# Southampton to London Pipeline Project

## Volume 6

### Environmental Statement (Volume D) Appendix 8.3: Groundwater Dependent Terrestrial Ecosystems

### Application Document: 6.4

Planning Inspectorate Reference Number: EN070005
APFP Regulation No. 5(2)(a)
Revision No. 1.0

May 2019

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## Contents

# Appendix 8.3: Groundwater Dependent Terrestrial Ecosystems

## 1.1 Approach

1.1.1 This appendix follows the UK Technical Advisory Group (UKTAG) guidance (UKTAG, 2009) to identify, prioritise and assess the impacts of the project on Groundwater Dependent Terrestrial Ecosystems (GWDTE).

1.1.2 This appendix only discusses potential impacts on groundwater flow and quality that support ecosystems. Other impacts on vegetation and habitats are discussed in Chapter 7 Biodiversity.

### Site Identification

1.1.3 All sites identified as supporting potential GWDTE in the Scoping Report (Esso, 2018) have been included in the assessment, along with additional potential GWDTE sites that have subsequently been identified. These potential GWDTE sites may have boundaries which differ from overlapping statutory/non-statutory site boundaries. In this report, the term 'site boundary' refers to the boundary of the potential GWDTE.

1.1.4 Sites supporting potential GWDTEs are shown on Figure A8.1.8. Sites have been grouped according to their groundwater study area (GWSA) as defined in Appendix 8.1 Groundwater Baseline (Figures A8.1.1 and A8.1.2).

### Desk Study

1.1.5 For each potential GWDTE site, topographic, geological, hydrogeological and hydrological information was gathered, comprising:

- Ordnance Survey mapping;
- historical maps;
- Light Detection and Ranging (LiDAR) digital terrain model;
- geological maps and borehole logs available at the British Geological Survey's (BGS's) GeoIndex website (BGS, 2018a);
- BGS groundwater flooding susceptibility mapping obtained by data request (BGS, 2017);
- BGS karst features database obtained by data request (Farrant and Cooper, 2008);
- Environment Agency (EA) data obtained from their website or via an information request (Environment Agency, 2018); and
- national soils mapping (Cranfield University, 2018).

1.1.6 Figures A8.1.1, A8.1.2, A8.1.4 and A8.1.5 respectively show bedrock geology, superficial geology, bedrock aquifers and superficial aquifers present along the

Order Limits. Figure A8.1.7 shows the groundwater flooding susceptibility along the Order Limits.

### Hydrogeological Site Investigations

1.1.7 Information from the project's ground investigation (GI) programme was used in the assessment to complement information gathered through desk study. Results available at the time of writing (20 February 2019) have been used where boreholes are located within a suitable distance from a potential GWDTE site.

1.1.8 Where deemed beneficial, hydrogeological walkover surveys were also undertaken to confirm the presence of groundwater features at potential GWDTE sites. Walkover surveys were undertaken in collaboration with ecological surveys of the sites in order to assist in identification of groundwater dependent vegetation.

1.1.9 In addition to the above, three sites (Ewshot Meadows, Folly Bog and Chobham Common) were identified as requiring a hand soil coring survey to better understand shallow ground conditions, sub-surface water flows and infiltration potential. Soil cores were logged based on guidance by the EA (2007) and Natural England (2008).

### Habitats and Vegetation

1.1.10 GWDTE are characterised by certain kinds of habitats and vegetation, and the identification of these provides information on the potential groundwater dependency of the GWDTE. For the majority of sites assessed, information about habitats and vegetation is based on the results of ecological surveys undertaken as part of the project, provided in Appendix 7.1 Habitats and Botany Factual Report. For sites where surveys were not undertaken, the sources of information about habitats and vegetation are described.

### Conceptual Site Models

1.1.11 For potential GWDTE sites where vegetation survey using the National Vegetation Classification (NVC) was undertaken, the UKTAG guidance (UKTAG, 2009) has been used to determine an initial groundwater dependency rating (1 as high, 2 as moderate, 3 as low and non GWDTE). The ratings provided for NVC communities in England and Wales, and the UK as a whole, were used for this project, generating the following categorisations:

- not groundwater dependent;
- low groundwater dependency;
- low to moderate groundwater dependency;
- moderate groundwater dependency;
- high to moderate groundwater dependency; and
- high groundwater dependency.

1.1.12 Sites of lower biodiversity value were not subject to NVC survey. Where no NVC information was available, the assessment was based on the results of Phase 1 habitat survey undertaken for the project.

1.1.13 The above initial classification was refined based on the site-specific information gathered through desk study and hydrogeological site investigations, adjusting the degree of groundwater dependency as required. Following this, all the information about each potential GWDTE site was synthesised into a conceptual site model (CSM).

1.1.14 For each site, the CSM describes conceptually the relative importance of sources of water supporting the GWDTE identified, conceptual supply mechanisms, conceptual water flows, levels and quality, and the main physical factors determining these. The CSM for each site is supported by conceptual hydrogeological cross sections.

1.1.15 Complicated sites, where there may be areas with varying groundwater dependency, were divided into sub-sites to facilitate the assessment of the hydro-ecological functioning of the site.

### Prioritisation and Valuation

1.1.16 The prioritisation of sites is reflected in the determination of the value of each GWDTE. As per UKTAG (2004) guidance, the prioritisation/value attribution is a combination of nature conservation designation, and the degree of groundwater dependency determined as per the CSM.

1.1.17 The prioritisation/value attribution of the identified GWDTE sites and sub-sites is defined in Table 8.3 in Chapter 8 Water with a summary compiled in Table 8.3.1.

**Table 8.3.1: Matrix for Defining Value of the GWDTE**

| | National Statutory Designation (e.g. Site of Special Scientific Interest (SSSI)) | National Non-statutory Designation | No Designation |
|---|---|---|---|
| High groundwater dependency | High | Medium | Low |
| Moderate groundwater dependency | High | Medium | Low |
| Low groundwater dependency | Medium | Low | Negligible |

### Assessment of Magnitude of Change to GWDTE

1.1.18 The CSM is used to assess potential changes in groundwater flow and/or quality which could impact on the GWDTE as a result of the project. The assessment of potential changes was made taking into account commitments to embedded design measures and good practice measures which are set out in the Register of Environmental Actions and Commitments (REAC, within Chapter 16 Environmental Management and Mitigation). Good practice measures are set out in the REAC and

secured through Development Consent Order requirements such as the Code of Construction Practice (CoCP).

1.1.19 The magnitude of change is assessed based on the criteria set out in Table 8.4 of Chapter 8 Water. The resultant potential significance of change, combining valuation and magnitude of change, is captured in Chapter 8 Water.

## 1.2 Limitations

1.2.1 The CSMs for the GWDTE have been constructed based on the information available at the time of writing, such as BGS records, GI data and groundwater strikes, site visits and hand coring. Extrapolation has been made where needed and further data would allow further refinement. However, the information available at the time of writing is considered robust enough to allow groundwater dependency characterisation of the different sites to be determined and to predict potential effects as a result of the project.

1.2.2 Reliance has been made on third party data, and these are assumed to be accurate.

1.2.3 NVC surveys have not been undertaken in Ministry of Defence (MoD) land away from the Order Limits due to access limitations.

## 1.3 GSWA-A

### Ford Lake

Site Setting, Topography and Hydrological Catchment

1.3.1 Ford Lake forms a headwater valley of the River Hamble. The site is located in the bottom of the valley, with relatively steep valley sides. The elevation along the Order Limits varies from 16m above Ordnance Datum (AOD) to 10mAOD.

1.3.2 The total hydrological catchment comprises two sub-catchments, to the west and the north. The northern sub-catchment is larger and extends around 5km upstream of the site. The confluence with the River Hamble is immediately downstream of the site.

1.3.3 The Order Limits cross the site perpendicular to the watercourse, before running parallel to the northeastern boundary 30m away. At this location, the proposed construction method for installation is using trenchless horizontal directional drilling (HDD) (Appendix 8.2 Detailed Trenchless and Targeted Open Cut Assessments, Section 1.5).

Geology and Soils

1.3.4 Most of the site is covered by soil association 711g Wickham 3, described as a slowly permeable seasonally waterlogged fine loamy over clayey and coarse loamy over clayey soils. The southeastern boundary of the site encroaches onto soil 571z Hamble 2 described as deep stoneless well-drained silty soils (Cranfield University, 2018).

1.3.5 The site is underlain by alluvium adjacent to the River Hamble, recorded as comprising silt. River Terrace Deposits are recorded slightly further up the valley sides, typically comprising sand and gravel (BGS, 2018b; 2018c). However, only some of the publicly available BGS boreholes (Table 8.3.2) record the presence of sand and gravel, with generally quite a high clay content in the shallower deposits (BGS, 2018a). No peat is recorded.

1.3.6 Bedrock at depth beneath the site comprises London Clay in the north and Wittering Formation in the south (BGS, 2018b; 2018c).

1.3.7 One 2018 GI borehole (BH126) has been completed close to the site. This shows a thick (>5m) layer of sandy superficial deposits over a bedrock predominantly of clay. It also shows that the River Terrace Deposits possibly extend beyond their mapped extent, but that the proportion of gravel becomes reduced at its edges.

1.3.8 A summary of the local boreholes is presented in Table 8.3.2, and the borehole locations are shown on Figure A8.3.1.

**Table 8.3.2: Borehole Records Close to Ford Lake GWDTE**

| Borehole Ref. | Top (mbgl*) | Base (mbgl) | Description | Groundwater Strike (mbgl) |
|---|---|---|---|---|
| SU51SW104 | 0.00 | 0.30 | Coil | 1.10 |
| | 0.30 | 2.70 | Sandy clay | |
| | 2.70 | 4.00 | Ballast | |
| SU51SW105 | 0.00 | 0.30 | Soil | - |
| | 0.30 | 6.10 | Clay | |
| SU51SW106 | 0.00 | 0.30 | Soil | - |
| | 0.30 | 6.10 | Clay | |
| SU51SW107 | 0.00 | 0.30 | Soil | - |
| | 0.30 | 1.80 | Clay | |
| | 1.80 | 4.30 | Ballast | |
| | 4.30 | 6.10 | Clay | |
| SU51SW108 | 0.00 | 0.30 | Soil | 0.50 |
| | 0.30 | 6.10 | Clay | |
| SU51SW109 | 0.00 | 0.30 | Soil | 2.70 |
| | 0.30 | 6.40 | Clay | |
| SU51SW110 | 0.00 | 0.30 | Soil | - |
| | 0.30 | 6.10 | Clay | |
| SU51SW111 | 0.00 | 0.40 | Soil | 1.50 |
| | 0.40 | 3.40 | Ballast with clay | |
| | 3.40 | 4.60 | Clay | |
| SU51SW112 | 0.00 | 0.30 | Soil | 4.60 |
| | 0.30 | 6.10 | Clay | |
| BH126 | 0.00 | 0.46 | Brown slightly gravelly sand | Unable to record because of the |
| | 0.40 | 2.45 | Brown slightly silty sand | |

| Borehole Ref. | Top (mbgl*) | Base (mbgl) | Description | Groundwater Strike (mbgl) |
|---|---|---|---|---|
| | 2.40 | 3.35 | Brown mottled grey very silty sand | drilling method applied |
| | 3.30 | 5.50 | Dark grey slightly silty sand | |
| | 5.50 | 17.20 | Dark grey slightly sandy clay | |
| | 17.20 | 20.22 | Dark brown/blue slightly sandy silty clay | |

**mbgl – metres below ground level*

Groundwater

1.3.9 BGS boreholes recorded groundwater in some of the locations, with the depth to the water table varying moderately (Table 8.3.2). Standing water was recorded close to the ground surface in some of the boreholes (SU51SW104, SU51SW108, SU51SW111). The locations of these correlate with the BGS (2017) groundwater flooding susceptibility map recording a high groundwater flooding susceptibility along the Order Limits intercepting the site.

1.3.10 Due to the method of drilling employed during the 2018 GI, no groundwater strike was recorded in BH126. The installation consisted of a long response zone within the bedrock London Clay Formation. Artesian groundwater conditions have been recorded since the borehole was completed. The maximum height of water above the ground level has been recorded as 0.94m. This is likely to be water contained at pressure within the sand partings of the bedrock and does not influence groundwater flooding at the site.

1.3.11 A walkover survey was undertaken on 4 and 5 June 2018. This noted the presence of seepages along the valley sides of the river, as well as the presence of springs within parts of the woodland, associated with gravelly horizons (Figure A8.3.1). Minor iron staining was noted at the springs. Some damp meadows were also observed in the north of the site. Based on the presence of these springs and seepages, the river is expected to be in continuity with groundwater in the superficial aquifers.

Habitats and Vegetation

1.3.12 The vegetation of the site was surveyed for the project in June 2018 (see Appendix 7.1 Habitats and Botany Factual Report). Much of the site was found to be dominated by wet woodland with smaller areas of grassland. Habitat and vegetation plans are provided in Figures A7.1.3 and A7.1.6, respectively.

1.3.13 Based on the UKTAG guidance, vegetation of high to moderate groundwater dependence was recorded on the site, comprising the wet woodland plant communities W5 *Alnus glutinosa-Carex paniculata* woodland and W7 *Alnus glutinosa-Fraxinus excelsior-Lysimachia nemorum* woodland, and the marshy grassland plant community M23 *Juncus acutiflorus/effusus-Galium palustre* rush pasture. Other plant communities recorded have low-to-moderate, low or no groundwater dependency. W7 *Alnus glutinosa-Fraxinus excelsior-Lysimachia nemorum* woodland comprised the main community of a mosaic of woodland types of mixed groundwater dependence continuing upstream through the site.

1.3.14 The parts of the site closest to the Order Limits include the high to moderate groundwater dependent wet woodland plant community W7 *Alnus glutinosa-Fraxinus excelsior-Lysimachia nemorum* woodland.

1.3.15 Table 8.3.3 lists the NVC types recorded at the site, alongside the groundwater dependency assigned by the UKTAG (2009) guidance. Figure A8.3.1 shows the distribution of groundwater dependency across the site.

**Table 8.3.3: UKTAG Derived Groundwater Dependency for Vegetation Encountered at Ford Lake**

| NVC Habitat Type* | Groundwater Dependency (according to UKTAG, 2009) |
|---|---|
| M23 | High to moderate |
| MG1 | Not groundwater dependent |
| MG7 | Not groundwater dependent |
| MG10 | Not groundwater dependent |
| MG13 | Low to moderate |
| OV24 | Not groundwater dependent |
| OV25 | Not groundwater dependent |
| OV28 | Not groundwater dependent |
| W5 | High to moderate |
| W6 | Low |
| W7 | High to moderate |
| W8 | Not groundwater dependent |
| W10 | Not groundwater dependent |
| W21 | Not groundwater dependent |
| W22 | Not groundwater dependent |
| W24 | Not groundwater dependent |
| W25 | Not groundwater dependent |

**Refer to Appendix 7.1 Annex G for full list of NVC names and sub-communities*

CSM

1.3.16 Groundwater feeding the site is expected to be associated with the River Terrace Deposits which are of limited lateral extent, although there may be some lateral flow from the Wittering Formation into the superficial deposits. The locations of springs and seepages are associated with both topographic and geological variation.

1.3.17 The vegetation aligns with the presence or absence of springs/seepages. W7 *Alnus glutinosa-Fraxinus excelsior-Lysimachia nemorum* woodland vegetation was, for example, associated with springs and areas of strong seepage. W8f *Fraxinus excelsior-Acer campestre-Mercurialis perennis Allium ursinum* sub-community was also noted to be associated with seepages, despite its UKTAG rating of no groundwater dependency. Other communities were associated with areas where discharge was clearly less strong, e.g. due to the gravels being less close to the surface. For this reason, assessment of the site specific characteristics confirms the groundwater dependency identified by UKTAG guidance.

1.3.18 Figure A8.3.2 shows a conceptualised cross section of the potential GWDTE, running from southwest to northeast approximately parallel to the Order Limits.

Assessment of Effects

1.3.19 The Order Limits cross the site with an HDD trenchless crossing. The drilling is anticipated to be housed within the London Clay Formation under most of the site. It may impinge into the superficials to the north of the watercourse, as it approaches trenching depth. The London Clay is an unproductive stratum, although some groundwater has been recorded, likely within isolated sandy lenses. If they are intercepted, it is possible that artesian water could be released to surface, although the small size and isolated nature of the lenses means that there will not be a large amount of groundwater. HDD does not require any dewatering except potentially at the launch and reception end, which require excavations to a depth equivalent to a trench. However, these excavations would be located outside the site, and therefore only a small magnitude of change is expected on the site during the construction. Long term impact on flows is expected to be negligible.

1.3.20 The London Clay Formation has low permeability and is therefore not recognised as an aquifer. The construction method would not penetrate beneath this horizon. Therefore, there is no risk of connecting two previously disconnected aquifers during the construction of the trenchless crossing resulting in a loss of water in the shallow groundwater system.

1.3.21 Table 8.3.4 provides a summary of the magnitude of change from different potential effects on groundwater flows supporting Ford Lake.

**Table 8.3.4: Summary of Groundwater Flow Effects on Ford Lake GWDTE**

| Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|
| Moderate | Site of Importance for Nature Conservation (SINC) | Medium | Trenchless crossing dewatering | Construction | Small |
| | | | Flow interception | Operation | Negligible |
| | | | Connection of aquifers | Construction / operation | Negligible |

## Durley Green Lane

Site Setting, Topography and Hydrological Catchment

1.3.22 The Durley Green Lane site is located within a localised and narrow valley, with elevations falling from 43mAOD at the upstream (northern) end, to 25mAOD at the downstream (southern). The valley splits at the northern end of the site into two contributing valleys.

1.3.23 The valley belongs to a wider hydrological catchment extending some 900m to the north. The hydrological catchment forms a headwater valley contributing to the River Hamble via Ford Lake.

1.3.24 The Order Limits run from south to north, initially on the eastern side of the valley, before dropping into the base and crossing the eastern branch to the hilltop between the two contributing valleys.

Geology and Soils

1.3.25 The site is covered by 0572j Bursledon soil association, described as deep fine loamy soils with slowly permeable subsoils (Cranfield University, 2018).

1.3.26 Alluvium deposits in the upper reaches of the eastern fork of the valley, extending beyond the northern limit of the site. No other superficial deposits are recorded (BGS, 2018c). The alluvium typically comprises heterogeneous deposits of clay, silt, sand and gravel in varying proportions.

1.3.27 The underlying bedrock comprises Durley Sand Member in the base of the valley, with Whitecliff Sand Member on the hilltops between the valleys. Both of these units are part of the London Clay Formation, and are stratigraphically equivalent, with the Durley Sand Member wedging out into the Whitecliff Sand Member. The London Clay Formation (comprising silty clay) outcrops at the top of the eastern valley (BGS, 2018c).

1.3.28 There are no publicly available BGS borehole records in the vicinity of the site to confirm the mapping (BGS, 2018a). No borehole location was proposed in this area as part of the 2018 GI.

Groundwater

1.3.29 The area has a limited potential for groundwater flooding (BGS, 2017).

1.3.30 There are no EA or BGS groundwater monitoring locations or borehole logs available in vicinity of the site.

1.3.31 No hydrogeological walkover was undertaken at this site.

Habitats and Vegetation

1.3.32 A detailed description of the habitat is provided in Appendix 7.1 Habitats and Botany Factual Report. Figure A7.1.21 shows the habitat mapping.

1.3.33 The habitat mapping showed the base of the valley to comprise purple moor grass and rush pasture and wet woodland priority habitats, both wetland habitats. The purple moor-grass and rush pastures priority habitat comprise vegetation referable to M23 *Juncus acutiflorus/effusus-Galium palustre* rush-pasture. The flanks of the valleys were identified as improved or semi-improved grassland.

1.3.34 Figure A8.3.3 shows the areas of the site which are expected to have a degree of groundwater dependency, according to the UKTAG (2009) guidance.

1.3.35 Based on the UKTAG guidance, vegetation of high to moderate groundwater dependency (M23) has been recorded in the base of the valley, particularly of the eastern stream. The western valley contains wet woodland but has not been assigned an NVC classification. This could also have groundwater dependency, although the information available is insufficient to assign based on the vegetation alone.

CSM

1.3.36 The hydrogeological setting of the site suggests that there is a restricted groundwater recharge area. Groundwater is expected to be mostly present in the thick soils and the alluvium deposits present at the base of the valley and to have some degree of hydraulic connection with groundwater present in the Secondary A bedrock aquifer (Durley Sand Member). The area is attributed a limited potential for groundwater flooding.

1.3.37 Surface water drains and runoff will also contribute towards maintaining wetland habitats. As such, the UKTAG guidance levels for the available NVC habitats have been downgraded based on the local conditions, and the site as a whole has been attributed with a moderate groundwater dependency level.

1.3.38 Figure A8.3.4 represents a conceptualised section of the site running from northwest to southeast, locating the presence of potential GWDTEs and their final classification.

Assessment of Effects

1.3.39 The Order Limits pass through the wetland habitats of Durley Green Lane, including those identified as groundwater dependent.

1.3.40 The trench required for installation of the pipeline would likely be below the groundwater within the alluvium deposits, therefore requiring dewatering to take place. This is expected to result in a temporary effect on the portion of the site through which the Order Limits pass. Despite the fact that the dewatering impact would be temporary and the vegetation is expected to recover following completion of works, the effect would be direct and affect wetland habitat of limited extent. For this reason, the magnitude of change during construction is expected to be medium. Long term impact on flow patterns is expected to be very localised and minor.

1.3.41 Table 8.3.5 provides a summary of the magnitude of change from different potential effects on groundwater flows supporting Durley Green Lane.

**Table 8.3.5: Summary of Groundwater Flow Effects on Durley Green Lane GWDTE**

| Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|
| Moderate | None | Low | Trench dewatering | Construction | Medium |
| | | | Flow interception | Operation | Small |

## Wintershill Floodplain

Site Setting, Topography and Hydrological Catchment

1.3.42 The Wintershill Floodplain is a small flat area in the base of a valley, with elevations falling from 33mAOD at the upstream end (northwest) to 31mAOD at the downstream (southeast). The site extends to 35mAOD on the sides of the valleys.

1.3.43 The valley is a natural collection point for groundwater and runoff, with a hydrological catchment extending to the north-northwest, north and west. The watercourse within the site is derived from springs upstream of the site, which are the headwaters of an unnamed tributary of the upper River Hamble.

1.3.44 The Order Limits cross the centre of the site, from southwest to northeast.

Geology and Soils

1.3.45 The site is covered by 721c Windsor soils which are described as slowly permeable seasonally waterlogged clayey soils with brown subsoils (Cranfield University, 2018).

1.3.46 Alluvium is recorded at the base of the valley, whilst the sides have no superficial deposits recorded. This is underlain by bedrock of the London Clay Formation (BGS, 2018c).

1.3.47 Alluvium is typically comprised of heterogeneous deposits of clay, silt, sand and gravel in varying proportions. The London Clay formation is a silty clay, with rare sandy lenses or pockets.

1.3.48 Available borehole records from close to the site are shown in Table 8.3.6, both from the 2018 GI and the publicly available boreholes (BGS, 2018a). BH124 is the nearest borehole, located adjacent to the southwest corner of the site and located on Figure A8.3.5.

**Table 8.3.6: Borehole Log Records Close to Wintershill Floodplain**

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater |
|---|---|---|---|---|
| BH124 | 0.00 | 0.10 | Topsoil | Rest water 1.7mbgl when hole <10m deep. Rest water artesian when hole >16m deep |
| | 0.10 | 0.30 | Made ground | |
| | 0.30 | 0.55 | Grey mottled orangish brown clay | |
| | 0.55 | 0.95 | Orangish gravelly clay | |
| | 0.95 | 1.10 | Orangish brown mottled grey slightly sandy clay | |
| | 1.10 | 1.70 | Orangish brown mottled grey slightly sandy gravelly clay | |
| | 1.70 | 2.45 | Orangish brown mottled grey clay | |
| | 2.45 | 4.55 | Dark grey clay | |
| | 4.55 | 6.40 | Light bluish grey mottled red and orangish brown clay | |
| | 6.40 | 12.30 | Multicoloured clay | |
| | 12.30 | 16.42 | Multicoloured mudstone | |
| SU51NW30 | 0.00 | 0.10 | Topsoil | Rest Water Level: 0.38mbgl |
| | 0.10 | 0.70 | Brown stoney clay | |
| | 0.70 | 1.50 | Grey/brown silty clay | |
| | 1.50 | 5.00 | Brown silty sand and gravel | |
| | 5.00 | 8.2 | Grey/brown silty sand | |

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater |
|---|---|---|---|---|
| | 8.20 | 10.00 | Grey clay | |
| SU51NW31 | 0.00 | 2.50 | Topsoil over brown silty stony clay | Strike: 3.3mbgl<br>Standing: 1.3magl* |
| | 2.50 | 8.00 | Grey and brown fine-coarse sand | |
| | 8.00 | 19.00 | Red brown mudstone | |
| | 19.00 | 51.00 | Flinty chalk | |

**magl – metres above ground level*

Groundwater

1.3.49 Groundwater strikes were recorded in all of the boreholes listed in Table 8.3.6. The horizon in which it was encountered varied, but the records show that groundwater can be found at shallow depths.

1.3.50 The London Clay Formation is an unproductive stratum. There is a potential for groundwater flooding at the surface along the base of the valley (BGS, 2017).

1.3.51 The BGS boreholes SU51NW30 and SU51NW31 in Table 8.3.6 are now used as monitoring boreholes by the EA (Wintershill Tertiary and Wintershill Chalk respectively). Chalk EA water levels are shown to reach artesian conditions but are confined at depth and not linked to groundwater supporting habitats at the surface (EA, 2018). The Tertiary EA groundwater levels show about 1m of seasonal fluctuation. The maximum water levels are restricted by the local ground level, showing that water levels in this horizon can rise above the local surface, confirming the groundwater flood susceptibility mapping (BGS, 2017).

1.3.52 BH124 has been installed with a continuous data logger, which has recorded maximum water levels of 0.24mbgl within the shallow deposits.

1.3.53 No hydrogeological walkover of Wintershill Floodplain was undertaken.

Habitats and Vegetation

1.3.54 A Phase 1 habitat survey was undertaken at Wintershill Floodplain. More detailed vegetation survey was not undertaken because the site was found to be of low biodiversity value, supporting predominantly agriculturally modified grassland. A description of the habitats of the site is provided in Appendix 7.1 Habitats and Botany Factual Report. Figure A7.1.27 shows habitats within the site.

1.3.55 Wet woodland was identified northwest of Wintershill Road. Land to southeast was primarily made up of poor semi-improved grassland and improved grasslands on the valley sides. A small area of marshy grassland was identified in the east of the site. The wet woodland and marshy grassland habitats are the only ones considered to be wetland habitats, though the habitats within the site have been modified by agriculture so that they may not represent natural responses to underlying hydrogeological conditions. The Phase 1 mapping is insufficient to apply the UKTAG guidance to derive a likely groundwater dependency for the site.

CSM

1.3.56 Groundwater is expected to be limited to the alluvium deposits present at the base of the valley. The alluvium deposits are bounded both at depth and laterally by the London Clay, which is an aquitard (Figure A8.3.6). However, the valley is expected to receive a contribution from the alluvium deposits as suggested by the groundwater flooding susceptibility map (BGS, 2017). As a result, the groundwater catchment associated with the alluvium deposits is expected to be very localised, small and mostly directly rainfed. For this reason, wetland vegetation in Wintershill Floodplain is expected to have a low groundwater dependency, with the habitats dependent predominantly on the surface water inputs.

1.3.57 Figure A8.3.6 represents a conceptualised section of the site, running from southwest to northeast, locating the presence of potential GWDTEs.

Assessment of Effects

1.3.58 The Order Limits pass through the wetland habitats, including those with some groundwater dependency, of Wintershill Floodplain. Direct impacts on the habitats are discussed in Appendix 7.1 Habitats and Botany Factual Report.

1.3.59 The trench required for installation of the pipeline would likely be below the groundwater within the alluvium deposits, therefore requiring dewatering to take place. This is expected to result in a temporary dewatering effect. However, the trench would pass through some of the low groundwater dependent parts of the site, as well as in an upslope location of other parts. The vegetation may therefore be impacted by the dewatering in the short term but would be expected to recover following completion of works. During construction, the effect would be direct and affect wetland habitat of limited extent. For this reason, the magnitude of change during construction is expected to be medium. The long term impact on flows is expected to very localised and minor.

1.3.60 Table 8.3.7 provides a summary of the magnitude of change from different potential effects on groundwater flows supporting Wintershill Floodplain.

**Table 8.3.7: Summary of Groundwater Flow Effects on Wintershill Floodplain GWDTE**

| Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|
| Low | None | Negligible | Trench dewatering | Construction | Medium |
| | | | Flow interception | Operation | Small |

## 1.4 GWSA-B

### Peck Copse

Site Setting, Topography and Hydrological Catchment

1.4.1 Peck Copse forms a localised flat area surrounded by high ground to the west and southwest, which defines the local hydrological catchment.

1.4.2 Peck Copse belongs to a larger catchment which forms the upper reaches of the Caker Stream, a tributary of the River Wey. No permanent watercourse is shown on the maps downslope between Peck Copse and the valley bottom (Ordnance Survey, 2015a).

