k is hydraulic conductivity (m/day);

h_1 is the head in the quarry void (m);

h_2 is the static groundwater level (m);

r_e is the effective well radius (see Equation 4) (m); and

R_0 is the radius of influence (see Equation 2) (m).

The effective well radius was determined by making the pit outline circular using Equation 4.

$$r_e = \sqrt{\frac{a \cdot b}{\pi}} \quad (4)$$

Where: r_e is the effective well radius (m);

a is the excavation width; and

b is the excavation length (m).

Horizontal groundwater inflows have been estimated using the parameters in Table 3.4.

Table 3.4 Input parameters for groundwater inflow calculations

Parameter	Value(s)	Justification
Hydraulic conductivity	3, 30, 75 m/day	Estimates of minimum, best estimate and maximum
Drawdown	6.5 m	Estimated mean drawdown at Phase 5 void
Seepage face	0 m	Conservative assumption
Radius of influence	Calculated	See calculated values in Table 3.3 based on Equation 2

For these calculations it has been assumed that the base of the sand and gravel aquifer is the contact with the Thames Group strata. This is considered valid due to the relatively high contrast in hydraulic conductivity between the sand and gravel and low permeability Thames Group.

Table 3.5 presents results of the inflow calculations for the three different hydraulic conductivities used. Inflows from groundwater are expected to be in the range of 810 to 6,967 m^3/day, but an inflow of around 3,616 m^3/day (41.8 l/s) is calculated for the most likely scenario.

Drawdown at the Site could induce inflows from the Sixpenny Brook, particularly for the western phases. However, water levels in the Sixpenny Brook are lower than the ambient groundwater levels at the Site. This means that drawdown at the Sixpenny Brook would be less and possible inflows from the watercourse would be no greater than those from radial groundwater. These calculations are therefore considered appropriate and conservative.

3.3.2 Surface water ingress

Rainfall and surface water ingress as well as groundwater inflows must be removed by pumping. For the Phase 5 quarry void, it is assumed that all inflows from the restored eastern catchment (as calculated by ESI (2018) and located broadly east of Footpath 24) will be directed towards the void. This is conservative as, in reality, some runoff will leave

the Site directly rather than be captured by the void and the eastern catchment will not have reached its full extent until after restoration.

Using the eastern catchment area of 36.8 ha and the mean rainfall from the EA rain gauge at Brightlingsea of 529 mm, surface water ingress is estimated to be 534 m^3/day (6.2 l/s). Runoff during individual storm events will exceed this amount. However, this estimation is conservative because losses due to interception and evapotranspiration have not been accounted for. Additionally, a percentage of runoff will infiltrate to the ground prior to reaching the quarry void.

3.3.3 Total inflows

Based on the calculations in this section, the best estimate of combined inflows from groundwater and surface water for Phase 5 is 4,150 m^3/day (48 l/s). Groundwater inflows for the other phases will likely be less due to a lower drawdown and smaller area. Inflows estimated here should therefore be treated as upper bounds.

Table 3.5 Results of groundwater inflow calculations

Hydraulic conductivity (m/day)	Radial groundwater ingress (m^3/day)	Mean surface water inflows (m^3/day)	Total inflows (m^3/day)
3	810	534	1,344
30	3,616	534	4,150
75	6,967	534	7,501

3.3.4 Water management and discharge routes

Dewatering is required to facilitate efficient extraction of the mineral. During quarrying operations, runoff from each quarry void catchment will accumulate in the lowest section of the active quarry void. Dewatering will occur to up to approximately 6.5 m below mean groundwater levels in the sand and gravel aquifer depending on the active phase.

According to calculations undertaken for this report, up to 4,150 m^3/day (48 l/s) of groundwater and surface water ingress must be removed from the Phase 5 extraction area. For other phases, total inflows will be much lower. Groundwater and surface water will be used for various consumptive purposes including dust suppression, mineral processing and wheel washing. Combined, the total abstraction rate is likely to exceed the permitted quantity of 20 m^3/day, and therefore an abstraction licence will be required. The remaining dewatering requirement will be transferred to the Sixpenny Brook and this will be subject to a transfer licence. Licencing arrangements will be agreed with the EA prior to the start of operations.

Groundwater will be collected in a sump at the base of each quarry void. This will then be pumped to an active silt lagoon prior to transfer to the clean water lagoon to facilitate silt settlement prior to discharge to the Sixpenny Brook.

It is proposed to trade the existing abstraction licence used at the current plant site to the proposed plant area. Quarry void dewatering would be covered by transfer licences. These may allow transfer of a small proportion of the water to top up the mineral processing circuit which would then be consumptively used under the terms of the abstraction licence. Mineral washing is a low consumption use and losses to the aquifer are expected to be minimal.

Water will be discharged to the Sixpenny Brook at a rate not exceeding the estimated greenfield runoff rate. This will be in accordance with the accompanying FRA (ESI, 2018). A discharge consent will be required from the EA prior to this activity commencing. It is recommended that a water management plan is agreed with the Mineral Planning Authority prior to commencement of quarrying operations, and this can be included for via appropriately worded planning conditions.

4 Hydrogeological Impact Assessment

4.1 Potential Impacts and Proposed Mitigation Measures

The array of potential impacts from quarrying activities associated with sand and gravel extraction and subsequent quarry void restoration is well understood. A well designed quarry and standard mitigation measures can avoid many of these potential impacts. Table 4.1 lists potential impacts and the typical mitigation measures applied.

In the following sections the potential for the general hydrogeological impacts listed in Table 4.1 to apply to the receptors identified in Section 2.7 is discussed for the operational and restoration phases at the Site. The impact assessment methodology applied is set out in Appendix G.

Each of the identified receptors has been assigned a value from low to high and, along with the magnitude of effect at each receptor, an associated degree of impact has been deduced. Where the degree of impact is more than minor, the potential impact is considered significant and mitigation measures have been proposed. These mitigation measures are detailed in Section 4.5.

Table 4.1 Potential impacts of quarry development

No.	Type of Impact	Typical Mitigation Measures
A	Impacts from quarry operation through lower groundwater levels in surrounding aquifer unit	
A1	Impacts on water levels in nearby abstractions	Avoid working nearby, wet working, cut off walls, recharge trenches, discharge of compensation flows to drains
A2	Impacts on habitats sensitive to shallow groundwater levels	
A3	Impacts on water levels in any nearby ponds and lakes in connection with the aquifer	
A4	Impacts on baseflows in drains and watercourses sourced from sand aquifer	
A5	Impacts on neighbouring buildings and infrastructure caused by drawdown related settlement	
B	Impacts from quarry operation on water quality	
B1	Impacts on groundwater and surface water quality from standard plant operation	Settlement lagoons, standard planning conditions regarding bunding of fuel tanks, appropriate spill response procedures etc.
C	Impacts from discharge of water	
C1	Impacts on receiving watercourse quality	Settlement lagoons, controlled by discharge consent to be applied for
C2	Impacts on receiving watercourse flows	Covered by FRA
C3	Diversion of baseflow from one catchment to another	Relocation of discharge point, discharge of compensation flows to drains
D	Impacts from restoration	
D1	Long-term impact on groundwater levels and baseflow (can be either increased or decreased depending on restoration scheme)	Appropriate design of restoration, particularly the materials used to restore slopes and the level and location of the overflow point
D2	Additional loss of water from open water evaporation	Reduce areas of open water in restoration concept
D3	Faster runoff and increased flood risk	SuDS-style overflow channels to minimise peak flows

4.2 Impacts from the Operational Phase

4.2.1 A1 Neighbouring abstractions

The upper estimate of the radius of influence is 575 m, with a best estimate of 363 m. Effects on known neighbouring private and licenced abstractions within 600 m of the Site have been assessed in this section. In accordance with Appendix G, all private water supplies have been assessed as low value receptors. Licenced abstractions have similarly been classified as low value receptors, except where the abstraction limit is > 1,000 m^3/day, when they have been classed as medium value receptors. This is the case for the J

Tinneveld and Sunnymead Farm abstractions.

The Tinneveld abstraction is on land under Tarmacs control, with the licence holder J Tinneveld, a Agricultural Tenant. This tenancy (and therefore the abstraction) will remain in place until Phase 4, but thereafter will be reduced over time as the scheme develops. As the restoration scheme is to nature conservation habitats, there will be no requirement for the abstraction into the future at this location.

Table 4.2 summarises the predicted effects and impact assessment. This assessment has been undertaken assuming that all groundwater abstractions are screened within the sand and gravel which is reported to be the case at the Furzedown well (4 m deep). Abstractions screened within the Chalk will be not be impacted due to the presence of the low permeability Thames Group which will isolate any effects. The range of drawdowns shown in the effects column is an estimate based on distance from the Site boundary and the maximum drawdown predicted. It does not account for distances from a particular phase and is therefore conservative as more drawdown will result from operation of the eastern phases compared to the western phases.

Groundwater abstractions located north or east of the Site within the best estimate radius of influence are most likely to be affected. Effects on those west or south of the Sixpenny Brook will be buffered by the brook itself and less drawdown is predicted for the western phases meaning that there will be less of an effect.

Effects are dependent on the available drawdown in the well. As depths and available drawdown are unknown for all of the wells, it is not possible to quantify this at this stage. Drawdown in excess of 1 m would be a high degree of effect in neighbouring boreholes if, such as the Furzedown Well, these are screened in the sand and gravel aquifer. Such a drawdown will induce a significant impact.

Due to the proximity of the six closest abstractions to the Site, it is highly likely that a significant drawdown will result and mitigation will be required. A significant drawdown will only develop in those wells > 250 m away if the sand and gravel aquifer at the Site is connected to these wells and drawdown is not buffered by surface water. Effects on the private Sunnymead Farm abstraction could be buffered by the Sixpenny Brook and historical flooded quarry voids and this is therefore assessed as insignificant. Indeed, this abstraction is surrounded to the north-east and north-west by the existing quarry and no effects from dewatering at the existing quarry have been reported. The level of impact at this location is assessed as minor.

Given the distance to the other abstractions, significant effects are considered unlikely.

Table 4.2 Assessment of effects on neighbouring abstractions

Name	Source	Distance from Site	Type	Possible Effect	Receptor Value	Degree of Effect	Degree of impact	Significant	Action required
J Tinneveld	GW	At the Site	Licenced	Well will be removed	Medium	High	Major	Yes	Mitigation to be agreed between Tarmac and abstractor
Furzedown	GW	Immediately west	Private	Drawdown in excess of 3 m	Low	High	Moderate		
Rose Cottage	GW	50 m east	Private		Low	High	Moderate		
White Lodge	GW	60 m east	Private		Low	High	Moderate		
Heath Farm	GW	85 m east	Private	2.7 – 3.1 m drawdown	Low	High	Moderate		
B1027 Well	GW	115 m east	Private	2.2 – 2.7 m drawdown	Low	High	Moderate		
Sunnymead Farm	SW	170 m west	Licenced	None – abstraction is from a lined reservoir	Medium	Negligible	Negligible	No	None
Orchard House	GW	220 south-east	Private	1 – 1.6 m drawdown	Low	High	Moderate	Yes	Mitigation to be agreed between Tarmac and abstractor
Sunnymead Farm	GW	260 m west	Private	0.7 – 1.4 m drawdown but likely much less due to Sixpenny Brook	Low	Medium	Minor	No	None
Elmstead Hall Farm	GW	520 m north-east	Licenced	0 – 0.2 m drawdown	Low	Negligible – Low	Negligible - Minor	No	None
Elmstead Hall Farm	GW	540 m north-east	Licenced	0 – 0.1 m drawdown	Low	Negligible – Low	Negligible - Minor		
Blue Gates Farm	SW	540 m east	Licenced	Surface water – very little	Low	Negligible	Negligible	No	None
Wivenhoe Road	GW	560 m south	Private	None	Low	Negligible	Negligible		

4.2.2 A2 Sensitive sites

Cockaynes Wood is the closest designated site to the Site and is considered as a high status receptor. Based on Figure 2.11, groundwater levels beneath the woodland will likely be between 1.5 and 4 m below ground level. The ecology impact assessment for the Site indicates that tree roots are generally not found at depths greater than 3 m and that 90% of tree roots will be in the shallowest 1 m of soil (Crestwood Environmental Limited, 2018). Based on existing groundwater levels, this indicates that trees rely upon percolating rainfall for water uptake rather than groundwater. Given this, the level of effect is considered to be negligible and the degree of impact is also negligible.

The Upper Colne Marshes SSSI and variously designated parts of the River Colne estuary are the next closest water dependent designated sites to the Site and these are all high status receptors. The Upper Colne Marshes is the closest and lies 800 m south-west of the Site along the River Colne. This lies outside of the radius of influence and, like the River Colne estuary sites, the habitats are likely mostly dependent on tidal rather than groundwater inflows. Therefore, any effect would be negligible and the degree of impact would also be negligible.

Other designated sites are located further away and effects and the degree of impact are similarly classified as negligible.

4.2.3 A3 Ponds and lakes in connection with the aquifer

The closest identified waterbodies that could be affected by dewatering at the Site are the ponds at Cockaynes Wildlife Site and the fishing lakes (Cox Lake, Worcester Lake and Bramley Lake) located to the south of the Site. The lakes have been conservatively classified as medium status receptors. Although the sand and gravel layer appears to thin towards the south, these lakes are reported to be spring fed.

The conceptual model indicates than these lakes are in hydraulic continuity with groundwater in the superficial deposits at the Site. Given that they all lie inside the predicted best estimate radius of influence, it is considered likely that levels in all the lakes could be affected.

Effects will be greatest in the ponds at Cockaynes Wildlife Site, Cox Lake and Worcester Lake which are closest to the Site. Effects will be greatest when the southern phases are being worked as these are closer to the waterbodies. The degree of effect on the closest lakes could be high, with effects on Bramley Lake being medium. The degree of impact is therefore major and moderate for the closer lakes and Bramley Lake respectively, and mitigation measures have been proposed below.

Waterbodies at Blue Gates Farm lie 540 m east of the Site and within the highest radius of influence of 575 m. These are also conservatively classified as medium value receptors, but given the distance from the Site, the degree of effect is considered to be negligible.

The agricultural reservoir located 100 m west of the Site is lined and therefore will not be impacted by dewatering operations at the Site. Other surface waterbodies located west of the Site are owned by Tarmac and therefore effects on these have not been considered.

4.2.4 A4 Baseflow in drains and watercourses

The Sixpenny Brook is the closest watercourse to the Site and lies within the radius of influence of quarry dewatering. This is considered to be a medium value receptor. It is likely that this watercourse is in hydraulic continuity with the sand and gravel aquifer and therefore there will be some reduction in baseflow.

It is proposed to discharge dewatering water to this watercourse and therefore any depletion

in flow will be compensated for by the direct discharge of dewatering water to the Brook. Provided the discharge location is adjacent to, or upstream of, the focus of dewatering, any effects on flows in the Sixpenny Brook will likely be small. The degrees of effect and impact are therefore considered to be negligible.

The small watercourse originating from Heath Farm east of the Site and flowing southwards through the fishing lake complex is classified as a low value receptor. This watercourse is also likely to be in continuity with the sand and gravel aquifer and could be affected by dewatering particularly for phases being working in the eastern part of the Site. The degree of effect could be medium and the degree of impact could be minor. Provided that levels in the fishing lakes are maintained through mitigation measures (see Section 4.5 below), it is considered that levels in this drain in the reach adjacent to the Site are not critical. Some of the fishing lakes outfall to this drain and these would support flows in the watercourse downgradient.

The Tenpenny Brook is located around 1.1 km east of the Site and is classed as a medium sensitivity receptor. This distance is greater than the highest radius of influence estimate and geological mapping suggests that the sand and gravel unit does not extend as far as this watercourse (Figure 2.2). Therefore, there is unlikely to be any impact on baseflow to the Tenpenny Brook due to dewatering at the Site. The degree of effect and degree of impact are therefore considered to be negligible.

Effects on more distant watercourses such as Alresford Creek will similarly be minimal.

4.2.5 A5 Settlement risk

Buildings and other infrastructure such as the railway line and roads could be susceptible to settlement if groundwater levels are drawn down at the Application Site and the underlying sediments are compressible. These are all classified as high value receptors. Settlement will only occur if the following conditions apply:

- Compressible (i.e. clay rich) sediment is present beneath the receptor;
- This sediment is saturated with groundwater;
- Groundwater in the sediment is in hydraulic continuity with groundwater in the sand and gravel aquifer; and
- The radius of influence of quarry dewatering extends to beneath the receptor.

The sand and gravel aquifer being dewatered at the Site has only a limited compressibility. However, the overlying overburden, which is clay and silt rich, could be compressible. Geological mapping suggests that this unit, which forms part of the Kesgrave Catchment Subgroup, underlies receptors in the surrounding area. Where this is saturated and in hydraulic continuity with the underlying sand and gravel, settlement could occur. Despite this, the overburden is relatively thin, not laterally pervasive and not always saturated. Therefore, the risk of settlement is considered minimal and the degrees of effect and impact are classified as negligible.

4.2.6 B1 Impacts on water quality from plant operation

Water quality could be affected either due to chemical spillage or mobilisation of suspended solids. The shallow sand and gravel aquifer is utilised for private and licenced water supply abstractions and has been assigned as a high value receptor. The Chalk is hydraulically disconnected from the shallower strata by the intervening low permeability Thames Group and is therefore considered separately. The Chalk aquifer is also assigned a high receptor status.

Spills at the Site could feasibly occur from the accidental loss of fluids from mobile or fixed plant equipment. The degree of effect on the shallow aquifer system is considered to be medium, meaning that there could be major degree of impacts. Given that the Chalk is not in hydraulic continuity with shallow strata, there will be a negligible effect on this aquifer and the impact will also be negligible. Due to the potentially major degree of impact on the shallow sand and gravel aquifer, mitigation measures are required.

The sand and gravel aquifer is in hydraulic continuity with surrounding surface watercourses and waterbodies. Any spills that affect the sand and gravel could therefore potentially also affect the fishing lakes, ponds at Cockaynes Wildlife site and the Sixpenny Brook. Dilution and attenuation to reduce the effect of any spills, but the degree of effect is conservatively assessed as medium with the degree of impact being moderate on these medium value receptors.

Inert materials will be imported in accordance with and environmental permit. This will control the material imported to the Site and material will be imported within these controls. An assessment of effects will be undertaken at the permitting stage and monitoring and mitigation measures will be undertaken in accordance with the permit.

4.2.7 C1 Impacts on receiving watercourse quality

It is proposed to discharge water to the Sixpenny Brook. Surface water quality of the Sixpenny Brook, which is a medium value receptor, is generally good and it is inferred that groundwater quality will be similar. There are no obvious impacts on the Sixpenny Brook due to discharges from the existing Wivenhoe Quarry and it is likely that this situation will continue. Discharges from the Site will be governed by a discharge licence and monitoring will be undertaken to ensure that the limits defined by the licence are not breached. The level of effect and degree of impact are therefore set as negligible.

4.2.8 C2 Impacts on receiving watercourse flows

There is to be no water discharge from the Site above greenfield runoff rates, and all excess runoff will be attenuated within the Site. Further information regarding this is found in the accompanying FRA (ESI, 2018).

4.2.9 C3 Diversion of baseflow from one catchment to another

If abstracted groundwater from dewatering is discharged to a different catchment to that from which it has been sourced, baseflow may effectively have been diverted. Dewatering water will be discharged to the Sixpenny Brook that lies in the same surface water catchment as the Site. There is an inferred groundwater flow divide through the eastern extraction phases and this will move eastwards due to dewatering. Therefore, there could be some baseflow diversion towards the fishing ponds and lower reaches of the Sixpenny Brook. However, any change in the divide will likely to small and the level of effect and degree of impact would be negligible.

4.3 Restoration Phase

4.3.1 D1 Long term impacts on groundwater levels and baseflow

Once quarrying operations cease, groundwater levels in the areas adjoining the Site are expected to recover to be similar to pre-development natural levels. Based on existing groundwater levels, levels in the restored lake are expected to be approximately 28 m AOD. Any changes in groundwater levels downgradient and upgradient of the lake would be small and insignificant. The formation of the lake will be unlikely to significantly move the groundwater flow divide either to the eastwards or westwards and this will not affect the distribution of baseflows to adjacent watercourses. The potential level of effect and impacts on the fishing lakes, Sixpenny Brook and Tenpenny Brook are therefore considered to be

negligible.

4.3.2 D2 Additional loss of water from open water evaporation

A restored lake is planned as part of the restoration to attenuate runoff from the Site. Open water evaporation would cause losses to groundwater which could affect the availability of water in the catchment. Losses to groundwater could affect baseflows in the neighbouring watercourses and discharges to local groundwater discharge points including the fishing lakes. However, the proposed area of open water and hence the rate of evapotranspiration is relatively small in comparison to the total catchments of the neighbouring watercourses. Consequently, the level of effect and degree of impact is inferred to be negligible.

4.3.3 D3 Faster runoff and increased flood risk

Runoff at the Application Site will increase due to climate change. This runoff will be attenuated by the restored lake and other smaller attenuation features in the west of the Site and as such there would not be an increased flood risk. The accompanying FRA contains a detailed drainage strategy to ensure that runoff from the Site will not increase above the greenfield runoff rates (ESI, 2018).

4.4 Summary

Table 4.3 summarises the impacts on neighbouring receptors for the operational phase of the Site. The required mitigation and monitoring is described in Section 4.5 where this is considered necessary.

Table 4.4 provides a summary of impacts from the restored Site on the water environment.

Table 4.3 Summary of impacts – operational phase

No.	Type of Impact	Receptor	Receptor Value	Degree of Effect	Degree of Impact pre mitigation	Mitigation Required	Degree of Impact post mitigation
A	**Impacts on groundwater levels**						
A1	Neighbouring abstractions	Licenced and private abstractions	See Table 4.2				
A2	Effects on environmental sites	Upper Colne Marshes SSSI	High	Negligible	Negligible	No	Negligible
		Colne Estuary SSSI, SAC, SPA, Ramsar	High	Negligible	Negligible	No	Negligible
		Cockaynes Wood Ancient Woodland	High	Negligible	Negligible	No	Negligible
A3	Impacts on surface water bodies	Cockaynes Wildlife Site	Medium	High	Major	Yes	Negligible
		Fishing Lakes	Medium	Medium – High	Moderate - Major	Yes	Negligible
		Blue Gates Farm	Medium	Negligible	Negligible	No	Negligible
A4	Impacts on baseflow and watercourses	Sixpenny Brook	Medium	Negligible	Negligible	No	Negligible
		Drain to east	Low	Medium	Minor	No	Minor
A5	Settlement risk	Surrounding buildings and infrastructure	High	Negligible	Negligible	No	Negligible
B	**Water quality impacts**						
B1	Spillage of fuels and release of suspended solids etc.	Sand and gravel aquifer	High	High	Major	Yes	Negligible
		Chalk	High	Negligible	Negligible	No	Negligible
		Sixpenny Brook	Medium	Medium	Moderate	Yes	Negligible
		Neighbouring waterbodies	Medium	Medium	Moderate	Yes	Negligible
C	**Impacts from discharge of water from dewatering operations**						

C1	Effects on receiving watercourse water quality	Sixpenny Brook	Medium	Negligible	Negligible	No	Negligible
C2	Impacts on receiving watercourse flows	Sixpenny Brook	See ESI (2018)				
C3	Diversion of baseflow between catchments	Sixpenny Brook	Medium	Negligible	Negligible	No	Negligible

Table 4.4 Summary of impacts – decommissioning/restored phase

No.	Type of Impact	Receptor	Receptor value	Level of Effect	Degree of Impact	Mitigation Required
D1	Long term impact on groundwater levels	Groundwater	High	Negligible	Negligible	No
D2	Additional loss of water from open water evaporation	Sixpenny Brook	Medium	Negligible	Negligible	No
D3	Faster runoff and increase in flood risk	Buildings & infrastructure	See ESI (2018)			

4.5 Monitoring and Mitigation Measures

4.5.1 Proposed mitigation measures

In addition to the standard practices that will be employed to manage the water quality effects of any spillages at the Site, mitigation methods are proposed for the following:

- Effects on neighbouring licenced and private water supplies; and
- Reduction in water levels at the fishing lakes and ponds in Cockaynes Wildlife Site.

The four closest private and licenced abstractions (see Table 4.2) will likely be significant affected by dewatering and appropriate mitigation will be agreed between Tarmac and the abstracter prior to the commencement of operations.

Additional effects on the Sunnymead Farm and Cockaynes private groundwater abstractions could be significant dependent on local hydrogeological conditions. It is therefore proposed that monitoring is undertaken in these boreholes with the type (automated or manual) and frequency to be agreed with the abstractor where access is allowed. Trigger levels would be set for these boreholes dependent on a period of baseline monitoring and the available drawdown at each location. It may be necessary to add more boreholes to this list if more private supplies are identified following the letter drop. These matters can be appropriately included for via a groundwater monitoring and action plan that can be secured through planning conditions.

Tarmac is in active liaison with the appropriate bodies regarding the water bodies at Cockaynes wildlife site and Alresford Angling Club and has agreed to install gauge boards to monitor water levels. These will be monitored for the life of the proposed development. A series of trigger levels will be devised for the waterbodies which will be based on a period of baseline monitoring. If these trigger levels are breached due to dewatering (most likely during dewatering of the southern phases) and the breach cannot be attributed to natural variability, mitigation measures will be employed. This will involve dewatering water being directed towards the waterbodies until levels are within the expected range. These matters can also be appropriately included for via a water monitoring and action plan that can be secured through planning conditions.

Potential water quality impacts will be addressed by standard planning conditions applied to the planning permission. A spill is considered unlikely however, were this to occur, it would be retained within the active quarry void for a sufficient length of time to allow it to be collected using oil absorbent materials, with standard operational procedures from Tarmac Environmental Management Systems. Contaminated material would then be disposed of in accordance with current best industry practices. Discharge from the quarry void would cease during this time.

Facilities for the storage of soils, fuels or chemicals will be sited on an impervious base and surrounded by impervious bund walls. The volume of the bunded compound will be greater than the tank capacity (i.e. at least 110%). Filling points, vents, gauges and sight glasses will be located within the bund walls. The bund drainage system will be sealed with no discharge to any watercourse, land, or underground strata permitted. Associated pipework will be located above ground and protected so as to prevent accidental damage. All filling points and tank overflow pipe outlets will discharge downwards into the bund.

Drainage systems at the Site will be regularly inspected to ensure that visible oil is not present. An environmental management system will be established to ensure that all procedures follow best practice.

Water in the active quarry sump will primarily be groundwater, and hence is expected to be clean. Suspended solid concentrations in the water may become elevated due to the movement of mobile plant equipment or run-off. Any discharge off Site will be controlled by the terms of a discharge licence. Suspended solids will be given ample time to settle out of suspension prior to discharge to the Sixpenny Brook. It is recommended that the suspended

solids concentration is monitored regularly to allow compliance as well as monitoring for visible oil. The suspended solids limit on the licence is likely to be 100 mg/l, which is the default licence standard from the EA (Environment Agency, 2012).

Flood risk and drainage mitigation measures are presented separately by ESI in the accompanying FRA (2018).

Monitoring and mitigation measures will be employed as required by the environmental permit. These will likely include groundwater and surface water quality monitoring.

4.5.2 Proposed monitoring

A water management plan including reporting schedule should be agreed with the Mineral Planning Authority prior to commencement of the development.

Groundwater level monitoring of existing groundwater monitoring boreholes around the Site should continue on a monthly basis until the development commences unless otherwise agreed with the EA. BH02, BH04, BH05, BH06, BH07, BH08, BH09, BH12, PZ1 and PZ3 should form the monitoring network.

Groundwater levels should be compared to the baseline to allow groundwater level variations due to seasonal variations and groundwater abstraction to be distinguished from any quarry dewatering effects.

The operation phase monitoring regime should include the following:

- Recording of monthly water level at groundwater monitoring boreholes around the Site (BH02, BH04, BH05 BH06, BH07, BH08, BH09, BH12, PZ1 and PZ3).
- Monitoring of water levels in neighbouring private and/or licenced water supply abstraction boreholes if permitted by the owners.
- Monthly monitoring of surface water levels in Cox Lake and Worcester Lake.
- Monthly monitoring of water levels in the closest pond at Cockaynes Wildlife site.

As is mentioned above, after the period of baseline monitoring, trigger levels should be set for the fishing lakes, pond at Cockaynes Wildlife site and neighbouring abstractions. If these are breached, mitigation measures would be employed.

Water quality monitoring would be covered by the conditions of future permitting applications.

5 Conclusions

Tarmac is proposing to extract sand and gravel from an area located east of the existing Wivenhoe Quarry. The Site is to be worked in a series of phases with progressive restoration using some inert restoration materials to species-rich grassland and open water.

ESI has reviewed the potential hydrogeological impacts of the development and subsequent restoration. The conceptual model indicates that the superficial sand and gravel deposits at the Site form an unconfined aquifer that is in hydraulic continuity with the neighbouring Sixpenny Brook and waterbodies.

Potential impacts to neighbouring abstractions, surface water bodies, water quality and sensitive sites have been assessed. The most proximal receptors include Cockaynes Wood, Alresford Angling Club fishing lakes, the Sixpenny Brook, and neighbouring licenced and private abstractions. It is proposed to discharge dewatered water to the Sixpenny Brook and therefore there will be no significant net effect on this watercourse.

Significant effects could occur at neighbouring abstractions and waterbodies but these can all be mitigated to insignificant through the implementation of appropriate mitigation measures secured though appropriately worded planning conditions.

Potential water quality impacts will be addressed by standard planning conditions applied to the planning permission. Any discharge off Site and water use will be controlled by permits to be applied for.

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APPENDICES

Appendix A

Operational Plans

Proposed Site Access

B1027

Tye Lane

Keelars Tye

Keelars Farm

Pond

Birds Farm

School Road

Englishes Farm

Rosedene

162/24

Mitchels Farm Shop

BUND C

BUND B

Beulah

The Fieldings

Blackboard Cottage

Boarded Cottage

Lee Oak

Elmstead Heath

FRESHWATER LAGOON

BUND A

Phase 1 and Plant Site

LAGOON 3

The Orchards

Near Dun

Wilwyn

Europa

Woodstock

Oakwood Cottage

Primrose Cottage

PROPOSED LOCATION OF TUNNEL UNDER FP24

BUND G

Sixpenny Brook

Piggery

LAGOON 2

LAGOON 1

Phase 4

Heath Lodge

Vine Cottage

Woodlands

Kimbar Gardens

St Christophers

Phase 3

LAGOON 4

Phase 5

Pond

FOOTPATH 162/24 RETAINED THROUGHOUT AND SECURED WITH FENCING AS APPROPRIATE

Phase 6

157/20

BUND F

BUND E

Phase 2

Cockaynes Lane

BUND H

Heath Farm

15m STAND OFF TO COCKAYNES WOOD

BUND I

Phase 7

BUND D

Cockaynes Wood

Broadview Cottages

Willow Lodge

Furzedown

Sunnymead Farm

162/19

157/2

White Lodge

Ponds

162/16

Legend

- Boundary: Application Site
- Boundary: Proposed Extraction Area
- Phase 1 — Proposed Phasing
- Proposed Direction of Working
- 27 — Existing Ground Surface Contour at 0.5m interval
- Existing Vegetation
- 157/2 — Existing Public Right of Way and Reference
- Permissive Footpath
- Proposed Soil Stores
- Proposed Silt Lagoons

DAVID JARVIS ASSOCIATES

TARMAC A CRH COMPANY

Site Name: W328 - Wivenhoe

Drawing Name: Proposed Working Plan

Drawn By:	Scale @ A1:
DJA	1:2,000
Date:	**Drawing Number:**
19/02/2018	W328-00062-3

B1027

Grass Verge

Lay-by

PROPOSED SURFACED ACCESS ROAD

Englishes Farm

Rosedene

Existing Fence

Existing Track

162/24

PART PHASE 1 TOPSOIL AND TOPSOIL STRIPPED FROM THE SUBSOIL STORAGE AREA PLACED INTO TEMPORARY STORAGE MOUND 3m HIGH

PHASE 1 SUBSOIL USED TO FORM A TEMPORARY 5m HIGH SCREEN BUND

PART PHASE 1 TOPSOIL TEMPORARY STORE

PROPOSED WHEEL WASH

PROPOSED OFFICE/ WELFARE FACILITIES

PROPOSED CAR PARK

PROPOSED WEIGHBRIDGE

A

C

B

Beulah

Def

FRESHWATER LAGOON

Phase 1

PROCESSED MATERIAL STOCKPILES

NEW LOW LEVEL PLANT

A.R.B STOCKPILE

30.5

30.5

REMAINING PHASE 1 OVERBURDEN AND INTERBURDEN PLACED INTO PHASE 1 EXTRACTION VOID

PROPOSED CHAIN LINK SAFETY FENCE

Phase 4

Piggery

SILT LAGOON 2

Phase 1

SILT LAGOON 1

MATERIALS EXTRACTED TO FORM THE FRESHWATER LAGOON AND PART PHASE 1 OVERBURDEN MATERIAL USED IN THE CONTSTUCTION OF THE SIDEWALL BETWEEN SILT LAGOON 1 AND LAGOON 2

162/24

Phase 3

Phase 5

Legend

- Boundary: Application Site
- Boundary: Proposed Extraction Area
- Phase 1 — Proposed Extraction Phasing
- 30.5 — Existing Ground Surface Contour (mAOD) 0.5m Interval
- Existing Fence
- Existing Vegetation
- 157/2 — Public Right of Way and Reference
- Proposed Hedgerow with Standard Trees
- Proposed Orchard Replacement Tree Planting
- Proposed Fence
- Proposed Fresh Water Lagoon
- Proposed Silt Lagoon
- A — Proposed Topsoil Store and Reference (Maximum 3m High)
- C — Proposed Subsoil Store and Reference (Maximum 5m High)

DAVID JARVIS ASSOCIATES

TARMAC
A CRH COMPANY

Site Name:
W328 - Wivenhoe

Drawing Name:
Plant Site Layout Plan

Drawn By:	Scale @ A2:
DJA	1:1250
Date:	**Drawing Number:**
16/02/2018	W328-00062-6

N

Appendix B

Restoration Plan

Elmstead Heath

Keelars Tye
Tye Lane
Pond
Keelars Farm
B1027
Birds Farm
School Road
Englishes Farm
Rosedene
162/24
Mitchels Farm Shop
Beulah
The Fieldings
Blackboard Cottage
Boarded Cottage
Lee Oak
Lagoon 3 restored to wet woodland
The Orchards
Near Dun
Europa
Wilwyn
Woodstock
Oakwood Cottage
Primrose Cottage
Heath Lodge
Vine Cottage
Sixpenny Brook
Piggery
Proposed viewpoint from footpath overlooking restored wetland mosaic within Lagoon 4
102/24
Woodlands
Kimbar Gardens
St Christophers
Pond
Proposed new permissive footpath link between footpath 157/20 and 162/24
157/20
Cockaynes Lane
Heath Farm
Broadview Cottages
Small retained sand and gravel cliff (up to 1 - 2m high)
Willow Lodge
Cockaynes Wood
Furzedown
Sunnymead Farm
162/19
Path (um)
157/2
White Lodge
Ponds
162/16