1.4.3 The Order Limits pass about 30m to the west of the site, slightly upgradient, around 1m to 2m higher than the site.

Geology and Soils

1.4.4 The site is covered by 0511d Blewbury described as well-drained calcareous clayey and fine silty over clayey soils over argillaceous chalk (Cranfield University, 2018).

1.4.5 No superficial deposits are recorded at the site, with the West Melbury Marly Chalk Formation outcropping at the surface (BGS, 2018d).

1.4.6 The absence of any superficial deposits is also confirmed by the nearest publicly available BGS boreholes, located approximately 500m to the north of the site (BGS, 2018a).

1.4.7 BH103 of the 2018 GI, located 290m west of Peck Copse, recorded 0.7 of clay directly overlying the Chalk bedrock. The borehole was terminated at 20mbgl without proving the base of the Chalk.

Groundwater

1.4.8 Ordnance Survey (2015a) mapping records the presence of a spring at the southern tip of the site, which coincides with a spring recorded in the BGS karst database (Farrant and Cooper, 2008). The karst spring database records two further chalk springs in the southern part of the site. This area of springs is the source of a tributary watercourse of the Caker Stream.

1.4.9 Groundwater's presence close to the surface is supported by the available EA groundwater modelling outputs, which indicate groundwater less than 1mbgl during a period of high stand (Entec, 2007; Amec, 2013; Amec Foster Wheeler, 2015). The site is also susceptible to groundwater flooding at surface (BGS, 2017).

1.4.10 BH103 did not record any water strikes due to the method of drilling used. No monitoring data are yet available.

1.4.11 No hydrogeological walkover of Peck Copse was undertaken.

Habitats and Vegetation

1.4.12 No vegetation survey has been undertaken at Peck Copse as part of the project. Ordnance Survey mapping and aerial imagery indicate the site is wooded. The local biodiversity plan describes the site as '*Wet ash-maple/base-rich springline alderwood.*' (Hampshire Biodiversity Partnership, 2003)

CSM

1.4.13 Groundwater discharges from one or several chalk spring(s) within the southern part of the site, which feeds the local surface water network and ultimately the Caker Stream. The location of spring(s) appears to be topographically controlled, occurring where the water table intercepts the ground surface. There is no evidence of the spring(s) coinciding with karstic features or with a geological boundary.

1.4.14 The presence of springs indicates the site may have a high or moderate degree of groundwater dependency, although the degree of groundwater dependency could not be verified in the absence of vegetation survey. Given the uncertainties, the site is attributed with a high groundwater dependency.

1.4.15 Figure A8.3.7 shows a conceptualised cross section of the potential GWDTE, running from west to east.

Assessment of Effects

1.4.16 Groundwater levels in the Chalk are expected to fluctuate significantly seasonally. During construction, the trench may intercept the water table in worst case conditions and this may require dewatering, depending on the rainfall and groundwater conditions prior to construction. Given that the spring(s) at Peck Copse is(are) located down gradient of the Order Limits, the spring(s) flow rates may be temporarily reduced, but not in a significant manner as the main groundwater flow feeding the spring is expected to remain unaffected. In any case, this effect would be very short lived. Long term impact on flows is expected to very localised and minor.

1.4.17 In this area of the Order Limits, the installed pipe would likely be above the groundwater table at most times, the exception only being times of particularly high groundwater level, with no to negligible impact to long term groundwater flows.

1.4.18 Table 8.3.8 provides a summary of the magnitude of change from different potential effects on groundwater flows supporting Peck Copse GWDTE.

**Table 8.3.8: Summary of Groundwater Flow Effects on Peck Copse GWDTE**

| Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|
| High | SINC | Medium | Trench dewatering | Construction | Small |
| | | | Flow interception | Operation | Negligible |

## Caker and Lavant Streams Floodplain

Site Setting, Topography and Hydrological Catchment

1.4.19 The Caker and Lavant Streams floodplain is located at the base of a relatively narrow and steep sided valley, with hills peaking at over 150mAOD. Elevation within the site falls from 105mAOD at the upstream (southern) end to 99mAOD at the downstream end.

1.4.20 The hydrological catchment stretches to the south and the west of the site, with the confluence of the Caker Stream and the Lavant Stream occurring within the site. The streams are tributaries of the River Wey.

1.4.21 The Order Limits cross the site only at its very southern (upstream) end.

Geology and Soils

1.4.22 The centre and the north of the site are covered by 0511f Coombe 1 soils which are described as well-drained calcareous fine silty soils deep in valley bottoms, shallow to chalk on valley sides in places. The south is covered by 0511d Blewbury described as well-drained calcareous clayey and fine silty over clayey soils over argillaceous chalk (Cranfield University, 2018).

1.4.23 Alluvium is recorded at the base of the Caker Stream and confluence area, and Head Deposits in the Lavant Stream valley (BGS, 2018d). Additional Head Deposits are recorded up the sides of the confluence valley. Both typically consist of heterogeneous deposits of clay, silt, sand and gravel in varying proportions.

1.4.24 The superficial deposits are underlain by the West Melbury Marly Chalk Formation. The Caker Stream flows across the West Melbury Marly Chalk for all of its upstream distance from the site. By contrast, the Lavant Stream flows across outcrop of the Zig Zag Chalk Formation.

1.4.25 Three publicly available borehole logs were identified close to the site (Table 8.3.9), with SU73NW23 being adjacent to the site and shown on Figure A8.3.8 (BGS, 2018a).

**Table 8.3.9: Borehole Records Close to the Caker and Lavant Streams Floodplain**

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater (mbgl) |
|---|---|---|---|---|
| SU73NW23 | 0.00 | 2.44 | Lower Chalk | Rest Water Level: 1.14 – 4.88 |
| | 2.44 | 6.71 | Marl and Rock Marl | |
| | 6.71 | 9.14 | Marl and Chloritic Marl | |
| SU73NW10 | 0.00 | 1.52 | Coarse gravel and Chalk | Not recorded |
| | 1.52 | 15.24 | Tough Chalk Marl | |
| SU73NW32 | 0.00 | 17.07 | Chalk Marl | Struck: 17.07<br>Standing: 11.58 |
| | 17.07 | 18.29 | Green sand | |

Groundwater

1.4.26 The EA groundwater models for the Test and Itchen Chalk (Amec, 2013) and the Mole Chalk (Amec Foster Wheeler, 2015) both indicate that groundwater levels are either at or very close to ground level during a period of high stand. This is reflected in the BGS (2017) groundwater flooding susceptibility map, which shows the site to be susceptible to clearwater flooding at the surface.

1.4.27 The publicly available borehole logs show substantially different rest water levels, varying from 1.1 to 11.6mbgl (BGS, 2018a). However, it should be noted that the deep water level is located on an interfluve, and the shallow close to the valley

bottom, suggesting that the absolute water levels in mAOD are very similar between the two locations.

1.4.28 No hydrogeological walkover of Caker and Lavant Streams Floodplain was undertaken.

Habitats and Vegetation

1.4.29 Habitat surveys have only taken place at the southern end of the site, where the Order Limits cross the site, the results of which are provided in Appendix 7.1 Habitats and Botany Factual Report. The site is dominated by poor semi-improved grassland (Figure A7.1.52). Although the vegetation may be highly modified by agriculture, the habitat recorded is not a wetland habitat.

1.4.30 The vegetation survey does not demonstrate the presence of any groundwater dependent habitats. However, the spatial distribution of the survey covered only a small portion of the site. This therefore does not allow GWDTE to be entirely discounted.

CSM

1.4.31 The Caker and Lavant Streams are both Chalk streams, with baseflow likely to make up a substantial component of their discharge, fed by chalk-derived groundwater.

1.4.32 At the site, surface water and groundwater will mix substantially, making differentiation of dependency difficult, especially when the surface water is derived directly from the groundwater. Flooding within the floodplains is likely to be mostly a mixture of groundwater and surface water, and the site has been assessed as being moderately groundwater dependent.

1.4.33 Figure A8.3.9 shows two conceptualised cross sections of the potential GWDTE, aligned parallel along the base and perpendicular across the valleys.

Assessment of Effects

1.4.34 During construction, the trench may require minor dewatering to take place, although it is uncertain if the groundwater level is within 1.5m of the ground surface and this may be dependent on the conditions prior to construction. Given that the Caker and Lavant Streams are located down hydraulic gradient from the Order Limits, part of the water that would otherwise discharge to Caker and Lavant streams and support the vegetation of the site may be intercepted, but this would likely be minor and would be temporary. Long term impact on flows is expected to be negligible.

1.4.35 Table 8.3.10 provides a summary of the magnitude of change of different potential effects on groundwater flows supporting Caker and Lavant Streams Floodplain.

**Table 8.3.10: Summary of Groundwater Flow Effects on Caker and Lavant Streams Floodplain GWDTE**

| Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|
| Moderate | None | Low | Trench dewatering | Construction | Small |
| | | | Flow interception | Operation | Negligible |

## Floodplain of the River Wey

Site Setting, Topography and Hydrological Catchment

1.4.36 The site is located within the valley of the River Wey, with ground levels falling from 98mAOD at the northwestern and southern edges to 89mAOD in the northeast.

1.4.37 The River Wey flows through the site from southwest to northeast. It has a very large upstream catchment to the west, draining a substantial portion of the local hills. The upper reaches comprise an ephemeral Chalk stream, although this reach of the river is permanently flowing.

1.4.38 The Order Limits cross the site from southeast to northwest, perpendicular to the River Wey. The pipeline is proposed to cross the River Wey with a trenchless crossing.

Geology and Soils

1.4.39 The vast majority of the site is covered by 571w Hucklesbrook soil, described as well-drained coarse loamy and some sandy soils, commonly over gravel (Cranfield University, 2018).

1.4.40 Alluvium is recorded at the base of the valley along the course of the River Wey. Small amounts of River Terrace Deposits are also mapped in the valley (BGS, 2018d). Alluvium typically comprises heterogeneous deposits of clay, silt, sand and gravel in varying proportions, often in discontinuous horizons. River Terrace Deposits are typically made up of sand and gravel, with occasional localised pockets of silt and clay.

1.4.41 The superficials are underlain by the Upper Greensand Formation under most of the site, with small areas of the overlying West Melbury Marly Chalk Formation. The West Melbury Marly Chalk Formation is limited to the western boundary of the site only (BGS, 2018d). The Upper Greensand typically comprises a glauconitic sandstone, which is variably cemented, whilst the West Melbury Marly Chalk is a marl-rich (argillaceous) grey chalk.

1.4.42 There are no publicly available boreholes within the site, but those closest to the site (120m to 320m south) all confirm the presence of the Upper Greensand outcrop in the vicinity, with one also potentially recording a thin layer of Chalk. Two of the boreholes are also located on a raised River Terrace Deposit, isolated from the River Wey outside the site, and confirm the presence of some sand and gravels over the bedrock (BGS, 2018a).

1.4.43 Two 2018 GI boreholes have been completed within the site boundaries (Table 8.3.11) as shown on Figure A8.3.10. Both boreholes showed a thin layer of alluvial soils over the Upper Greensand Formation, the top of which is quite heavily weathered. This confirms the absence of the Chalk Group under much of the site.

**Table 8.3.11: 2018 GI Logs at the Floodplain of the River Wey**

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater |
|---|---|---|---|---|
| BH98 | 0.00 | 0.05 | Sandy clay (topsoil) | Struck: 2.80mbgl<br>Standing: 2.80mbgl |
| | 0.05 | 0.80 | Slightly sandy very gravelly clay | |
| | 0.80 | 1.40 | Gravelly clay | |
| | 1.40 | 1.85 | Slightly gravelly clay | |
| | 1.85 | 4.55 | Gravelly clay (weathered bedrock) | |
| | 4.55 | 6.80 | Clayey gravel (weathered bedrock) | |
| | 6.80 | 14.30 | Very fine sandstone | |
| | 14.30 | 20.15 | Mudstone | |
| BH69 | 0.00 | 0.10 | Topsoil | Struck: 1.60mbgl |
| | 0.10 | 0.60 | Brown sandy clay | |
| | 0.60 | 1.90 | Brown clayey sandy gravel | |
| | 1.90 | 4.90 | Light grey very sandy clay (weathered bedrock) | |
| | 4.90 | 6.10 | Dark grey sandy clay, in parts still lithified (weathered bedrock) | |
| | 6.10 | 7.02 | Light grey and grey siltstone | |
| | 7.02 | 8.40 | Interbedded close to medium light brownish grey and dark greenish grey sandstone and siltstone | |
| | 8.40 | 17.20 | Light greyish brown very fine sandstone partially weathered | |

Groundwater

1.4.44 Most of the site is recorded as having a potential to flood at the surface; the exception to this is at the southern boundary of the site (BGS, 2017).

1.4.45 The 2018 GI recorded groundwater at 2.80mbgl and 1.60mbgl during construction of the boreholes. The difference in strike depths is likely to be reflective of the difference in seasonal conditions during the construction of the two boreholes, rather than their relative locations.

1.4.46 Subsequent monitoring data showed similar water levels, with maximum recorded water levels of 2.46mbgl and 2.42mbgl in BH98 and BH69 respectively. BH98 is located downslope and closer to the river from BH69, but this monitoring indicates the water table could be relatively flat north of the River Wey.

1.4.47 The EA groundwater models for the Test and Itchen (combined Chalk and Upper Greensand) (Amec, 2013) and the Mole (Upper Greensand) (Amec Foster Wheeler, 2015) confirms that the water table is less than 5mbgl beneath the site, and frequently above the local ground surface in high water conditions in some parts.

1.4.48 A groundwater monitoring borehole 400m southeast of the site records water levels in the Upper Greensand Formation generally deeper than 15mbgl, with about 2m to 3m of variation through a complete hydrological year (EA, 2018). This is substantially lower than the EA groundwater model outputs for the same location.

1.4.49 There are no springs or seepages recorded within the site from either the BGS karst database (Farrant and Cooper, 2008) or from the available Ordnance Survey (2015b) mapping. However, the BGS karst database records a line of springs running parallel to the River Wey downstream of the site. This suggests that there are likely to be seepage points along the banks of the Wey at some locations nearby.

1.4.50 No hydrogeological walkover of the Floodplain of the River Wey was undertaken.

Habitats and Vegetation

1.4.51 A Phase 1 habitat survey was undertaken at the Floodplain of the River Wey site. More detailed vegetation surveys were not undertaken because the site was found to be of low biodiversity value, supporting predominantly agriculturally modified grassland. A description of the habitats of the site is provided in Appendix 7.1 Habitats and Botany Factual Report. Figure A7.1.60 shows habitats within the site.

1.4.52 The survey showed the site to mostly be improved or semi-improved grassland. These habitats are not wetland habitats. However, as the habitats within the site have been modified by agriculture, they may not represent natural responses to underlying hydrogeological conditions.

CSM

1.4.53 Groundwater in the chalk, the alluvium and River Terrace Deposits are likely to be in close continuity. Groundwater levels are expected to be shallow in the valley, except in times of particularly low water levels, and the River Wey is expected to be groundwater fed as a result of direct baseflow or seepages along the river banks. The groundwater is expected to be primarily sourced from the regional catchment.

1.4.54 Groundwater is understood to discharge directly into the River Wey rather than to the surface and there is a lack of evidence of wetland habitats. For these reasons, the vegetation on site is assessed as having a low groundwater dependency.

1.4.55 Figure A8.3.11 shows a conceptualised cross section of the potential GWDTE, running from northwest to southeast along the line of the Order Limits and perpendicular to the River Wey.

Assessment of Effects

1.4.56 The site has been assessed as having only low groundwater dependency and is not designated. The use of trenchless directional drilling to cross most of the site means that no groundwater dewatering is expected along the trenchless crossing

(Appendix 8.2 Detailed Trenchless and Targeted Open Cut Assessments, Section 1.12). Very localised dewatering may be needed along the short trench portion in the southwest corner of the site and the launch and reception point of the directional drilling. Long term impacts on flows are expected to be negligible.

1.4.57 Table 8.3.12 provides a summary of the magnitude of change from different potential effects on groundwater flows supporting Floodplain of the River Wey.

**Table 8.3.12: Summary of Groundwater Flow Effects on Floodplain of River Wey GWDTE**

| Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Effect |
|---|---|---|---|---|---|
| Low | None | Negligible | Trench dewatering | Construction | Negligible |
| | | | Flow interception | Operation | Negligible |

### Ashley Head Spring

Site Setting, Topography and Hydrological Catchment

1.4.58 Ashley Head Spring is located on the sides of a relatively steep valley. Surface elevation changes from 94mAOD to 83mAOD over a short distance.

1.4.59 Ashley Head Spring forms the top of the hydrological catchment, being the source of the River Hart. The upgradient hydrological catchment extends upslope to the south and east (Amec Foster Wheeler, 2015). However, only a small number of artificial drainage ditches are present close to the site, and these are likely to only handle surface water runoff and water encountered in the soil horizons. There are no substantial surface water features observed within the topographic catchment.

1.4.60 The Order Limits pass within 500m to the east at the closest point on higher ground than the site.

Geology and Soils

1.4.61 The site is covered by 711h Wickham 4 soil described as slowly permeable seasonally waterlogged fine loamy over clayey and fine silty over clayey soils associated with similar clayey soils often with brown subsoils (Cranfield University, 2018).

1.4.62 There are River Terrace Deposits immediately outside the site, with alluvium at the base of the valley further downstream. The site itself is not situated on any recorded superficial deposits (BGS, 2018e).

1.4.63 The bedrock geology beneath the site is the Seaford Chalk Formation, part of the White Chalk subgroup (BGS, 2018e). It is close to where the Chalk becomes semi-confined beneath the Palaeogene deposits of the London Basin.

1.4.64 The closest publicly available borehole with a geological record (350m southeast) shows thin topsoil over Chalk (BGS, 2018a).

Groundwater

1.4.65 A spring is noted on the Ordnance Survey (2015b) mapping and was confirmed within the BGS karst datasets on the western boundary of the site (Farrant and Cooper, 2008). An additional spring is recorded in the karst database about 100m downslope to the north of Ashley Head Spring.

1.4.66 The site mostly sits within an area susceptible to groundwater flooding (BGS, 2017).

1.4.67 The Mole (Amec Foster Wheeler, 2015) and the Test and Itchen (Amec, 2013) groundwater models cover the site, with contours for a period of high groundwater levels displayed. These show depths to the water table beneath the site between 5mbgl and above local ground level, while along the Order Limits the modelling shows groundwater levels between 5–10mbgl at high water levels.

1.4.68 Groundwater monitoring is undertaken at an observation borehole less than 500m southwest (up gradient) of Ashley Head Spring (EA, 2018). Average water levels for the available monitoring period are around 5mbgl, although the highest water table recorded was around 2mbgl. Variation over a typical year was around 2m to 4m. This puts it within the range shown in both groundwater models at the same location.

1.4.69 The hydrogeological catchment feeding the spring extends at least 3km to the south, according to the EA groundwater modelling contours.

1.4.70 No hydrogeological walkover of Ashley Head Spring was undertaken.

Habitats and Vegetation

1.4.71 No habitat survey has been undertaken at Ashley Head Spring. Available mapping shows the site as open land, whilst the aerial images appear to show the site as pasture or arable. There is a small stand of trees collocated around the spring itself. This is insufficient to derive potential groundwater dependency.

CSM

1.4.72 Ashley Head Spring is a major discharge point of groundwater where the Chalk transitions from unconfined to confined. It is likely drawing water from a large hydrogeological catchment of the confined Chalk. The flow toward the spring is dominated by the Chalk's secondary porosity and karstic features, meaning that the rate of flow is very rapid.

1.4.73 Ashley Head Spring discharges directly into the headwaters of the River Hart. The vegetation is unlikely to have the same level of groundwater reliance as the river, but in the absence of more evidence is classified as moderate.

1.4.74 Figure A8.3.12 shows a conceptualised cross section of the potential GWDTE, running from northwest to southeast.

Assessment of Effects

1.4.75 Based on the EA groundwater model contours, the trench is highly unlikely to intercept the water table, and hence no dewatering would be required. As a result,

no impact is expected on the hydrogeology of the area and the discharge rate at Ashley Head Spring.

1.4.76 Table 8.3.13 provides a summary of the magnitude of change from different potential effects on groundwater flows supporting Ashley Head Spring.

**Table 8.3.13: Summary of Groundwater Flow Effects on Ashley Head Spring GWDTE**

| Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|
| Moderate | None | Low | Trench dewatering | Construction | None |
| | | | Flow interception | Operation | None |

## 1.5 GWSA-C

### Ewshot Meadows

Site Setting, Topography and Hydrological Catchment

1.5.1 The site is split into two parts, each part located in a local valley running southeast to northwest. The topography falls from northwest to southeast from approximately 135mAOD to 108mAOD across the site. At the point where the Order Limits cross the site from south to north, the ground elevation is in the order of 110mAOD.

1.5.2 A soil bund runs along the western boundary. A drain runs through the centre of the site which rises from outside the southeastern boundary. Discharge of this drain at the western boundary is through the bund via a brick sluice structure. A second drain is also present on site with the start shown as '*issues*' and '*collects*' in the centre of the site. This second drain discharges through the bund via a pipe. The two drains form a small valley feature.

1.5.3 The hydrological catchment expands some 400m further to the northwest.

1.5.4 The Order Limits cross the most western part of the site, with the valley feature having relatively gentle slopes.

Geology and Soils

1.5.5 Most of the site is underlain by Wickham 3 soil assemblages, described as slowly permeable seasonally waterlogged fine loamy over clayey, and coarse loamy over clayey, soils. Similar, but more permeable soils, are also present with slight waterlogging along with some deep coarse loamy soils affected by groundwater. The eastern extent of the northern part of the site is mapped as being over Holidays Hill soil assemblage, described as naturally very acid sandy over clayey soils and loamy over clayey soils, locally with humose or peaty surface horizons. There are slowly permeable subsoils and slight seasonal waterlogging. Holidays Hill also contains some very acid well-drained sandy soils, and some deep sandy soils, affected by groundwater with humose surface horizons (Cranfield University, 2018).

1.5.6 Superficial deposits are shown to be largely absent throughout most of the site (BGS, 2018e; 2018f). However, Head deposits are shown at the western part of the site where the Order Limits pass through it and associated with the valley feature. Head deposits typically comprise gravel, sand and clay depending on upslope source and distance from the source. They are usually poorly sorted and poorly stratified and formed mostly by solifluction and/or hillwash and soil creep.

1.5.7 The bedrock geology comprises London Clay at the point where the Order Limits cross the site. The Bagshot Formation (a sand deposit) outcrops on the higher ground to the east of the Order Limits (BGS, 2018e; 2018f).

1.5.8 There are no BGS geological logs for the site (BGS, 2018a). A hand coring survey was undertaken on 10 October 2018 in the vicinity of the Order Limits. The deposits recorded generally showed a clayey sand overlying a clayey sand with flint gravel (Head deposits) which largely agreed with the BGS maps. In many of the soil coring locations, limited progress could be made due to the increase in gravel with depth. Greater depth could be reached away from the drains and centre of the valley feature where less gravel was encountered in EM1, EM2 and EM5.

1.5.9 Figure A8.3.13 shows the location of hand coring points and Table 8.3.14 records the soils and superficial geology encountered at these points.

**Table 8.3.14: Hand Coring Geological Record**

| Hand Coring Ref. | Top (cm) | Base (cm) | Description | Field Notes |
|---|---|---|---|---|
| EM1 | 0 | 15 | Brown, mottled grey speckled orange, sandy silty clay with many roots. | Dry |
| | 15 | 100 | Orangish brown with many faint grey mottles, clayey medium sand. Becomes very clayey. Becomes clayey. Diffuse boundary. | Dry |
| | 100 | 150 | Stiff, orangish brown mottled grey sandy clay. Becomes bluish grey, mottled orange. Occasional dark purplish grey pockets and occasional wood debris. | Slightly moist |
| EM2 | 0 | 25 | Greyish brown silty fine sand with many roots. Gradual boundary. | Dry |
| | 25 | 70 | Orange with many faint mottles, slightly clayey fine to medium sand. Occasional fine gravel of flint. Becomes dark brown with black sand pockets. Abrupt boundary. | Dry |
| | 70 | 125 | Orange, mottled greenish grey very sandy stiff clay with some woody debris. Becomes grey, mottled orange. At 90cm becomes very clayey sand. Becomes grey with few distinct orange mottles. At 100cm becomes very sandy clay. Becomes greenish or purplish grey, mottled orange. At 120cm, becomes with flint gravel. | Slightly damp |
| EM3 | 0 | 20 | Brown speckled grey clayey silty fine sand with many rootlets. Diffuse boundary. | Dry |
| | 20 | 50 | Pale yellowish brown with many faint grey mottles slightly clayey fine sand, with flint gravel. | Dry |

| Hand Coring Ref. | Top (cm) | Base (cm) | Description | Field Notes |
|---|---|---|---|---|
| EM4 | 0 | 12 | Greyish brown, slightly sandy clay with many rootlets. Diffuse boundary. | Dry |
| | 12 | 36 | Brownish grey, mottled orange, clayey fine sand with a few roots. | Dry |
| | 36 | 55 | Grey mottled orange, slightly clayey sand with abundant gravel. Gravel is black (coal like), fine, angular and medium flint. | Dry |
| EM5 | 0 | 30 | Greyish brown silty fine sand with few fine gravel and few rootlets. Diffuse boundary. | Dry |
| | 30 | 80 | Brown with few faint grey or orange mottles very clayey sand. Becoming clayey sand. Becomes greyish brown mottled orange. Diffuse boundary. | Dry |
| | 80 | 110 | Dense, brittle orangish brown with few faint grey mottles sandy clay with many fine to coarse gravel of flint and few woody debris. With pockets of clayey sand. | Dry |
| EM6 | 0 | 10 | Brown, speckled grey, sandy clay with many roots. | Dry |
| | 10 | 35 | Greyish brown with occasional distinct black mottles, clayey sand with many fine to coarse gravel of flint. | Dry |
| EM7 | 0 | 18 | Brown clayey silt with abundant rootlets. Gradual boundary. | Dry |
| | 18 | 40 | Brown with rare orange mottles fine to medium sand with fine to coarse gravel of flint. Abrupt boundary. | Dry |
| | 40 | 55 | Grey with rare distinct reddish orange mottles clayey fine sand. Some fine gravel of flint. Becoming brownish grey. | Dry |
| EM8 | 0 | 25 | Brown silty fine sand with many roots and some gravel of flint. Diffuse boundary. | Dry |
| | 25 | 45 | Brown with faint grey mottles, slightly clayey fine sand. Some woody roots. Second hole attempted adjacent to original EM8 recovers red brick fragments. | Dry |
| EM9 | 0 | 20 | Brown speckled grey fine sandy silt with many roots. Diffuse boundary. | Dry |
| | 20 | 45 | Orangish brown, clayey fine sand with pockets of clayey sand mottled orange and grey. Occasional fine gravel of flint. | Dry |
| EM10 | 0 | 18 | Brown speckled grey slightly clayey sandy silt with many roots. | Dry |
| | 18 | 82 | Soft brown sandy clay with some roots. Becomes stiffer with depth. Becomes mottled orange. Becomes grey, mottled orange. Appearance of black spots. At 75cm becomes few fine gravel of flint. Then becomes with many fine gravel of flint. | Dry |
| EM11 | 0 | 24 | Brown, slightly sandy clay with many roots. Abrupt boundary. | Dry |

| Hand Coring Ref. | Top (cm) | Base (cm) | Description | Field Notes |
|---|---|---|---|---|
| | 24 | 50 | Orange, mottled brownish grey moderately stiff sandy clay. Slightly gravelly, with fine gravel of flint. Some roots. | Dry |
| | 50 | 75 | Dark bluish grey with rare orange mottles, stiff very sandy clay with some roots and woody debris. Abrupt boundary. | Dry |
| | 75 | 83 | Orange clayey sand with frequent fine gravel of flint. Occasional black spots. | Dry |
| EM12 | 0 | 22 | Greyish brown slightly sandy silt with many roots. Gradual boundary. | Dry |
| | 22 | 48 | Orangish brown with few faint grey mottles, clayey fine sand with gravel of flint. | Dry |
| EM13 | 0 | 20 | Greyish brown with few faint orange mottles, clayey fine sand and some rootlets. | Dry |
| | 20 | 35 | Brown, mottled grey and orange, clayey fine sand with fine gravel of flint.<br>Becomes with black angular gravel (possibly coal). Becomes greyish greenish brown with orange faint mottles. | Dry |

Groundwater

1.5.10 A hydrogeological site walkover was undertaken on 18 July 2018. The 2018 summer conditions were exceptionally dry and this was clearly reflected in the extreme dryness of the site. No water was present in the drain that flows through the site, and the areas marked on maps as being issues and collects were dry. A potential pond or spring feature situated near the longer drain (at National Grid Reference (NGR) 481431, 150615 and outside of the Order Limits) was identified by the presence of slightly damp earth but water would be expected to be present during wetter periods. Another pond feature marked on Ordnance Survey (2018a) at NGR 481384, 150613 (near to soil coring location EM1 and within the Order Limits) was also observed to be dry during both site visits.

1.5.11 The only feature where water was observed was a small man-made pond near the western boundary into which the longer drain discharges prior to discharging through the sluice. This pond had banks showing a cobbly, gravelly, sandy clay. The water level in the pond was notably lower at the time of the soil coring in October compared with the walkover survey in July.

1.5.12 However, half of the Order Limits which pass through the site fall within an area susceptible of groundwater flooding (BGS, 2017). The location of the Order Limits is at the low point of a wider catchment which recharges from south and east. The areas susceptible of groundwater flooding correlate with topographical contours and the localised low topographical area.

1.5.13 The hand coring generally recorded dry soils, with only damp or moist horizons being recorded at the bases of EM1 and EM2, which were the deepest cores recorded. However, there was also evidence of redoximorphic features which suggests that the conditions are generally wetter.

1.5.14 Surface and sub-surface flows are expected to be flashy, i.e. quite responsive to rainfall. The nature of the superficial deposits is such that they would be unlikely to retain much water during prolonged periods of drought, but the shallow groundwater would move more slowly and would sustain flows for a longer period of time than any surface runoff and surface ponding. Whilst the soil coring survey did not identify a consistent clay horizon at shallow depth, the deeper holes at EM1 and EM2 did identify clay at depth. Furthermore, the geology maps show London Clay underlying the site (BGS, 2018e; 2018f). Given the local nature of the Head deposits that are mapped, it is unlikely that they are of substantial thickness. As such, local rainfall could create shallow perched groundwater conditions at the location of the Order Limits.

Habitats and Vegetation

1.5.15 The vegetation of the site was surveyed for the project in July 2018, and a detailed description is provided in Appendix 7.1 Habitats and Botany Factual Report. Figure A7.1.83 shows the vegetation mapping. The survey shows a relative uniformity in the vegetation present across the site, dominated by large stands of grassland associated with poorly drained soil.

1.5.16 Within the Order Limits, on the southern edge of the site at soil coring location EM1, M23a *Juncus acutiflorus/effusus-Galium palustre* rush pasture, *Juncus acutiflorus* sub-community was recorded. UKTAG guidance classes this plant community as having high to moderate groundwater dependency. Adjacent to this area and within the Order Limits is an area classed as the wet woodland plant community W1 *Salix cinerea-Galium palustre* woodland, classed as having moderate groundwater dependency. Outside of the Order Limits for the pipeline, in the location of the mapped issues and collects (near soil coring location EM12), the plant community M27b *Filipendula ulmaria-Angelic sylvestris* mire, *Urtica dioica-Vicia cracca* sub-community was recorded. This plant community is classed as having moderate to low groundwater dependency.

1.5.17 A larger area of M23b *Juncus acutiflorus/effusus-Galium palustre* rush pasture, *Juncus effusus* sub-community vegetation (also classed as having high to moderate groundwater dependency) is mapped to the east of the Order Limits associated with the drain and valley feature.

1.5.18 Table 8.3.15 lists the NVC types recorded at the site, alongside the groundwater dependency assigned by the UKTAG (2009) guidance. Figure A8.3.14 shows the distribution of groundwater dependency across the site.

**Table 8.3.15: UKTAG Derived Groundwater Dependency for Vegetation Encountered at Ewshot Meadows**

| NVC Habitat Type* | Groundwater Dependency (according to UKTAG, 2009) |
|---|---|
| M23 | High to moderate |
| M27 | Moderate to low |
| MG1 | Not groundwater dependent |
| MG6 | Not groundwater dependent |
| MG7 | Not groundwater dependent |
| MG9 | Not groundwater dependent |

| NVC Habitat Type* | Groundwater Dependency (according to UKTAG, 2009) |
|---|---|
| MG11 | Moderate to low |
| W1 | Moderate |
| W6 | Low |
| W10 | Not groundwater dependent |
| W21 | Not groundwater dependent |
| W22 | Not groundwater dependent |
| W24 | Not groundwater dependent |
| W25 | Not groundwater dependent |

**Refer to Appendix 7.1 Annex G for full list of NVC names and sub-communities*

CSM

1.5.19 Topography appears to be the key factor controlling the depth to groundwater, with superficial deposits of generally homogeneous nature. The review of available geological and hydrogeological information confirms a degree of groundwater contribution to sustaining the mapped GWDTE vegetation.

1.5.20 In the vicinity of the Order Limits, the BGS groundwater flooding susceptible areas overlap with vegetation classed by UKTAG guidance as high to moderate groundwater dependency. However, to the east an area identified as having vegetation with high to moderate groundwater dependency does not overlap with the groundwater susceptibility flooding map (BGS, 2017). Hand coring surveys in the vicinity of the Order Limits did not identify any groundwater, and at the time of the walkover and hand coring surveys no groundwater features (springs, seepages) were identified, even though at wetter times of the year groundwater levels are expected to move closer to the surface. In addition, the topography is such that surface water runoff contribution is expected to be of some importance. For this reason, areas of M23 are reduced to moderate groundwater dependency, and the UKTAG classification of M27b is confirmed as low to moderate.

1.5.21 Figure A8.3.15 represents two conceptualised sections, one running southwest to northeast along the Order Limits (Section A-A) and the other perpendicular to the Order Limits (Section B-B). Both surface water and groundwater flow dominantly from southeast to northwest. The CSM locates the presence of vegetation with potential for groundwater dependency in the flatter topography areas also receiving surface water inputs.

Assessment of Effects

1.5.22 The pipeline is proposed to be installed adjacent to the existing pipeline. In the vicinity of Ewshot Meadows, the Order Limits passes through one area of vegetation identified as being potentially groundwater dependent, this being of moderate groundwater dependency. During construction, the trench may require dewatering, although it is uncertain if the groundwater level is typically within 1.5m of the ground surface. Locally, dewatering would impact on water levels in areas which are groundwater dependent if undertaken at a time when groundwater levels are high. This would be a temporary effect during construction, and groundwater dependent

vegetation, if impacted, would likely recover. Long term impacts on flows are also expected to very localised and minor.

1.5.23 Table 8.3.16 provides a summary of the magnitude of change from different potential effects on groundwater flows supporting Ewshot Meadows.

**Table 8.3.16: Summary of Groundwater Flow Effects on Ewshot Meadows GWDTE**

| Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|
| Moderate (to low to moderate) | SINC | Medium | Trench dewatering | Construction | Small |
| | | | Flow interception | Operation | Small |

### Bourley and Long Valley

Site Setting, Topography and Hydrological Catchment

1.5.24 The topographical variation across Bourley and Long Valley is relatively low, ranging from 95mAOD to 80mAOD over the entire site. However, some local rises are notable, with steep gradients. The central part of the site forms a flat bottom valley.

1.5.25 The hydrological catchment extends several kilometres to the south, with streams, including the Gelvert Stream, flowing into the site from this direction.

1.5.26 The Order Limits run through the centre of the site. It follows a track for part of its length, before cutting through an area of woodland. The site is divided in two parts by the Aldershot Road. South of the road it follows a strip of open land associated with the existing pipeline easement.

Geology and Soils

1.5.27 The south and centre of the site is mapped as being over Holidays Hill soil assemblage, described as naturally very acid sandy over clayey soils and loamy over clayey soils, locally with humose or peaty surface horizons. There are slowly permeable subsoils and slight seasonal waterlogging. Holidays Hill also contains some very acid well-drained sandy soils, and some deep sandy soils, affected by groundwater with humose surface horizons. The north of the site is mapped as being over Swanwick soil assemblage, described as deep permeable coarse loamy and sandy soils some with peaty surface horizons affected by groundwater (Cranfield University, 2018).

1.5.28 The site is partially covered by Head deposits. However, only the eastern end of the Order Limits within the site is on an area of recorded Head deposits, with the rest of the Order Limits being on exposed Windlesham Formation or Camberley Sand Formation bedrock (BGS, 2018f). Head deposits typically comprise mixed sand silt and clay in varying proportions. The Camberley Sand Formation is comprised principally of sand, with only minor components of silt, clay and gravel. The Windlesham Formation is a sandy clay, with lenses of either particularly sand- or clay-rich horizons.

1.5.29 Only one publicly available borehole record is available from within the site (BGS, 2018a), located 500m to the northwest of the Order Limits (Figure A8.3.16). This borehole confirmed the presence of 1.7m of Head deposits over the Windlesham Formation in its vicinity. However, this is insufficient to allow verification of the extent of the Head deposits over the rest of the site.

Groundwater

1.5.30 The site mostly has only a limited susceptibility to groundwater flooding, with only two single grid cells recording a sub-surface groundwater flooding susceptibility (BGS, 2017). This was confirmed by the only available borehole, which showed a groundwater strike at 4.7mbgl from the north of the site. This places the groundwater within the Windlesham Formation, rather than the superficial deposits.

1.5.31 A hydrogeological walkover of the site was undertaken on 25 June 2018. The preceding weather had been abnormally hot and dry.

1.5.32 Springlines were observed in several locations across the site during the site visit (Figure A8.3.16). These were associated with the observed junction between overlying sandier soils and clayey soils. The seepages were located at the base of localised hills in the north of the site, whilst a broader seepage line was observed in the south. However, no active seepage flow was observed.

1.5.33 Separately, one discrete spring was observed as flowing during the site visit, supplying a small braided stream flowing towards the northeast.

Habitats and Vegetation

1.5.34 A detailed description of the habitats and vegetation within the site is provided in Appendix 7.1 Habitats and Botany Factual Report. Habitat and vegetation plans are provided in Figures A7.1.93 and A7.1.96, respectively.

1.5.35 The north of the site comprises mostly woodland, with areas of wet dwarf shrub heath and marshy grassland. The south of the site is dominated by wet and dry dwarf shrub heaths, with gradation between the two. Small areas of valley mire were also observed in both areas. Based on UKTAG guidance, a mixture of groundwater dependencies is observed, from high to moderate, to low or none.

1.5.36 There is an area of wet woodland immediately south of the road, primarily W4 *Betula pubescens-Molinia caerulea* woodland. This gives way to a larger area of open heathland, with wet dwarf shrub heath and small areas of valley mire in the lower parts to the north, giving way to dry dwarf shrub heath as the land rises to the south. The Order Limits follow an area of marshy grassland (M25 *Molinia caerulea-Potentilla erecta* mire) between plantation forestry (open ground maintained for the existing pipeline easement).

1.5.37 The wet woodland by the road is rated as high to moderate under UKTAG guidance, whilst the heathland is a mixture from high to moderate, to low groundwater dependency habitats. The open easement is rated as a low to moderate dependency.

1.5.38 Table 8.3.17 lists the NVC types recorded at the site, alongside the groundwater dependency assigned by the UKTAG (2009) guidance. Figure A8.3.17 shows the distribution of guideline groundwater dependencies across the site.

**Table 8.3.17: UKTAG Derived Groundwater Dependency for Vegetation Encountered at Bourley and Long Valley**

| NVC Habitat Type* | Groundwater Dependency (according to UKTAG, 2009) |
|---|---|
| H2 | Not groundwater dependent |
| M2 | Low to moderate |
| M3 | Low to moderate |
| M6 | High to moderate |
| M16 | High to moderate |
| M21 | High to moderate |
| M23 | High to moderate |
| M25 | Low to moderate |
| M29 | High to moderate |
| M30 | Moderate |
| MG1 | Not groundwater dependent |
| MG5 | Low to moderate |
| MG7 | Not groundwater dependent |
| MG9 | Not groundwater dependent |
| MG11 | Low to moderate |
| S7 | Moderate |
| U1 | Not groundwater dependent |
| U2 | Not groundwater dependent |
| U5 | Not groundwater dependent |
| U20 | Not groundwater dependent |
| W1 | Moderate |
| W4 | High to moderate |
| W10 | Not groundwater dependent |
| W23 | Not groundwater dependent |
| W25 | Not groundwater dependent |

**Refer to Appendix 7.1 Annex G for full list of NVC names and sub-communities*

CSM

1.5.39 Surface water flows into the site from the south, with the Gelvert Stream being the largest of these inputs. The fluvial source is originally derived from a distant spring line. Areas of poor drainage due to clay-rich soils inhibit infiltration from direct precipitation and allow surface ponding during periods of high rainfall or high runoff.

1.5.40 Groundwater dependency in the site appears to be controlled by the underlying geology, i.e. the transition from outcrop of sandier upper horizons onto clayeyer substrate provides the location for both seepage fronts and springs, and the topography feeding into small local topographical depressions and supporting the valley mire vegetation. These are flush-like features. On this basis, UKTAG rating

has been confirmed for the parts of the site south of the road and for the wet heath and valley mire to the north of the road.

1.5.41 However, the area between the road and Order Limits has been assessed as having a lower groundwater dependency than is suggested by the UKTAG guidance. Similarly, the wet woodland within the Gelvert Stream floodplain is assessed as having a lower groundwater dependency than is predicted based on the NVC classifications within the area. In both instances, a large surface water input has been identified, whilst the evidence suggests limited groundwater availability. Therefore, the surface water input is considered to be dominant over the groundwater in sustaining the wetland habitats. These areas were observed to be the parts of the site with more clay-rich soils.

1.5.42 Figure A8.3.18 shows two conceptualised cross sections with adjusted groundwater dependency classification, one running from southwest to northeast parallel to the Order Limits, and one running northwest to southeast perpendicular to the Order Limits.

Assessment of Effects

1.5.43 Based on the assessment above and the interaction with the Order Limits, the site can be divided into five sub-sites to review potential effects (Figure A8.3.16):

- wet heathland, comprising the open heath to both the north and south of the road, and the associated valley mires;
- Gelvert Stream floodplain, comprising the areas of wet woodland and associated minor habitats lying within the floodplain;
- southerly wet woodland, comprising the zone immediately south of Aldershot Road fed by the spring;
- southwest Order Limits, comprising the open easement up towards Tweseldown Hill; and
- northeast Order Limits, comprising the hillside area along the track.

1.5.44 The areas of wet heathland, and the areas of valley mire found in the depressions in the same locations, are located away from the Order Limits. On both sides of the road, they are located up hydraulic gradient, or in a different hydrogeological catchment. These areas of high to moderate groundwater dependent habitat would therefore not be affected during the construction or operational phases of the project.

1.5.45 The spring identified on site is in the western end of the Order Limits and downgradient of the Limits of Deviation and part of the southerly wet woodland, with the associated vegetation of this sub-site to the east. The trench required for installation of the pipeline in this part of the Order Limits would likely be below any groundwater table, therefore requiring dewatering to take place. This would require dewatering of the trench during construction. This is expected to result in a drawdown of water levels in the immediate vicinity and could reduce the water flux to the spring. With the REAC, measure NW12 (where the Limit of Deviation comprises of a maximum 15m working width, on the western side of the Order

Limits, for a distance of approximately 140m, from Grid Ref E:482693 N:152719 to Grid Ref E:482625 N:152595), potential drawdown effects would be reduced but recharge to the spring may still be intercepted. However, the dewatering impact would be localised away from the spring and temporary, and the vegetation would recover from any impact following completion of work. In addition, the good practice measure O7 will place stanks through the pipe bedding and side fill, and G199 will identify specific areas in the vicinity of GWDTEs where increased frequency of stanks would be required to safeguard sensitive habitats which depend on groundwater. As a result, the magnitude of change during construction is expected to be small. Long term impact on flows is expected to be negligible.

1.5.46 The trench required to install the pipeline in the southwest sub-site and northeast sub-site would likely be located above the water table. Therefore dewatering in these parts of the Order Limits is unlikely to be required and effects on the groundwater dependent habitats within these sub-sites are unlikely.

1.5.47 It is proposed to use directional drilling trenchless techniques to install the pipeline under the Gelvert Stream floodplain sub-site (Appendix 8.2 Detailed Trenchless and Targeted Open Cut Assessments, Sections 1.15 and 1.16). This does not require any dewatering of groundwater except at the launch and reception points where shallow excavations equivalent to trench depth may be required. As a result, there would be no effect on any groundwater dependent vegetation along the actual trenchless section. No perched groundwater has been identified, and the bedrock aquifer is in continuity with the surface. As such, the trenchless crossing would not connect two previously isolated aquifers.

1.5.48 The northeastern end of the Order Limits within the site lead to the trenchless crossing of the Basingstoke Canal (Appendix 8.2 Detailed Trenchless and Targeted Open Cut Assessments, Section 1.17). The crossing would be constructed by directional drilling, which does not require dewatering except at the launch and reception points, where shallow excavations equivalent to trench depth may be required, although these would be above the water table in this location. Additionally, this part of the site is not groundwater dependent. Therefore, it would not be affected by the construction or operational phases.

1.5.49 Table 8.3.18 provides a summary of the magnitude of change from different potential effects on groundwater flows supporting the sub-sites of Bourley and Long Valley SSSI.

**Table 8.3.18: Summary of Groundwater Flow Effects Across Bourley and Long Valley GWDTE**

| Sub-site | Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|---|
| Wet heathland | High to moderate | Special Protection Area (SPA), SSSI | High | Trench dewatering | Construction | None |
| | | | | Flow interception | Operation | None |
| Gelvert Stream floodplain | Low | SPA, SSSI | Medium | Trenchless crossing dewatering | Construction | None |
| | | | | Flow interception | Operation | None |

| Sub-site | Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|---|
| | | | | Connection of aquifers | Construction / operation | None |
| Southerly wet woodland | High to moderate | SPA, SSSI | High | Trench dewatering | Construction | Medium |
| | | | | Flow interception | Operation | Negligible |
| Southwest Order Limits | Low | SPA, SSSI | Medium | Trench dewatering | Construction | Negligible |
| | | | | Flow interception | Operation | Negligible |
| Northeast Order Limits | Low | SPA, SSSI | Medium | Trench dewatering | Construction | Negligible |
| | | | | Trenchless crossing dewatering | Construction | None |
| | | | | Flow interception | Operation | Negligible |
| | | | | Connection of aquifers | Construction / operation | None |

### Eelmoor Marsh

Site Setting, Topography and Hydrological Catchment

1.5.50 The topography at Eelmoor Marsh ranges from 85mAOD in the northwest to 70mAOD in the southeast corner. The southern part of the site is comparatively flat.

1.5.51 The Order Limits runs parallel and adjacent to the northern boundary of the site, which is the highest topographical area within the site.

Geology and Soils

1.5.52 Most of the site is mapped as over Holidays Hill soil assemblage, described as naturally very acid sandy over clayey soils and loamy over clayey soils, locally with humose or peaty surface horizons. There are slowly permeable subsoils and slight seasonal waterlogging. Holidays Hill also contains some very acid well-drained sandy soils, and some deep sandy soils, affected by groundwater with humose surface horizons. A small part of the northwest of the site is mapped as Swanwick soil assemblage, described as deep permeable coarse loamy and sandy soils some with peaty surface horizons affected by groundwater (Cranfield University, 2018).

1.5.53 Head deposits are recorded in small areas at the northern and southern boundary of the site. Across most of the site the bedrock Camberley Sand Formation is directly exposed (BGS, 2018f). The Camberley Sand Formation is a homogeneous sand horizon, with only minor clay and gravel components. The Windlesham Formation, a sandy clay, outcrops along the southern boundary of the site.

1.5.54 The publicly available borehole logs support this, with sand recorded in all locations, with small amounts of secondary clay and silt contained within the lithology (BGS,

2018a). Table 8.3.19 shows the available borehole records from within the site, although exact locations are not known.

**Table 8.3.19: Borehole Records from within the Eelmoor Marsh Site**

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description |
|---|---|---|---|
| SU85SW33 | 0.0 | 0.2 | Topsoil |
| | 0.2 | 3.3 | Sand. Medium dense, yellowish green, fine, with a little clay and silt |
| | 3.3 | 4.0 | Sand. Medium dense, greyish green, fine, with occasional pockets of grey sand |
| | 4.0 | 10.0 | Sand. Dense or very dense, greenish yellow brown, fine, with a little clay or silt |
| SU85SW34 | 0.0 | 0.3 | Topsoil |
| | 0.3 | 0.7 | Sand. Light grey, fine, clayey and silty |
| | 0.7 | 2.7 | Sand. Loose becoming medium dense, green, fine, with a little clay and silt |
| | 2.7 | 10.0 | Sand. Medium dense, rapidly becoming dense, orangish yellow, fine, with a little clay and silt |
| SU85SW35 | 0.0 | 0.3 | Topsoil |
| | 0.3 | 2.8 | Sand. Loose, becoming medium dense, green, fine with a little clay and silt |
| | 2.8 | 10.0 | Sand. Medium dense, orangish yellow, fine with a little clay and silt |
| SU85SW36 | 0.0 | 0.3 | Topsoil |
| | 0.3 | 1.2 | Sand. Medium dense, yellowish brown banded green, fine, with some clay and silt |
| | 1.2 | 2.7 | Sand. Medium dense, yellowish brown, fine, with a little clay and silt |
| | 2.7 | 5.0 | Sand. Dense, yellowish brown, fine, with a little clay and silt |
| | 5.0 | 10.0 | Sand. Dense, yellowish green becoming greener with depth, fine, with a little clay and silt |
| SU85SW37 | 0.0 | 0.4 | Topsoil |
| | 0.4 | 0.7 | Clay. Firm, brownish green, very sandy |
| | 0.7 | 2.5 | Sand. Medium dense, greyish light green, fine, clayey, with pockets of green clay |
| | 2.5 | 5.0 | Sand. Medium dense, yellowish green, fine, with a little clay |
| | 5.0 | 7.2 | Sand. Dense, yellowish green, fine, with a little clay |
| | 7.2 | 10.0 | Sand. Dense, greenish yellow brown, fine, slightly clayey with very occasional layers and pockets of greenish clay |
| SU85SW38 | 0.0 | 0.5 | Topsoil |
| | 0.5 | 1.1 | Sand. Loose, greenish yellow, fine, clayey with occasional 10–20mm thick layers of green clay |
| | 1.1 | 4.5 | Sand. Medium dense, green, fine, with a little clay and silt |
| | 4.5 | 7.0 | Sand. Dense, yellowish green, fine, with a little clay and silt |

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description |
|---|---|---|---|
| | 7.0 | 10.0 | Sand. Dense, greenish yellow brown, fine, with a little clay and silt |
| SU85SW39 | 0.0 | 0.5 | Topsoil |
| | 0.5 | 1.2 | Sand. Medium dense, light green, fine, with some clay and clayey layers |
| | 1.2 | 3.2 | Sand. Medium dense, green, fine, with a little clay and silt |
| | 3.2 | 7.0 | Sand. Medium dense, becoming dense, yellowish green, fine, with a little clay and silt |
| | 7.0 | 10.0 | Sand. Dense, greenish yellow brown, fine, with a little clay and silt, becoming browner with depth |
| SU85SW40 | 0.0 | 0.5 | Sand. Medium dense, yellowish brown with a trace of clay and silt |
| | 0.5 | 4.0 | Sand. Medium dense becoming dense, fine, greyish light green, with a little silt and clay |
| | 4.0 | 10.0 | Sand. Dense, rapidly becoming very dense, fine, orangish yellow, with a little silt and clay |

Groundwater

1.5.55 Publicly available borehole records from BGS (2018a) showed groundwater strikes and monitoring data from a previous GI. Results are presented in Table 8.3.20. It should be noted that an accurate grid reference for the boreholes was withheld, and as such, their exact locations are not known. Nevertheless, they show that the water table can approach close to the surface across some parts of the site as the ground level falls.

**Table 8.3.20: Groundwater Records from Boreholes within the Eelmoor Marsh Site**

| BH Ref. | Elevation (mAOD) | Water Strike (mbgl) | Standing Water Level (mbgl) | Monitoring Visit Records (mbgl) | | | | |
|---|---|---|---|---|---|---|---|---|
| SU85SW33 | 74.8 | 2.5 | 3.1 | - | - | - | - | - |
| SU85SW34 | 70.6 | 2.7 | 0.9 | - | - | - | - | - |
| SU85SW35 | 69.4 | 1.5 | 1.1 | 1.2 | 0.8 | 0.8 | 0.8 | - |
| SU85SW36 | 78.3 | 8 | 6.8 | 6.8 | 6.7 | 6.8 | 7.5 | 6.6 |
| SU85SW37 | 72.6 | 4.7 | 2.4 | - | - | - | - | - |
| SU85SW38 | 73.2 | 4.5 | 3.4 | - | - | - | - | - |
| SU85SW39 | 73.8 | 4.5 | 3.1 | 2.8 | 2.9 | - | - | - |
| SU85SW40 | 87.3 | 10 | - | - | - | - | - | - |

1.5.56 The groundwater flooding susceptibility map corroborates the GI data, with an increased groundwater flooding susceptibility in the south and east of the site (BGS, 2017).

1.5.57 Many stream issues are mapped along the southern boundary of the site, which based on available evidence are likely to be groundwater fed (Ordnance Survey, 2015c).

1.5.58 No site walkover of Eelmoor Marsh was undertaken.

Habitats and Vegetation

1.5.59 The vegetation survey was limited to the Order Limits to the north of the site, with no survey of Eelmoor Marsh. The results of the survey are provided in Appendix 7.1 Habitats and Botany Factual Report, and show the area to comprise non-wetland habitats, supporting broadleaved woodland, coniferous plantation woodland, dense scrub and small areas of acid grassland (Figure A7.1.101).

1.5.60 The site has been designated as an SSSI for the presence of acid rich wetland habitats and species, including some areas of peat and the following plant communities: H2 *Calluna vulgaris – Ulex minor*, M25 *Molinia caerulea – Potentilla erecta* and U1e *Festuca ovina – Agrostis capillaris – Rumex acetosella* grassland, *Galium saxatile-Potentilla erecta* sub-community (Natural England, 2019). M25 is classified as high to moderate groundwater dependency under UKTAG guidance.

CSM

1.5.61 Groundwater appears to generally flow towards the south, following the topography. The hydraulic gradient is relatively flat, but the topographic change means that the unsaturated zone becomes thinner rapidly in this direction. Issues and springs occur at the base of the slope where the Camberley Sand Formation thins and the Windlesham Formation outcrops.

1.5.62 The habitats within the Order Limits are situated on the top of the hill and over a thick unsaturated zone. These are not considered to be groundwater dependent.

1.5.63 The identified seepages and springs from the Camberley Sand have the ability to sustain the vegetation, particularly communities such as M25 recorded by Natural England. For this reason, the habitats within the south of the site have to potential to be highly groundwater dependent.

1.5.64 Figure A8.3.19 shows the distribution of guideline groundwater dependencies surrounding the site. Figure A8.3.20 shows a conceptualised cross section of the potential GWDTE, running from northwest to southeast.

1.5.65 As it is not groundwater dependent, the area around the Order Limits has been excluded from the site boundaries, and potential effects are not considered here.

Assessment of Effects

1.5.66 During construction, the trench required to install the pipeline is expected to be located above the water table. There would be no need for dewatering in this part of the Order Limits. Therefore, there would be no impact to the groundwater dependent parts of the site located down gradient during construction or operation.

1.5.67 Table 8.3.21 provides a summary of the magnitude of change from different potential effects on groundwater flow supporting Eelmoor Marsh.

**Table 8.3.21: Summary of Groundwater Flow Effects on Eelmoor Marsh GWDTE**

| Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|
| High | SPA, SSSI | High | Trench dewatering | Construction | None |
| | | | Flow interception | Operation | None |

### Cove Brook and Ively Road

Site Setting, Topography and Hydrological Catchment

1.5.68 The north of the site is located in the Cove Brook valley, whilst the south is parallel to Ively Road. The site ranges from 67mAOD to 61mAOD in elevation across its entire extent. Elevations fall generally towards the north. The site is bisected by the A327, running from north to south.

1.5.69 The hydrological catchment is relatively large, but with gentle slopes. It extends to the south and east, and includes Farnborough Airport, an area which has been extensively modified. The Cove Brook flows into the site through a culvert in the southeast part. Runoff may also be derived from the sides of the valleys to east and west, although this is a principally urban catchment. The northeast of the site is a designated flood storage area, with an embankment of 1.5m to 3m height separating this from the rest of the site.

1.5.70 The Order Limits crosses through the middle of the site, with elevation ranging from 66mAOD to 61mAOD.

Geology and Soils

1.5.71 The higher parts of the site to the west and south are recorded to be over Holidays Hill soil assemblage, described as naturally very acid sandy over clayey soils and loamy over clayey soils, locally with humose or peaty surface horizons. There are slowly permeable subsoils and slight seasonal waterlogging. Holidays Hill also contains some very acid well-drained sandy soils, and some deep sandy soils, affected by groundwater with humose surface horizons. The lower parts of the site in the base of valleys are recorded to be Swanwick soil assemblage, described as deep permeable coarse loamy and sandy soils some with peaty surface horizons affected by groundwater (Cranfield University, 2018).

1.5.72 Much of the site is underlain by alluvium, whilst some Head deposits have also been recorded, mostly in the south and southwest (BGS, 2018f). There may be more Head deposits beneath the alluvium.

1.5.73 Superficial deposits are underlain by the Windlesham Formation, a sandy clay. However, the sides of the valleys are recorded to be outcrops of the Camberley Sand Formation, a homogeneous sand deposit (BGS, 2018f). Both units are part of the parent unit Bracklesham Group.

1.5.74 There are no publicly available boreholes from within the site (BGS, 2018a). The closest boreholes are around 150m from the site boundaries and show between 0.7m and 1.75m of alluvial deposits over bedrock of the Bracklesham Group.

1.5.75 Two 2018 GI boreholes have been completed within the site boundaries (Table 8.3.22). Both show that the site is underlain by a sandy bedrock, potentially indicating a more extensive outcrop of Camberley Sand Formation than in the mapping.