Legend

- Boundary: Application Site
- Boundary: Proposed Extraction Area
- 27 — Existing Ground Surface Contour at 0.5m interval
- 30 — Proposed Restoration Ground Surface Contour at 0.5m interval
- Existing Vegetation
- Existing Vegetation (to be retained)
- 157/2 — Existing Public Right of Way and Reference
- Permissive Footpath
- Proposed New Permissive Footpath
- Proposed Hedgerow with Standard Trees
- Proposed Orchard tree Planting
- Land restored to Species Rich Grassland
- Land restored to Rough Grassland Scrub
- Land restored to Woodland
- Land restored to Wet Woodland
- Land Restored to Reedbed
- Land Restored to Exposed Margins/ Mudflat
- Retained Sand and Gravel Cliffs
- Open Water

DAVID JARVIS ASSOCIATES

TARMAC
A CRH COMPANY

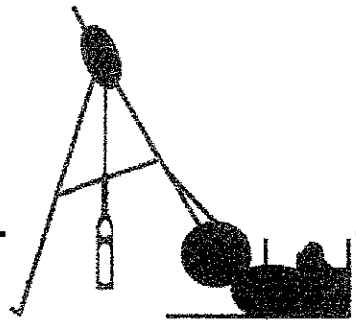
Site Name: W328 - Wivenhoe

Drawing Name: Proposed Restoration Scheme

Drawn By:	Scale @ A1:
DJA	1:2,000
Date:	**Drawing Number:**
16/02/2018	W328-00062-12

Appendix C

Tarmac Borehole Logs



Direct Drilling LTD

N V Q Level 2

Site Investigation
Soakaways
Bored Wells

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Colney Heath
Herts AL4 0NP
www.directdrillingltd.co.uk
Mobile 07831239668
Tel / Fax : (01727) 823866
Tel / Fax : (01795) 666221

Proprietors: D.S.Watts & M.Claxton
Vat No :905016070

Depth	Strata Description	Penetration Testing and Samples										
		Type	From	To	75	150	225	300	375	450	Blows	
G/L	TOP SOIL	B	1.00	1.50								
		B	2.00	2.50								
0.90	LIGHT ORANGE BROWN FINE TO MEDIUM SAND WITH FINE TO MEDIUM SUB ANGULAR AND SEMI ROUNDED GRAVELS	B	3.00	3.50								
1.40	LIGHT GRAY SOFT TO FIRM SILTY CLAY WITH SCATTERED GRAVELS											
1.80	AS AT 0.90											
3.40	ORANGE BROWN FIRM SILTY CLAY											
4.00	DARK GRAY FIRM SILTY CLAY	FILLED BOWSER 1 HR										
		CLEARED SPOILS ½ HR										
	DRILLED TO 4.50m	COLLECTED SHINGEL/BALLAST AND INSTALLATION PIPE FROM PIT 1¼ HRS										

Remarks MOBILIZED RIG AND EQUIPMENT TO SITE

Driller Data Protection Act

H2O	Strike 1	Strike 2	Strike 3
Depth			
Depth 5 mins			
Depth 10 mins			
Depth 15 mins			
Depth 20 mins			
Casing			

Water Levels	Depth	Casing	Time
Morning			

Depth at end of day	Borehole	Casing
Diameter (mm)		
150	4.50	4.00

Hard Strata / Chiseling			
From (m)	To (m)	From (Hrs)	To (Hrs)

Total number of samples				
SPT's	Bulks	U100's	Disturbs	H2O
	3			

Move	Drill	Stand	D Work's	Back filling
1	4.50		2 3/4	

Site WIVENHOE

Job No

B/H No 6

Day MONDAY

Date 12-12-11

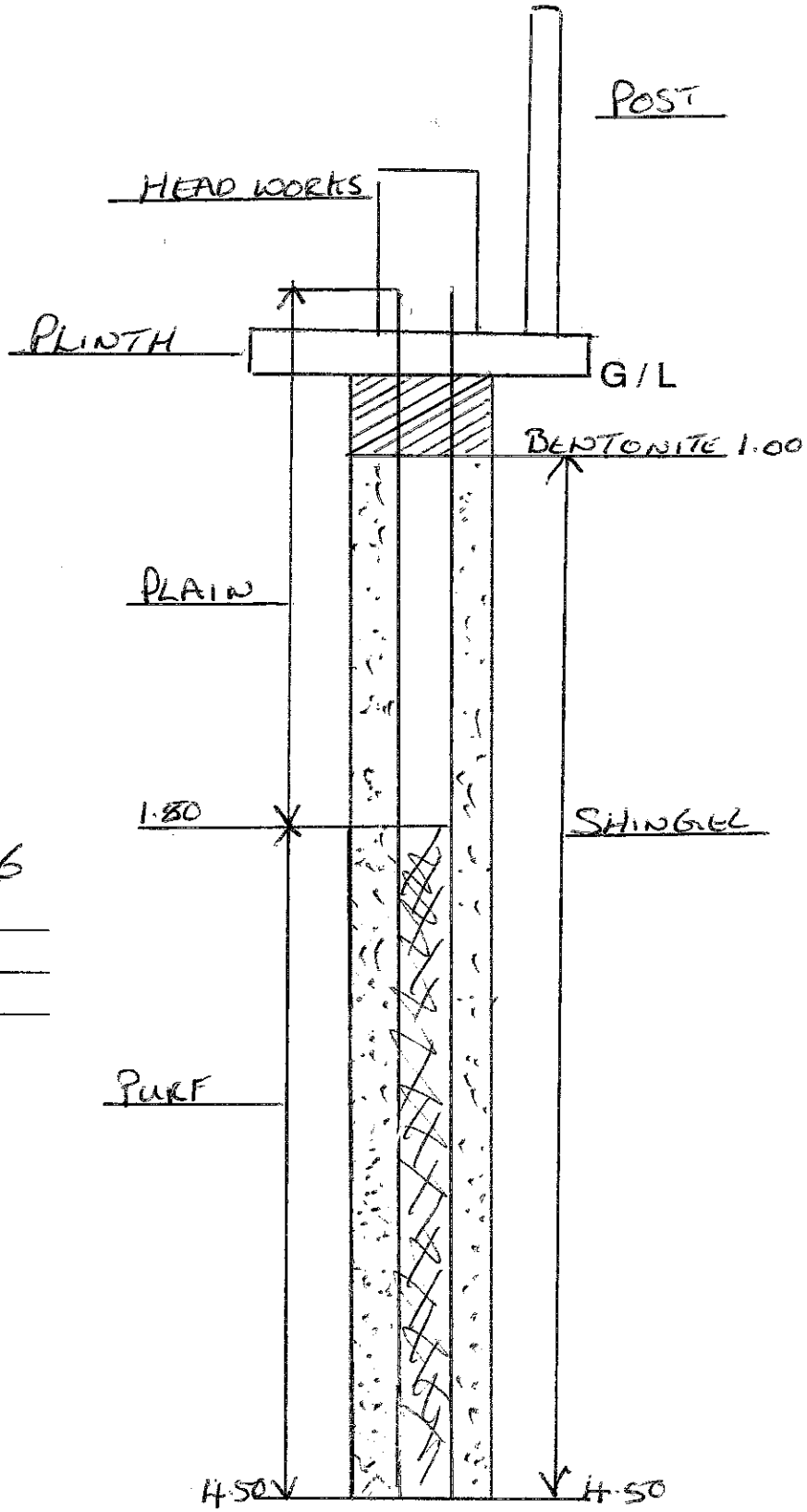
Direct Drilling

BDA accredited

LANDFILL
SOAKAWAYS
SITE INVESTIGATION

106 High Street
Colney Heath
Herts AL4 0NP

Tel / Fax : (01727) 823866
Tel : (01795) 666221
Mobile : (07831) 239668



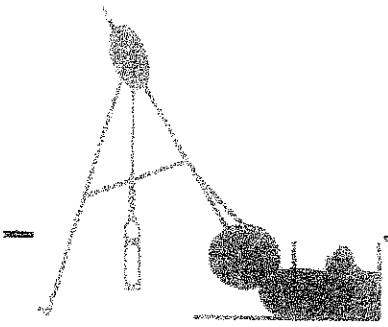
Installation of B / H.6

Site : WILKENHOE

Job No :

Date : 12/12/11

NOT TO SCALE



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Tel / Fax : (01795) 666221

Proprietors: D.S.Watts & M.Claxton
Vat No :905016070

Site Investigation
Soak aways
Bored Wells

Depth	Strata Description
G/L	TOP SOIL.
0.40	ORANGE BROWN FINE TO MEDIUM SAND, WITH FINE TO MEDIUM SIZED SUB ANGULAR GRAVELS.
2-70	SOFT BUFF - BROWN SILT.
2-90	ORANGE BROWN FINE TO MEDIUM SAND, WITH FINE - MEDIUM AND LARGE SUB - ANGULAR GRAVELS.
4-00	LIGHT ORANGE BROWN COURSE SAND, WITH FINE - MEDIUM AND LARGE SUB ANGULAR AND SEMI ROUNDED GRAVELS, DENSE AND FREE DRAINING.
7-50	AS ABOVE, WITH FINE BANDS OF SOFT BUFF - BROWN SILT.
8-90	STIFF MOTTLED BROWN SILTY CLAY.
9-20	STIFF DARK GREY CLAY.
	DRILLED TO 9-40

Penetration Testing and Samples										
Type	From	To	75	150	225	300	375	450	Blows	
B	0-50	1-00								
B	1-50	2-00								
B	3-00	3-50								
B	4-00	4-50								
B	5-00	5-50								
B	6-00	6-50								
B	7-00	7-50								
B	8-00	8-50								
		DAY WORKS.								
		COLLECTED SHINGEL - BALLAST AND INSTALLTION EQUIPMENT FROM PIT								1¼
		CLEARED SPOILS.								½HR

Remarks: LONG MOVE WITH DIFFICULT ACCESS TO B/H 7 POSITION = 1HR.
INSTALLED 9-70 x 50mm LINER, DETAILS ON SEPARATE SHEET.

Driller: Data Protection Act

H2O	Strike 1	Strike 2	Strike 3
Depth	7-50		
Depth 5 mins			
Depth 10 mins			
Depth 15 mins			
Depth 20 mins			
Casing			

Water Levels	Depth	Casing	Time
Morning			

Depth at end of day		
Diameter (mm)	Borehole	Casing
150	9-40	9-20

Hard Strata / Chiseling			
From (m)	To (m)	From (Hrs)	To (Hrs)

Total number of samples				
SPT's	Bulks	U100's	Disturbs	H2O
	8			

Move	Drill	Stand	D Work	Back filling
1	9-40		2¾ HRS	

Site: WIVENHOE

Job No

B/H No 7

Day TUESDAY WEDNESDAY

Date 13-12-11 14-12-11

Direct Drilling LTD

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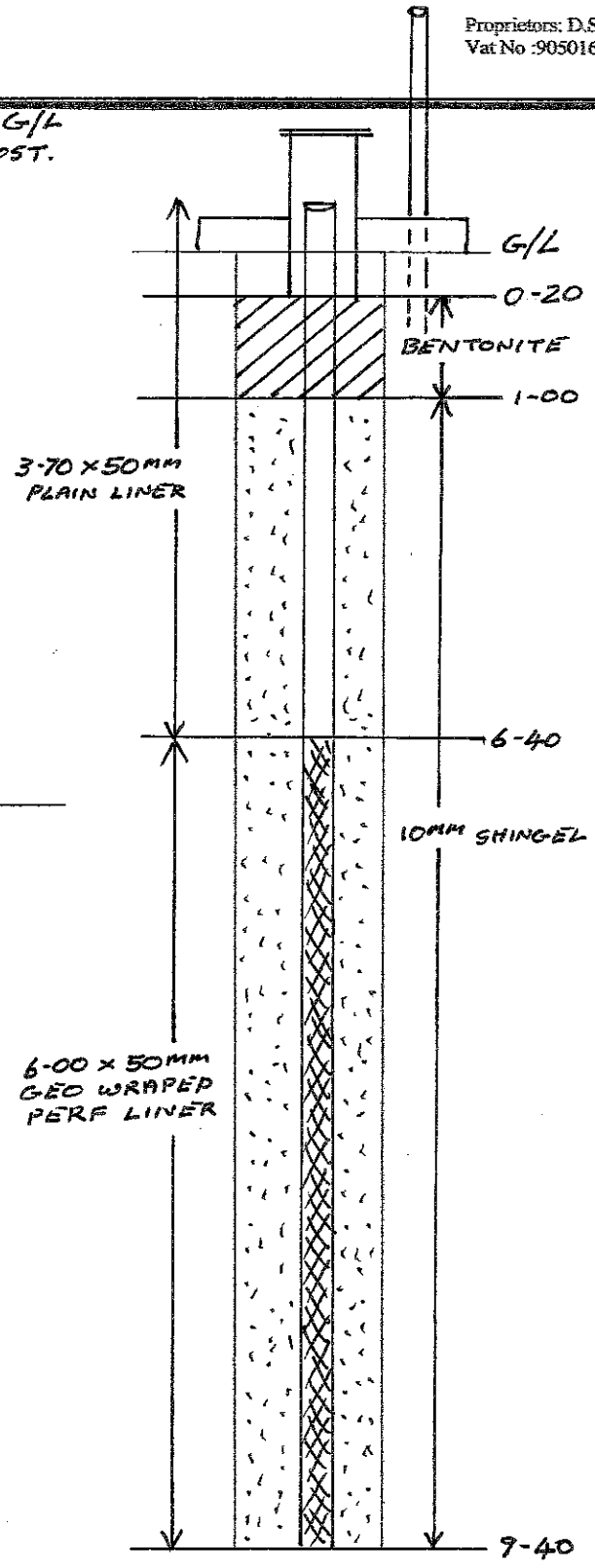
Colney Heath
Herts AL4 0NP

Mobile 07831239668
Tel / Fax : (01727) 823866
Tel / Fax : (01795) 666221

Site Investigation
Soakaways
Bored Wells

Proprietors: D.S.Watts & M.Claxton
Vat No :905016070

HEAD WORKS CONCRETED ON AT G/L
WITH PLINTH AND MARKER POST.



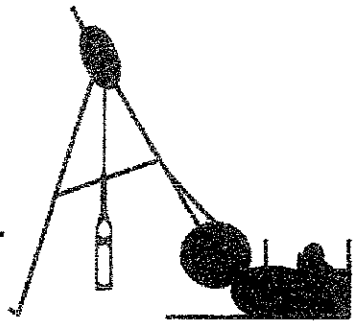
Installation Of B/H. 7

Site : WIVENHOE

Job No :

Date : 14-12-11

Not to scale



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Site Investigation
Soakaways
Bored Wells

Proprietors: D.S.Watts & M.Claxton
Vat No :905016070

Depth	Strata Description	Penetration Testing and Samples										
		Type	From	To	75	150	225	300	375	450	Blows	
G/L	TOP SOIL	B	2.50	3.00								
		B	3.00	4.00								
0.80	LIGHT ORANGE AND GRAY SOFT SILTY CLAY											
2.20	LIGHT ORANGE BROWN FINE TO MEDIUM SAND WITH FINE TO MEDIUM SUB ANGULAR AND SEMI ROUNDED GRAVELS											
4.70	ORANGE BROWN FIRM SILTY CLAY											
4.90	DARK GRAY STIFF SILTY CLAY											
	DRILED TO 5m	¾ HR TO MOVE RIG / BOWZER AND CLEAR UNDER GROWTH										
		½ TO CLEAR SPOILS										
		1 HR TO COLLECT SHINGEL/BALLAST AND INSTALATION EQUIPMENT										

Remarks

Drille

H2O	Strike 1	Strike 2	Strike 3
Depth			
Depth 5 mins			
Depth 10 mins			
Depth 15 mins			
Depth 20 mins			
Casing			

Water Levels	Depth	Casing	Time
Morning			

Depth at end of day		
Diameter (mm)	Borehole	Casing
1.50	5.00	5.00

Hard Strata / Chiseling			
From (m)	To (m)	From (Hrs)	To (Hrs)

Total number of samples				
SPT's	Bulks	U100's	Disturbs	H2O
	2			

Move	Drill	Stand	D Work's	Back filling
1	5		2¼	

Site: WIVENHOE

Job No

B/H No 8

Day TUESDAY

Date 13/12/11

Direct Drilling

BDA accredited

LANDFILL
SOAKAWAYS
SITE INVESTIGATION

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Colney Heath
Herts AL4 0NP

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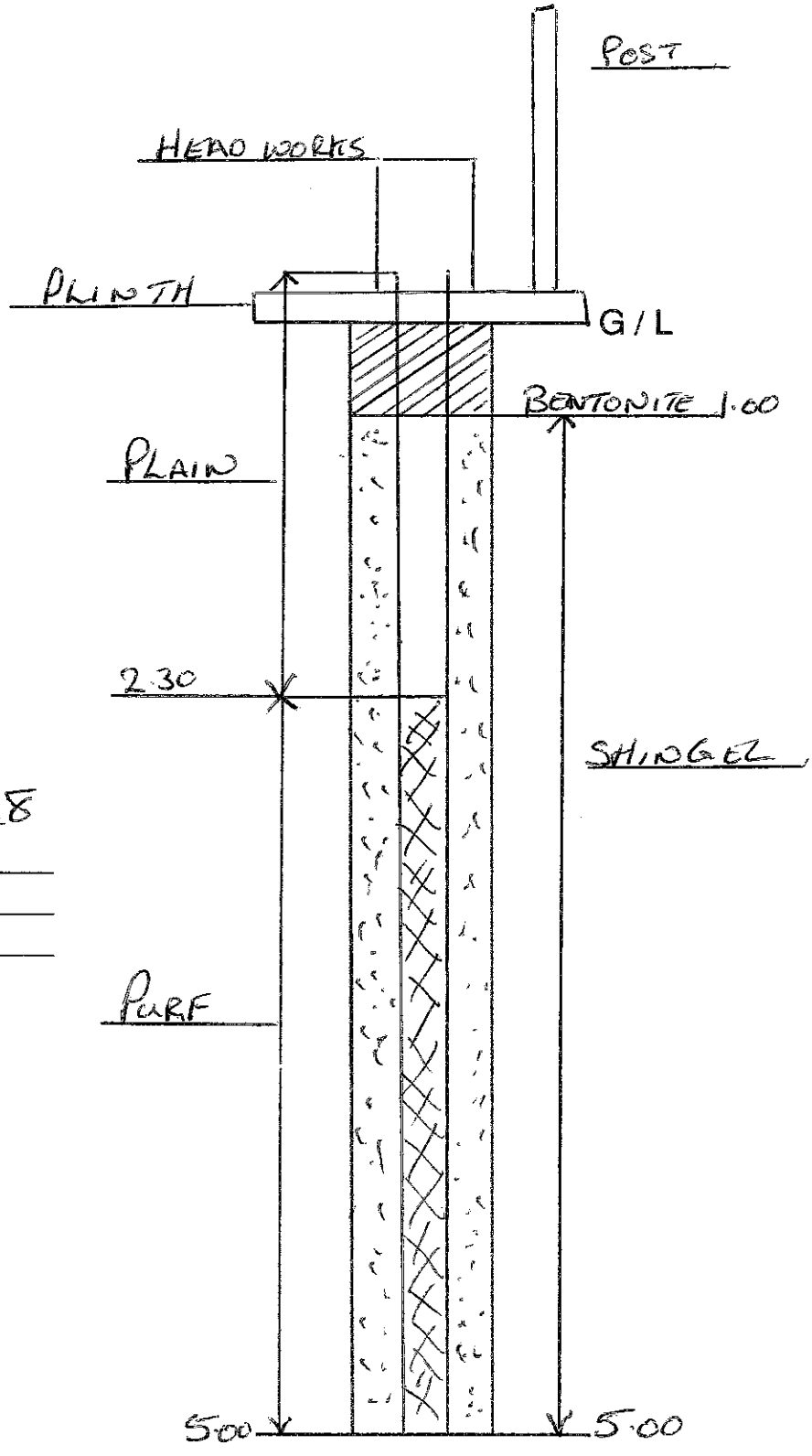
Mobile : (07831) 239668