**Table 8.3.22: 2018 GI Logs at Cove Brook and Ively Road**

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater |
|---|---|---|---|---|
| BH56 | 0.00 | 0.38 | Made Ground: dark brown slightly gravelly silty sand. | Struck: 1.40mbgl<br>Rise: 1.40mbgl |
| | 0.38 | 1.32 | Light brown slightly silty sand. | |
| | 1.32 | 2.15 | Dark brown mottled orangish grey slightly sandy clay. | |
| | 2.15 | 9.30 | Dark greenish grey slightly silty sand. | |
| | 9.30 | 10.55 | Dark greenish grey slightly gravelly slightly silty sand. | |
| BH59 | 0.00 | 0.10 | Made Ground: Brown silty sandy clay | Struck: 1.65mbgl |
| | 0.10 | 1.00 | Made Ground: Dark brown slightly clayey very gravelly sand | |
| | 1.00 | 1.40 | Made Ground: Dark grey slightly clayey slightly gravelly sand. | |
| | 1.40 | 2.35 | Light greyish green mottled dark grey silty sand. | |
| | 2.35 | 3.90 | Dark greyish green silty sand. | |
| | 3.90 | 15.45 | Greenish grey silty sand. | |

Groundwater

1.5.76 Groundwater strikes were recorded between 1.40-1.65mbgl as part of the 2018 GI within the site. Subsequent groundwater monitoring has shown water levels reach up to 0.47mbgl in BH59, and 1.50mbgl in BH56, although the available record is relatively short and from the winter period only.

1.5.77 Groundwater was recorded in local boreholes, with strikes at 2.4mbgl (rising to 1.4mbgl) and 4.4mbgl (BGS, 2018a). Both of these strikes were from the bedrock strata.

1.5.78 However, there is only a limited risk of clearwater flooding throughout the site (BGS, 2017).

1.5.79 Ordnance Survey (2015c) does not show any apparent groundwater features (e.g. springs, issues) within the site, although there are some drains which may have been installed to intercept shallow groundwater from the alluvium.

Habitats and Vegetation

1.5.80 A detailed description of the habitats is provided in Appendix 7.1 Habitats and Botany Factual Report. A full NVC survey was not undertaken. A Phase 1 habitat map is presented in Figure A7.1.108 and Figure A7.1.115.

1.5.81 Much of the site was used as a golf course or playing fields, dominated by amenity grassland and woodland. Artificial drainage ditches are recorded as having swamp, tall-herb or inundation habitats. Some of the woodland was recorded as being wet woodland priority habitat. The flood storage areas in the northeast of the site was recorded to be a mixture of marshy grassland, with woodland, scrub and poor semi-improved grassland making up most of the rest of this part of the site.

1.5.82 Of the NVC plant communities identified, only one has a UKTAG groundwater dependency rating, MG10 *Holcus lanatus-Juncus effusus* rush pasture, of low to moderate dependency. MG10 is located within the flood storage area. The Phase 1 habitat mapping showed some other areas that are wetland. However, it is not possible to assess the degree of groundwater dependency based on the available survey results.

1.5.83 Table 8.3.23 lists the NVC types recorded at the site, alongside the groundwater dependency assigned by the UKTAG (2009) guidance. Figure A8.3.21 shows the distribution of groundwater dependency across the site.

**Table 8.3.23: UKTAG Derived Groundwater Dependency for Vegetation Encountered at Cove Brook and Ively Road**

| NVC Habitat Type* | Groundwater Dependency (according to UKTAG, 2009) |
|---|---|
| M25 | Low to moderate |
| MG5 | Not groundwater dependent |
| MG9 | Not groundwater dependent |
| MG10 | Low to moderate |
| U1 | Not groundwater dependent |

**Refer to Appendix 7.1 Annex G for full list of NVC names and sub-communities*

CSM

1.5.84 Year-round groundwater levels are not known and the timing of the monitoring, but winter groundwater levels seem to be relatively shallow (0.5 to 1.5mbgl). However, a notable surface water input has been identified and the area is a known floodplain and part of it is a designated flood storage area. The alluvium is likely to have some intergranular porosity to contain groundwater and would be expected to be in continuity with the surface water. With only a small outcrop, most recharge would be indirect from the Cove Brook.

1.5.85 A degree of groundwater contribution to the surface water would be expected where the Camberley Sand Formation outcrop ends, and the less permeable Windlesham Formation is present at the surface. Although the available mapping shows this to be outside of the site boundaries the 2018 GI may indicate that it outcrops over a wider extent.

1.5.86 The flood storage area is lower than the rest of the surrounding site, whilst the vegetation is notably different. Groundwater, particularly any perched water table within the alluvium, would be expected to be a lot closer to the ground surface in this area.

1.5.87 The assessment of the hydrogeological characteristics of the site suggest that there is likely to be a low to moderate groundwater dependency in the flood storage area, corroborating the UKTAG guidance for this part of the site. Despite the shallow groundwater recorded in BH29, the rest of the site is considered to have low groundwater dependency, partly due to the presence of amenity grassland removing wetland plant communities. It is possible that the swamp communities noted in the ditches could have a slightly higher groundwater dependency.

1.5.88 Figure A8.3.22 shows two conceptualised cross sections of the potential GWDTE, with Section A-A running through the golf course and Section B-B through the flood storage area.

Assessment of Effects

1.5.89 Due to the above differences across the site, the site has been divided into two sub-sites for the effect assessment:

- the flood storage area, located in the northeast of the site; and
- the former golf course, comprising the remainder of the west and south of the site.

1.5.90 Through the former golf course sub-site, the trench required to install the pipeline is expected to be located above the water table. There would therefore be no need for dewatering in this part of the Order Limits and no long-term flow disturbance as a result of the shallow pipeline. However, the A327 auger bore trenchless crossing would require launch and reception shafts which would be likely to intercept groundwater, with an anticipated radius of drawdown extending only 30m from the shaft (Appendix 8.2 Detailed Trenchless and Targeted Open Cut Assessments, Section 1.18). However, the parts of the site within this area have been identified as not having a groundwater dependency, and as such, there is not expected to be a direct or indirect effect. Similarly, as there is no shallow groundwater aquifer, and the bore is not expected to be more than a few metres deep, there is no risk of connecting two previously independent aquifers.

1.5.91 It is unclear if the trench required for installation of the pipeline would intercept the water table through the flood storage area sub-site. However, this remains a possibility and some degree of dewatering may be needed. Any dewatering would be likely to have only a localised effect on groundwater levels. There are small patches of potentially groundwater dependent habitat in proximity to the Order Limits in this sub-site, although most of the habitat is beyond expected influence of dewatering. Temporary dewatering would therefore have a small effect. Long term impact on flows is expected to be negligible.

1.5.92 Table 8.3.24 provides a summary of the magnitude of change from different potential effects groundwater flows supporting Cove Brook and Ively Road.

**Table 8.3.24: Summary of Groundwater Flow Effects on Cove Brook and Ively Road GWDTE**

| Sub-site | Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|---|
| Flood storage area | Low to moderate | SINC | Medium | Trench dewatering | Construction | Small |
| | | | | Flow interception | Operation | Negligible |
| Golf course | Low | None | Negligible | Trenchless crossing dewatering | Construction | None |
| | | | | Shaft dewatering | Construction | None |
| | | | | Flow interception | Operation | None |
| | | | | Connection of aquifers | Construction / operation | Negligible |

### Blackwater Valley Frimley Hatches

Site Setting, Topography and Hydrological Catchment

1.5.93 The Blackwater Valley Frimley Hatches site comprises a wide, flat valley bottom, with virtually no surface elevation variation within this part of the site. The River Blackwater is close to the western boundary inside the site, flowing from south to north. The site extends upslope to the east within the base of another small valley, extending up to an elevation of 70mAOD from 62mAOD in the base. The site forms part of the flood plain, as defined by the EA fluvial Flood Zone 3.

1.5.94 The hydrological catchment extends to the east and slightly to the west. The catchment beyond the site boundaries has been extensively urbanised, altering the natural processes. Open water makes up a considerable portion of the surface area, with a number of lakes present within the site.

1.5.95 The Order Limits cut across the northern end of the site, perpendicular to the River Blackwater. The Order Limits continue northeast at the base of the side valley. The pipeline would be installed using a trenchless crossing beneath the western part of the site.

Geology and Soils

1.5.96 The base of the Blackwater Valley is mapped as being on Fladbury soil assemblage, described as stoneless clayey, fine silty and fine loamy soils affected by groundwater. The side of the valley is on Swanwick soil assemblage, described as deep permeable coarse loamy and sandy soils some with peaty surface horizons affected by groundwater. The top of the side valley is on Holidays Hill soil assemblage, described as naturally very acid sandy over clayey soils and loamy over clayey soils, locally with humose or peaty surface horizons. There are slowly permeable subsoils and slight seasonal waterlogging. Holidays Hill also contains some very acid well-drained sandy soils, and some deep sandy soils, affected by groundwater with humose surface horizons (Cranfield University, 2018).

1.5.97 The site sits on alluvium overlying river terrace deposits (BGS, 2018f). The alluvium is recorded to comprise clay, silt, sand and gravel, whilst the River Terrace Deposits are sand and gravel. The bedrock beneath the superficials is the Camberley Sand Formation, comprising homogeneous sand.

1.5.98 A number of publicly available borehole records are available from the edges of the site (BGS, 2018a), and two boreholes (BH151 and BH152) have been completed as part of the 2018 GI. The results are presented in Table 8.3.25, whilst the locations are shown on Figure A8.3.23.

**Table 8.3.25: Borehole Log Records in Close Proximity to the Blackwater Valley Frimley Hatches Site**

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater Strikes (mbgl) |
|---|---|---|---|---|
| BH151 | 0.00 | 1.00 | Made ground | 1.40 and 3.18 |
| | 1.00 | 1.30 | Light bluish mottled dark brownish orange slightly gravelly slightly sandy clay. | |
| | 1.30 | 1.70 | Light orangish brown very gravelly sand. | |
| | 1.70 | 3.50 | Light bluish grey very gravelly sand. | |
| | 3.50 | 3.90 | Light grey clay. | |
| | 3.90 | 8.40 | Multicoloured sandy gravel. | |
| | 8.40 | 17.00 | Bluish grey silty clayey sand. | |
| | 17.00 | 20.28 | Dark bluish grey silt clayey sand. | |
| BH152 | 0.00 | 1.48 | Made Ground: dark brown gravelly clayey sand. | Not recorded |
| | 1.48 | 1.95 | Dark brown slightly sandy silty clay. | |
| | 1.95 | 2.20 | Light greenish grey slightly gravelly sand. | |
| | 2.20 | 3.94 | Light brown very gravelly sand. | |
| | 3.94 | 5.18 | Light orangish brown sand. | |
| | 5.18 | 17.20 | Greenish grey and light greyish green silty sand. | |
| SU85NE1 (BH1) | 0.00 | 1.75 | Sand with loam | 1.85 |
| | 1.75 | 2.62 | Light grey sand | |
| | 2.62 | 2.90 | Peat | |
| | 2.90 | 3.96 | Dark grey sand | |
| | 3.96 | 5.00 | Gravel with some sand | |
| | 5.00 | 5.18 | Green sand and gravel | |
| | 5.18 | 6.15 | Green sand | |
| SU85NE1 (BH2) | 0.00 | 0.91 | Sandy top soil | 2.21 |
| | 0.91 | 1.22 | Orange sand | |
| | 1.22 | 2.57 | Light grey sand | |
| | 2.57 | 2.84 | Peat | |

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater Strikes (mbgl) |
|---|---|---|---|---|
| | 2.84 | 3.73 | Dark grey sand | |
| | 3.73 | 4.19 | Grey sand and gravel | |
| | 4.19 | 5.94 | Green sand and gravel | |
| | 5.94 | 6.40 | Green sand | |
| SU85NE99 | 0.00 | 0.30 | Loamy top soil | 2.50 |
| | 0.30 | 4.90 | Sandy gravel | |
| | 4.90 | 6.50 | 'Clayey' sand | |
| SU85NE117 | 0.00 | 0.30 | Vegetation soil | Struck: 1.83<br>Standing: 0.46 |
| | 1.30 | 0.91 | Brown loamy soil | |
| | 0.91 | 1.83 | Grey loamy sand | |
| | 1.83 | 3.96 | Grey ballast | |
| | 3.96 | 6.71 | Grey sandy ballast | |
| | 6.71 | 8.84 | Brown ballast and sand | |
| | 8.84 | 10.06 | Green loamy sand | |
| SU85NE118 | 0.00 | 0.30 | Vegetation soil | Struck: 2.29<br>Standing: 0.46 |
| | 0.30 | 0.91 | Brown loamy clay | |
| | 0.91 | 1.83 | Grey loamy sand | |
| | 1.83 | 3.96 | Grey sandy ballast | |
| | 3.96 | 5.18 | Grey sharp sand | |
| | 5.18 | 5.79 | Grey ballast and sand | |
| | 5.79 | 7.01 | Green loamy sand | |
| SU85NE53 | 0.00 | 0.46 | Topsoil and roots | Struck: 1.83<br>Standing: 0.91 |
| | 0.46 | 1.22 | Brown silty sandy clay | |
| | 1.22 | 3.96 | Sand and gravel | |
| | 3.96 | 6.71 | Grey green silty fine sand | |
| SU85NE52 | 0.00 | 0.46 | Made Ground | 2.29 |
| | 0.46 | 1.83 | Grey green silty clayey fine sand | |
| | 1.83 | 5.18 | Brown sand and fine to medium gravel | |
| | 5.18 | 6.55 | Grey green silty fine sand | |

1.5.99 BH151 indicates that there could be relatively thick clay alluvium deposits in the east of the site over the River Terrace Deposits, whilst BH152 indicates thinner alluvium in the west. Both boreholes show deep gravelly deposits, assumed to be the River Terrace Deposits. They also recorded what is likely the Windlesham Formation below the base of the Camberley Sand Formation. This means the Camberley Sand Formation could be of relatively limited thickness beneath the site.

1.5.100 The River Terrace Deposits have been historically quarried for aggregate and have subsequently been restored to open water gravel lakes. This is recorded as worked ground – void (BGS, 2018f). Mineral workings are understood to be 3.5m deep, and so are unlikely to have removed the full thickness of the gravel aquifer.

1.5.101 Part of the site is recorded as a historical landfill by the EA (2018). This does not align spatially with the artificial deposits dataset. The landfill was used for the deposition of silty spoil from the construction of the link road. Although it cannot be confirmed, it is unlikely that there is an engineered lining to landfill. In addition, it is also understood from the landowner that the northern pits were used as a silt trap during the construction of the road.

Groundwater

1.5.102 Groundwater has been recorded in the available borehole records at relatively shallow depths (<2.5mbgl). Monitoring in BH151 shows water levels up to 1.2mbgl in the River Terrace Deposits. No monitoring data are yet available from BH152.

1.5.103 The southern end of the site has the potential for groundwater flooding at the surface. The susceptibility reduces going north through the site, such that in the vicinity of the Order Limits there is only a limited potential for groundwater flooding (BGS, 2017).

1.5.104 Only Frimley Hatches Pits 1 and 3 are identified in available mapping to have a surface water inflow that would support water levels, whilst only Pit 1 has a mapped outflow (Ordnance Survey, 2018a). The gravel pit lakes within the site are therefore assumed to be groundwater fed and are considered an expression of groundwater levels within the superficial deposits. This would indicate that water levels are around 62mAOD and falling slightly towards the north of the site. This aligns with the only groundwater strike to be recorded against Ordnance datum (62.6mAOD – located upslope on the valley sides), as well as the groundwater monitoring at BH151.

1.5.105 A site walkover was undertaken on 21 November 2018 to clarify the relationship between the different gravel pit lakes, the River Blackwater and any other surface water feature. An additional inflow was identified from a drain to the northeast, as well as an outflow into a backchannel of the River Blackwater. No linkage was observed between the main pits (1–5) and the surface water features in the north of the site.

Habitats and Vegetation

1.5.106 A detailed description of the habitats is provided in Appendix 7.1 Habitats and Botany Factual Report. An NVC survey was not undertaken. A Phase 1 of the main valley habitat map is presented in Figure A7.1.127, and the eastern side valley in Figure A7.1.133.

1.5.107 The habitats within the base of the main valley in the west of the site are dominated by broadleaved woodland, most of which comprises wet woodland and large bodies of standing water. In the north of the site, a large area of infilled former gravel working has been colonised by reedbed and wet woodland, including W1 *Salix cinerea – Galium palustre* woodland, and W6 *Alnus glutinosa – Urtica dioica* woodland, which UKTAG guidance classes as having moderate and low groundwater dependencies respectively.

1.5.108 The eastern side valley comprises mostly semi-natural deciduous woodland and amenity grassland. The woodland includes one part mapped as wet woodland priority habitat. The information available from vegetation mapping is insufficient to derive a likely groundwater dependency.

1.5.109 Table 8.3.26 lists the NVC types recorded at the site, alongside the groundwater dependency assigned by the UKTAG (2009) guidance. Figure A8.3.23 shows the distribution of guideline groundwater dependencies across the site.

**Table 8.3.26: UKTAG Derived Groundwater Dependency for Vegetation Encountered at Blackwater Valley Frimley Hatches**

| NVC Habitat Type* | Groundwater Dependency (according to UKTAG, 2009) |
|---|---|
| M23 | High to moderate |
| MG1 | Not groundwater dependent |
| A9 | Not groundwater dependent |
| MG5 | Low to moderate |
| W1 | Moderate |
| W6 | Low |
| W10 | Not groundwater dependent |
| W16 | Not groundwater dependent |

**Refer to Appendix 7.1 Annex G for full list of NVC names and sub-communities*

CSM

1.5.110 Groundwater is expected to flow towards the centre of the valley, providing a baseflow component to the River Blackwater. The partial backfilling of the former gravel workings by silty spoil is expected to restrict the ability of groundwater to flow through part of the site. However, the effect of this would be limited by the presence of remnant gravels beneath the silt.

1.5.111 As described above, the southern lakes are understood to be heavily groundwater fed with limited surface water input. However, the silty build-up and landfill at the base of the more northerly lakes are expected to restrict the degree of interaction between surface waters and groundwater, even if a degree of groundwater input remains likely.

1.5.112 Whilst the landfill material is primarily made up of silts from either gravel workings or the construction of the adjacent relief road, it is possible that this also contains unauthorised inert wastes that may be contaminated (Appendix 11.1 Soils and Geology Supporting Information, Annex B). Such wastes may already be impacting the water quality within the potential GWDTE.

1.5.113 The habitats that are reliant on the presence of the lakes (e.g. reedbeds) are considered to be moderately groundwater dependent due to the mixed input sources into the lakes, confirming the UKTAG rating. Similarly, the wet ground around the rest of the site is also expected to be moderately groundwater dependent.

1.5.114 The eastern valley extends beyond the mapped limits of the River Terrace Deposits that are supporting potential GWDTE within the base of the Blackwater Valley. Additionally, the higher ground level is expected to result in a deeper water table

within the Camberley Sand Formation bedrock, although the absence of any boreholes in this part of the site mean this is not possible to confirm. As such, the potential GWDTE in this part of the site are considered to have at most a low groundwater dependency.

1.5.115 Figure A8.3.24 shows three conceptualised cross sections of the potential GWDTE, running parallel and perpendicular to the Order Limits within the base of the Blackwater Valley, and a third crossing perpendicular to the Order Limits in the eastern side valley.

Assessment of Effects

1.5.116 Due to the above differences across the site, the site has been divided into two sub-sites for the effect assessment:

- Frimley Hatches, comprising the main Blackwater Valley and the fishery lakes; and
- Frimley Green, comprising the side valley extending to the northeast.

1.5.117 The pipeline would be installed by trenchless crossing through the Frimley Hatches sub-site. The preferred technique is still to be confirmed, and as such, the augur bore method is assessed as the worst case scenario from a dewatering aspect (Appendix 8.2 Detailed Trenchless and Targeted Open Cut Assessments, Section 1.24). This construction method would likely place the bore at the base of the River Terrace Deposits or top of the Camberley Sand Formation, depending on the exact relation between the bedrock and superficials.

1.5.118 The launch and reception shafts for the trenchless crossing would be expected to be below the water table and require dewatering, associated with an estimated radius of influence of approximately 125m. This drawdown would be a temporary effect over much of the western part of the site, although the silty surface layers are expected to limit the loss of water from the wetland. No long term impact on flows is expected.

1.5.119 The superficial River Terrace Deposits and the bedrock Camberley Sand Formation are both high permeability clastic aquifers and are therefore likely to be in continuity. Therefore, there is no major concern in connecting two previously disconnected aquifers during the construction of a trenchless crossing resulting in either a change in water quality or loss of water from the shallow groundwater system.

1.5.120 It is unclear if the trench required for installation of the pipeline would intercept the water table through the Frimley Green sub-site. However, this remains a possibility and some degree of dewatering may be needed. Any dewatering would likely have only a localised effect on groundwater levels. Given the low groundwater dependency of this sub-site, temporary dewatering would therefore have a negligible effect.

1.5.121 Table 8.3.27 provides a summary of the magnitude of change from different potential effects groundwater flow supporting Blackwater Valley Frimley Hatches.

**Table 8.3.27: Summary of Groundwater Flow Effects on Blackwater Valley Frimley Hatches GWDTE**

| Sub-site | Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|---|
| Blackwater Valley – Frimley Hatches | Moderate | SINC | Medium | Trenchless crossing dewatering | Construction | None |
| | | | | Shaft dewatering | Construction | Small |
| | | | | Flow interception | Operation | None |
| | | | | Connection of aquifers | Construction / operation | Negligible |
| Blackwater Valley – Frimley Green | Low | None | Negligible | Trench dewatering | Construction | Negligible |
| | | | | Flow interception | Operation | Negligible |

### Colony Bog and Bagshot Heath

Site Setting, Topography and Hydrological Catchment

1.5.122 The Colony Bog and Bagshot Heath SSSI, a component of Thames Basin Heaths SPA is divided into a number of units, with the Order Limits crossing the following: Chobham Ridges (Unit 9) in the west, Folly Bog (Unit 4) towards the northern central part of the SSSI and Turf Hill (Unit 5) in the east (Natural England, 2018). The bulk of the SSSI site comprises the Colony Bog unit (Unit 10), although the Order Limits do not cross it. The other units of the SSSI are to the south and distant from the Order Limits.

1.5.123 The SSSI site shows a large variation in the ground elevation, falling from 120mAOD in the west to 50mAOD in the east of the site. There are three east–west trending parallel valleys, with some subordinate smaller valleys, within the site.

1.5.124 The western boundary of the site (Chobham Ridges) forms the edge of the hydrological catchment, being coincident with a major topographic divide. Surface water flows exit the site towards the east, forming the headwaters of Trulley Brook and the Bourne.

1.5.125 The Order Limits follow the western and northern boundaries of the site. This places them at the higher points in the site.

1.5.126 At the site, dry and wet heath grade into valley mire in hollows and valley bottoms, supporting a diversity of wetland vascular plants and bryophytes, and many county rarities.

1.5.127 The only area of valley mire near the Order Limits is Folly Bog (SSSI Unit 4) (Department for Environment, Food and Rural Affairs ‘Defra’, 2018). This is located on the northern boundary of the Colony Bog and Bagshot Heath SSSI, a component of Thames Basin Heaths SPA. Ground elevations fall to between 55 and 60mAOD in this area, and the Order Limits are closer to the likely groundwater level. Therefore, Folly Bog is the main potential GWDTE part of the Colony Bog and

Bagshot Heath SSSI site to be potentially impacted. As previously indicated, Folly Bog has been considered separately from the rest of the site and is presented in a separate section below.

Geology and Soils

1.5.128 Soil mapping (Cranfield University, 2018) indicates the presence of the following soil associations:

- Wickham 3 – Slowly permeable seasonally waterlogged fine loamy over clayey and coarse loamy over clayey soils and similar more permeable soils with slight waterlogging. Some deep coarse loamy soils affected by groundwater. Landslips with irregular terrain locally.
- Holidays Hill – Naturally very acid sandy over clayey and loamy over clayey soils locally with humose or peaty surface horizons, slowly permeable subsoils and slight seasonal waterlogging. Some very acid well-drained sandy soils, and some deep sandy soils, affected by groundwater with humose surface horizons.
- Adventurers' 2 – Deep peat soils over variable subsoils, usually sandy sometimes gravelly. Sandy soils with a peaty or humose surface horizon. Complex soil patterns locally. Flat land. Groundwater levels controlled by ditches and pumps. Risk of wind erosion.
- Swanwick – Deep permeable coarse loamy and sandy soils some with peaty surface horizons affected by groundwater. Groundwater affects the principal soils causing extended and often severe waterlogging for long periods in winter.

1.5.129 River Terrace Deposits are recorded on the higher ground in the west and northwest of the site. Head deposits are recorded in the upper reaches of the parallel valleys, with alluvium lower down the valleys, mostly where streams are also recorded. One area of peat is recorded inside the site, associated with Hagthorn Bog in Unit 10 of the SSSI (Figure A8.3.25) (BGS, 2018f; 2018g).

1.5.130 River Terrace Deposits are comprised of gravel with subordinate sands. Alluvium typically comprises heterogeneous deposits of clay, silt, sand and gravel in varying proportion. Head deposits comprise gravel, sand and clay depending on upslope source and distance from the source. They are usually poorly sorted and poorly stratified.

1.5.131 In the western third of the site, the superficial deposits are recorded to be underlain by bedrock of the Camberley Sand Formation, changing to the Windlesham Formation in the centre of the site at Folly Bog before moving back into the Camberley Sand Formation in the east (the Turf Hill area of the site).

1.5.132 The publicly available borehole logs are all located around the edges of the site as shown on Figure A8.3.25 (BGS, 2018a), due to the presence of historic unexploded ordnance risk in the middle of the site. BH39 from the 2018 GI is also located just outside the site boundaries. This makes it difficult to verify the accuracy of the mapping over the centre of the site (Colony Bog sub-unit). The available logs are presented in Table 8.3.28.

**Table 8.3.28: Borehole Log Records in Proximity to Colony Bog and Bagshot Heath**

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater Strike |
|---|---|---|---|---|
| SU95NW11 | 0.00 | 6.00 | River Terrace Deposits (Ninth Terrace) – 'Clayey' gravel | 2.00mbgl |
| | 6.00 | 9.00 | Barton Beds – 'Very clayey' sand | |
| SU96SW34 | 0.00 | 1.80 | River Terrace Deposits (Tenth Terrace) – 'Very clayey' gravel | Not struck |
| | 1.80 | 4.80 | Barton Beds – 'Very clayey' sand | |
| SU96SW99 | 0.00 | 1.91 | Clayey coarse sand with small amount of gravel | Not struck |
| | 1.91 | 4.57 | Fine to medium sand | |
| SU96SW98 | 0.00 | 0.15 | Topsoil | Not struck |
| | 0.15 | 1.22 | Brown and grey mottled silty fine sand | |
| | 1.22 | 1.52 | Reddish brown silty fine sand | |
| SU96SW91 | 0.00 | 0.38 | Brown sandy topsoil | Not struck |
| | 0.38 | 0.53 | Black sandy peaty clay | |
| | 0.53 | 1.22 | Dark brown fine sand with small amount of gravel | |
| | 1.22 | 1.52 | Light brown silty fine sand | |
| SU96SW92 | 0.00 | 0.30 | Black peaty topsoil | Not struck |
| | 0.30 | 3.05 | Reddish brown silty medium sand with fine to medium gravel | |
| SU96SW35 | 0.00 | 3.20 | Downwash Gravel – 'Clayey' sandy gravel.<br>Topmost 1.0m with peaty soil | Not struck |
| | 3.20 | 6.20 | Barton Beds 'Clayey' sand | |
| SU96SW108 | 0.00 | 0.15 | Dark brown sandy topsoil | Not struck |
| | 0.15 | 2.43 | Brown fine to medium sand | |
| SU96SW102 | 0.0 | 0.30 | Dark brown sandy topsoil with gravel | Groundwater first encountered at 2.1mbgl |
| | 0.30 | 4.57 | Brown silty fine sand | |
| SU96SW103 | 0.00 | 0.71 | Brown sandy topsoil with gravel | Groundwater first encountered at 2.1mbgl |
| | 0.71 | 2.00 | Brown fine to medium sand | |
| | 2.00 | 2.90 | Firm mottled brown and grey clay with traces of fine sand | |
| | 2.90 | 4.72 | Rounded medium and coarse gravel with brown silty fine sand | |
| | 4.72 | 6.40 | Dark green sandy silt | |
| BH39 | 0.00 | 0.30 | Dark brown sand (topsoil). | None observed due to drill flush. |
| | 0.30 | 1.00 | Light orange slightly gravelly sand. | |
| | 1.00 | 1.60 | Light green and orange slightly clayey sand. | |

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater Strike |
|---|---|---|---|---|
| | 1.60 | 1.80 | Light grey light pink clay. | |
| | 1.80 | 2.30 | Light orange light grey clayey sand. | |
| | 2.30 | 3.90 | Light grey light orange clay. | |
| | 3.90 | 4.80 | Dark grey slightly sandy clay. | |
| | 4.80 | 5.80 | Dark grey slightly clayey sand. | |
| | 5.80 | 7.10 | Dark grey slightly clayey sand. | |
| | 7.10 | 9.30 | Dark grey clayey sand. | |
| | 9.30 | 10.70 | Dark greenish grey sandy clay. | |
| | 10.70 | 12.10 | Dark greenish grey sand. | |
| | 12.10 | 12.50 | Dark greyish green very sandy clay. | |
| | 12.50 | 15.72 | Dark greyish green slightly clayey sand. | |

1.5.133 The boreholes have verified the presence of River Terrace Deposits around the edges of the site, as well as some minor Head deposits. They also indicate that there may be organic-rich soils within the site. The deeper boreholes have also confirmed the bedrock deposits comprising silty and clayey sand deposits.

1.5.134 No additional boreholes from the 2018 GI are available in vicinity of the site.

Groundwater

1.5.135 Ordnance Survey (2015c; 2015d) mapping shows a large number of springs, issues and collects across the site, focused in the bases of the valleys in the Colony Bog sub-unit as shown in Figure A8.3.25. Closer to the Order Limits, no springs are shown.

1.5.136 There is only limited potential for groundwater flooding to occur across most of the site. Two very small areas in the east in the Turf Hill sub-unit show that there is potential for groundwater flooding of below ground structures associated with slightly lower ground (BGS, 2017).

1.5.137 Borehole logs do not generally record any water along the Order Limits (BGS, 2018a). However, these boreholes are all relatively shallow and located on the higher ground around the edges of the site, where groundwater would be anticipated to be deeper. In the east, in Unit 5 of the SSSI, groundwater is likely to be shallower as identified by two small areas where there is susceptibility to groundwater flooding of below ground structures. BGS borehole log data shows recorded groundwater levels at just over 2m below ground level.

1.5.138 Groundwater strikes were not recorded in BH39 due to the use of drilling fluid. Subsequent groundwater monitoring indicates that water levels are around 3.5mbgl, although these only cover a winter period.

1.5.139 No hydrogeological walkover of Colony Bog and Bagshot Heath has been undertaken to confirm the presence of identified groundwater features such as

springs as all these features are distant from the Order Limits and on inaccessible land.

Habitats and Vegetation

1.5.140 Due to the distance between the Order Limits and the centre of the site, which is inaccessible MoD land, only habitats around the edge of the site immediately adjacent to the Order Limits have been surveyed. Folly Bog was surveyed in more detail, and the results are discussed separately. Descriptions of the habitats and vegetation are provided in Appendix 7.1 Habitats and Botany Factual Report. Habitat and vegetation plans are provided in Figures A7.1.146 and A7.1.149, respectively.

1.5.141 The habitat survey mostly recorded plantation woodland, with thin strips of grassland. The majority of the grassland was dry, with one small strip of potential wet grassland (M25b *Molinia caerulea-Potentilla erecta* mire, *Anthoxanthum odoratum* sub-community) mapped. However, this area was observed to not be wet and it can be found in many situations, even on quite dry sandy soils.

1.5.142 In the eastern area (Turf Hill sub-unit), the vegetation is described mainly as non-groundwater dependent (coniferous woodland), although two areas of potential GWDTE vegetation were recorded adjacent to the Order Limits (M16a and M25a NVC classification).

1.5.143 Figure A8.3.25 shows the distribution of guideline groundwater dependencies across the site based on the mapping produced for the project.

1.5.144 The site was designated an SSSI on the basis of the wet and dry heaths grading into valley mires in topographic lows (Natural England, 2018). The western boundary of the site in particular is noted as being an area of dry heath. Wet heath and valley mire have the potential to be groundwater dependent, although this information on its own is insufficient to confirm groundwater dependency. According to the UKTAG guidance, several of the notified plant communities cited by Natural England (2018) for the whole SSSI would have groundwater dependency as follows:

- M2 *Sphagnum cuspidatum/recurvum* bog pool community (moderate to low groundwater dependency);
- M6 *Carex echinata-Sphagnum recurvum/auriculatum* mire (high to moderate groundwater dependency);
- M14 *Schoenus nigricans-Narthecium ossifragum* valley mire (high groundwater dependency);
- M16 *Erica tetralix-Sphagnum compactum* wet heath (high to moderate groundwater dependency);
- M21 *Narthecium ossifragum-Sphagnum papillosum* valley mire (high to moderate groundwater dependency);
- M23 *Juncus effusus/acutiflorus-Galium palustre* rush pasture (high to moderate groundwater dependency);

- M24 *Molinia caerulea-Cirsium dissectum* fen meadow (high groundwater dependency);
- M25 *Molinia caerulea-Potentilla erecta* mire (moderate to low groundwater dependency);
- W4 *Betula pubescens-Molinia caerulea* woodland (high to moderate groundwater dependency); and
- W5 *Alnus glutinosa-Carex paniculata* woodland (high to moderate groundwater dependency).

1.5.145 There is also priority habitat mapping which shows areas of Lowland Fen within the site, i.e. the location of valley mire.

CSM

1.5.146 Due to topographical changes and associated transition from the Camberley Sand Formation to the Windlesham Formation from west to east, springs and areas of seepage are present in the west of the site. These are formed where groundwater emerges along the boundary of the more permeable Camberley Sand Formation and the less permeable Windlesham Formation. The recharge catchment for these springs comprises the topographically elevated areas to the west and north. Peaty deposits have built up in the areas around the seepages, particularly where the discharges correspond to areas of the Head deposits.

1.5.147 The parts of the site where habitats and vegetation have been surveyed as part of this assessment are generally rated as having low or no groundwater dependence according to UKTAG guidance. With a thick unsaturated zone identified beneath the Chobham Ridges and to the west of the Folly Bog Unit, no groundwater dependency is expected along most of the Order Limits.

1.5.148 In the eastern area (Turf Hill Unit), the two areas of groundwater dependent vegetation are in areas where the ground is slightly lower and groundwater would be closer to the ground surface. The vegetation classified by UKTAG guidance in the Turf Hill sub-unit is considered to be of moderate groundwater dependency. This is due to the nature of the superficial deposits which are of moderate permeability, and also the identified groundwater level data.

1.5.149 No habitat survey has been undertaken in the central area of the site due to restricted site access. Therefore, the UKTAG guidance cannot be applied. However, with the presence of many springs and seepages, the notified plant species (many of which are likely to have high groundwater dependency) as well as peaty type deposits, there is considered to be a high groundwater dependency in the middle of the site (Colony Bog sub-unit).

1.5.150 Figure A8.3.26 shows two conceptualised cross sections of the GWDTE, running approximately from northwest to southeast and west to east across the Chobham Ridges and Colony Bog Unit 10, and a third running approximately northwest to southeast across the Turf Hill unit.

Assessment of Effects

1.5.151 Due to the differences in groundwater dependence across the site, the site has been divided into three sub-sites (excluding Folly Bog) for the effect assessment:

- 'West and North Order Limits', comprising the Order Limits and the land immediately adjacent to the west and north (Chobham Ridges and to the west of Folly Bog units);
- 'Turf Hill' comprising the Order Limits and the land immediately adjacent in the east; and
- 'Centre of Site', comprising the land south and down gradient of the Order Limits (principally the Colony Bog Unit 10).

1.5.152 During construction, the trench required to install the pipeline running along the western and northwestern boundaries is expected to be located above the water table. Therefore, it is unlikely that dewatering would be required during construction. The pipeline is expected to have no direct or indirect effect on the groundwater flow supporting the GWDTE during installation or operation in the 'Centre of Site' and 'West and North Order Limits' sub-sites.

1.5.153 For Turf Hill (further to the east), where BGS logs show groundwater to be around 2m deep, it is possible that if the trench was excavated at times of high groundwater levels, groundwater could be encountered. However, the Order Limits themselves do not pass through the areas of groundwater dependent vegetation. Based on the anticipated groundwater flow direction, parts of the Order Limits along the northern boundary of the sub-site and all of the other areas would be up hydraulic gradient of the areas of groundwater dependent vegetation. As a result, effects during construction and operation are expected to be negligible on groundwater flow.

1.5.154 Table 8.3.29 provides a summary of the magnitude of change from different potential effects on groundwater flows supporting the Colony Bog and Bagshot Heath sub-sites.

**Table 8.3.29: Summary of Groundwater Flow Effects on Colony Bog and Bagshot Heath GWDTE**

| Sub-site | Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|---|
| West and North Order Limits | Low | SPA, Special Area of Conservation (SAC), SSSI | Medium | Trench dewatering | Construction | None |
| | | | | Flow interception | Operation | None |
| Turf Hill | Moderate | SPA, SAC, SSSI | High | Trench dewatering | Construction | Negligible |
| | | | | Flow interception | Operation | Negligible |
| Centre of Site | High | SPA, SAC, SSSI | High | Trench dewatering | Construction | None |
| | | | | Flow interception | Operation | None |

### Folly Bog

Site Setting, Topography and Hydrological Catchment

1.5.155 Folly Bog is an area within Unit 4 of the Colony Bog and Bagshot Heath SSSI. The wider Colony Bog and Bagshot Heath SSSI is discussed separately above. This section considers the Folly Bog area of the SSSI. Folly Bog is identified as a valley mire in the SSSI citation (Natural England, 2018).

1.5.156 Whilst not having a clearly defined boundary, the area considered as the Folly Bog site for this assessment comprises the area of flat, wet ground to the south of the Order Limits, adjacent to the point where the Order Limits move into Red Road and centred at NGR 492510, 161339. Whilst the land is owned by the MoD, much of Folly Bog is publicly accessible. However, a MoD security fence runs through the site in an east–west direction, and the area to the south of the fence is not accessible. An MoD perimeter access track runs along the site's northern and eastern boundary. A drainage outlet flows under the perimeter track in the east, via two pipes, each approximately 30cm in diameter.

1.5.157 Folly Bog is relatively level, with ground levels falling very gently to the east from around 62mAOD to 54mAOD at the drainage outlet for the site. To the immediate north of the wetland, the ground levels rise steeply to the SSSI's perimeter track. For much of the length, the perimeter track in which the pipeline may be installed is around 10m higher than the rest of the site. However, towards the eastern end of the Order Limits through the SSSI (before the Order Limits move into Red Road) the level of the track is observed to be close (within 1m) to the level of the wetland.

1.5.158 To the west of Folly Bog, the land rises steeply with the elevation of the Colony Bog and Bagshot Heath SSSI, a component of Thames Basin Heaths SPA, being over 120mAOD on its western boundary at Chobham Ridges. This provides a surface water catchment boundary for the site. However, no surface water features are mapped as flowing into Folly Bog from this direction. Ordnance Survey (2018a) mapping shows collects to the north of the MoD security fence, with a watercourse running from this through Folly Bog and discharging on the site's eastern boundary via two pipes which run under the perimeter track. Historical maps (Old-Maps, 2018) show this watercourse rises from a spring on the land to the south of the security fence. On-site observations and historical maps would suggest that the watercourse has been artificially modified by being straightened.

1.5.159 On-site observations, including consideration of the vegetation type, would indicate that there is a very shallow watershed within the site running broadly east–west to the south of the marked drain. The watershed is reflected in the vegetation with the flow routes picked out by the M14 vegetation.

1.5.160 Within the wider Colony Bog and Bagshot Heath SSSI, a component of Thames Basin Heaths SPA, the system is characterised by a spring line which originates from the junction of the Camberley Sands Formation and lower permeability Windlesham Formation. The springs form a series of drains and streams which flow in a generally west to east direction.

Geology and Soils

1.5.161 The published soil map (Cranfield University, 2018) indicates the presence of the following soil associations in the vicinity of Folly Bog:

- Wickham 3 – Slowly permeable seasonally waterlogged fine loamy over clayey and coarse loamy over clayey soils and similar more permeable soils with slight waterlogging. Some deep coarse loamy soils affected by groundwater. Landslips with irregular terrain locally.
- Holidays Hill – Naturally very acid sandy over clayey and loamy over clayey soils locally with humose or peaty surface horizons, slowly permeable subsoils and slight seasonal waterlogging. Some very acid well-drained sandy soils, and some deep sandy soils, affected by groundwater with humose surface horizons.
- Adventurers' 2 – Deep peat soils over variable subsoils, usually sandy sometimes gravelly. Sandy soils with a peaty or humose surface horizon. Complex soil patterns locally. Flat land. Groundwater levels controlled by ditches and pumps. Risk of wind erosion.

1.5.162 Within Folly Bog itself, there is the presence of alluvium (sand, silt and clay) and sand and gravel or diamicton Head deposits (BGS, 2018g). The alluvium is shown to be associated with the drainage ditch that passes through the site. No peat deposits are shown on the geology map for Folly Bog.

1.5.163 Camberley Sand Formation is present to the western end of Folly Bog with the Windlesham Formation in the eastern part of the site (BGS, 2018g). The Camberley Sand is described as a fairly uniform sequence of homogeneous, yellow-brown, silty fine-grained sand, or sandy silt, with some ironstone concretions and masses of white sandstone. The Windlesham Formation is described as clay, silt and sand and is generally of low permeability.

1.5.164 Given the few borehole logs in the vicinity of Folly Bog and that the Order Limits pass close to the site (BGS, 2018a), hand coring was undertaken to understand the depth to groundwater and variation in the permeability of the superficial deposits which may play a role in groundwater flow patterns. The hand coring survey was undertaken on 9 October 2018 in the vicinity of the Order Limits and assessed the shallow deposits in three areas along transects from the Order Limits into Folly Bog. This included a transect into the site from the point where the perimeter track is close to the level of the site (Figure A8.3.27).

1.5.165 The deposits recorded in the BGS logs and soil cores generally agree with the information shown on the BGS (2018g) map, generally showing a clayey sand with occasional flint gravel. However, peat deposits were encountered at a small number of locations, at borehole SU96SW94 and in soil cores FB2, FB3, FB4 and FB8. At the locations where peat was recorded, the thickest deposit was identified in FB3 at around 62cm. At this location, the peat was underlain by a blue clayey sand.

1.5.166 Figure A8.3.27 shows the location of boreholes and hand coring points, and Table 8.3.30 and Table 8.3.31 records the soils and superficial geology encountered at these points.

**Table 8.3.30: BGS Borehole Logs in Proximity to the Folly Bog Site**

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater Strike |
|---|---|---|---|---|
| SU96SW93 | 0.00 | 0.3 | Topsoil. | Dry |
| | 0.3 | 1.1 | Dark brown clayey fine to medium sand. | |
| | 1.1 | 1.5 | Mottled grey and brown fine to medium sand. | |
| SU96SW94 | 0.0 | 0.6 | Black peaty topsoil. | 1.4m |
| | 0.6 | 1.5 | Medium to coarse gravel with green medium sand. | |
| SU96SW94A | 0.0 | 0.2 | Dark brown peaty topsoil | 1.1m |
| | 0.2 | 2.4 | Very dense yellowish brown fine sand with fine to medium gravel. | |
| | 2.4 | 6.1 | Dense light brown fine o medium sand. | |
| SU96SW95 | 0.0 | 0.2 | Soft peaty topsoil | Dry |
| | 0.2 | 0.9 | Medium to coarse gravel with green medium sand. | |
| | 0.9 | 1.5 | Pale green fine to medium sand | |

**Table 8.3.31: Hand Coring Geological Recording from Folly Bog**

| Hand Coring Ref. | Top (cm) | Base (cm) | Description | Field Notes |
|---|---|---|---|---|
| FB1 | 0 | 45 | Dark brown, speckled light grey, clayey sand with many roots and rootlets. | Dry |
| | 45 | 55 | White, fine sand. Diffuse boundary. | Dry |
| | 55 | 80 | Orange, medium to fine sand. Becomes clayey with depth. Distinct boundary. | Damp |
| | 80 | 87 | Dark brown clay with partially decomposed woody matter. Distinct boundary. | Damp |
| | 87 | 140 | Bluish, greenish grey clayey fine sand. Increasing clay content with depth. Becomes greyish blue. | Wet. Saturated at 130cm. Potentially standing water. |
| FB2 | 0 | 10 | Dark brown sandy silt becoming peat. Many roots of various sizes. Distinct boundary. | Dry |
| | 10 | 33 | Orangish brown silty fine sand with abundant roots. Gradual boundary. | Moist |
| | 33 | 90 | Greyish brown fine to medium clayey sand. Becomes sandy clay. Becomes mottled black. Some woody fragments. Distinct boundary. | Damp, becoming wet |
| | 90 | 125 | Greyish green very clayey sand. Becomes bluish green, very sandy clay. | Wet |
| FB3 | 0 | 10 | Reddish brown silty sandy clay with abundant roots. Gradual boundary. | Dry |
| | 10 | 72 | Clayey peat. Dark brownish black clay with abundant roots and woody debris, partially decomposed. Distinct boundary. | Wet |

| Hand Coring Ref. | Top (cm) | Base (cm) | Description | Field Notes |
|---|---|---|---|---|
| | 72 | 100 | Blue fine to medium clayey sand. | Wet |
| FB4 | 0 | 30 | Topsoil over fibrous peat. | Becomes wet |
| | 30 | 95 | Bluish grey clayey fine to medium sand with some woody debris. At 85cm becomes slightly gravelly with gravel of flint. Becoming gravellier with depth. | Water standing at 24cm |
| FB5 | 0 | 18 | Loose, dark brown speckled pale grey very sandy silt with many roots and some woody material. | Dry |
| | 18 | 45 | Pale brownish grey fine to medium sand. Distinct boundary. | Dry |
| | 45 | 60 | Dark brown stiff clayey fine sand. Brittle. Gradual boundary. | |
| | 60 | 95 | Pale brownish grey fine to medium sand. Distinct boundary. | Moist |
| | 95 | 110 | Dark reddish brown clay (peaty). Many medium to coarse partially decomposed organic woody fragments. Indistinct boundary. | Damp |
| | 110 | 140 | Greenish grey clayey medium sand. Becomes very clayey. Few faint brown mottles. Occasional woody debris. Becomes greyish brown, mottled grey. | Very damp, becoming wet |
| | 140 | 145 | Bluish green very sandy clay. | Wet |
| FB6 | 0 | 20 | Dark brown speckled pale grey slightly silty clayey sand. Abundant roots | Dry |
| | 20 | 90 | Pale yellowish brown, fine to medium sand. Becoming yellowish brown, then greyish brown. Diffuse boundary. | Damp |
| | 90 | 130 | Brownish grey, very sandy clay. Contains orange woody fragments. | Very damp, becoming wet |
| | 130 | 133 | Greenish blue, clayey sand. | Wet. Standing water at 100cm |
| FB7 | 0 | 12 | Brown, silty clayey sand with many roots. | Dry |
| | 12 | 40 | Purplish grey, fine sand with occasional coarse gravel of flint. Abrupt boundary. | Dry |
| | 40 | 60 | Brownish orange fine sand with frequent fine to coarse gravel of flint. | Dry |
| FB8 | 0 | 18 | Black, speckled orange, silty clay with abundant roots and organic woody debris (peaty). Abrupt boundary. | Dry |
| | 18 | 42 | Pale yellowish grey mottled orange fine to medium sand with many fine to medium gravel of flint. Abrupt boundary. | Slightly damp |
| | 42 | 50 | Orange, very sandy soft clay. Abrupt boundary. | Damp |
| | 50 | 125 | Greyish blue stiff sandy clay with occasional medium gravel of flint. Becomes clayey sand. Gravel band with woody debris at 105cm. | Damp |
| FB9 | 0 | 10 | Brown silty clay with abundant roots. Abrupt boundary. | Dry |
| | 10 | 15 | Purplish grey slightly clayey fine sand. Abrupt boundary. | Dry |

| Hand Coring Ref. | Top (cm) | Base (cm) | Description | Field Notes |
|---|---|---|---|---|
| | 15 | 50 | Orange mottled grey fine to medium sand with frequent fine to coarse gavel of flint. | Dry |
| FB10 | 0 | 15 | Black, soft silty clay with abundant roots and organic debris. | Very damp |
| | 15 | 94 | Blue, very sandy soft to stiff clay with occasional gravel. Becomes very gravelly at 60cm. Gravel is fine to medium flint. Few woody debris. | Damp |
| FB11 | 0 | 15 | Brown, fine sandy silty clay with frequent fine gravel. Many roots. Gradual boundary. | Dry |
| | 15 | 60 | Greyish purplish brown, loose fine sandy silt with rare fine gravel. Sharp boundary. | Dry |
| | 60 | 85 | Orange mottled greenish white clayey fine sand. Becomes with frequent fine to medium gravel of flint. | Dry |
| FB12 | 0 | 10 | Brown sandy silt with few roots. Gradual boundary. | Dry |
| | 10 | 55 | Loose, soft pale purplish white very fine sand. Few rootlets. Becomes mottled black at 40cm. Diffuse boundary. | Dry |
| | 55 | 110 | Dark brown with few faint pale grey mottles, fine sand. Becomes dark brown mottled pale yellowish grey with many distinct mottles. Becomes mottled orange. Becomes orange with a few faint greenish grey mottles. Few fine to medium gravel of flint at 90cm. Becomes white mottled orange. | Dry |
| FB13 | 0 | 7 | Purplish brown slightly sandy silt with infrequent fine gravel and many roots. Abrupt boundary. | Dry |
| | 7 | 15 | Brownish orange, clayey fine sand. Diffuse boundary | Dry |
| | 15 | 45 | Greenish brown with a few faint orange mottles, clayey fine to medium sand with many fine to coarse gravel of flint. | Dry |
| FB14 | 0 | 20 | Greyish purplish brown silty fine sand with frequent roots. Diffuse boundary. | Dry |
| | 20 | 47 | Orange mottled pale yellowish grey dense fine sand with occasional; gravel of flint. Becomes greenish grey, mottled orange. | Dry |

Groundwater

1.5.167 An initial hydrogeological site walkover was undertaken on 9 July 2018. The summer conditions had been exceptionally dry, although water was present and flowing in the drain that discharges on Folly Bog's eastern boundary. The site was also wet, although it was apparent that the water level within the site was relatively low. At the time of the soil coring (9 October 2018), preceding conditions had remained dry and the levels were lower than in July, although water was still noted to be flowing out of the drain to the east. This flow during a dry period indicates the reliance of the discharge on groundwater.

1.5.168 There were no observed surface water streams flowing into Folly Bog from the wider surface water catchment and no springs or seepages were observed to be flowing from the bank along the west and north of the site. However, this bank was heavily vegetated and could have hidden small discharges. Access to land to the south of

the MoD security fence was not possible. Although maps do not show flow into this area of the site (Ordnance Survey, 2016), flow from this area is shown on historical maps (Old-Maps, 2018) as being derived from a spring.

1.5.169 Although Ordnance Survey (2016) shows a defined channel flowing from the area of collects (and historically marked spring to the south of the security fence), on site it was observed that this is represented more by a series of small ditches and an area where groundwater collects on both sides of the MOD security fence (i.e. on the inaccessible MOD land and the publicly accessible land).

1.5.170 The Order Limits in the vicinity of Folly Bog pass through an area with limited potential for groundwater flooding to occur (Figure A8.3.27). However, the eastern end of the Folly Bog mire itself is shown to be in an area where there is potential for groundwater flooding to occur at the surface. The area susceptible to groundwater flooding correlates with topographical contours and the localised low topographical area (BGS, 2017).

1.5.171 The hand coring frequently recorded dry soils, even in holes situated at the base of the slope of the perimeter track including along the transect of FB11 to FB14 (although due to gravel content halting progress, these holes did not always reach great depth). Along the transect from FB7 to FB10, it was noted that the soils were starting to get wetter away from the Order Limits and into the main area of the Folly Bog mire. Soil coring locations FB1 to FB6 are located within or near the area identified as having potential for flooding at the surface, and all of these holes did record groundwater either as standing water in the hole or as wet soils. This included FB1, FB5 and FB6 which were situated just to the south of the track, where standing water was recorded at a depth of around 100cm in FB6.

Habitats and Vegetation

1.5.172 A detailed description of the habitats and vegetation of Folly Bog is provided in Appendix 7.1 Habitats and Botany Factual Report. Habitat and vegetation plans are provided in Figures A7.1.146 and A7.1.149, respectively. Within the Order Limits, dry dwarf shrub heath is the dominant habitat, which is not a groundwater dependent habitat. However, towards the eastern end of the Order Limits, prior to the Order Limits moving into Red Road, the habitat changes to wet dwarf shrub heath. The main area of Folly Bog to the south was found to support wet dwarf shrub heath and valley mire habitats.

1.5.173 Based on the UKTAG guidance, for vegetation within the Order Limits, stands of the plant community M25a *Molinia caerulea-Potentilla erecta* mire, *Erica tetralix* sub-community are classed as having moderate to low groundwater dependency. Within the main area of the site to the south, outside of the Order Limits, the vegetation is classed as being of high to moderate to low groundwater dependency, with valley mire habitats likely to be highly groundwater dependent. Highly groundwater dependent plant communities include M14 *Schoenus nigricans-Narthecium ossifragum* mire and M21 *Narthecium ossifragum-Sphagnum papillosum* valley mire.

1.5.174 In the area south of the Order Limits at the point where the Order Limits move into Red Road, the vegetation appears to be strongly controlled by drainage. The

vegetation is dominated by large tussocks of purple moor-grass with only patchy cover by bog mosses (*Sphagnum*). This contrasts with the areas of valley mire to the south and west of the main drain and indicates a widely fluctuating water table. This is likely to be the result of drainage in this area with the main drain and smaller drains that are now largely vegetated over controlling the water levels.

1.5.175 The northern end and northwestern part of Folly bog support dry dwarf shrub heath and other habitats that are not groundwater dependent. These areas have therefore been excluded from the effect assessment below.

1.5.176 Table 8.3.32 lists the NVC types recorded at the site, alongside the groundwater dependency assigned by the UKTAG (2009) guidance. Figure A8.3.28 shows the distribution of guideline groundwater dependencies across the site.

**Table 8.3.32: UKTAG Derived Groundwater Dependency for Vegetation Encountered at Folly Bog**

| NVC Habitat Type* | Groundwater Dependency (according to UKTAG, 2009) |
|---|---|
| A24 | Not groundwater dependent |
| H2 | Not groundwater dependent |
| H3 | Low to moderate groundwater dependency |
| M2 | Low to moderate groundwater dependency |
| M3 | Low to moderate groundwater dependency |
| M6 | Moderate to high groundwater dependency |
| M14 | High groundwater dependency |
| M16 | Moderate to high groundwater dependency |
| M21 | Moderate to high groundwater dependency |
| M25 | Moderate to high groundwater dependency |
| M30 | Moderate groundwater dependency |
| U3 | Not groundwater dependent |
| U5 | Not groundwater dependent |
| U20 | Not groundwater dependent |
| W1 | Moderate groundwater dependency |
| W4 | Moderate to high groundwater dependency |
| W23 | Not groundwater dependent |
| W25 | Not groundwater dependent |

**Refer to Appendix 7.1 Annex G for full list of NVC names and sub-communities*

CSM

1.5.177 Topography appears to be the key factor controlling the depth to groundwater, with topography cutting below the regional groundwater table, and the low permeability Windlesham Formation and Head deposits impeding drainage. Water drains from the site in an easterly direction via a watercourse that appears to have been modified.

1.5.178 The review of available geological and hydrogeological information confirms a substantial degree of groundwater contribution to sustaining the mapped GWDTE vegetation within Folly Bog. A shallow watershed observed within the site may also reflect the inputs of groundwater in Folly Bog with groundwater input to the northern

surface water catchment draining off the higher ground to the north of Folly Bog. However, the major input to the site would appear to be in the south where groundwater flows into Folly Bog from the area shown as collects and the spring shown on historical maps to the south of the MOD security fence. The drain discharging from Folly Bog was observed to be flowing following a sustained dry period which indicates that there is a considerable discharge of groundwater into the site.

1.5.179 At Folly Bog, in the vicinity of the Order Limits, the UKTAG classification overlaps with the area identified by the BGS (2017) groundwater flooding susceptibility mapping as being susceptible to groundwater flooding at the surface. However, along the rest of the Order Limits, where the flood susceptibility map shows there being limited potential for groundwater flooding, it is considered that due to elevation the groundwater is too deep to provide a flooding risk. This is confirmed by the vegetation survey which does not show any groundwater dependent vegetation in this area.

1.5.180 Hand coring surveys in the vicinity of the Order Limits identified groundwater only at the low point prior moving into Red Road. At the time of the walkover and soil coring surveys, no groundwater features (springs, seepages) were identified within the Order Limits. The area to the south appeared to be groundwater fed, as despite the dry weather, outflow was observed on both occasions the site was visited. This groundwater input relates to the topographical low point where the groundwater table meets the ground surface at the site. As such, it is likely that, at wetter times of the year, groundwater levels would rise and a greater area of the site would have water at the surface. Outflow during these times would be greater, although it is understood that water levels in the site can be controlled (Natural England, 2018).

1.5.181 On the basis of the above, it is considered that groundwater is a major control on the vegetation at the site, and the UKTAG groundwater dependency classifications for each vegetation type are appropriate for this site.

1.5.182 Figure A8.3.29 represents three conceptualised sections, one running west to east, broadly parallel to the Order Limits (Section A-A), and the other two perpendicular to the Order Limits (Section B-B and C-C). The CSM locates the presence of vegetation with potential for groundwater dependency in the topographical low where the ground intercepts the regional groundwater table.