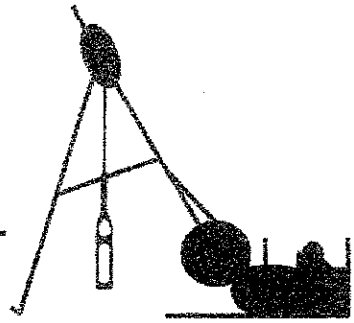
Installation of B / H. 8

Site : WILKENHOE

Job No :

Date : 13/12/11

NOT TO SCALE



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Tel / Fax : (01795) 666221

Site Investigation
Soakaways
Bored Wells

Proprietors: D.S.Watts & M.Claxton
Vat No :905016070

Depth	Strata Description	Penetration Testing and Samples										
		Type	From	To	75	150	225	300	375	450	Blows
G/L	TOP SOIL	B	1.00	1.50							
		B	2.00	2.50							
0.50	ORANGE BROW FINE SILTY SAND	B	3.00	3.50							
		B	4.00	4.50							
2.70	ORANGE BROWN FINE TO MEDIUM	B	5.00	5.50							
	SAND WITH FINE TO MEDIUM	B	6.00	6.50							
	SUB ANGULAR AND SEMI										
	ROUNDED GRAVELS										
6.70	ORANGE BROWN STIFF TO FIRM										
	SILTY CLAY										
	DRILLED TO 7M	½ HR TO MOVE RIG AND BOWZER FROM B/H 8									
		½ TO CLEAR SPOILS									
		1 HR TO COLLECT SHINGLE/BALLAST AND INSTALLATION EQUIPMENT									

Remarks

Driller

Data Protection

H2O	Strike 1	Strike 2	Strike 3
Depth			
Depth 5 mins			
Depth 10 mins			
Depth 15 mins			
Depth 20 mins			
Casing			

Water Levels	Depth	Casing	Time
Morning			

Depth at end of day		
Diameter (mm)	Borehole	Casing
150	7.00	7.00

Hard Strata / Chiseling			
From (m)	To (m)	From (Hrs)	To (Hrs)

Total number of samples				
SPT's	Bulks	U100's	Disturbs	H2O
	6			

Move	Drill	Stand	D Work's	Back filling
1	7		2	

Site: WIVENHOE

Job No

B/H No 9

Day: WEDNESDAY THURSDAY

Date: 14/15/12/11

Direct Drilling

BDA accredited

LANDFILL
SOAKAWAYS
SITE INVESTIGATION

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Colney Heath
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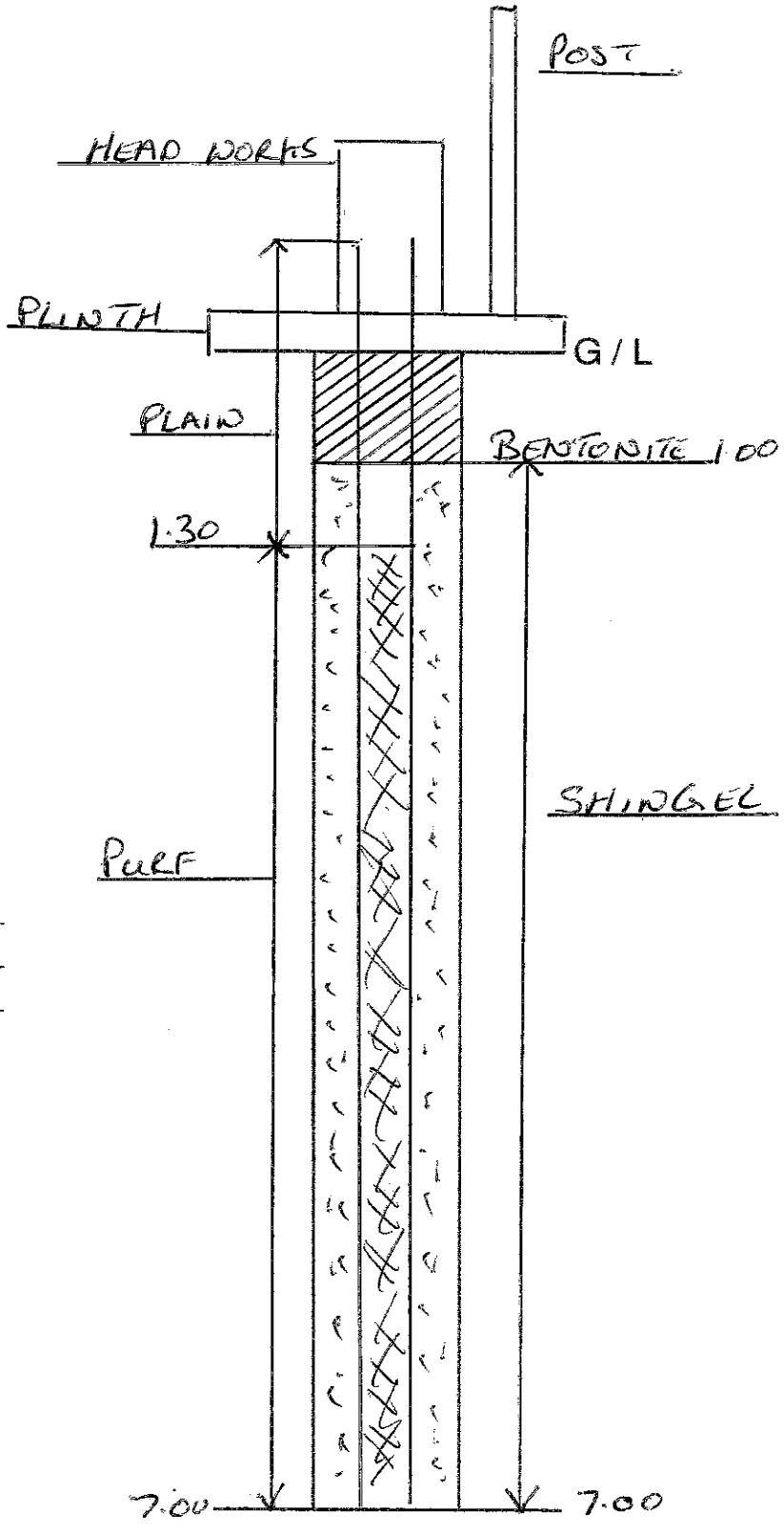
Mobile : (07831) 239668



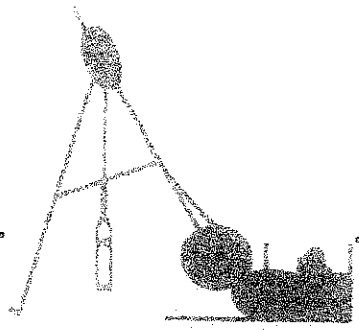
Installation of B / H. 9

Site : WIVENHOE

Job No :

Date : 15/12/11

NOT TO SCALE



Direct Drilling LTD

N V Q Level 2

Site Investigation
Soak aways
Bored Wells

106 High Street
Colney Heath
Herts AL4 0NP

Mobile 07831239668
Tel / Fax : (01727) 823866
Tel / Fax : (01795) 666221

Proprietors: D.S.Watts & M.Claxton
Vat No :905016070

Depth	Strata Description
G/L	TOP SOIL.
0.30	ORANGE BROWN SANDY CLAY, IMPREGNATED WITH FINE GRAVELS.
1-50	ORANGE BROWN FINE SAND, WITH FINE TO MEDIUM SIZED SUB ANGULAR GRAVELS.
4-00	SOFT TO FIRM RUST - BROWN SILT.
4-40	LIGHT ORANGE BROWN MEDIUM SAND, WITH FINE - MEDIUM AND LARGE SUB - ANGULAR AND SEMI ROUNDED GRAVELS.
8-00	STIFF DARK GREY CLAY.
	DRILLED TO 8-50

Penetration Testing and Samples										
Type	From	To	75	150	225	300	375	450	Blows	
B	1-50	2-00								
B	2-50	3-00								
B	3-50	4-00								
B	4-50	5-00								
B	5-50	6-00								
B	6-50	7-00								
B	7-50	8-00								
		DAY WORKS								
		LONG MOVE ON ROAD								1HR.
		FILLED BOWSER TO ASSIST DRILLING								1HR.
		COLLECTED SHINGEL - BALLAST AND INSTALLATION EQUIPMENT FROM PIT								1 1/2
		CLEARED SPOILS.								1/2 HR.

Remarks: INSTALLED 8-80 x 50 mm RINER, DETRILS ON SEPARATE SHEET.

Data Protection Act

H2O	Strike 1	Strike 2	Strike 3
Depth			
Depth 5 mins			
Depth 10 mins			
Depth 15 mins			
Depth 20 mins			
Casing			

Water Levels	Depth	Casing	Time
Morning			

Diameter and depth of Hole		
Diameter (mm)	Borehole	Casing
150	8-50	8-30

Hard Strata / Chiseling			
From (m)	To (m)	From (Hrs)	To (Hrs)

Total number of samples				
SPT's	Bulks	U100's	Disturbs	H2O
	7			

Work	Drill	Stand	D Works	Backfilling
1	8-50		4HRS	

Site: WIVENHOE

Job No

B/H No 10

Day WEDNESDAY. THURSDAY.

Date 14-12-11 15-12-11

Direct Drilling

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SOAKAWAYS
SITE INVESTIGATION

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Colney Heath
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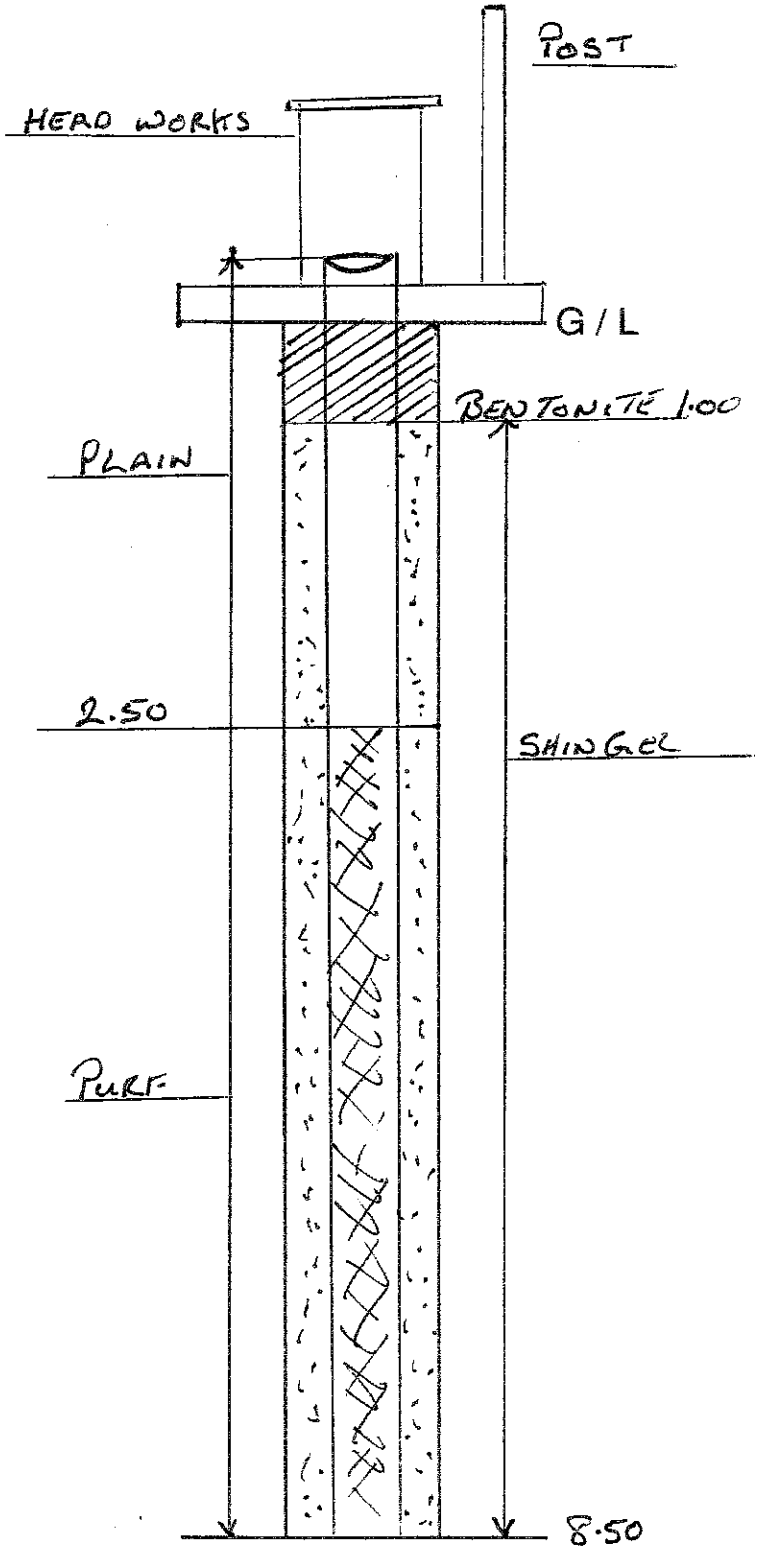


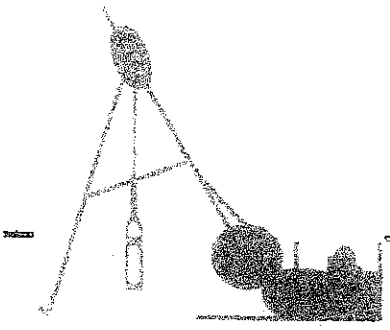
Installation of B / H. 10

Site : WIVENHOE

Job No :

Date : 15-12-11

NOT TO SCALE



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Site Investigation
Soak aways
Bored Wells

Proprietors: D.S.Watts & M.Claxton
Vat No :905016070

Depth	Strata Description
G/L	TOP SOIL.
0·20	FIRM RUST - BROWN SILTY CLAY.
1·00	FIRM RUST - BROWN SILTY CLAY, WITH SCATTERD FINE TO MEDIUM SIZED GRAVELS.
1·50	ORANGE BROWN FINE TO MEDIUM SAND WITH FINE TO MEDIUM SIZED SUB - ANGULAR GRAVELS.
6·00	ORANGE BROWN MEDIUM SAND, WITH FINE - MEDIUM AND LARGE SUB ANGULAR AND SEMI ROUNDED GRAVELS.
8·70	STIFF MOTTLED BROWN SILTY CLAY.
9·00	STIFF DARK GREY CLAY.
	DRILLED TO 9·20

Penetration Testing and Samples										
Type	From	To	75	150	225	300	375	450	Blows	
B	1-50	2-00								
B	2-50	3-00								
B	3-50	4-00								
B	4-50	5-00								
B	5-50	6-00								
B	6-50	7-00								
B	7-50	8-00								
B	8-50	8-70								
		DAY WORKS								
		FILLED BOWZER TO ASSIST DRILLING								1HR.
		COLLECTED SHINGLE + BALLAST AND INSTALLTION EQUIPMENT FROM PIT								1½HR
		COLLECTED POSTS AND RAILS AND PAINTED, TO ERECT AROUND B/H POSITION								2 HRS
		CLEARED SPOILS								½ HR
		ERECTED POSTS AND RAILS AREXUND B/H POSITION								¾HR

Remarks: INSTALLED 9·50 × 50MM LINER, DETRILS ON SEPARATE SHEET.