Assessment of Effects

1.5.183 In the vicinity of Folly Bog, the Order Limits only pass through one area of vegetation identified as being groundwater dependent, at the point where the Order Limits are at a similar elevation to the Folly Bog valley mire itself. The vegetation here is classed as having moderate to low groundwater dependency.

1.5.184 At this location, during construction the trench required to install the pipeline may require dewatering, as the groundwater elevation is likely to be within 1.5m of the ground surface. A wide impact is unlikely, although locally, a temporary effect is expected during construction. However, compared to the rest of Folly Bog, the vegetation at this location appears to already be affected due to artificial drainage ditches. Given the short time that any effects from dewatering would occur, it is likely

that groundwater dependent vegetation, if temporarily impacted, would quickly recover.

1.5.185 During the operational phase of the project, the good practice measure O7 will place stanks through the pipe bedding and side fill, and G199 will identify specific areas where increased frequency of stanks would be required to safeguard sensitive habitats which depend on groundwater. Table 8.3.33 provides a summary of the magnitude of change from different potential effects on groundwater flows on Folly Bog.

**Table 8.3.33: Summary of Potential Effects on Folly Bog GWDTE**

| Sub-site | Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|---|
| Majority of Folly Bog mire | High | SPA, SAC, SSSI | High | Trench dewatering | Construction | Negligible |
| | | | | Flow interception | Operation | Negligible |
| Northeastern area (prior to where the Order Limits move into Red Road) | Moderate | SPA, SAC, SSSI | High | Trench dewatering | Construction | Medium |
| | | | | Flow interception | Operation | Small |

## Chobham Common

Site Setting, Topography and Hydrological Catchment

1.5.186 The topography of the Chobham Common site and around the site is not particularly steep, ranging from 70mAOD in the northwest to 30mAOD in the southeast.

1.5.187 The hydrological recharge catchment of the site sits within the site itself, with the top of the catchment located along the northwest boundary of the site. The site is therefore fed very locally by surface water runoff.

1.5.188 The Order Limits run through the centre of the site in a southwest to northeast direction, following an existing track. Along the Order Limits the topography is relatively flat, ranging from 37mAOD to 49mAOD.

Geology and Soils

1.5.189 Holidays Hill soils are present throughout the site, which are described as naturally very acid sandy over clayey soils and loamy over clayey soils, locally with humose or peaty surface horizons. There are slowly permeable subsoils and slight seasonal waterlogging. Holidays Hill also contains some very acid well-drained sandy soils, and some deep sandy soils, affected by groundwater with humose surface horizons (Cranfield University, 2018). They are wet at the surface for long periods in winter and thin humose or peaty surface horizons develop under heathland.

1.5.190 In localised topographical low areas (i.e. localised valleys), the mapping indicates the presence of peat deposits (BGS, 2018h). A review of readily available borehole

logs mostly recorded the presence of sandy clay and clayey sand deposits. However, no boreholes were located in the localised topographical low areas (BGS, 2018a).

1.5.191 To understand the variation in properties of the superficial deposits which may play a role in groundwater flow patterns, a hand coring survey was undertaken on 18 and 19 September 2018. In contradiction of mapping, the hand coring survey indicated an absence of peat in the areas surveyed. The combination of hand coring and borehole logs record the dominant and constant presence of medium to fine clayey sand to medium to fine sandy clay.

1.5.192 Figure A8.3.30 shows the locations of boreholes and hand coring points, and Table 8.3.34 and Table 8.3.35 records the soils and superficial geology encountered at these points.

1.5.193 Bedrock present beneath the site at depth comprises the Bagshot Formation in the half of the site north of the existing track and the Camberley Sand Formation in the half south of the track (BGS, 2018h).

**Table 8.3.34: BGS Borehole Logs in Proximity to the Chobham Common Site**

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater Strike |
|---|---|---|---|---|
| SU96SE16 | 0.00 | 0.15 | Black peaty topsoil | - |
| | 0.15 | 1.50 | Greyish brown fine sand | - |
| SU96SE17 | 0.00 | 0.45 | Dark brown sandy topsoil | - |
| | 0.45 | 1.50 | Mottled grey and brown fine sand | - |
| SU96SE18 | 0.00 | 0.60 | Black sandy topsoil with gravel | - |
| | 0.60 | 1.50 | Mottled grey and brown silty fine sand | - |
| SU96SE20 | 0.00 | 0.15 | Peaty topsoil | - |
| | 0.15 | 0.55 | Green fine to medium sand | - |
| | 0.55 | 0.77 | Light brown silty clay with pockets of green silt | - |
| | 0.77 | 1.50 | Dark green clayey medium sand | - |
| SU96SE44 | 0.00 | 0.45 | Dark brown sandy topsoil | Water added during boring |
| | 0.45 | 1.22 | Mottled brown and grey clayey fine sand | Water added during boring |
| | 1.22 | 6.10 | Medium dense to dense light brown sand | Water added during boring |
| SU69SE43 | 0.00 | 0.60 | Brown sandy topsoil | Groundwater at ground level |
| | 0.60 | 6.10 | Medium dense light brown fine sand | |
| SU96SE47 | 0.00 | 0.35 | Dark brown clayey topsoil | - |
| | 0.35 | 0.72 | Soft mottled brown and grey clay | Groundwater at 60cm |

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater Strike |
|---|---|---|---|---|
| | 0.72 | 1.80 | Firm dark green fine sandy clay with traces of fine gravel | |
| | 1.80 | 6.10 | Dense dark grey fine sand, clayey in parts | |
| SU96SE46 | 0.00 | 0.23 | Dark brown sandy topsoil | - |
| | 0.23 | 1.65 | Loose to medium dense dark green clayey fine sand | - |
| | 1.65 | 2.00 | Stiff dark green silty clay | - |
| | 2.00 | 6.10 | Medium dense to dense mottled grey and brown fin sand | Groundwater at 600cm |
| SU96SE40 | 0.00 | 0.60 | Dark brown sandy topsoil | - |
| | 0.60 | 2.45 | Brown fine sand | - |
| SU96SE41 | 0.00 | 0.60 | Dark brown sandy peaty topsoil | - |
| | 0.60 | 0.90 | Mottled grey and brown sandy silt | Groundwater at 90cm |
| | 0.90 | 2.45 | Light brown fine to medium sand | |
| SU96SE42 | 0.00 | 0.30 | Dark brown sandy topsoil | - |
| | 0.30 | 6.10 | Medium dense to dense brownish grey fine to medium sand | Groundwater at 60cm |
| SU96SE111 | 0.00 | 0.50 | Loose brown with some grey sand | - |
| | 0.50 | 0.80 | Loose medium dark brown sand | - |
| | 0.80 | 4.00 | Green clay | - |
| | 4.00 | 8.60 | Orange brown clayey sand | Groundwater at 400–600cm |
| | 8.60 | 10.30 | Sand with clay lenses | |
| SU96SE110 | 0.00 | 0.30 | Dark brown silty sand | - |
| | 0.30 | 1.50 | Medium dense brownish grey silty gravelly sand | - |
| | 1.50 | 2.80 | Medium dense grey brown sand with clay bands | - |
| | 1.80 | 4.00 | Medium dense brown silty sand | - |
| SU96SE108 | 0.00 | 1.10 | Greyish brown sandy clay | - |
| | 1.10 | 11.50 | Loose yellow brown silty sand | Groundwater at 625cm |
| SU96SE39 | 0.00 | 0.45 | Brown sandy topsoil with gravel | - |
| | 0.45 | 0.75 | Mottled green and brown sandy silt with medium rounded gravel | - |
| | 0.75 | 3.15 | Light grey clayey silt | - |
| | 3.15 | 4.80 | Light brown sand | - |
| SU96SE113 | 0.00 | 0.50 | Dark brown silty sand | - |
| | 0.50 | 7.00 | Grey sand | - |
| SU96SE114 | 0.00 | 1.50 | Silty sand | - |
| BH34 | 0.00 | 0.15 | Brown slightly silty sand | - |

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater Strike |
|---|---|---|---|---|
| | 0.15 | 2.20 | Orangish brown and grey slightly clayey sand. | - |
| | 2.20 | 3.37 | Brownish light grey fine to medium sand. | - |
| | 3.37 | 4.60 | Brownish light grey fine to medium clayey sand. | - |
| | 4.60 | 8.51 | Light grey fine to medium silty sand. | - |
| | 8.51 | 9.15 | Greyish brown clay. | - |
| | 9.15 | 10.15 | Dark grey fine to medium sand. | - |
| BH35 | 0.00 | 0.20 | Brown slightly silty sand. | - |
| | 0.20 | 2.20 | Orangish brown and light grey slightly clayey sand. | - |
| | 2.20 | 2.50 | Brown slightly sandy clay. | - |
| | 2.50 | 9.80 | Brownish grey slightly silty sand. | - |
| | 9.80 | 10.00 | Brown clay. | - |
| | 10.00 | 10.45 | Brownish grey slightly silty sand. | - |
| BH138 | 0.00 | 0.20 | Brown slightly silty sand. | - |
| | 0.20 | 1.55 | Orangish brown and grey slightly clayey sand. | Groundwater at 80cm |
| | 1.55 | 5.65 | Light grey fine to medium sand. | - |

**Table 8.3.35: Hand Coring Geological Recording from Chobham Common**

| Hand Coring Ref. | Top (cm) | Base (cm) | Description | Field Notes |
|---|---|---|---|---|
| C1 | 0 | 8 | Dark brown with some light grey mottles clayey sand. Few stones, many fine roots. Clear boundary. | |
| | 8 | 38 | Dark brown slightly sandy silty clay. No mottles. Some fine to medium roots | Damp |
| | 38 | 50 | Light brownish grey fine sand. Becomes clayey with depth. | Damp |
| | 50 | 90 | Bluish greenish grey very sandy clay. Few faint reddish-brown mottles and dark purplish brown. | Damp becoming wet |
| C2 | 0 | 4 | Brown litter layer | |
| | 4 | 35 | Pale brownish grey speckled white loose medium to fine sand. Few stones, few medium to fine roots. Diffuse boundary | Dry |
| | 35 | 55 | Orangish yellow medium to fine sand. Diffuse boundary | Dry |
| | 55 | 65 | Orange mottled pale grey sand with orange mottles | Becoming damp |
| | 65 | 90 | Pale grey medium sand becoming clayey with depth, turning into bluish grey fine sandy clay at the base. Some relict vegetation fragments | Damp |
| C3 | 0 | 35 | Dark brown to black silty clay with vegetation. Abrupt boundary | Slightly damp |
| | 35 | 45 | White slightly clayey fine sand. Abrupt boundary | Slightly damp |

| Hand Coring Ref. | Top (cm) | Base (cm) | Description | Field Notes |
|---|---|---|---|---|
| | 45 | 95 | Pale grey clayey fine sand with orange mottles, becoming more clayey with depth. Abrupt boundary | Slight increase of moisture with depth |
| | 95 | 100 | Blue slightly sandy clay | Moist to wet |
| C4 | 0 | 20 | Dark brown slightly silty clay. Some vegetation remains. Many roots | |
| | 20 | 25 | Brown sandy clay | Slightly damp |
| | 25 | 80 | Orange clayey fine sand with distinct grey mottles becoming bluish grey mottles with depth. | Damp |
| | 80 | 100 | Blueish greenish grey clayey fine sand, with clay content increasing with depth. | Damp to wet (increasing with depth) |
| C5 | 0 | 30 | Pale greyish brown medium to fine sand. Slightly speckled, few roots | Dry |
| | 30 | 40 | Orange mottled grey medium to fine sand. | Dry |
| | 40 | 73 | Pale greenish grey medium to fine sand becoming brownish orange with depth. Few flint gravels | Dry |
| | 73 | 75 | Bright orange medium to fine sand with fine gravel | Dry |
| C6 | 0 | 36 | Pale greyish brown fine sand becoming. Occasional gravel of flint | Dry becoming slightly moist |
| | 36 | 36 | Refusal. Potential gravel | |
| C7 | 0 | 25 | Pale greyish brown fine sand. Few roots | Dry |
| | 25 | 65 | Orange mottled grey slightly clayey fine sand. Diffuse boundary | Dry |
| | 65 | 105 | Yellowish grey soft slightly silty fine to very fine sand. Becomes clayey with depth. Then becomes brownish yellow and then brownish orange with depth | Slightly moist |
| | 105 | 115 | White clayey fine to very fine sand with few distinctive orange mottles. | Slightly moist |
| C8 | 0 | 18 | Pale brown speckled grey fine sand. Some flint gravels. | Very dry |
| | 18 | 18 | Refusal. Potential gravel. | |
| C9 | 0 | 20 | Pale brown speckled grey fine sand. Some flint gravels. | Very dry |
| | 20 | 20 | Refusal. Potential gravel. | |
| C10 | 0 | 25 | Dark brown soft sandy silty clay with organic matter. Gradual boundary | Dry |
| | 25 | 60 | Greyish orangish brown fine sand with orange mottles. Some gravels of flint | Dry |
| | 60 | 105 | Pale yellowish brown with grey mottles slightly clayey fine sand with some gravels of flint. Becomes medium to fine sand with depth. | Slightly moist; damp at the base |
| C11 | 0 | 20 | Pale brown speckled grey fine sand. Some flint gravels. | Very dry |
| | 20 | 20 | Refusal. Potential gravel | |
| C12 | 0 | 10 | Orange fine sand | |

| Hand Coring Ref. | Top (cm) | Base (cm) | Description | Field Notes |
|---|---|---|---|---|
| | 10 | 25 | Orange bluish grey, purple mottled clayey fine to medium sand | Slightly damp |
| | 25 | 55 | Dark brown speckled pale brown slightly clayey fine sand. Becomes darker with depth. Contains some organic material. | Damp |
| | 55 | 75 | Bluish grey clayey sand becomes very sandy clay with depth. Few faint orange mottles. | Damp |
| | 75 | 75 | Refusal on hard ground or large gravel/cobble. | |
| C13 | 0 | 30 | Brown fine to medium becoming pale with depth. Diffuse boundary | Dry |
| | 30 | 60 | Greenish grey slightly clayey fine to medium sand, becoming orangish brown mottled with depth | Dry |
| | 60 | 85 | Stiff dark green sandy clay with orange mottles | Dry |
| C14 | 0 | 10 | Light brown fine to medium sand | Dry |
| | 10 | 15 | Orange fine sand | Dry |
| | 15 | 55 | Greenish grey speckled light brown fine sand | Dry |
| | 55 | 65 | Pale yellowish green fine sand with frequent gravels of flint | Dry |
| | 65 | 65 | Refusal – possible gravel | |
| C15 | 0 | 32 | Dark brown slightly clayey fine sand becoming paler with depth. Gradual boundary | Dry |
| | 32 | 55 | Pale brownish white medium to fine sand with orange mottles. Gradual boundary | Dry |
| | 55 | 62 | Orange very sandy clay. Sharp boundary | Slightly damp |
| | 62 | 95 | Greenish grey sand. Gradual boundary | Damp |
| | 95 | 160 | Greenish grey sandy clay, becoming slightly more clayey with depth and wetter | Water at 152cm |
| C16 | 0 | 25 | Dark brown fine sand with rootlets | Dry |
| | 25 | 50 | Pale brown fine sand. Gradual boundary | Dry |
| | 50 | 105 | Orange clayey sand with few gravels of flint and with few faint grey mottles with depth. Abrupt boundary | Damp |
| | 105 | 157 | Grey clayey sand with some vegetation relicts | Wetter with depth |
| C17 | 0 | 20 | Pale brown fine sand. Many gravels of flint | Dry |
| | 20 | 20 | Refusal. Gravels. | |
| C18 | 0 | 30 | Pale greyish brown fine sand | Dry |
| | 30 | 80 | Pale grey mottled orange slightly clayey fine sand. Becomes white mottled and brownish orange with depth | Dry |
| C19 | 0 | 10 | Brownish grey fine sand | Dry |
| | 10 | 35 | Brown with few faint orange mottles slightly clayey fine sand with some gravels of flint | Dry |
| C20 | 0 | 18 | Pale greyish brown speckled grey medium to fine sand | Dry |

| Hand Coring Ref. | Top (cm) | Base (cm) | Description | Field Notes |
|---|---|---|---|---|
| | 18 | 60 | Pale reddish brown speckled grey medium to fine sand, becoming yellowish greyish brown with depth. Diffuse boundary | Dry |
| | 60 | 80 | Orange mottled grey with sandy clay. Diffuse boundary | Damp |
| | 80 | 105 | Blueish grey sandy clay | Moist |
| C21 | 0 | 25 | Black organic rich sand with many roots | |
| | 25 | 35 | Pale brown sand | Moist |
| | 35 | 110 | Grey sandy clay becoming greenish grey slightly clayey sand with depth | Wet with water at 85cm |
| C22 | 0 | 45 | Brown speckled grey fine sand with roots | |
| | 45 | 105 | Grey mottled orange, speckled black very sandy clay – becoming pale grey mottled orange at 60cm and then pale greenish grey mottled orange at 65cm | Dry |
| C23 | 0 | 7 | Reddish brown litter layer | |
| | 7 | 30 | Dark grey mottled pale grey clayey medium to fine sand with some gravel of flint | Dry |
| | 30 | 50 | Greenish brownish grey mottled orange slightly clayey fine sand | Slightly damp |
| | 50 | 70 | Greenish grey mottled orange sandy clay becoming brownish green mottled orange with depth | Slightly damp |
| | 70 | 105 | Orange mottled grey slightly sandy silty stiff clay | Slightly damp |
| | 105 | 110 | Blueish grey sandy clay | Damp |
| C24 | 0 | 20 | Brown speckled grey slightly clayey fine sand with many roots | |
| | 20 | 35 | Greyish brown fine sand with gravel of flint. Diffuse boundary. | |
| | 35 | 55 | Dark brown fine sand with gravel of flint, gaining yellow mottles from 45cm | |
| | 55 | 110 | Orange sandy clay with few faint grey mottles. Mottles become more abundant and prominent with depth. Becomes very sandy from 95cm. | Slightly moist. Water level in the ground does not seem to correlate with water level in the adjacent artificial pond. |

Groundwater

1.5.194 A hydrogeological site walkover was undertaken on 30 and 31 July 2018. The summer conditions had been exceptionally dry, and this was clearly reflected in the extreme dryness of the site. There was no evidence of springs or seepages, permanent or seasonal.

1.5.195 However, a large proportion of the site falls within an area susceptible to groundwater flooding (BGS, 2017), as shown on Figure A8.3.30. The site is located in the low ranges of a wider hydrogeological catchment which recharges from further

northwest. Despite the exceptionally dry conditions, the hand coring frequently recorded damp to wet horizons at depths shallower than 1m and met groundwater at 1.52m and 0.85m respectively at C15 and C21. Several of the BGS boreholes (SU96SE47, SU96SE46, SU96SE41, SU96SE42, SU96SE111 and SU96SE108) also recorded shallow groundwater strikes which correlate with areas identified as susceptible to groundwater flooding in the west and centre part of the site.

1.5.196 Groundwater monitoring as part of the 2018 GI recorded shallow groundwater levels, with highs between 2.4mbgl and 0.6mbgl. All the boreholes coincided with areas recorded as being susceptible to groundwater flooding at surface. The period of groundwater monitoring is short and covers a winter period when water levels would be expected to be naturally higher than average conditions.

1.5.197 The areas susceptible to groundwater flooding correlate with topographical contours outlining localised low and/or flat topographical areas. The groundwater table appears to generate shallow groundwater conditions along specific topographical areas in a widespread fashion rather than through distinctive spring lines. This could be explained by the relatively homogeneous nature of the superficial deposits.

1.5.198 The existing track running southwest to northeast forms a flow barrier to surface and sub-surface flow, occasioning ponding zones immediately north of the track during wet periods. The existing track is equipped in places by a two-level plastic culvert system preventing ponding water from overtopping the track and allowing over-flow towards the south.

1.5.199 Artificial ponds appear to have been created to enhance vegetation in parts of the site, as information gathered during both the walkover and the hand coring exercise (location C24) suggest these ponds are not sustained by groundwater.

1.5.200 Surface and sub-surface flows are expected to be relatively flashy, i.e. responsive to rainfall. The superficial deposits do not have the ability to retain much water during prolonged periods of drought, but the flow of shallow groundwater will be slower (i.e. moderately flashy) and will last longer than the surface runoff and surface ponding. There is no consistent clay horizon at shallow depth encountered by the borehole logs nor the hand coring which could create perched groundwater conditions. Groundwater feeding the site is expected to originate from the local and wider hydrogeological catchment extending to the northwest. Based on the nature of superficial deposits, moderate seasonal groundwater level fluctuations are expected.

Habitats and Vegetation

1.5.201 A detailed description of the habitats and vegetation of the site is provided in Appendix 7.1 Habitats and Botany Factual Report. The vegetation is largely uniform across the site, dominated by large stands of dry dwarf shrub heath, which is not a wetland habitat. Wet heath occurs in lower and/or flatter localised topographical areas, referable to M16 *Erica tetralix-Sphagnum compactum* wet heath. Habitat and vegetation plans are provided in Figures A7.1.161 and A7.1.164, respectively.

1.5.202 Based on the UKTAG guidance, vegetation of high to moderate-to-low groundwater dependency has been recorded mostly in the central to west central part of the Order

Limits, but also in part of the northeastern area of the Order Limits. Some areas of no groundwater dependency are also present.

1.5.203 Table 8.3.36 lists the NVC types recorded at the site, alongside the groundwater dependency assigned by the UKTAG (2009) guidance. Figure A8.3.31 shows the distribution of guideline groundwater dependencies across the site.

**Table 8.3.36 UKTAG Derived Groundwater Dependency for Vegetation Encountered at Chobham Common**

| NVC Habitat Type* | Groundwater Dependency (according to UKTAG, 2009) |
|---|---|
| A16 | Not groundwater dependent |
| A24 | Not groundwater dependent |
| H1 | Not groundwater dependent |
| H2 | Not groundwater dependent |
| H3 | Low to moderate groundwater dependency |
| M1 | Low to moderate groundwater dependency |
| M6 | High groundwater dependency |
| M16 | Moderate to high groundwater dependency |
| M23 | Moderate to high groundwater dependency |
| M25 | Low to moderate groundwater dependency |
| M30 | Moderate groundwater dependency |
| MG1 | Not groundwater dependent |
| S12 | Low groundwater dependency |
| S22 | Low groundwater dependency |
| S23 | Low groundwater dependency |
| U20 | Not groundwater dependent |
| W1 | Low groundwater dependency |
| W4 | Moderate to high groundwater dependency |
| W16 | Not groundwater dependent |
| W23 | Not groundwater dependent |
| W24 | Not groundwater dependent |
| W25 | Not groundwater dependent |

**Refer to Appendix 7.1 Annex G for full list of NVC names and sub-communities*

CSM

1.5.204 At the scale of the Chobham Common site, topography appears to be the key factor controlling depth to groundwater, with superficial deposits of generally homogeneous nature. However, locally, the minor variations in superficial deposits and soils will influence groundwater pathways.

1.5.205 The review of available geological and hydrogeological information confirms a degree of groundwater contribution to sustaining the mapped UKTAG based GWDTE vegetation.

1.5.206 At Chobham Common, the plant communities with a higher dependence on groundwater according to the UKTAG classification overlap reasonably well with the

BGS (2017) groundwater flood susceptibility areas, except in the southwestern part of the Order Limits. Hand coring surveys have confirmed that the southwestern part is much drier and has a much reduced groundwater contribution. For this reason, W4 *Betula pubescens-Molinia caerulea* woodland is downgraded to low groundwater dependency.

1.5.207 Adjustments to the UKTAG groundwater dependency ratings are also needed locally in relation to the existing track. Based on observations from the site walkover, where the track is raised on embankments where it crosses valley bottoms, it appears to act as a barrier to surface and sub-surface flow, thereby artificially enhancing the wetness of soils immediately upgradient, i.e. to the northwest. This is particularly marked in the centre part of the site, where there are stands of M6 *Carex echinata-Sphagnum recurvum/auriculatum* mire. The groundwater dependency of this plant community has therefore been revised to moderate at this location.

1.5.208 In the centre and the northeast part of the Order Limits, the vegetation classified by UKTAG guidance as high-to-moderate groundwater dependency are considered to be of moderate groundwater dependency. This is on the basis that the system is moderately flashy, as well as the nature of the superficial deposits, being of moderate permeability, and groundwater levels fluctuating moderately seasonally.

1.5.209 However, downgrading the groundwater dependency of the centre and northeast of the Order Limits and M6 *Carex echinata-Sphagnum recurvum/auriculatum* mire community does not alter the value of these habitats, which remain high as per Table 8.3.37 below.

1.5.210 Figure A8.3.32 represents two conceptualised sections: one running along the main access track southwest to northeast (Section A-A) and the other perpendicular to the track (Section B-B). Both surface and groundwater flow from northwest to southeast. The CSMs locate the presence of groundwater dependent vegetation typically in areas of flatter topography and/or local valleys, allowing groundwater to seep closer to the surface and support the vegetation growth. This is particularly visible along Section B-B which is in the same direction as groundwater and surface water patterns. Section A-A magnifies topographical changes with groundwater dependent vegetation located in low topographical areas correlating with valleys or in flatter areas. The adjusted groundwater dependency classification is displayed along Section A-A.

Assessment of Effects

1.5.211 Trenchless Horizontal Directional Drilling (HDD) construction method is proposed in the central and northeastern parts of the Order Limits where the main areas of GWDTEs are present (Figure A8.3.32). Except at the launch and reception end of the trenchless crossing, where shallow excavations equivalent to the depth of a trench would be required, the HDD would dive under the main areas of GWDTE with no dewatering effect. Therefore, no change to groundwater flow supporting the main areas of GWDTE is expected.

1.5.212 Elsewhere, the pipeline is proposed to be installed by open cut trenching using the existing track and up to a total 20m working width to the south of the track.

1.5.213 Along the open cut sections and the launch and reception of directional drilling trenchless crossings, the conditions are expected to be wet as construction within the site is expected to take place from October to February. Dewatering would therefore be required. Near to areas requiring dewatering, it has been determined that GWDTE are either absent or of low groundwater dependency and therefore classified as of medium sensitivity. The CSM has highlighted that the surface and sub-surface water flows are already altered by the existing track, so whether the pipeline is installed within the track or immediately downgradient of it, only a localised effect of dewatering is expected. Given the anticipated localised effect of dewatering, the magnitude of change resulting from dewatering during construction would be small at the scale of the site.

1.5.214 During operation, the presence of the pipeline, sheltered within the track or immediately downgradient of it, is expected to have a negligible localised effect on shallow groundwater flow as a negligible extension of effects already created by the track.

1.5.215 Table 8.3.37 provides a summary of the magnitude of change from different potential effects on groundwater flows supporting Chobham Common.

**Table 8.3.37: Summary of Groundwater Flow Effects across Chobham Common GWDTE**

| Sub-site | Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|---|
| Trenchless crossings – Central and northeastern part of the Order Limits | Moderate | SSSI, SPA | High | Dewatering | Construction | None |
| | | | | Flow interception | Operation | Negligible |
| Trenched section – Order Limits excluding central and northeastern parts | None to low | SSSI, SPA | Medium | Trench dewatering | Construction | Small |
| | | | | Flow interception | Operation | Negligible |

### Foxhills

Site Setting, Topography and Hydrological Catchment

1.5.216 Two connected ridges are the main topographical features of the site, one trending east to west in the south, and one trending north to south in the east. Small valleys have been incised into the sides of the associated slopes. The elevation ranges from 45mAOD to 70mAOD across the site.

1.5.217 A number of artificial drainage ditches have been constructed to assist with draining the golf course to which this site belongs to. The ditches flow towards the north. The hydrological catchment is relatively small, with the hydrological recharge area some 600m away to the southeast.

1.5.218 The Order Limits run from west to east through the site, north of the east–west trending ridge. Elevations along the Order Limits vary from 45mAOD to 55mAOD.

Geology and Soils

1.5.219 The high ground in the site is located on Holidays Hill soil assemblage, described as naturally very acid sandy over clayey soils and loamy over clayey soils, locally with humose or peaty surface horizons. There are slowly permeable subsoils and slight seasonal waterlogging. Holidays Hill also contains some very acid well-drained sandy soils, and some deep sandy soils, affected by groundwater with humose surface horizons. The eastern sides of the ridges are Bursledon soil assemblage, described as deep fine loamy soils with slowly permeable subsoils and slight seasonal waterlogging associated with deep coarse loamy soils variably affected by groundwater. Some slowly permeable seasonally waterlogged loamy over clayey soils. The west of the ridges are Swanwick soil assemblage, described as deep permeable coarse loamy and sandy soils, some with peaty surface horizons affected by groundwater (Cranfield University, 2018).

1.5.220 No superficial deposits are recorded by BGS mapping near the site (BGS, 2018i).

1.5.221 The Windlesham Formation outcrops within the site, overlying the Bagshot Formation (BGS, 2018i). This is verified by the nearest BGS borehole logs (TQ06NW292 on Figure A8.3.33), which record a relatively thick soil horizon directly over the bedrock formations (BGS, 2018a).