Data Protection Act

H2O	Strike 1	Strike 2	Strike 3
Depth			
Depth 5 mins			
Depth 10 mins			
Depth 15 mins			
Depth 20 mins			
Casing			

Water Levels	Depth	Casing	Time
Morning			

Depth at end of day		
Diameter (mm)	Borehole	Casing
150	9·20	9·00

Hard Strata / Chiselling			
From (m)	To (m)	From (Hrs)	To (Hrs)

Total number of Samples				
SPT's	Bulks	U100's	Disturbs	H2O
	8			

Move	Drill	Stand	D Work's	Back filling
1	9·20		5 HRS. 45 MINS	

Site: WIVENHOE

Job No:

B/H No: 12

Day: MONDAY

Date: 12-12-11

Direct Drilling LTD

N V Q Level 2

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Herts AL4 0NP

Mobile 07831239668
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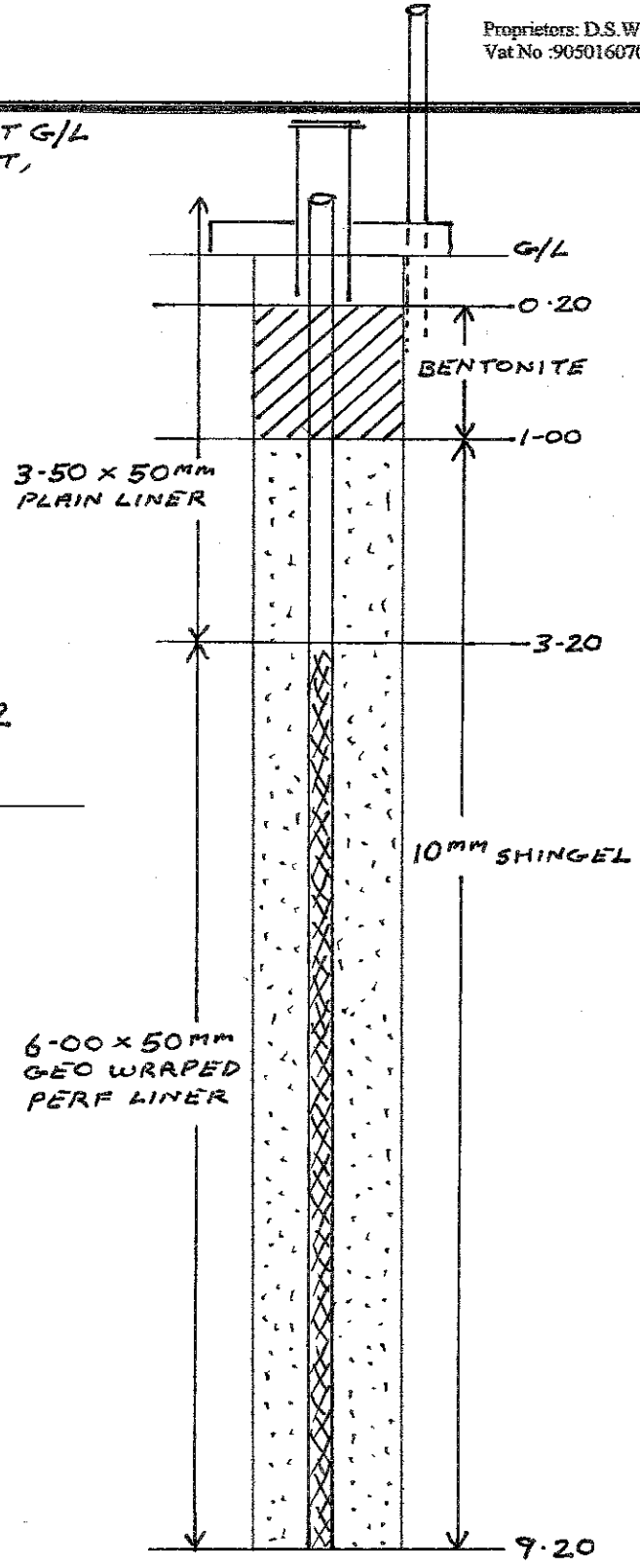
Site Investigation
Soakaways
Bored Wells

Proprietors: D.S.Watts & M.Claxton
Vat No :905016070

HEAD WORKS CONCRETED ON AT G/L
WITH PLINTH AND MARKER POST,
AND POST x RAILS FENCING



Installation Of B/H. 12

Site : WIVENHOE

Job No :

Date : 13-12-11

Not to scale

December 1991

WIVENHOE PIT, ESSEX
Water Monitoring Borehole

0·3m	Topsoil
0·3m	Sandy silt
3·4m	Dry, slightly silty, good sandy gravel
0·9m	Slightly clayey dry sand
3·7m	Wet, silty good gravel
3·7m	Very hard blue clay

9·1m steel pipe installed. Top 1 metre of annulus concreted. Top hat installed

Direct Drilling

BDA accredited

LANDFILL
SOAKAWAYS
SITE INVESTIGATION

160 Invicta Road
Sheerness
Kent ME12 2AG

Tel / Fax : (01795) 664283
Tel : (01795) 666221
Mobile : (0831) 239668

Depth	Strata Description
G/L	SOFT TO FIRM, BROWN TOP SOILS.
0·30	FIRM MOTTLED BROWN AND GRAY SILTY CLAY.
0·70	SOFT TO FIRM, BROWN - GRAY SANDY - SILTY CLAY, WITH SCATTERD MED SIZED GRAVELS.
1·20	SOFT, BROWN - GRAY SILTY CLAY WITH RUST - BROWN FRIABLE SILT VAINS. BECOMING FIRM, AND GRAYER WITH DEPTH.
2·70	FIRM TO STIFF, DARK GRAY SILTY CLAY.

Penetration Testing and Samples										
Type	From	To	75	150	225	300	375	450	Blows
		DAY WORKS							
		HAND DUG TRIAL PIT TO 1·20 DEPTH. = 1HR.							
		WINCHED RIG FROM B/H 2 TO ROAD. = 1HR.							
		COLLECTED INSTALLATION EQUIPMENT FROM PIT = ½HR.							
		CLEARED EXCESS SPOILS = ¼ HR.							
		STAND							
		ON STAND FROM 8·30 TO 11·30 27-2-97 ACCESS TO RIG ON B/H 2 BLOCKED BY CRANE = 3 HRS							

Remarks INSTALLED 3·00 x 100MM LINER, DETAILS ON SEPARATE SHEET.

Driller Data Protection Act

Water Levels	Depth	Casing	Time
Morning			
Evening			
Other			

Depth at end of day		
Diameter (mm)	Borehole	Casing
200	3·20	1·50

Hard Strata / Chiselling			
From (M)	To (M)	From (Hrs)	To (Hrs)

Total number of samples					
SPT	B	U100	D	H^2O	P

H^2O	Strike 1	Strike 2	Strike 3
Depth	1·00		
Depth 5 mins	SEEPAGE.		
Depth 10 mins			
Depth 15 mins			
Depth 20 mins			
Casing			
Cut off at			

Move	Drill	Stand	Break	Work
1	3·20	3HRS		2 ¾ HR

Site WIVENHOE

Job No. | B / H No. 2

Day THURSDAY | Date 27-2-97

Direct Drilling

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LANDFILL
SOAKAWAYS
SITE INVESTIGATION

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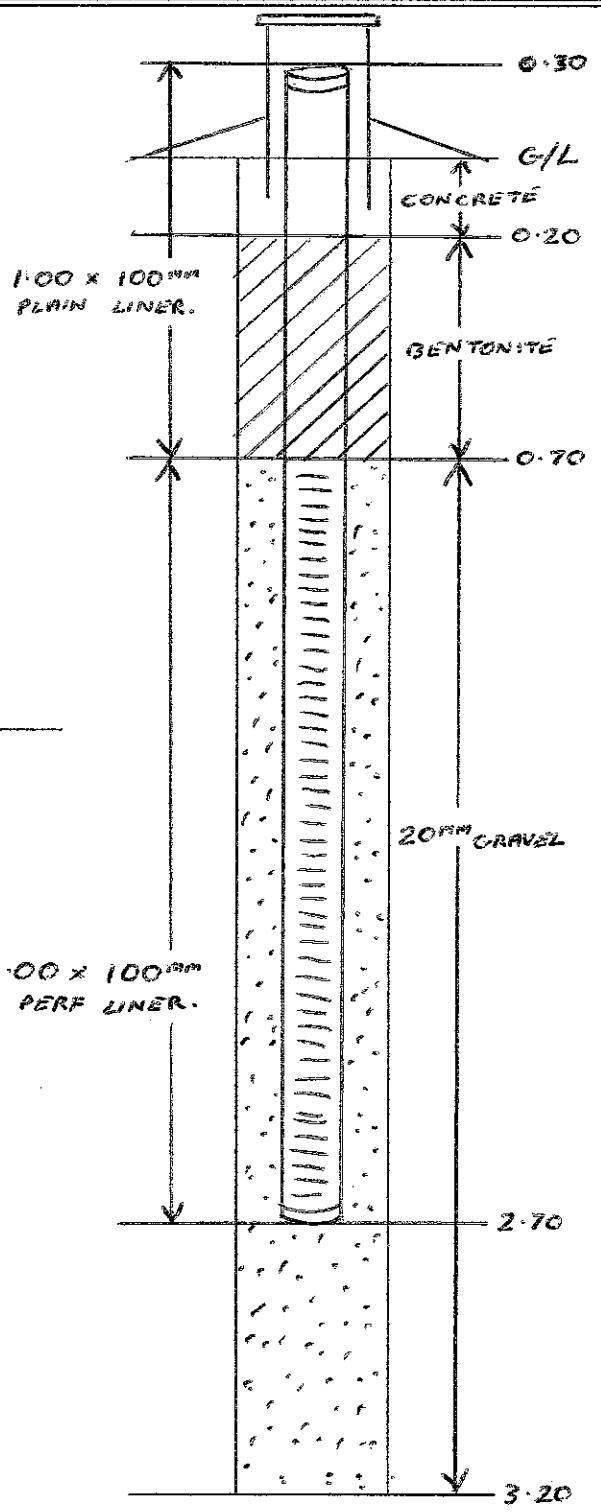
Mobile : (0831) 239668



Installation Of B/H. 2

Site : WIVENHOE

Job No :

Date : 27-2-97

Not to scale

Direct Drilling

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SOAKAWAYS
SITE INVESTIGATION

160 Invicta Road
Sheerness
Kent ME12 2AG

Tel / Fax : (01795) 664283
Tel : (01795) 666221
Mobile : (0831) 239668

Depth	Strata Description
G/L	FIRM, BROWN TOP SOILS.
0·30	FIRM, MOTTLED RUST-BROWN SILTY CLAY.
1·00	LIGHT REDDISH-BROWN FINE-MED SAND WITH FINE TO MED SUB-ANG-ULAR GRAVELS IN A SILTY 'CLAY BOUND' MATRIX.
1·40	FIRM TO STIFF, MOTTLED RUST-BROWN AND GRAY SILTY CLAY.
1·70	FIRM TO STIFF, DARK GRAY SILTY CLAY.

Penetration Testing and Samples

Type	From	To	75	150	225	300	375	450	Blows
		DAY WORKS.							
		LONG SITE MOVE, WINCHED RIG OFF B/H 3 AND ON TO B/H 2 POSITION. = 1 HR.							
		COLLECTED INSTALLATION EQUIPMENT FROM PIT. = ½ HR.							
		CLEARED EXCESS SPOILS = ¼ HR.							

Remarks INSTALLED 2·00 × 100^{mm} LINER, DETAILS ON SEPARATE SHEET.

Driller Data Protection Act

Water Levels

	Depth	Casing	Time
Morning			
Evening			
Other			

Depth at end of day

Diameter (mm)	Borehole	Casing
200	2·20	1·50

Hard Strata / Chiselling

From (M)	To (M)	From (Hrs)	To (Hrs)

Total number of samples

SPT	B	U100	D	H²O	P

H²O	Strike 1	Strike 2	Strike 3
Depth	1·20		
Depth 5 mins	SEEPAGE		
Depth 10 mins			
Depth 15 mins			
Depth 20 mins			
Casing			
Cut off at			

Move	Drill	Stand	Break	Work
1	2·20			1 ¾ HRS

Site WIVENHOE

Job No.

B / H No. 3

Day WEDNESDAY

Date 26-2-97

Direct Drilling

BDA accredited

LANDFILL
SOAKAWAYS
SITE INVESTIGATION

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Sheerness
Kent ME12 2AG

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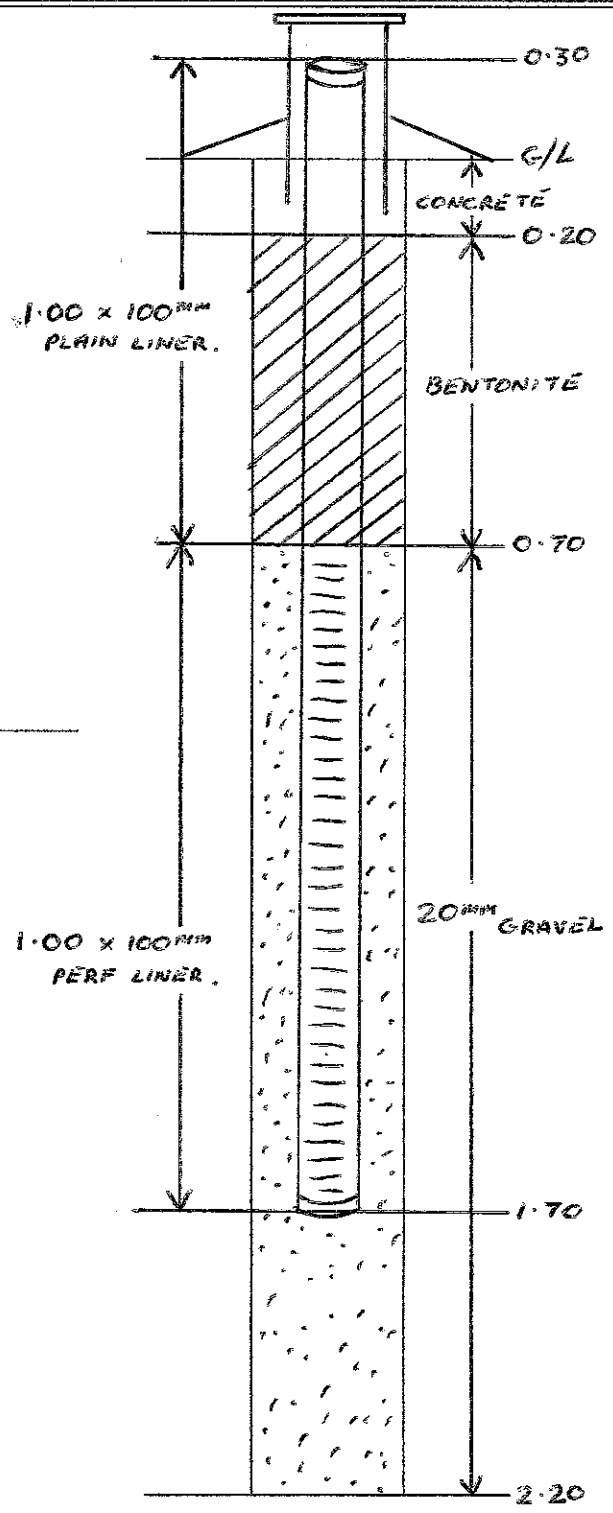
Mobile : (0831) 239668



Installation Of B/H. 3

Site : Wivenhoe

Job No :

Date : 26-2-97

Not to scale

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LANDFILL
SOAKAWAYS
SITE INVESTIGATION

160 Invicta Road
Sheerness
Kent ME12 2AG

Tel / Fax : (01795) 664283
Tel : (01795) 666221
Mobile : (0831) 239668

Depth	Strata Description
G/L	SOFT BROWN TOP SOILS.
0·20	SOFT TO FIRM, BROWN - GRAY MOTTLED 'CLAY BOUND' SILT.
0·60	FIRM BROWNISH - GRAY 'CLAY BOUND' SANDY SILT, WITH ABUNDENT FINE TO MED SIZED GRAVELS
0·80	BUFF - BROWN FINE TO MED SAND, WITH FINE TO MED SUB - ANGULAR GRAVELS.
1·20	FIRM TO STIFF, BROWN - GRAY MOTTLED SILTY CLAY WITH RUST - BROWN FRIABLE SILT VAINS.
2·00	STIFF, DARK GRAY SILTY CLAY.

Penetration Testing and Samples

Type	From	To	75	150	225	300	375	450	Blows
			DAY WORKS.						
			WINCHED RIG TO B/H POSITION			= ½ HR.			
			COLLECTED INSTALLATION EQUIPMENT FROM PIT			= ½ HR.			
			CLEARED EXCESS SPOILS			= ¼ HR.			

Remarks INSTALLED 2·30 × 100MM LINER, DETAILS ON SEPARATE SHEET.

Driller Data Protection Act

Water Levels

	Depth	Casing	Time
Morning			
Evening			
Other			

Depth at end of day

Diameter (mm)	Borehole	Casing
200	2·50	1·50

Hard Strata / Chiselling

From (M)	To (M)	From (Hrs)	To (Hrs)

Total number of samples

SPT	B	U100	D	H²O	P

H²O	Strike 1	Strike 2	Strike 3
Depth	0·80		
Depth 5 mins			
Depth 10 mins			
Depth 15 mins			
Depth 20 mins			
Casing			
Cut off at			

Move	Drill	Stand	Break	Work
1	2·50			1 ¼ HRS

Site WIVENHOE

Job No.

B / H No. 4

Day TUESDAY

Date 25-2-97

Direct Drilling

BDA accredited

LANDFILL
SOAKAWAYS
SITE INVESTIGATION

160 Invicta Road
Sheerness
Kent ME12 2AG

Tel / Fax : (01795) 664283
Tel : (01795) 666221
Mobile : (0831) 239668

Depth	Strata Description
G/L	SOFT TO FIRM BROWN TOP SOILS.
0·30	FIRM BROWN - GRAY MOTTLED CLAY - BOUND SILT
1·00	FIRM BROWNISH - GRAY 'CLAY BOUND' SANDY SILT, WITH SCATTERD GRAVELS.
1·40	FIRM TO STIFF, BROWN - GRAY MOTTLED SILTY CLAY, WITH RUST - BROWN FRIABLE SILT VAINS.
2·50	FIRM TO STIFF, DARK GRAY SILTY CLAY.