1.5.222 There are no 2018 GI boreholes in vicinity of the site.

Groundwater

1.5.223 Groundwater was recorded in publicly available borehole records at a depth of 2.6mbgl (TQ06NW292).

1.5.224 The site is recorded as having a limited potential for clearwater groundwater flooding (BGS, 2017).

1.5.225 The ecological survey of the site identified seepages along the sides of some of the ditches.

1.5.226 No hydrogeological walkover of Foxhills was undertaken.

Habitats and Vegetation

1.5.227 Phase 1 habitat survey was undertaken at Foxhills. More detailed vegetation survey was not undertaken because the site was found to be of low biodiversity value, supporting predominantly artificial habitats created for the golf course. A description of the habitats of the site is provided in Appendix 7.1 Habitats and Botany Factual Report. A habitat plan is provided in Figure A7.1.169.

1.5.228 The habitats of the site are dominated by non-wetland habitats, but there were small areas of swamp and marshy grassland. These were mostly associated with ponds and drainage features. The marshy grasslands within the site were identified as potential GWDTE, located in an area of seepage above a watercourse. The

vegetation was referred to M23 *Juncus acutiflorus/effusus-Galium palustre* rush pasture and M25 *Molinia caerulea-Potentilla erecta* mire. These plant communities are classed by UKTAG guidance as of high to moderate groundwater dependency.

1.5.229 A further location with potential GWDTE habitat was identified to the northeast, comprising bryophyte dominated vegetation within a ditch.

1.5.230 Figure A8.3.33 shows the distribution of guideline groundwater dependencies across the site.

CSM

1.5.231 The identified seepage faces are associated with the pinching out of the Windlesham Formation over the Swinley Clay Member, with the Swinley Clay acting as an aquiclude, coinciding with changes in topography.

1.5.232 The artificial ditches are likely to be locally dewatering the site and draw local groundwater, creating seepages along their banks.

1.5.233 The local conditions suggest that the wetland ecosystems identified are moderately groundwater dependent, with some input from surface runoff.

1.5.234 This corroborates and confirms the UKTAG rating for the site of having a high to moderate groundwater dependency over small areas, with much of the rest not being groundwater dependent.

1.5.235 Figure A8.3.34 shows a conceptualised cross section of the GWDTE, running from southwest to northeast.

Assessment of Effects

1.5.236 During construction, the trench required to install the pipeline along the Order Limits would likely be located above the water table. Therefore, no dewatering requirement is expected in this part of the Order Limits. In this instance, there would be no effect on the GWDTE during construction and operation.

1.5.237 Table 8.3.38 provides a summary of the magnitude of change from different potential effects on groundwater flows supporting Foxhills.

**Table 8.3.38: Summary of Groundwater Flow Effects on Foxhills GWDTE**

| Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|
| High to moderate | None | Low | Trench dewatering | Construction | None |
| | | | Flow interception | Operation | None |

## 1.6 GWSA-D

### Addlestone Moor

Site Setting, Topography and Hydrological Catchment

1.6.1 The site ranges from a very flat eastern part at around 14mAOD to 15mAOD, to 27mAOD in the west, which acts as a local topographic divide. The topographic catchment extends a short distance upslope south of the site (about 800m). Overall, the site is located in the upper reaches of the topographical catchment.

1.6.2 The Order Limits pass through the southern part of the site from west to east, before turning to head north along the eastern boundary of the site.

Geology and Soils

1.6.3 Most of the site is over Swanwick soil assemblage, although the higher ground in the west is on Bursledon soil assemblage. Swanwick is described as deep permeable coarse loamy and sandy soils some with peaty surface horizons affected by groundwater. Bursledon is described as deep fine loamy soils with slowly permeable subsoils and slight seasonal waterlogging associated with deep coarse loamy soils variably affected by groundwater; some slowly permeable seasonally waterlogged loamy over clayey soils (Cranfield University, 2018).

1.6.4 The site is underlain by alluvium and the Kempton Park Gravel Member (BGS, 2018i). It is likely that the Kempton Park Gravel Member continues in sub-crop beneath the alluvium. There are also parts of the site that have no recorded superficial deposits. The bedrock is the Bagshot Formation.

1.6.5 Alluvium typically comprises heterogeneous deposits of clay, silt and sand with minor gravel in varying proportions. The Kempton Park Gravel Member comprises sand and gravel, with localised lenses of silt, clay and peat. The Bagshot Formation is typically a clayey sand.

1.6.6 An historical landfill is recorded immediately to the east of the site (EA, 2018). This is not recorded within the artificial ground datasets of the BGS (2018i).

1.6.7 A number of publicly available borehole logs are located either within or close to the site (Figure A8.3.35), results of which are presented in Table 8.3.39 (BGS, 2018a). Only one of the boreholes was located in an area with superficial deposits recorded in the mapping; this borehole confirmed the presence of the gravels beneath the alluvium in the site. The other boreholes confirmed the absence of superficial deposits beyond a thin layer of topsoil or made ground.

1.6.8 One borehole from the 2018 GI was completed at the western end of the site. This recorded sandy bedrock beneath this part of the site.

**Table 8.3.39: Borehole Records from within the Addlestone Moor Site**

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater Strike (mbgl) |
|---|---|---|---|---|
| TQ06NW156 | 0.00 | 0.20 | Topsoil | Not recorded |

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater Strike (mbgl) |
|---|---|---|---|---|
| | 0.20 | 1.30 | Silty clay | |
| | 1.30 | 1.60 | Sandy silty clay | |
| | 1.60 | 2.60 | Gravel | |
| | 2.60 | 5.70 | Sandy gravel | |
| | 5.70 | 8.80 | Silty fine sand | |
| TQ06NW118 | 0.00 | 0.46 | Topsoil | Strike: 7.1<br>Standing: 3.1 |
| | 0.46 | 4.67 | Very silty fine sandy clay | |
| | 4.67 | 7.92 | Silty very fine sand | |
| TQ06NW103 | 0.00 | 0.15 | Topsoil | Strike: 6.2<br>Standing: 4 |
| | 0.15 | 0.40 | Sandy clay with some gravel | |
| | 0.40 | 4.70 | Sandy silty clay | |
| | 4.70 | 8.00 | Fine sand with layers of clay and silt | |
| | 8.00 | 13.30 | Silty with layers of clayey silt | |
| TQ06NW570 | 0.00 | 0.30 | Made ground | Not encountered |
| | 0.30 | 0.45 | Dark brown silty fine to medium sand with occasional gravel | |
| | 0.45 | 3.00 | Orange brown silty fine to medium sand | |
| TQ06NW571 | 0.00 | 0.80 | Made ground | Not encountered |
| | 0.80 | 2.20 | Light brown silty fine to medium sand | |
| | 2.20 | 2.80 | Brown very silty very sandy clay | |
| TQ06NW572 | 0.00 | 0.30 | Topsoil | Not encountered |
| | 0.30 | 0.60 | Made ground | |
| | 0.60 | 0.90 | Orange brown very silty fine to medium sand | |
| | 0.90 | 3.20 | Light brown very silty fine to medium sand | |
| BH32 | 0.00 | 0.08 | Made Ground: Dark brown slightly gravelly sand. | Strike: 1.40 |
| | 0.08 | 1.13 | Brown slightly gravelly silty sand. | |
| | 1.13 | 8.70 | Light yellowish brown and light grey clayey sand with occasional thin bands of sandy clay. | |
| | 8.70 | 10.20 | Dark grey clayey fine to medium sand. | |
| | 10.20 | 15.30 | Dark grey silty sand. | |

Groundwater

1.6.9 Groundwater was recorded from the publicly available borehole records in the bedrock formations only. This was encountered relatively deep but rose to a slightly shallower level during the drilling, indicating a potential slight confinement. This level

is reflected in the groundwater flooding susceptibility map which shows a limited potential for groundwater flooding beneath the entirety of the site (BGS, 2017).

1.6.10 Groundwater was encountered at a relatively shallow depth from within BH32; it should be noted that this borehole was drilled during the winter months, and this may be a higher than average water level. No monitoring has yet been undertaken at this borehole.

1.6.11 A large number of drains are recorded in the site which may be intercepting a shallow groundwater table. Historical mapping shows the presence of wet areas, which could have been historically caused by groundwater (Ordnance Survey, 2018b). However, it is considered more likely these are acting to intercept surface water that would otherwise be ponding on the thick impermeable clay-rich soils that have been recorded to underlie the site.

1.6.12 No hydrogeological walkover of Addlestone Moor has been undertaken to confirm the presence of groundwater features.

Habitats and Vegetation

1.6.13 Phase 1 habitat survey was undertaken at Addlestone Moor. More detailed vegetation survey was not undertaken because the site was found to be of low biodiversity value, supporting modified grassland used for grazing. A description of the habitats of the site is provided in Appendix 7.1 Habitats and Botany Factual Report. A habitat plan is provided in Figure A7.1.176.

1.6.14 The site is dominated by grassland, comprising improved and other modified grassland habitats divided into small fields and used for grazing. There is a small field in the centre of the site that is less heavily modified, comprising marshy grassland and supporting vegetation referred to M23b *Juncus acutiflorus/effusus-Galium palustre* rush pasture, *Juncus effusus* sub-community, which is given a high to moderate groundwater dependency in UKTAG guidance. The boundaries of the fields are wooded, and there is a stand of wet woodland to the east, referred to W6 *Alnus glutinosa-Urtica dioica* woodland, rated as low groundwater dependency. The southern part of the site, through which the Order Limits pass, is dominated by improved grassland. Figure A8.3.35 shows the distribution of guideline groundwater dependencies across the site.

CSM

1.6.15 The site is underlain by thick slowly permeable soils that would limit infiltration and become seasonally waterlogged with local precipitation. There may be some surface water runoff from the top of the catchment into the lower areas, as well as from the sides of the valleys, although the small size of the topographic catchment will limit this. Any shallow groundwater is likely to be perched within the thick soils, and not in continuity with any regional groundwater field. It is therefore controlled more by the surface water and local infiltration characteristics. The clay-rich soils mean they are poorly draining, holding water near the surface and feeding the wetland habitats in the site.

1.6.16 The gravel aquifer has only a limited recharge area upgradient of the site, with most of its extent to the north. The high permeability means that there is unlikely to be a large hydraulic gradient maintained within this deposit.

1.6.17 Taking account of the site specific characteristics and limited available NVC mapping, the groundwater dependency from the M23 is downgraded, and it is considered that the site as a whole has a moderate to low groundwater dependency.

1.6.18 Figure A8.3.36 shows a conceptualised cross section of the GWDTE, running from west to east.

Assessment of Effects

1.6.19 The Order Limits pass to the south of the identified rush pasture wetland habitats of Addlestone Moor. The Order Limits pass through the wet woodland habitats identified at the eastern end of the site.

1.6.20 The trench required for installation of the pipeline would likely be above the water table for most of its length adjacent to the site; it may fall below the water table at the far eastern end, where is coincides with the wet woodland. In this instance, a small amount of dewatering may be required. There are some minor patches of potentially low groundwater dependent habitats within the expected area affected by dewatering. The vegetation may therefore be impacted by the dewatering but would be expected to recover following completion of works. Long term impacts on flows are expected to be negligible.

1.6.21 Table 8.3.40 provides a summary of the magnitude of change from different potential effects on groundwater flows supporting Addlestone Moor.

**Table 8.3.40: Summary of Groundwater Flow Effects on Addlestone Moor GWDTE**

| Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|
| Moderate to low | None | Low | Trench dewatering | Construction | Small |
| | | | Flow interception | Operation | Negligible |

## Chertsey Meads

Site Setting, Topography and Hydrological Catchment

1.6.22 The Chertsey Meads site is very flat, with ground elevation around 15mAOD.

1.6.23 The site is bounded on the north and east by the River Thames, and to the south by the Bourne. These define the bounds of the topographical catchment, meaning that there is no runoff external to the site into the area.

1.6.24 The Order Limits run south to north in the west of the site.

Geology and Soils

1.6.25 The site is covered by superficial deposits comprising alluvium, apart from a small area of exposed Kempton Park Gravel Member (BGS, 2018j). It is likely that the Shepperton Gravel Member continues from beneath the River Thames to underlie the alluvium. The bedrock under the site is the Bagshot Formation.

1.6.26 Soils at Chertsey Meads is mapped as being on Thames soil assemblage, described as stoneless mainly calcareous clayey soils affected by groundwater (Cranfield University, 2018).

1.6.27 Eight publicly available boreholes have been identified from within the site (BGS, 2018a) (Table 8.3.41). These generally demonstrate the presence of a comparatively thick clayey layer of alluvium, sometimes with peaty horizons.

1.6.28 Three 2018 GI boreholes were completed either within or immediately adjacent to the site (Figure A8.3.37). This confirmed the presence of thick River Terrace Deposits over a clay and sand bedrock.

**Table 8.3.41: Borehole Log Records from Inside the Site**

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater Strike (mbgl) |
|---|---|---|---|---|
| TQ06NE183 | 0.00 | 0.46 | Dark brown clayey topsoil | 1.22 |
| | 0.46 | 1.52 | Brown silty clay | |
| | 1.52 | 2.29 | Green mottled brown silty clay | |
| | 2.29 | 3.66 | Grey medium to coarse sand | |
| | 3.66 | 4.57 | Grey fine to medium gravel | |
| TQ06NE181 | 0.00 | 0.61 | Brown clayey topsoil | 0.76 |
| | 0.61 | 1.68 | Brown silty clay | |
| | 1.68 | 4.27 | Black fine to medium gravel | |
| | 4.27 | 6.10 | Sand and gravel | |
| TQ06NE184 | 0.00 | 0.91 | Dark brown clayey topsoil | 1.37 |
| | 0.91 | 2.44 | Black peaty clay | |
| | 2.44 | 2.74 | Dark grey fine sandy clay | |
| TQ06NE177 | 0.00 | 0.30 | Brown clayey topsoil | 1.52 |
| | 0.30 | 1.98 | Mottled grey brown silty clay | |
| | 1.98 | 2.59 | Coarse sand with fine gravel | |
| | 2.59 | 6.10 | Brown sandy fine to medium gravel | |
| TQ06NE179 | 0.00 | 0.46 | Dark brown clayey topsoil | 0.86 |
| | 0.46 | 1.37 | Brown peaty sandy clay | |
| | 1.37 | 6.10 | Grey fine to medium gravel | |
| TQ06NE178 | 0.00 | 0.23 | Topsoil and fill | 0.84 |
| | 0.23 | 1.52 | Brown fine sandy clay | |
| | 1.52 | 7.77 | Brown fine to medium gravel | |
| | 7.77 | 9.75 | Grey fine sandy clay | |
| | 9.75 | 10.67 | Light green medium sand | |

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater Strike (mbgl) |
|---|---|---|---|---|
| TQ06NE182 | 0.00 | 1.22 | Brown gravelly topsoil | 1.37 |
| | 1.22 | 6.10 | Brown coarse sand with fine to medium gravel | |
| TQ06NE180 | 0.00 | 0.30 | Brown clayey topsoil | 0.61 |
| | 0.30 | 1.37 | Brown silty clay | |
| | 1.37 | 2.90 | Dark brown clayey fine sand | |
| | 2.90 | 7.92 | Black fine to medium gravel | |
| | 7.92 | 9.14 | Clayey silt | |
| BH26 | 0.00 | 0.32 | Made Ground: dark brown slightly clayey fine to medium sand. | 1.26 |
| | 0.32 | 0.79 | Brown sandy clay. | |
| | 0.79 | 1.26 | Light brown slightly sandy clay. | |
| | 1.26 | 1.68 | Light brown with dark orangish brown slightly clayey sand. | |
| | 1.68 | 1.88 | Multicoloured sandy gravel. | |
| | 1.88 | 3.30 | Dark grey and white very gravelly sand. | |
| | 3.30 | 5.98 | Multicoloured gravel | |
| | 5.98 | 10.20 | Fissured dark grey silty sandy clay. | |
| | 10.20 | 12.70 | Dark green slightly silty sand. | |
| | 12.70 | 16.15 | Dark grey clay. | |
| BH150 | 0.00 | 0.42 | Made Ground: light brown sandy gravelly clay. | Struck: 1.50mbgl<br>Rise: 0.60mbgl |
| | 0.42 | 1.20 | Dark greyish brown slightly gravelly clay. | |
| | 1.20 | 1.48 | Brown slightly gravelly clay. | |
| | 1.48 | 2.28 | Dark grey slightly sandy slightly gravelly silt. | |
| | 2.28 | 3.45 | Multicoloured slightly sandy gravel. | |
| | 3.45 | 4.52 | Light brown gravelly sand. | |
| | 4.52 | 5.01 | Light brown sand. | |
| | 5.01 | 8.39 | Multicoloured slightly sandy gravel. | |
| | 8.39 | 14.90 | Grey slightly silty sand. | |
| | 14.90 | 18.15 | Dark grey slightly silty clay. | |
| BH139 | 0.00 | 0.15 | Dark brown sandy clay (topsoil) | Struck: 1.93mbgl<br>Standing: 1.88mbgl |
| | 0.15 | 1.50 | Light orangish brown slightly sandy clay | |
| | 1.50 | 3.20 | Light orangish brown very sandy gravel | |
| | 3.20 | 3.70 | Light brown sandy slightly gravelly clay | |

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater Strike (mbgl) |
|---|---|---|---|---|
| | 3.70 | 5.20 | Dark grey clayey sandy silt | |
| | 5.20 | 8.00 | Dark grey mottled dark green silty gravelly sand | |
| | 8.00 | 8.80 | Dark brownish grey slightly clayey silty sand | |
| | 8.80 | 9.50 | Dark greyish brown slightly silty slightly sandy clay | |
| | 9.50 | 10.60 | Dark brownish grey clayey silty sand | |
| | 10.60 | 12.00 | Dark brownish grey silty sand | |
| | 12.00 | 13.50 | Dark brownish grey very clayey silty sand | |
| | 13.50 | 15.30 | Dark brownish grey silty sand | |

Groundwater

1.6.29 The site has only a limited susceptibility to clearwater flooding from the bedrock formations (BGS, 2017).

1.6.30 Water strikes in the publicly available BGS (2018a) boreholes and 2018 GI show a shallow groundwater table, often less than 1m below the surface within the superficial deposits. This is likely to be perched above the bedrock water table.

1.6.31 Groundwater monitoring recorded shallow water levels, with BH26 up to 0.88mbgl BH139 0.89mbgl, and BH150 to 0.09mbgl. It should be noted that BH150 is recorded water levels in the deep bedrock, which may have some degree of confinement; BH26 has a very long response zone that covers both the superficial and bedrock aquifers. BH139 has the longest monitoring record, but it still primarily only covers the winter period.

1.6.32 Private water supplies have been identified for properties adjacent to the site (Runnymede Borough Council, 2018), although the depth to water is not known from these.

1.6.33 No hydrogeological site walkover of Chertsey Meads was carried out.

Habitats and Vegetation

1.6.34 Phase 1 habitat survey was undertaken at Chertsey Meads. More detailed vegetation survey was not undertaken due to survey programme constraints, but the NVC affinities of most of the vegetation was identified from the habitat survey. A description of the habitats and vegetation of the site is provided in Appendix 7.1 Habitats and Botany Factual Report. A habitat plan is provided in Figure A7.1.183.

1.6.35 The site is dominated by grassland, with stands of swamp and reedbed and peripheral stands of wet woodland. Most of the grassland comprises improved and poor semi-improved grasslands, but the area northwest of Mead Lane was dominated by semi-improved and unimproved neutral grasslands, with smaller

areas of these habitats to the east. Marshy and inundation grasslands occupied topographic depressions.

1.6.36 The semi-improved and unimproved grasslands comprised vegetation referred to MG5b *Cynosurus cristatus-Centaurea nigra* grassland, *Galium verum* sub-community and MG7c *Lolium perenne* leys and related grasslands*, Lolium perenne-Alopecurus pratensis-Festuca pratensis* grassland. The former plant community is typical of drier situations within floodplain meadows and was found in elevated areas that likely represented areas where river terrace gravels come closer to the surface. The latter plant community was more extensive and is a damp grassland typical of alluvial meadows. The small areas of wet woodland around the site comprise W6b *Alnus glutinosa-Urtica dioica* woodland, *Salix fragilis* sub-community, and swamps comprise S4 *Phragmites australis* swamps and reedbeds and S6 *Carex riparia* swamp.

1.6.37 UKTAG guidance identifies most of these plant communities as having low groundwater dependency, the exception being MG5, which has low to moderate groundwater dependency.

1.6.38 Table 8.3.42 lists the NVC types recorded at the site, alongside the groundwater dependency assigned by the UKTAG (2009) guidance. Figure A8.3.37 shows the distribution of guideline groundwater dependencies across the site.

**Table 8.3.42: UKTAG Derived Groundwater Dependency for Vegetation Encountered at Chertsey Meads**

| NVC Habitat Type* | Groundwater Dependency (according to UKTAG, 2009) |
|---|---|
| MG1 | Not groundwater GWDTE |
| MG5 | Low to moderate |
| MG6 | Not groundwater GWDTE |
| MG7 | Not groundwater GWDTE |
| S4 | Low |
| S6 | Low |
| W6 | Low |

**Refer to Appendix 7.1 Annex G for full list of NVC names and sub-communities*

CSM

1.6.39 Groundwater levels in the Shepperton Gravel Member are likely to be near flat across the entire site due to the small variation in surface topography and high permeability of the deposits. Groundwater is also expected to be hydraulically connected with water levels in the River Thames, and to a lesser extent, the Bourne.

1.6.40 Surface water inputs through direct precipitation and runoff are likely to be an important input to the water balance, with the flat ground surface limiting runoff and the clayey alluvium restricting infiltration rates. Additionally, the water levels within the River Thames may exert an influence over water levels within the site due to the probable hydraulic connection between the two. Taken together and in light of the Phase 1 habitat information, the site is assessed as having a low groundwater dependency.

1.6.41 Figure A8.3.38 shows a conceptualised cross section of the GWDTE, running from southwest to northeast.

Assessment of Effects

1.6.42 The trench required for installation of the pipeline would likely be below the groundwater within the superficial deposits, therefore requiring dewatering to take place during construction. This is expected to result in a temporary dewatering effect. However, the habitats closest to the Order Limits are mostly not groundwater dependent, although there are some small patches of potentially low groundwater dependency within the area expected to be affected by the dewatering. As a result, temporary dewatering is expected to result in a small effect on vegetation. Long term impacts on flows are expected to be negligible.

1.6.43 Table 8.3.43 provides a summary of the magnitude of change from different potential effects on groundwater flows supporting Chertsey Meads.

**Table 8.3.43: Summary of Groundwater Flow Effects on Chertsey Meads GWDTE**

| Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|
| Low | Local Nature Reserve, SNCI | Low | Trench dewatering | Construction | Small |
| | | | Flow interception | Operation | Negligible |

## Dumsey Meadow

Site Setting, Topography and Hydrological Catchment

1.6.44 Dumsey Meadow is located inside a meander of the River Thames, which forms the southern, eastern and western boundaries of the site, flowing from west to east. The topography of the site is very flat, with only 1m of change across the site.

1.6.45 The topographical catchment extends slightly to the north, but with only very slight gradients. Overall, the catchment is small and mostly confined to the site boundary.

1.6.46 The Order Limits pass the site immediately to the east of the site. The proposed construction method would be to use a trenchless crossing beneath the River Thames along the eastern boundary (Appendix 8.2 Detailed Trenchless and Targeted Open Cut Assessments, Section 1.52).

Geology and Soils

1.6.47 Most of the site is over Hucklesbrook soil assemblage, described as well-drained coarse loamy and some sandy soils, commonly over gravel; some similar permeable soils affected by groundwater. The very west of the site is over Thames soil assemblage, described as stoneless mainly calcareous clayey soils affected by groundwater (Cranfield University, 2018).

1.6.48 The site is underlain by the Shepperton Gravel Member, a sand and gravel river terrace deposit. There is some recorded alluvium at the edge of the site, immediately

adjacent to the course of the River Thames. The underlying bedrock is the Bagshot Formation (BGS, 2018j).

1.6.49 An area containing authorised and historical landfills are located to the north of the site (EA, 2018), mapped by BGS (2018j) as worked ground. These are understood to have been part of an aggregate quarrying operation, with the landfills part of the restoration. Some of the mineral extraction area has been left as open water gravel pit lakes.

1.6.50 There is one publicly available borehole from within the site (BGS, 2018a) (Figure A8.3.39). There is one additional borehole available just north of the site. One borehole from the GI is available, located to the east of the site. The boreholes all show a layer of clay (alluvium) over a relatively thick gravel deposit (Table 8.3.44).

**Table 8.3.44: Borehole Records in Proximity to the Dumsey Meadow Site**

| Borehole Ref. | Top (mbgl) | Base (mbgl) | Description | Groundwater Strike (mbgl) |
|---|---|---|---|---|
| TQ06NE7 | 0.00 | 0.15 | Soil | 3.05 |
| | 0.15 | 1.67 | Brown clay | |
| | 1.67 | 7.46 | Gravel (brown) | |
| | 7.46 | 7.92 | Blue sandy clay with sand seams | |
| | 7.92 | 12.34 | Blue sand | |
| | 12.34 | 15.24 | Blue sandy clay | |
| BH25 | 0.00 | 1.80 | Clay | 13.5 |
| | 1.80 | 7.60 | Gravel with bands of sand and coarser gravels | |
| | 7.60 | 8.10 | Sand | |
| | 8.10 | 8.50 | Clay | |
| | 8.50 | 10.40 | Very clayey sand/very sandy clay | |
| | 10.40 | 13.50 | Clay | |
| | 13.50 | 14.60 | Sand | |
| | 14.6 | 20.41 | Clay of varying properties | |
| TQ06NE450 | 0.00 | 1.52 | Grey clay | 1.52 |
| | 1.52 | 2.29 | Soft blue clay | |
| | 2.29 | 2.90 | Silt with pebbles | |
| | 2.90 | 6.71 | Ballast | |
| | 6.71 | 7.32 | Sandy blue clay | |

Groundwater

1.6.51 Groundwater strikes were recorded in the superficial deposits in both boreholes, although the GI borehole only showed groundwater strikes in the bedrock formations (Table 8.3.44). Subsequent groundwater monitoring has recorded water levels in the superficial deposits up to 0.55mbgl in BH25.

1.6.52 A small area in the northwest of the site shows a susceptibility to groundwater flooding at surface, whilst the rest of the site has groundwater flooding susceptibility to below ground structures (BGS, 2017). This suggests that, whilst the water table can reach to relatively shallow levels, it does not exceed ground level.

1.6.53 No hydrogeological site walkover of Dumsey Meadow was undertaken.

Habitats and Vegetation

1.6.54 A detailed description of the habitats and vegetation within the site is provided in Appendix 7.1 Habitats and Botany Factual Report. Habitat and vegetation plans are provided in Figures A7.1.189 and A7.1.191, respectively.

1.6.55 Most of the site is covered by unimproved neutral grassland, with some small areas of swamp or marshy grassland recorded in the various hollows that are seen across the site. Some stands of trees and shrubs were also recorded, scattered around the site. The grassland habitats comprise vegetation referred to as MG1 *Arrhenatherum elatius* grassland and MG5 *Cynosurus cristatus-Centaurea nigra* grassland, which have low groundwater dependency according to UKTAG guidance. The NVC habitats recorded have only either low or low to moderate groundwater dependency.

1.6.56 Table 8.3.45 lists the NVC types recorded at the site, alongside the groundwater dependency assigned by the UKTAG (2009) guidance. Figure A8.3.39 shows the distribution of guideline groundwater dependencies across the site.

**Table 8.3.45: UKTAG Derived Groundwater Dependency for Vegetation Encountered at Dumsey Meadow**

| NVC Habitat Type* | Groundwater Dependency (according to UKTAG, 2009) |
|---|---|
| MG1 | Not groundwater GWDTE |
| MG5 | Low to moderate |
| MG6 | Not groundwater GWDTE |
| MG7 | Not groundwater GWDTE |
| MG11 | Low to moderate |
| MG12 | Not groundwater dependent |
| MG13 | Low to moderate |
| OV23 | Not groundwater dependent |
| OV24 | Not groundwater dependent |
| OV27 | Not groundwater dependent |
| OV28 | Not groundwater dependent |
| S5 | Low |
| S6 | Low |
| S8 | Low |
| S19 | Low |
| S22 | Low |
| S28 | Low |
| W6 | Low |
| W21 | Not groundwater dependent |

| NVC Habitat Type* | Groundwater Dependency (according to UKTAG, 2009) |
|---|---|
| W22 | Not groundwater dependent |
| W24 | Not groundwater dependent |

**Refer to Appendix 7.1 Annex G for full list of NVC names and sub-communities*

CSM

1.6.57 The groundwater recharge area for Dumsey Meadow is very small, restricted by the presence of the River Thames, and the quarrying and landfill operations to the north of the site.

1.6.58 Groundwater levels within the Shepperton Gravel Member are expected to be in hydraulic continuity with water levels in the River Thames. The water table is expected to remain relatively flat, due to being bounded on three sides by the river, with some potential for minor riparian flow shortcutting the meander. Groundwater is expected to vary through the year closely in line with the river levels, with recharge of groundwater in the site restricted to direct precipitation and indirect recharge through bank flow.