Penetration Testing and Samples

Type	From	To	75	150	225	300	375	450	Blows

Remarks DRILLED TO 5·00, BACKFILLED WITH SPOILS.

Driller Data Protection Act

Water Levels

	Depth	Casing	Time
Morning			
Evening			
Other			

Depth at end of day

Diameter (mm)	Borehole	Casing
200	5·00	1·50

Hard Strata / Chiselling

From (M)	To (M)	From (Hrs)	To (Hrs)

Total number of samples

SPT	B	U100	D	H²O	P

H²O	Strike 1	Strike 2	Strike 3
Depth			
Depth 5 mins			
Depth 10 mins			
Depth 15 mins	DRY		
Depth 20 mins			
Casing			
Cut off at			

Move	Drill	Stand	Break	Work
1	5·00			

Site WIVENHOE

Job No.

B / H No. 4A

Day TUESDAY

Date 25 - 2 - 97

Direct Drilling

BDA accredited

LANDFILL
SOAKAWAYS
SITE INVESTIGATION

160 Invicta Road
Sheerness
Kent ME12 2AG

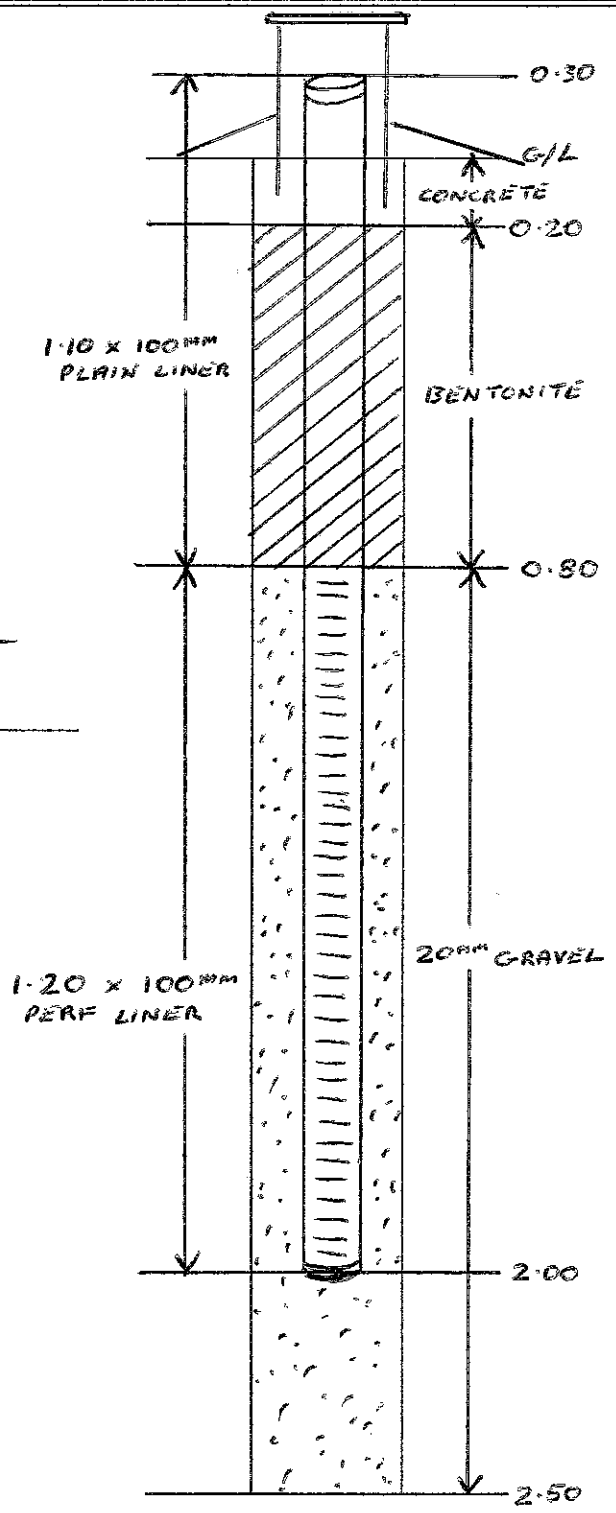
Tel / Fax : (01795) 664283
Tel : (01795) 666221
Mobile : (0831) 239668

Installation Of B/H. 4

Site : WIVENHOE

Job No :

Date : 25-2-97



Not to scale

Direct Drilling

BDA accredited

LANDFILL
SOAKAWAYS
SITE INVESTIGATION

160 Invicta Road
Sheerness
Kent ME12 2AG

Tel / Fax : (01795) 664283
Tel : (01795) 666221
Mobile : (0831) 239668

Depth	Strata Description
G/L	FIRM BROWN TOP SOILS.
0·40	FIRM DARK RUST - BROWN SANDY CLAY WITH ABUNDENT FINE TO MED SIZED GRAVELS.
1·20	LIGHT REDDISH - BROWN FINE TO MED SAND, WITH FINE TO MED SUB - ANGULAR GRAVELS.
4·30	SOFT GREENISH - GRAY MOTTLED SILT.
4·60	LIGHT REDDISH - BROWN FINE TO MED SAND, WITH FINE - MED AND LARGE SUB - ANGULAR AND SEMI - ROUNDED GRAVELS.
6·80	STIFF MOTTLED BROWN SILTY CLAY.
7·00	STIFF DARK GRAY SILTY CLAY.

Penetration Testing and Samples

Type	From	To	75	150	225	300	375	450	Blows
		DAY WORKS							
		COLLECTED INSTALLATION EQUIPMENT FROM PIT				= 1/2 HR.			
		CLEARED EXCESS SPOILS				= 1/4 HR.			

Remarks INSTALLED 7·10 x 100$^{mm\phi}$ LINER DETAILS ON SEPARATE SHEET.

Driller Data Protection Act

Water Levels

	Depth	Casing	Time
Morning			
Evening			
Other			

Depth at end of day

Diameter (mm)	Borehole	Casing
200	7·50	7·00

Hard Strata / Chiselling

From (M)	To (M)	From (Hrs)	To (Hrs)

Total number of samples

SPT	B	U100	D	H²O	P

H²O	Strike 1	Strike 2	Strike 3
Depth	4·80		
Depth 5 mins	4·00		
Depth 10 mins	3·60		
Depth 15 mins	3·40		
Depth 20 mins	3·20		
Casing	4·80		
Cut off at	7·00		

Move	Drill	Stand	Break	Work
1	7·50	20 MIN		3/4 HR

Site WIVENHOE

Job No.

B / H No. 5

Day MONDAY

Date 24 - 2 - 97

Direct Drilling

BDA accredited

LANDFILL
SOAKAWAYS
SITE INVESTIGATION

160 Invicta Road
Sheerness
Kent ME12 2AG

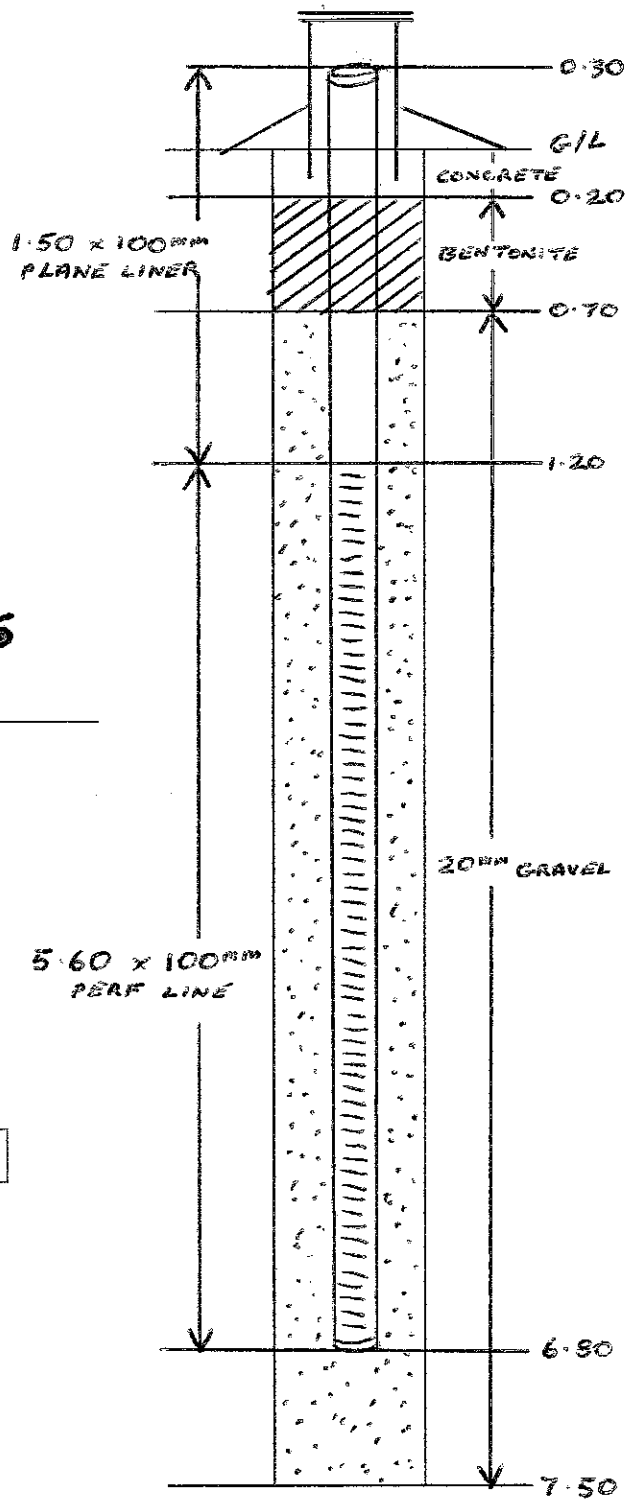
Tel / Fax : (01795) 664283
Tel : (01795) 666221
Mobile : (0831) 239668

Installation Of B/H. 5

Site : WIVENHOE

Job No :

Date : 24-2-97



Not to scale

Appendix D

Existing Discharge Consent

Consent No. PRENF/11541

ENVIRONMENT AGENCY

WATER RESOURCES ACT 1991 - SCHEDULE 10

(as amended by the Environment Act 1995)

CONSENT

To: Lafarge Redland Aggregates Ltd ("the discharger")
Bradgate House
Groby
Leicester
LE6 0FA

The ENVIRONMENT AGENCY ("the Agency") in pursuance of its powers under the Water Resources Act 1991 (as amended by the Environment Act 1995) HEREBY CONSENTS to the making of a discharge of TRADE EFFLUENT.

Trade Effluent

FROM: Wivenhoe Sand and Gravel Pit, Alresford Road, Wivenhoe, CO7 9JY

TO: Sixpenny Brook.

SUBJECT TO the conditions set out in the following schedules:

Trade Effluent Schedule No. PRENF/11541 01

Subject to the provisions of Paragraphs 7 and 8 of Schedule 10 of the Water Resources Act 1991 as amended by the Environment Act 1995, no notice shall be served by the Agency, altering this consent without the agreement in writing of the discharger, during a period of 4 years from the date this consent takes effect or such later date as may be specified in an endorsement to this document.

This consent is issued and takes effect on the 29th January 1999

Data Protection Act [redacted]

JOHN DANIELS
Team Leader Water Quality Consents

Attention is drawn to the notes overleaf.

ENVIRONMENT AGENCY

Consent No.	PRENF/11541
Schedule No.	PRENF/11541 01
Date issued	29th January 1999

CONDITIONS OF CONSENT TO DISCHARGE

Trade Effluent ("the discharge")

FROM: Wivenhoe Sand and Gravel Pit, Alresford Road, Wivenhoe, CO7 9JY

1. (i) The discharge shall not contain any poisonous, noxious, or polluting matter or solid waste matter.

   (ii) Provided that the discharge hereby consented is made in accordance with the following conditions of this consent, such discharge shall not be taken to be in breach of condition (i) above by reason of containing substances or having properties identified in and controlled by those conditions.

2. The discharge shall consist solely of trade effluent from the prevention of interference with quarrying.

3. The discharge shall be made through an outlet between National Grid Reference TM 0554 2308 and TM 0540 2272 into Sixpenny Brook.

4. The volume discharged shall not exceed 3928 cubic metres in any period of 24 hours.

5. The rate of discharge shall not exceed 45 litres per second.

6. A continuous recorder shall be provided and maintained at the prescribed effluent sample point to enable the volume and rate of the discharge to be measured.

7. Records of the volume and rate of the discharge shall be maintained by the discharger these records shall be kept conveniently available to representatives of the Agency for inspection at all reasonable times

8. The discharge shall not contain more than 30 milligrams per litre of suspended solids (measured after drying at 105°C)

Environment Agency Anglian Region Eastern Area Cobham Road Ipswich Suffolk IP3 9JE

Consent No.	PRENF/11541
Schedule No.	PRENF/11541 01
Date issued	29th January 1999

9. As far as is reasonably practicable, the site shall be operated so as to prevent:

   (i) any matter being present in the effluent, other than matter specifically covered by numerical conditions in this consent, to such an extent as to cause the receiving waters, or any waters of which the receiving waters are a tributary, to be poisonous or injurious to fish in those waters, or to the spawning grounds, spawn or food of fish in those waters, or otherwise cause damage to the ecology of those waters; and

   (ii) the discharge from having any other adverse environmental impact.

10. As far as is reasonably practicable, the site shall be operated so as to prevent the discharge from containing any significant trace of visible oil or grease.

11. The discharge shall be made through an outlet constructed and maintained so that a direct sample of the discharge may be readily obtained.

Environment Agency Anglian Region Eastern Area Cobham Road Ipswich Suffolk IP3 9JE

Appendix E

Records of Neighbouring Licenced Abstractions

EAN/2017/62273/Request For Information - Brightlingsea.

Report created 11/10/2017

Water Act Lic. Type Descri	Licence No.	Orig. Effective Da	Expiry Date	Version Start Date	Salutation	Initials	Forename	Name	Line 1	Line 2	Line 3	Line 4	Town	County	Postcode	Primary Descripti	Secondary Descri	Use Description	Period Start	Period End	Source Type	Point Name	Point Category	NGR 1	NGR 2	NGR 3	NGR 4	NGR 1 Cartesian	NGR 2 Cartesian	NGR 3 Cartesian	NGR 4 Cartesian
Full Licence (>=28 Days)	8/37/25/*G/0014	01/06/1966		08/12/2010				Data	Elmstead Hall Farm	Church Road	Elmstead		Colchester	ESSEX	CO7 7AR	Agriculture	General Agriculture	Spray Irrigation - D	01/04	30/09	GW	PT 'A' WELL AT PARK FAR	SP	TM06402330				606400 223300			
Full Licence (>=28 Days)	8/37/25/*G/0014	01/06/1966		08/12/2010				Data	Elmstead Hall Farm	Church Road	Elmstead		Colchester	ESSEX	CO7 7AR	Agriculture	General Agriculture	Spray Irrigation - D	01/04	30/09	GW	PT 'B' WELL AT PARK FAR	SP	TM06702310				606700 223100			
Full Licence (>=28 Days)	8/37/25/*G/0014	01/06/1966		08/12/2010				Data	Elmstead Hall Farm	Church Road	Elmstead		Colchester	ESSEX	CO7 7AR	Agriculture	General Agriculture	Spray Irrigation - D	01/04	30/09	GW	PT 'C' BORE AT PARK FAR	SP	TM06502320				606500 223200			
Full Licence (>=28 Days)	8/37/25/*G/0028	01/11/1966		26/10/2015				Data	Portland House	Bickenhill Lane			Birmingham	WEST MIDLANDS	B37 7BQ	Industrial, Commer	Extractive	Mineral Washing	01/01	31/12	GW	WIVENHOE GRAVEL PITS	SP	TM04702240				604700 222400			
Full Licence (>=28 Days)	8/37/25/*G/0089	01/05/1966		07/05/2002		[redacted]	[redacted]	[redacted]	ALRESFORD GRA	WIVENHOE ROAD	ALRESFORD		COLCHESTER	ESSEX	CO7 8BG	Agriculture	General Agriculture	General Farming &	01/01	31/12	GW	ALRESFORD GRANGE, AL	SP	TM056210				605600 221000			
Full Licence (>=28 Days)	8/37/25/*G/0093	01/11/1966		31/07/2017	[redacted]	[redacted]	[redacted]	[redacted]	KEELARS	ELMSTEAD			COLCHESTER	ESSEX	CO7 7EZ	Agriculture	General Agriculture	Spray Irrigation - A	01/04	01/06	GW	GRAVEL PIT AT WIVENHO	SP	TM047225				604700 222500			
Full Licence (>=28 Days)	8/37/25/*G/0093	01/11/1966		31/07/2017	[redacted]	[redacted]	[redacted]	[redacted]	KEELARS	ELMSTEAD			COLCHESTER	ESSEX	CO7 7EZ	Agriculture	General Agriculture	Spray Irrigation - D	01/04	30/09	GW	GRAVEL PIT AT WIVENHO	SP	TM047225				604700 222500			
Full Licence (>=28 Days)	8/37/25/*G/0093	01/11/1966		31/07/2017	[redacted]	[redacted]	[redacted]	[redacted]	KEELARS	ELMSTEAD			COLCHESTER	ESSEX	CO7 7EZ	Agriculture	General Agriculture	Spray Irrigation - D	01/04	30/09	GW	WELL AT HEATH FARM, E	SP	TM058224				605800 222400			
Full Licence (>=28 Days)	8/37/25/*G/0105	01/06/1966		15/12/2000		[redacted]	[redacted]	[redacted]	TALL TREES	CLACTON ROAD	FRATING		COLCHESTER	ESSEX	CO7 7DG	Agriculture	General Agriculture	Spray Irrigation - D	01/01	31/12	GW	TALL TREES, FRATING	SP	TM080233				608000 223300			
Full Licence (>=28 Days)	8/37/25/*G/0110	01/05/1967		16/12/2013				Data	150 Aldersgate Street				London		EC1A 4AB	Industrial, Commer	Mineral Products	Mineral Washing	01/01	31/12	GW	ALRESFORD PIT, COLCHE	SP	TM063200				606300 220000			
Full Licence (>=28 Days)	8/37/25/*G/0110	01/05/1967		16/12/2013				Data	150 Aldersgate Street				London		EC1A 4AB	Industrial, Commer	Mineral Products	Process Water	01/01	31/12	GW	ALRESFORD PIT, COLCHE	SP	TM063200				606300 220000			
Full Licence (>=28 Days)	8/37/25/*G/0112	01/11/1966		16/12/2013				Data	150 Aldersgate Street				London		EC1A 4AB	Industrial, Commer	Mineral Products	Mineral Washing	01/01	31/12	GW	ALRESFORD PIT, GRAVEL	SP	TM063200				606300 220000			
Full Licence (>=28 Days)	8/37/25/*G/0169	01/02/1967		02/05/1985				Data	LUFKINS FARM	FRATING			COLCHESTER	ESSEX	CO7 7HN	Agriculture	General Agriculture	General Farming &	01/01	31/12	GW	LUFKINS FARM 1, FRATIN	SP	TM092220				609200 222000			
Full Licence (>=28 Days)	8/37/25/*G/0169	01/02/1967		02/05/1985				Data	LUFKINS FARM	FRATING			COLCHESTER	ESSEX	CO7 7HN	Agriculture	General Agriculture	General Farming &	01/01	31/12	GW	SLOUGH FARM, FRATING	SP	TM091221				609100 222100			
Full Licence (>=28 Days)	8/37/25/*G/0169	01/02/1967		02/05/1985				Data	LUFKINS FARM	FRATING			COLCHESTER	ESSEX	CO7 7HN	Agriculture	General Agriculture	Spray Irrigation - D	01/01	31/12	GW	LUFKINS FARM 1, FRATIN	SP	TM092220				609200 222000			
Full Licence (>=28 Days)	8/37/25/*G/0169	01/02/1967		02/05/1985				Data	LUFKINS FARM	FRATING			COLCHESTER	ESSEX	CO7 7HN	Agriculture	General Agriculture	Spray Irrigation - D	01/01	31/12	GW	SLOUGH FARM, FRATING	SP	TM091221				609100 222100			
Full Licence (>=28 Days)	8/37/25/*G/0170	01/02/1967		01/04/2001		[redacted]		Data	GROVE FARM	ELMSTEAD MARKET			COLCHESTER	ESSEX	CO7 7EW	Agriculture	General Agriculture	Spray Irrigation - D	01/04	31/10	GW	GROVE FARM, ELMSTEAD	SP	TM066236				606600 223600			
Full Licence (>=28 Days)	8/37/25/*G/0179	01/09/1970		18/11/2014		[redacted]		[redacted]	Fen Farm	Fen Chase	Elmstead Market		Colchester	ESSEX	CO7 7ER	Agriculture	General Agriculture	Spray Irrigation - D	01/04	30/09	GW	WIVENHOE LODGE 1, WIV	SP	TM039238				603900 223800			
Full Licence (>=28 Days)	8/37/25/*G/0179	01/09/1970		18/11/2014		[redacted]		[redacted]	Fen Farm	Fen Chase	Elmstead Market		Colchester	ESSEX	CO7 7ER	Agriculture	General Agriculture	Spray Irrigation - D	01/04	30/09	GW	WIVENHOE LODGE 2, WIV	SP	TM038238				603800 223800			
Full Licence (>=28 Days)	8/37/25/*G/0179	01/09/1970		18/11/2014		[redacted]		[redacted]	Fen Farm	Fen Chase	Elmstead Market		Colchester	ESSEX	CO7 7ER	Agriculture	General Agriculture	Transfer Between S	01/04	30/09	GW	WIVENHOE LODGE 1, WIV	SP	TM039238				603900 223800			
Full Licence (>=28 Days)	8/37/25/*G/0179	01/09/1970		18/11/2014		[redacted]		[redacted]	Fen Farm	Fen Chase	Elmstead Market		Colchester	ESSEX	CO7 7ER	Agriculture	General Agriculture	Transfer Between S	01/04	30/09	GW	WIVENHOE LODGE 2, WIV	SP	TM038238				603800 223800			
Full Licence (>=28 Days)	8/37/25/*G/0188	01/12/1972		16/12/2013				Data	150 Aldersgate Street				London		EC1A 4AB	Industrial, Commer	Mineral Products	Mineral Washing	01/01	31/12	GW	SEEPAGE RESERVOIR, AL	SP	TM05402160				605400 221600			
Full Licence (>=28 Days)	8/37/25/*G/0199	01/03/1974		01/11/2000		[redacted]	[redacted]	[redacted]	POPLARS CHASE	STATION ROAD			THORRINGTON	ESSEX	CO7 8HZ	Industrial, Commer	Extractive	Mineral Washing	01/01	31/12	GW	POPLARS CHASE FARM, I	SP	TM08302120				608300 221200			
Full Licence (>=28 Days)	8/37/25/*G/0224	01/04/1979		28/03/2014				Data	Elmstead Hall Farm	Church Road	Elmstead		Colchester	ESSEX	CO7 7AR	Agriculture	General Agriculture	Spray Irrigation - D	01/04	31/10	GW	ELMSTEAD HALL, ELMSTE	SP	TM06302615				606300 226150			
Full Licence (>=28 Days)	8/37/25/*G/0231	01/05/1982		18/11/2014		[redacted]		[redacted]	Fen Farm	Fen Chase	Elmstead Market		Colchester	ESSEX	CO7 7ER	Agriculture	General Agriculture	Transfer Between S	01/11	31/03	GW	10 JETWELLS AT PARK FA	SP	TM042244				604200 224400			
Full Licence (>=28 Days)	8/37/25/*G/0282	01/02/1985		18/11/2014		[redacted]		[redacted]	Fen Farm	Fen Chase	Elmstead Market		Colchester	ESSEX	CO7 7ER	Agriculture	General Agriculture	Spray Irrigation - D	01/04	31/10	GW	EXCAV. FEN FARM, ELMS	SP	TM058238				605800 223800			
Full Licence (>=28 Days)	8/37/25/*G/0284	01/02/1985		28/03/2014				Data	Collierswood Farm	Ardleigh			Colchester	ESSEX	CO7 7SN	Agriculture	General Agriculture	Spray Irrigation - D	01/04	31/10	GW	JETWELLS AT COLLIERSV	SP	TM05602650				605600 226500			
Full Licence (>=28 Days)	8/37/25/*G/0289	01/04/1986		28/03/2014	[redacted]	[redacted]	[redacted]	[redacted]	ALLENS FARM	ELMSTEAD MARKET			COLCHESTER	ESSEX	CO7 7BB	Agriculture	General Agriculture	Spray Irrigation - D	01/04	31/03	GW	14 WELLPOINTS-ALLENS	SP	TM05202560				605200 225600			
Full Licence (>=28 Days)	8/37/25/*G/0302	01/06/1988		01/10/1988				Data	ELMSTEAD MARKET				COLCHESTER	ESSEX	CO7 7DB	Agriculture	General Agriculture	Spray Irrigation - D	01/01	31/12	GW	WHITE BARN HOUSE, ELM	SP	TM069238				606900 223800			
Full Licence (>=28 Days)	8/37/25/*S/0015	01/06/1966		01/04/2001		[redacted]		[redacted]	GROVE FARM	ELMSTEAD MARKET			COLCHESTER	ESSEX	CO7 7EW	Agriculture	General Agriculture	Spray Irrigation - D	01/04	31/10	SW	RES. ON TRIB TENPENNY	SP	TM068236				606800 223600			
Full Licence (>=28 Days)	8/37/25/*S/0015	01/06/1966		01/04/2001		[redacted]		[redacted]	GROVE FARM	ELMSTEAD MARKET			COLCHESTER	ESSEX	CO7 7EW	Agriculture	General Agriculture	Spray Irrigation - D	01/04	31/10	SW	RES. ON TRIB TENPENNY	SP	TM070235				607000 223500			
Full Licence (>=28 Days)	8/37/25/*S/0041	01/06/1966		31/07/2017	[redacted]	[redacted]	[redacted]	[redacted]	KEELARS	ELMSTEAD			COLCHESTER	ESSEX	CO7 7EZ	Agriculture	General Agriculture	Spray Irrigation - D	01/04	30/09	SW	RES ON SIXPENNY BK, CI	SP	TM058210				605800 221000			
Full Licence (>=28 Days)	8/37/25/*S/0049	01/06/1966		01/06/1966				Data	MILL FARM	BRIGHTLINGSEA	THORRINGTON		COLCHESTER	ESSEX	CO7 8JJ	Agriculture	General Agriculture	Spray Irrigation - D	01/02	31/10	SW	MILL FARM, THORRINGTC	RC	TM080198	TM082194			608000 219800	608200 219400		
Full Licence (>=28 Days)	8/37/25/*S/0084	20/05/1966		26/08/2009				Data	HOCKLEY FARM	CHURCH ROAD	FRATING		COLCHESTER	ESSEX	CO7 7HG	Agriculture	General Agriculture	Spray Irrigation - D	01/03	30/09	SW	POND FED BY TRIB OF TE	SP	TM086216				608600 221600			
Full Licence (>=28 Days)	8/37/25/*S/0096	01/05/1966		18/11/2014		[redacted]		[redacted]	Fen Farm	Fen Chase	Elmstead Market		Colchester	ESSEX	CO7 7ER	Agriculture	General Agriculture	Spray Irrigation - D	01/04	30/09	SW	TRIB.OF R.COLNE-WIVEN	SP	TM032231				603200 223100			
Full Licence (>=28 Days)	8/37/25/*S/0096	01/05/1966		18/11/2014		[redacted]		[redacted]	Fen Farm	Fen Chase	Elmstead Market		Colchester	ESSEX	CO7 7ER	Agriculture	General Agriculture	Spray Irrigation - S	01/11	31/03	SW	TRIB.OF R.COLNE-WIVEN	SP	TM032231				603200 223100			
Full Licence (>=28 Days)	8/37/25/*S/0127	01/05/1966		01/11/1987		[redacted]		[redacted]	BLUE GATES FARM		ALRESFORD		COLCHESTER	ESSEX	CO7 8DE	Agriculture	General Agriculture	Spray Irrigation - D	01/05	30/09	SW	RES 1 FED BY TRIB TENP	SP	TM068225				606800 222500			
Full Licence (>=28 Days)	8/37/25/*S/0127	01/05/1966		01/11/1987		[redacted]		[redacted]	BLUE GATES FARM		ALRESFORD		COLCHESTER	ESSEX	CO7 8DE	Agriculture	General Agriculture	Spray Irrigation - D	01/05	30/09	SW	RES 2 FED BY TRIB TENP	SP	TM070225				607000 222500			
Full Licence (>=28 Days)	8/37/25/*S/0127	01/05/1966		01/11/1987		[redacted]		[redacted]	BLUE GATES FARM		ALRESFORD		COLCHESTER	ESSEX	CO7 8DE	Agriculture	General Agriculture	Spray Irrigation - D	01/05	30/09	SW	RES 3 FED BY TRIB TENP	SP	TM071225				607100 222500			
Full Licence (>=28 Days)	8/37/25/*S/0178	01/09/1970		10/04/2015				Data	Elmstead Hall Farm	Church Road	Elmstead		Colchester	ESSEX	CO7 7AR	Agriculture	General Agriculture	Spray Irrigation - S	01/11	31/03	SW	BROMLEY BROOK AT ELM	SP	TM0694626237				606946 226237			
Full Licence (>=28 Days)	8/37/25/*S/0196	01/06/1973		01/09/1995				Data	ADMIRALS FARM	ADMIRALS FARM	HECKFORD ROAD	GREAT BENTLEY	COLCHESTER	ESSEX	CO7 8RS	Agriculture	General Agriculture	Spray Irrigation - S	01/11	31/03	SW	TENPENNY BROOK,HILL F	SP	TM076234				607600 223400			
Full Licence (>=28 Days)	8/37/25/*S/0198	01/01/1974		01/04/2016				Data	FRATING HALL	FRATING			COLCHESTER	ESSEX	CO7 7HD	Agriculture	General Agriculture	Spray Irrigation - D	01/04	30/09	SW	TRIB TENPENNY BK AT FF	SP	TM079226				607900 222600			
Full Licence (>=28 Days)	8/37/25/*S/0198	01/01/1974		01/04/2016				Data	FRATING HALL	FRATING			COLCHESTER	ESSEX	CO7 7HD	Agriculture	General Agriculture	Spray Irrigation - D	01/04	30/09	SW	TRIB TENPENNY BK AT FF	SP	TM081227				608100 222700			
Full Licence (>=28 Days)	8/37/25/*S/0209	01/05/1977		20/11/2006		[redacted]	[redacted]	[redacted]	25 BATEMAN ROAD				BRIGHTLINGSEA	ESSEX	CO7 0SG	Agriculture	General Agriculture	Spray Irrigation - D	01/04	30/09	SW	ON-STREAM RES LODGE	SP	TM07232489				607230 224890			
Full Licence (>=28 Days)	8/37/25/*S/0209	01/05/1977		20/11/2006		[redacted]	[redacted]	[redacted]	25 BATEMAN ROAD				BRIGHTLINGSEA	ESSEX	CO7 0SG	Agriculture	General Agriculture	Spray Irrigation - S	01/11	31/03	SW	TRIB OF TENPENNY BRO	SP	TM07232482				607230 224820			
Full Licence (>=28 Days)	8/37/25/*S/0222	01/01/1979		01/01/1979		[redacted]		[redacted]	SUNNYMEAD FAR	WIVENHOE			COLCHESTER	ESSEX	CO7 9JZ	Agriculture	General Agriculture	Spray Irrigation - S	01/11	31/03	SW	SUNNYMEAD FARM, WIVE	SP	TM053223				605300 222300			
Full Licence (>=28 Days)	8/37/25/*S/0230	01/11/1981		29/03/2017			[redacted]	Data	Brook View	Tenpenny Hill	Thorrington		Colchester	Essex	CO7 8JB	Agriculture	General Agriculture	Spray Irrigation - D	01/04	31/10	SW	TENPENNY BROOK AT AL	SP	TM077211				607700 221100			
Full Licence (>=28 Days)	8/37/25/*S/0230	01/11/1981		29/03/2017			[redacted]	Data	Brook View	Tenpenny Hill	Thorrington		Colchester	Essex	CO7 8JB	Agriculture	General Agriculture	Spray Irrigation - S	01/11	31/03	SW	TENPENNY BROOK AT AL	SP	TM077211				607700 221100			
Full Licence (>=28 Days)	8/37/25/*S/0241	01/04/1984		19/12/2011				Data	ADMIRALS FARM	ADMIRALS FARM	HECKFORD ROAD	GREAT BENTLEY	COLCHESTER	ESSEX	CO7 8RS	Agriculture	General Agriculture	Spray Irrigation - S	01/11	31/03	SW	TENPENNY BROOK, FRAT	SP	TM07402310				607400 223100			
Full Licence (>=28 Days)	8/37/25/*S/0280	01/06/1984		01/10/1988				Data	ELMSTEAD MARKET				COLCHESTER	ESSEX	CO7 7DB	Agriculture	General Agriculture	Spray Irrigation - D	01/04	31/10	SW	TRIB OF TENPENNY BK, V	SP	TM06802379				606800 223790			
Full Licence (>=28 Days)	8/37/25/*S/0291	01/04/1986		01/04/1986		[redacted]		[redacted]	BLUE GATES FARM		ALRESFORD		COLCHESTER	ESSEX	CO7 8DE	Agriculture	General Agriculture	Spray Irrigation - S	01/11	31/03	SW	TENPENNY BROOK, ELMS	SP	TM075223				607500 222300			
Full Licence (>=28 Days)	8/37/25/*S/0297	01/04/1987		18/11/2014		[redacted]		[redacted]	Fen Farm	Fen Chase	Elmstead Market		Colchester	ESSEX	CO7 7ER	Agriculture	General Agriculture	Transfer Between S	01/11	31/03	SW	SIXPENNY BROOK AT TYE	SP	TM056239				605600 223900			
Full Licence (>=28 Days)	8/37/39/*S/0111	01/06/1996		27/07/2016				Data	Holmwood Farm	Brook Hall Road	Fingringhoe		Colchester	ESSEX	CO5 7DG	Agriculture	General Agriculture	Spray Irrigation - S	01/11	31/03	SW	TRIB OF TIDAL RIVER CO	SP	TM040198				604000 219800			
Full Licence (>=28 Days)	AN/037/0025/004/R01	03/05/2016	31/03/2028	03/05/2016				Data	Norfolk House Farm	Gedney Marsh	Holbeach		Spalding	LINCOLNSHIRE	PE12 9PB	Agriculture	General Agriculture	Spray Irrigation - S	01/04	31/10	GW	WELLPOINTS AT HOCKLE	RC	TM0824821891	TM0844121871			608248 221891	608441 221871		
Full Licence (>=28 Days)	AN/037/0025/004/R01	03/05/2016	31/03/2028	03/05/2016				Data	Norfolk House Farm	Gedney Marsh	Holbeach		Spalding	LINCOLNSHIRE	PE12 9PB	Agriculture	General Agriculture	Spray Irrigation - S	01/04	31/10	GW	WELLPOINTS AT HOCKLE	RC	TM0826722151	TM0823921939			608267 222151	608239 221939		
Full Licence (>=28 Days)	AN/037/0025/004/R01	03/05/2016	31/03/2028	03/05/2016				Data	Norfolk House Farm	Gedney Marsh	Holbeach		Spalding	LINCOLNSHIRE	PE12 9PB	Agriculture	General Agriculture	Spray Irrigation - S	01/11	31/03	GW	WELLPOINTS AT HOCKLE	RC	TM0824821891	TM0844121871			608248 221891	608441 221871		
Full Licence (>=28 Days)	AN/037/0025/004/R01	03/05/2016	31/03/2028	03/05/2016				Data	Norfolk House Farm	Gedney Marsh	Holbeach		Spalding	LINCOLNSHIRE	PE12 9PB	Agriculture	General Agriculture	Spray Irrigation - S	01/11	31/03	GW	WELLPOINTS AT HOCKLE	RC	TM0826722151	TM0823921939			608267 222151	608239 221939		
Full Licence (>=28 Days)	AN/037/0025/005/R01	03/05/2016	31/03/2028	03/05/2016				Data	Norfolk House Farm	Gedney Marsh	Holbeach		Spalding	LINCOLNSHIRE	PE12 9PB	Agriculture	General Agriculture	Spray Irrigation - S	01/11	31/03	SW	TENPENNY BROOK AT HC	SP	TM0763521950				607635 221950			
Full Licence (>=28 Days)	AN/037/0025/016	01/04/2013	31/03/2028	01/04/2013				Data	TOWN WALL HOU	BALKERNE HILL			COLCHESTER	ESSEX	CO3 3AD	Agriculture	General Agriculture	Spray Irrigation - D	01/01	31/12	GW	WELL AT WHISTLEBERRY	SP	TM0733220371				607332 220371			
Full Licence (>=28 Days)	AN/037/0025/016	01/04/2013	31/03/2028	01/04/2013				Data	TOWN WALL HOU	BALKERNE HILL			COLCHESTER	ESSEX	CO3 3AD	Agriculture	General Agriculture	Spray Irrigation - D	01/01	31/12	GW	WELL AT WHISTLEBERRY	SP	TM0753920535				607539 220535			
Transfer Licence	8/37/25/*S/0354	20/11/2006		16/12/2013				Data	150 Aldersgate Street				London		EC1A 4AB	Industrial, Commer	Extractive	Transfer Between S	01/10	31/03	SW	SIXPENNY BROOK, ALRES	SP	TM054216				605400 221600			
Transfer Licence	AN/037/0025/003/R01	14/06/2016	31/03/2028	14/06/2016				Data	150 Aldersgate Street				London		EC1A 4AB	Industrial, Commer	Extractive	Transfer Between S	01/04	31/03	GW	MOVERONS FARM PIT BF	AR	TM0677719174	TM0772718380	TM0755717701	TM0642218316	606777 219174	607727 218380	607557 217701	606422 218316

EAN/2017/62273/Request For Information - Brightlingsea.

Report created 11/10/2017

Licence No.	Max Annual Qua	Max Daily Quantity	Purpose/Point Des	Aggregate to Othe
8/37/25/*G/0014	18200	682	Multiple Points / Sin	N
8/37/25/*G/0028	455000	2100	Single Point / Single	N
8/37/25/*G/0089	545	21	Single Point / Single	N
8/37/25/*G/0093	79547	6341.67	Multiple Points / Mu	N
8/37/25/*G/0105	1910	95	Single Point / Single	N
8/37/25/*G/0110	10400	36.36	Single Point / Multip	N
8/37/25/*G/0112	22727	136	Single Point / Single	N
8/37/25/*G/0169	91000	1920	Multiple Points / Mu	N
8/37/25/*G/0170	5000	480	Single Point / Single	N
8/37/25/*G/0179	22730	874	Multiple Points / Mu	N
8/37/25/*G/0188	180000	650	Single Point / Single	N
8/37/25/*G/0199	160000	900	Single Point / Single	N
8/37/25/*G/0224	22700	909	Single Point / Single	N
8/37/25/*G/0231	13700	227	Single Point / Single	Y
8/37/25/*G/0282	172900	3300	Single Point / Single	Y
8/37/25/*G/0284	30000	682	Single Point / Single	N
8/37/25/*G/0289	31800	474	Single Point / Single	N
8/37/25/*G/0302	10000	100	Single Point / Single	N
8/37/25/*S/0015	11400	656	Multiple Points / Sin	N
8/37/25/*S/0041	36400	683	Single Point / Single	N
8/37/25/*S/0049	4546	386	Single Point / Single	N
8/37/25/*S/0084	1820	32	Single Point / Single	N
8/37/25/*S/0096	37490	37490	Single Point / Multip	N
8/37/25/*S/0127	14000	455	Multiple Points / Sin	N
8/37/25/*S/0178	100000	5184	Single Point / Single	N
8/37/25/*S/0196	9090	680	Single Point / Single	N
8/37/25/*S/0198	77700	336	Multiple Points / Mu	N
8/37/25/*S/0209	18200	518	Multiple Points / Mu	N
8/37/25/*S/0222	22700	22700	Single Point / Single	N
8/37/25/*S/0230	27300	1640	Single Point / Multip	N
8/37/25/*S/0241	10000	2030	Single Point / Single	N
8/37/25/*S/0280	2300	91	Single Point / Single	N
8/37/25/*S/0291	45500	12100	Single Point / Single	N
8/37/25/*S/0297	69000	1000	Single Point / Single	Y
8/37/25/*S/0354	18000	120	Single Point / Single	N
8/37/39/*S/0111	22700	22700	Single Point / Single	N
AN/037/0025/003/R01			Single Point / Single	N

AN/037/0025/004/R	72700	276.48	Multiple Points / Sin	N
AN/037/0025/005/R	3600	960	Single Point / Single	N
AN/037/0025/016	10000	40	Multiple Points / Sin	N

Appendix F

Records of Private Abstractions

Question

ESI is undertaking a study of a site located on Alresford Road, Wivenhoe, Colchester, CO7 9JY, (**605362, 222624**). Please could I request the following data within yo

Please find attached a map showing the search area.

Requested information on private water supplies:
National grid reference
Name of user
Name of location
Type of abstraction (groundwater or surface water)
Use to which the water is put

Answer

Further to your request for information relating to known private water supplies within a 4km radius of Alresford Road, Wivenhoe, I can provide the following infor

606555, 220297	Brook Cottage, Ford	groundwater	Domestic
606558, 220300	Broomlands, Ford La	groundwater	Domestic
606821, 220921	Crestland Wood Hou	groundwater	Domestic
607240, 219642	Plumptons Farm, St	groundwater	Domestic
606871, 224454	Evergreens, Bromley	groundwater	domestic
606243, 224557	Greenside, Chapel L	groundwater	domestic
606233, 225528	Parsonage Farm, Ch	groundwater	domestic
605091, 224526	3 Brook Cottages, Co	groundwater	domestic
604220, 226459	Ellenward, Green La	groundwater	domestic
605612, 224918	Drumcairn, Lane End	groundwater	domestic
606328, 223472	Park Farm South Bu	groundwater	domestic
606553, 223390	Park Farm South, Sc	groundwater	domestic
606769, 223436	Park Farm House, So	groundwater	domestic
604220, 225679	Peacocks Farm, Slou	groundwater	domestic

607687, 223303	Hill Farm, Frating Hi	groundwater	domestic
608526, 223825	Morehams Hall, Col	groundwater	domestic
608048, 223317	Tall Trees, Clacton R	groundwater	domestic
609243, 223066	Mannings Farm, Gre	groundwater	domestic
609179, 222965	St Margarets, Great	groundwater	domestic

We are not required to disclose the names of the users of the supplies and it should be noted that these records were last updated before 2009 when the regulatic

Part of the area you have requested falls within the borough of Colchester so you will need to contact them for information.

From:	Gary Weaver
To:	Christopher Woodhouse
Subject:	RE: Private water supplies data request for Alresford Road, Wivenhoe (our reference 61272)
Date:	09 March 2018 10:12:42
Attachments:	image003.png image004.png image005.png image006.png

Good morning Christopher

This information hasn't changed.

Regards
Gary Weaver

Gary Weaver
Environmental Health Technical Officer
Environment Services | Colchester Borough Council

Tel: +44(0)1206 282837
Data Protection
Web: www.colchester.gov.uk

Sign Up to a new Air Quality Health Alert Service
Offering daily information on air quality, temperature, UV, and pollen levels.

Register at www.airtext.info/colchester to receive free air quality alerts

---

From: Christopher Woodhouse [mailto:chriswoodhouse@esi-consulting.co.uk]
Sent: 01 March 2018 15:38
To: Gary Weaver <Gary.Weaver@colchester.gov.uk>
Cc: Andrew Tait <AndrewTait@esi-consulting.co.uk>
Subject: RE: Private water supplies data request for Alresford Road, Wivenhoe (our reference 61272)

Hi Gary,

You provided the Private Water Supplies info below in June 2016 (see email chain). I am updating a report and need to confirm whether this list is still current. I would be grateful if you could confirm whether there have been any changes to your database. If there have been some updates, will you be able to send through this information?

Many thanks,

Chris

Chris Woodhouse
Project Consultant

t. +44 (0) 1743 276 158
Data Protection Act
Shrewsbury | Reading | Cardiff

ESI Consulting

From: Gary Weaver [mailto:Gary.Weaver@colchester.gov.uk]
Sent: 02 June 2016 10:45
To: Caroline Chestnutt <CarolineChestnutt@esi-consulting.co.uk>
Subject: FW: Private water supplies data request for Alresford Road, Wivenhoe (our reference 61272)

Good morning Ms Chestnutt

In response to your enquiry the following premises are listed on our Private Water Supplies database:

603385 / 2249062	Well/PWS	New Park, Elmstead Road.
601567 / 223874	Well/PWS	Glen Cottage, Distillery Lane
602530 / 221046	B-H/PWS	The Lodge, Fingringhoe Rd
602689 / 220947	B-H/PWS	East Donyland Hall, Fingringhoe Road
602844 / 221012	B-H/PWS	Lawn Cottage, Fingringhoe Road
602895 / 220401	Spring/PWS	Fingringhoe Oak, Church Green

Regards

Data Protection Act

Gary Weaver
Environmental Health Technical Officer
Professional Services | Colchester Borough Council

Tel: +44(0)1206 282837
Data Protection
Web: www.colchester.gov.uk

Sign Up to a new Air Quality Health Alert Service
Offering daily information on air quality, temperature, UV, and pollen levels.

Register at www.airtext.info/colchester to receive free air quality alerts

cid:image001.png@01D1ACFE.462A6830

car

From: David Martin
Sent: 01 June 2016 09:28

To: Gary Weaver
Subject: FW: Private water supplies data request for Alresford Road, Wivenhoe (our reference 61272)

From: Caroline Chestnutt [mailto:CarolineChestnutt@esi-consulting.co.uk]
Sent: 31 May 2016 16:36
To: Environmental Protection Team
Subject: Private water supplies data request for Alresford Road, Wivenhoe (our reference 61272)

Dear Gary,

ESI is undertaking a study of a site located on Alresford Road, Wivenhoe, Colchester, CO7 9JY, (**605362, 222624**). Please could I request the following data within your council district, **within a 4 km radius from centre** (**605362, 222624**) for use in the study?

Please find attached a map showing the search area.

Requested information on private water supplies:
National grid reference
Name of user
Name of location
Type of abstraction (groundwater or surface water)
Use to which the water is put

I have previously been in touch with your colleagues at Colchester Council. I first got in contact over one month ago and your colleague told me that Colchester council could not help with my data and referred me to Anglican Water. Since then, Anglican Water has informed us that they do not hold private water supplies data. I have since been in touch with your colleague Will to inform him of this. He has passed on your email address and put me through to your phone regarding this freedom of information request. If you have any queries regarding this data request, please do not hesitate to contact me.

Kind regards,

Caroline

Caroline Chestnutt
Assistant Consultant

ESI: The UK's leading independent scientific environmental consultancy specialising in water, land and sustainable development.

T: +44 (0) 1743 276100 | DD: +44 (0) 1743 276117 | Data Protection Act
E: CarolineChestnutt@esinternational.com | W: www.esinternational.com
ESI Ltd, New Zealand House, 160 Abbey Foregate, Shrewsbury, SY2 6FD

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accept responsibility for any loss or damage arising from the use of this email or attachments.

Appendix G

Impact Assessment Methodology

1 Introduction

1.1 Background and Objectives

ESI Limited (ESI) has developed an impact assessment methodology for determining the degree of impact of quarrying activities on neighbouring receptors. The objective of this technical note is to outline a methodology for assigning a degree of impact to potential effects on neighbouring receptors that have been identified in a Hydrogeological Impact Assessment (HIA). This methodology will also determine whether an effect is significant and if any mitigation measures are required. This methodology is to be applied across all HIAs undertaken by ESI to ensure a consistent approach.

2 Impact Assessment Methodology

2.1 Overview

A source-pathway-receptor methodology has been applied to the impact assessment. In the context of the impact assessment for the Site these elements may be defined as:

Source: Activities associated with mineral extraction, including dewatering, water quality effects, and the quarry discharge;

Pathways: The groundwater flow pathways or hydrogeological linkages identified in the conceptual model;

Receptors: Abstractions, designated sites, rivers, aquifers and other key water features. The risk assessment process can be subdivided into a number of steps as described below.

2.2 Identification of Receptors

The identification of a risk requires the presence of all three elements in the source-pathway-receptor chain. The source for this assessment is, by definition, the proposed extraction activities within the Application Area. The first task in the risk assessment process is therefore to identify any relevant receptors. As a minimum, the following should be considered:

- Neighbouring groundwater and surface water abstractions including both licenced and private supplies;
- Underlying aquifers;
- Neighbouring surface water features (including waterbodies and watercourses); and
- Neighbouring water-dependent designated sites.

2.3 Identification of Pathways

Having established all potential impact sources and receptors, it is necessary to identify potential pathways between the quarry (the source) and each receptor (i.e. determine all source-pathway-receptor linkages). The assessment process must establish whether the quarrying activities could potentially affect any of the identified receptors. This is achieved by considering each potential source-pathway-receptor chain in the context of the conceptual model. Where there is believed to be no significant groundwater pathway between the quarry and a given receptor, this receptor can be removed from the impact assessment process. Where a pathway linkage is unclear, possibly due to uncertainty in the conceptual model, the pathway is assumed to exist at this stage of the assessment process.

This risk assessment approach serves to filter the list of potential receptors, and only those that are considered vulnerable (i.e. within the radius of influence or with a linking pathway) are considered in the impact assessment.

2.4 Quantification of Effects

The presence of a hydrogeological pathway between the quarry and receptor does not indicate that an effect will occur at the receptor. The next step in the impact assessment process must therefore be to address whether or not there is likely to be an effect at each potential receptor resulting from quarry development and restoration. This may require quantification, for example of the degree of groundwater level change at a receptor. As a minimum a qualitative assessment will be provided.

2.5 Assessment of Level of Impact and Significance

The demonstration and quantification of a potential effect does not necessarily indicate that the impact will be significant. The significance of potential effects is assessed individually for each receptor. There are two aspects to the assessment of significance.

- The size of the potential effect should be compared with a criterion that indicates the smallest significant impact. If the size of effect is smaller than the criterion then the effect does not represent a significant impact. In some cases it may be more appropriate to determine this on a qualitative basis.
- If the size of effect is potentially greater than the relevant criterion, it is necessary to assess the significance that the potential impact represents. The significance of an impact is dependent on the magnitude of the effect and the importance of the receptor.

2.5.1 Importance of receptors

Receptors have been assigned to one of three status categories; low, medium or high. The methodology for assigning to a particular category is based on the following criteria:

- Low Status: Unlikely to be of significant ecological or societal value (e.g. small ephemeral pond); surface water and groundwater abstractions that supply or impact on an individual or small number of people (e.g. farm or home supply), although this may be locally significant;
- Medium Status: Of local ecological or societal value or supporting medium or high status ecological features (e.g. springs); surface water or groundwater abstractions that supply or impact on a local community (e.g. local water supply or water supply to a local amenity);
- High Status: Nationally and internationally designated ecological sites (e.g. SACs) or features supporting these (e.g. springs); surface or groundwater abstractions that are utilised for public water supply. Also includes aquifers that are defined as Source Protection Zones (SPZs) or similar.

2.5.2 Degree of effect

The degree of effect at each receptor is to be evaluated separately on the basis of the conceptual model. The degree of effect is assessed without the application of mitigation measures. To assist in this evaluation, the following conservative guidelines have been adopted for screening purposes.

- For licensed groundwater abstraction boreholes a predicted groundwater level reduction in excess of 0.5 m is taken to indicate a medium to high degree of effect, with the exact category dependent on the magnitude of the predicted change and the available drawdown.
- For shallow wells and ponds, a predicted reduction in level in excess of 0.25 m is taken to indicate a medium to high degree of effect, with the exact category dependent on the magnitude of the predicted change and the available drawdown or degree to which levels fluctuate.
- For spring flows or baseflow-dependent watercourses, a derogation of flow in excess of 10% of mean low flows is taken to indicate a medium to high degree of effect. The exact category is dependent on the magnitude of the predicted change and the degree to which flows are groundwater dependent.
- Potential water quality effects will be greatest in the shallowest aquifer. Deeper aquifers will be less likely to be affected, and the level of effect will also be correspondingly lower, given the increased capacity for dilution and attenuation with depth. Effects on surface water will be dependent on the distance between the quarry and the relevant surface water feature.

Where an effect falls below the threshold criteria described above, it is taken to be negligible. Where it exceeds the critical thresholds, the degree of effect (low, medium, or high) is assessed, based on the particular conditions at that receptor. This assessment should relate the predicted effect to measured baseline conditions. For example, for groundwater levels, the effect should be compared to seasonal variability, and for stream flows, the change should be compared to measured baseflows.

2.5.3 Degree of impact

Table 2.1 shows how the receptors value and degree of effect are brought together to determine the degree of impact. A moderate or major degree of impact is considered to be significant. When a degree of impact is significant, mitigation measures are required.

Table 2.1 Impact assessment matrix

		Receptor Value		
		Low	**Medium**	**High**
Degree of Effect	**Negligible**	Negligible	Negligible	Negligible
	Low	Minor	Minor	**Moderate**
	Medium	Minor	**Moderate**	**Major**
	High	**Moderate**	**Major**	**Major**