1.6.59 The areas of lower topography, such as the hollows and ditches where wet grassland and swamp habitats are present, are expected to be wetter due to the water table being closer to the ground surface. These habitats are therefore partially supported by groundwater, although closely linked to the river fluctuations. The areas of lower topography will also naturally collect runoff, concentrating the local precipitation into smaller areas. These habitats are therefore likely to also be partially surface water fed. Higher water tables in these areas will also help to maintain surface water ponding by preventing infiltration.

1.6.60 The assessment has generally shown the dependency to likely be the same as recorded by UKTAG guidance at this site, giving small areas of low to moderate dependency in the localised hollows. These areas will be supported by a combination of groundwater and surface water.

1.6.61 Figure A8.3.40 shows a conceptualised cross section of the potential GWDTE, running from southwest to northeast.

Assessment of Effects

1.6.62 Due to the localised nature of the assessed groundwater dependency, Dumsey Meadow has been split into two sub-sites for the purposes of the effect assessment:

- Hollows sub-site, comprising the isolated low-lying areas in the microrelief of the site where groundwater approaches the surface; and
- High ground sub-site, comprising the higher parts that make up the rest of the site between the hollows.

1.6.63 The high ground sub-site contains the areas with no groundwater dependency. As such, there would be no effect.

1.6.64 The construction method closest to the site is proposed to be by trenchless HDD crossing, which does not require any dewatering, except at the launch and reception

end points where shallow excavations equivalent to trench depth are expected. However, the launch and reception end points would be located well outside Dumsey Meadow. As such, it is not expected that there would be any effect on the hydrogeology supporting Dumsey Meadow hollows during construction and operation.

1.6.65 The superficial River Terrace Deposits and the bedrock Bagshot Formation are both permeable clastic aquifers and are therefore likely to be in continuity. Therefore, there is a low risk of connecting two previously disconnected aquifers during the construction of a trenchless crossing.

1.6.66 Table 8.3.46 provides a summary of the magnitude of change from different potential effects groundwater flows supporting Dumsey Meadow.

**Table 8.3.46: Summary of Groundwater Flow Effects on Dumsey Meadow GWDTE**

| Sub-site | Groundwater Dependency | Designation | Value | Effect | Timing | Magnitude of Change |
|---|---|---|---|---|---|---|
| Dumsey Meadow hollows | Low to moderate | SSSI | High | Trenchless crossing dewatering | Construction | None |
| | | | | Flow interception | Operation | None |
| | | | | Connection of aquifers | Construction / operation | Negligible |
| Dumsey Meadow high ground | None | SSSI | Medium | Trench dewatering | Construction | None |
| | | | | Flow interception | Operation | Negligible |
| | | | | Connection of aquifers | Construction / operation | None |

## 1.7 References

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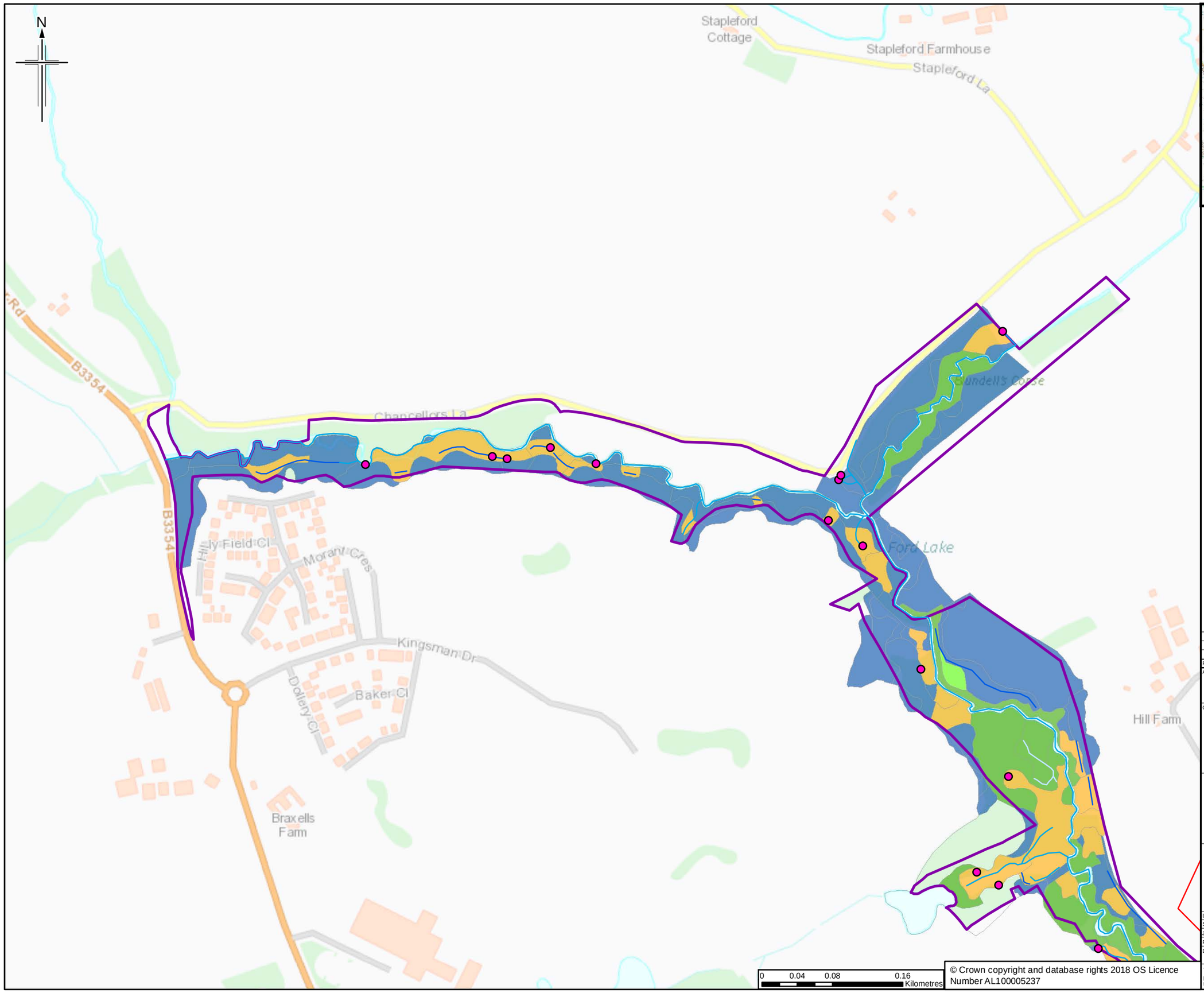
# Figures






**Legend**

- Order Limits
- Potential GWDTE site
- Boreholes
- Trenchless crossing

Hydrologic Features

- Flowing watercourse
- Seepage
- Watercourse
- Spring

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section A

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| 0 | 6/03/2019 | For Issue | HM | JW | VSM | SH |

Author
JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client
Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project
Esso | Southampton to London Pipeline Project

Drawing title
ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND
GROUNDWATER DEPENDENCY - FORD LAKE
APFP Reg. (2009) 5(2)(l)

| | | |
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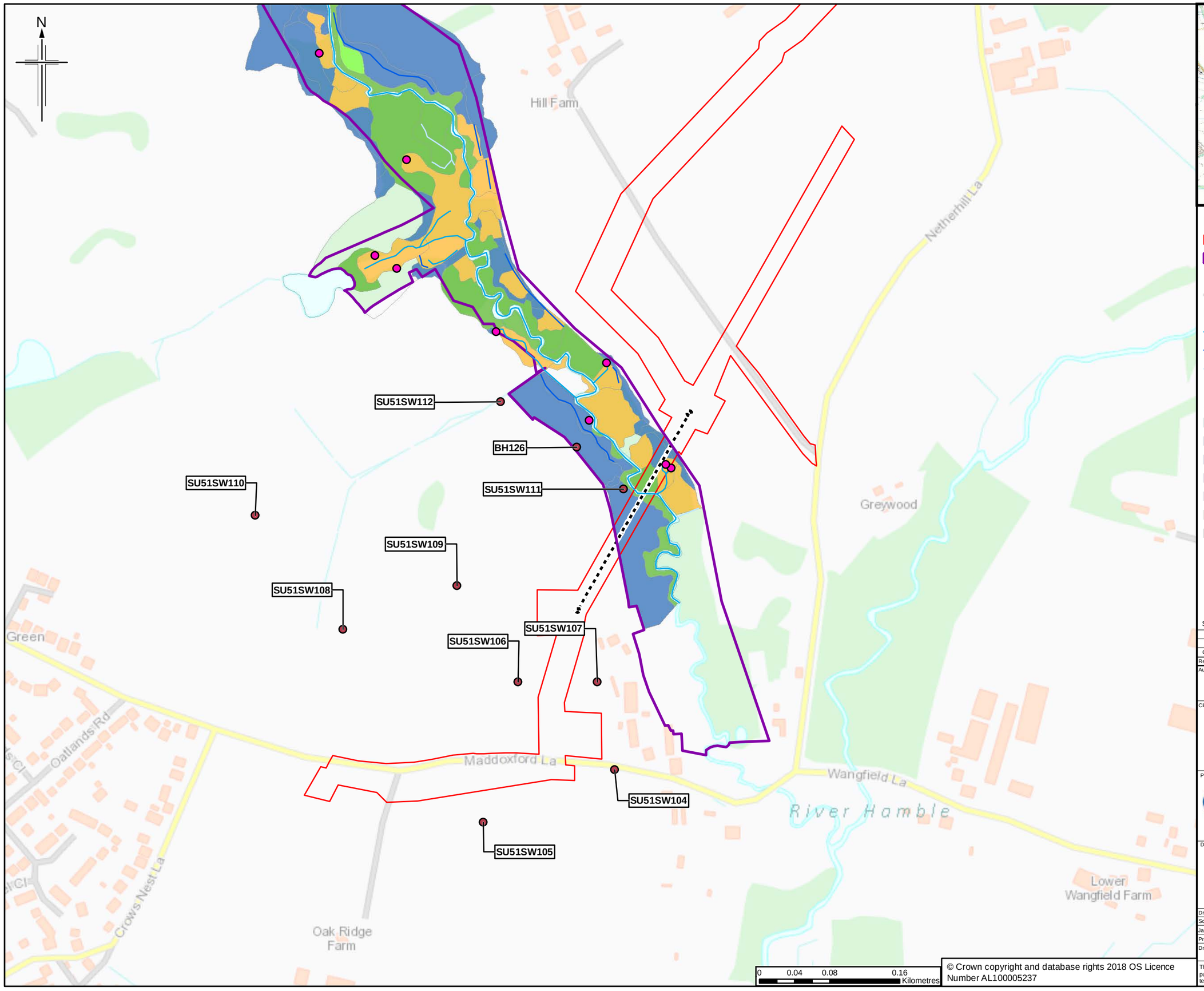
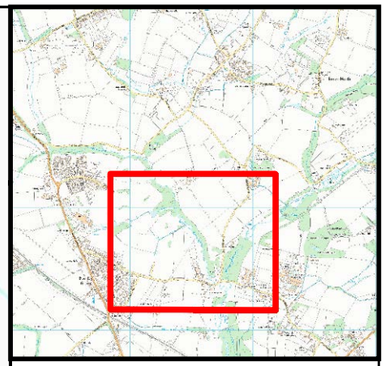
| Drawing number | Figure A8.3.1 Sheet 1 of 2 | Rev 0 |





**Legend**

- Order Limits
- Potential GWDTE site
- Boreholes
- Trenchless crossing

Hydrologic Features

- Flowing watercourse
- Seepage
- Watercourse
- Spring

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section A

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| 0 | 6/03/2019 | For Issue | HM | JW | VSM | SH |

Author
JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client
Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

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ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND
GROUNDWATER DEPENDENCY - FORD LAKE
APFP Reg. (2009) 5(2)(l)

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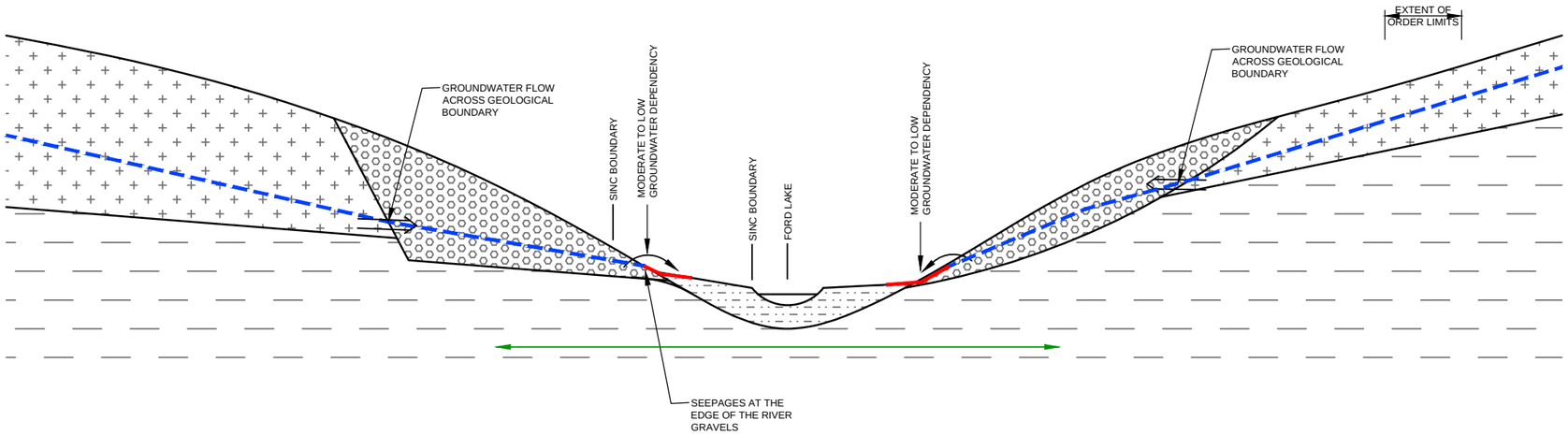
FORD LAKE LOCATION PLAN

Scale 1:5000




TYPICAL SECTION A-A

Scale NTS


KEY PLAN

LEGEND

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- SANDY SILTY CLAY - ALLUVIUM
- SAND & GRAVEL - RIVER TERRACE DEPOSITS
- CLAYEY SAND - WITTERING FORMATION
- SILTY CLAY - LONDON CLAY FORMATION
- EXTRAPOLATED GROUNDWATER LEVEL
- TRENCHLESS PORTIONS
- ORDER LIMITS
- CROSS SECTION ALIGNMENT



0 50 100 150 200 250 m

SCALE 1 : 5000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
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JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited, Ermyn House, Ermyn Way, Leatherhead, Surrey, KT22 8UX

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Drawing title: FORD LAKE CSM FIGURE A8.3.2

Drawing status: Initial Status or WIP

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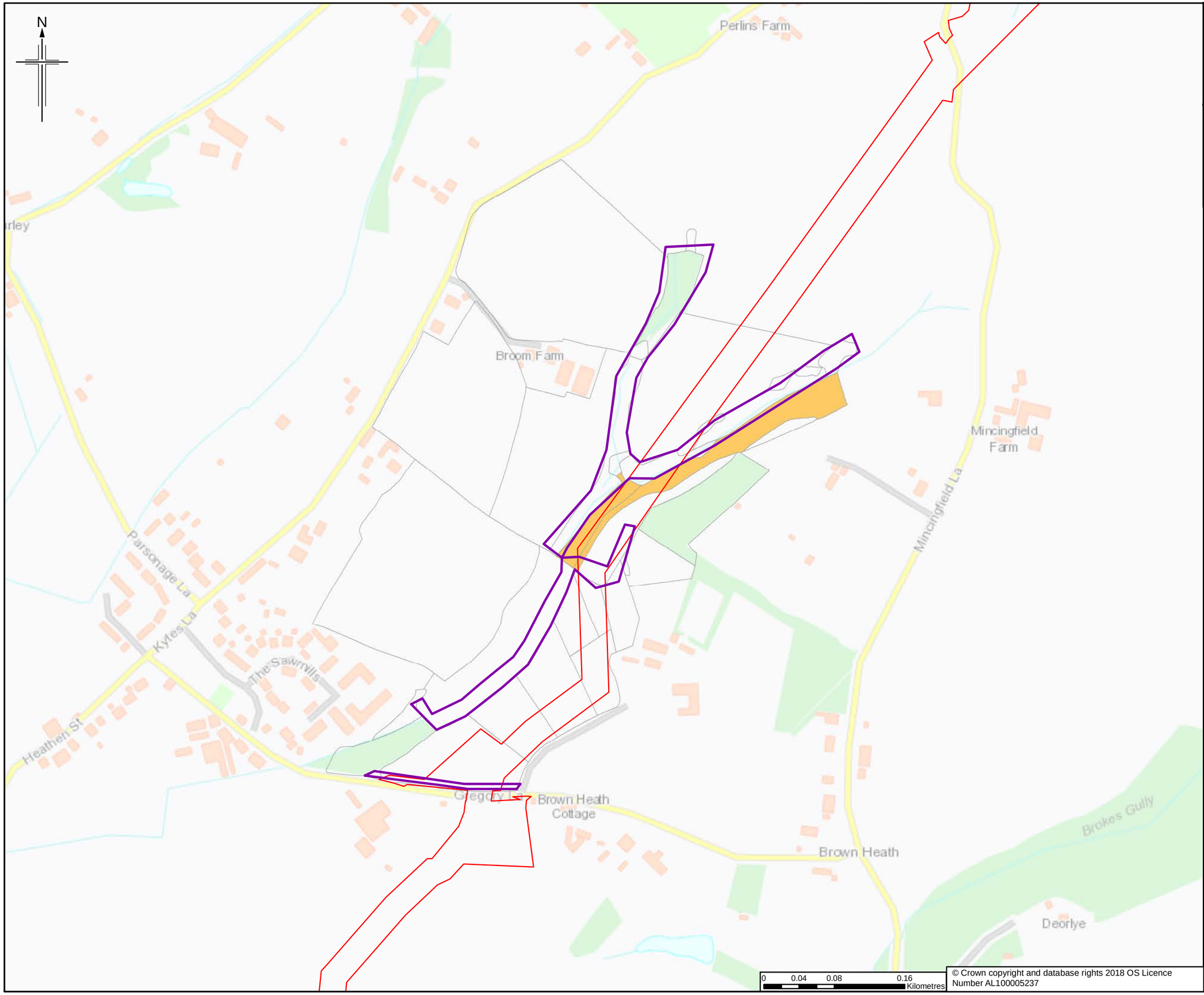


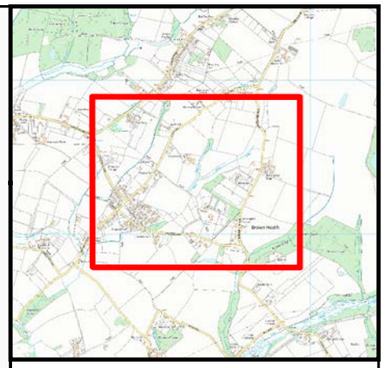

**Legend**

- Order Limits
- Potential GWDTE site

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section A

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| 0 | 12/03/2019 | For Issue | HM | JW | VSM | SH |

Author

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project

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ENVIRONMENTAL STATEMENT
NVC HABITAT SURVEY AND
GROUNDWATER DEPENDENCY
- DURLEY GREEN LANE
APFP Reg. (2009) 5(2)(l)

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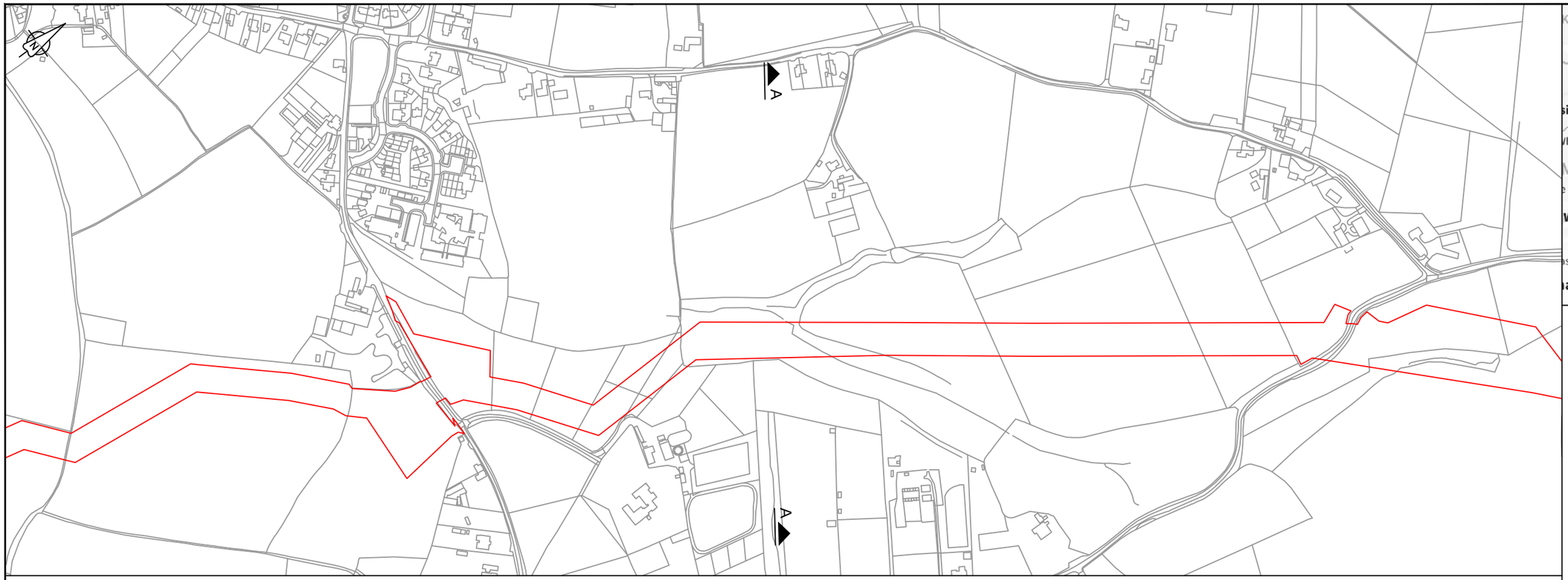
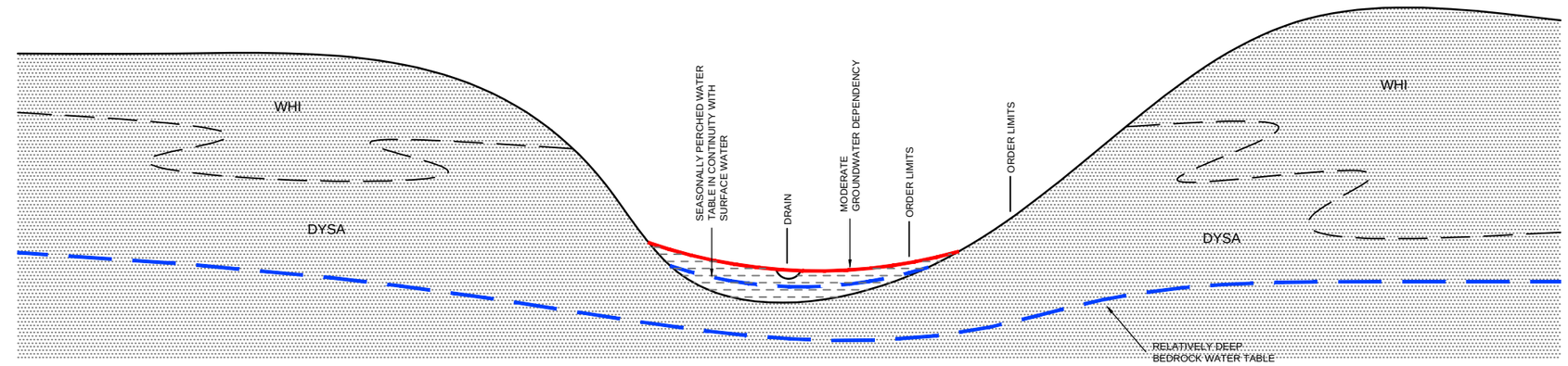



DURLEY GREEN LANE LOCATION PLAN

Scale 1:5000




TYPICAL SECTION A-A

Scale NTS


KEY PLAN

LEGEND

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- THICK CLAY-RICH SUBSOILS
- WHI — SAND - WHITECLIFF SAND MEMBER
- DYSA — SAND - DURLEY SAND MEMBER
- EXTRAPOLATED GROUNDWATER LEVEL
- ORDER LIMITS
- CROSS SECTION ALIGNMENT



0 50 100 150 200 250 m

SCALE 1 : 5000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Appr'd |
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JACOBS

1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey.
KT22 8UX

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# DURLEY GREEN LANE CSM FIGURE A8.3.4

Drawing status: Initial Status or WIP

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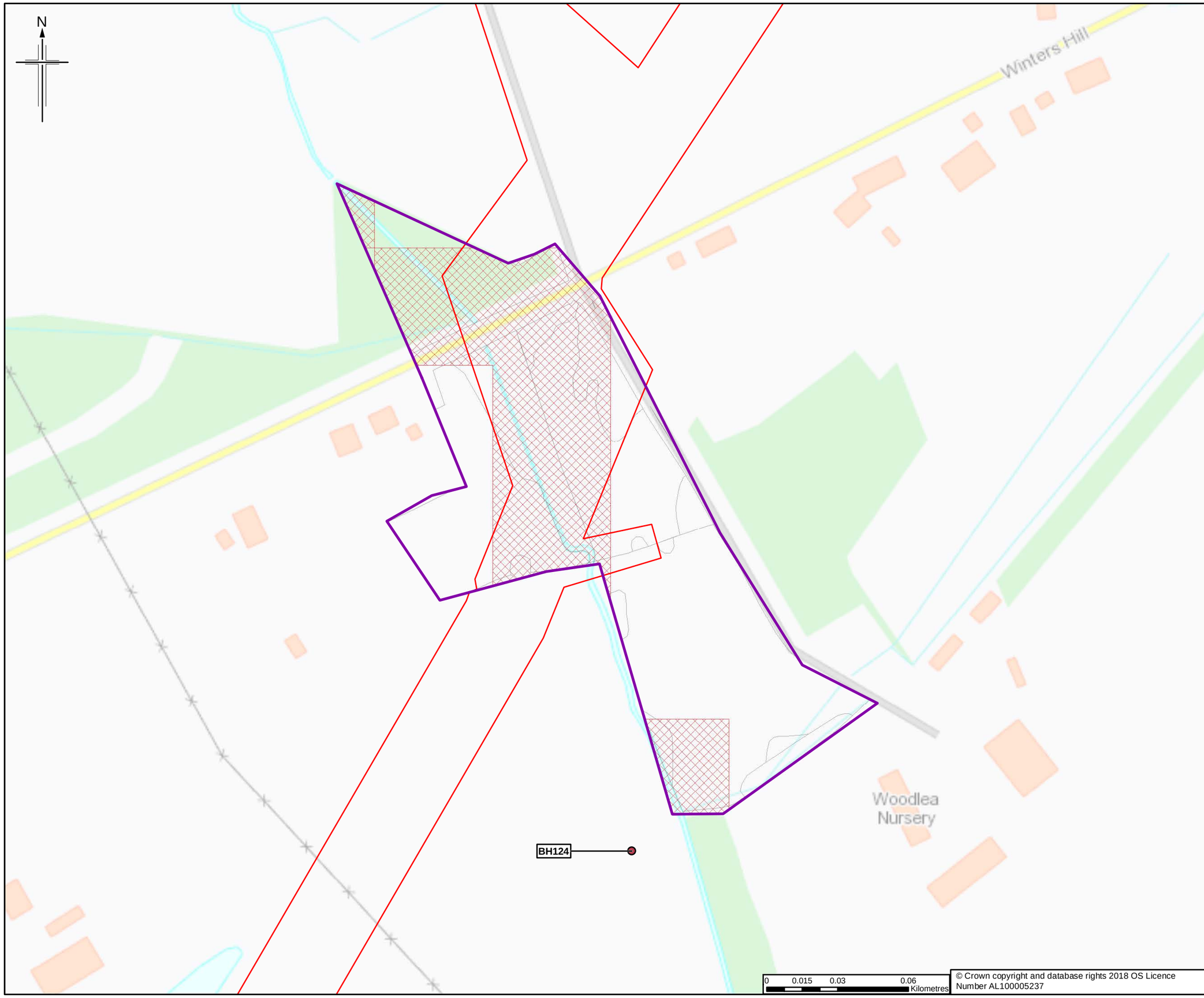


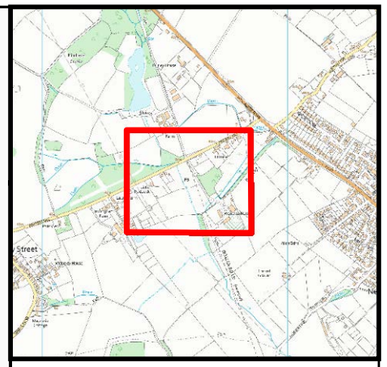

**Legend**

- Order Limits
- Potential GWDTE site
- Boreholes

**Groundwater Flooding Susceptibility**

- Potential for groundwater flooding to occur at surface

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section A

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| 0 | 6/03/2019 | For Issue | HM | JW | VSM | SH |

Author
JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client
Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

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ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND GROUNDWATER DEPENDENCY
- WINTERSHILL FLOODPLAIN
APFP Reg. (2009) 5(2)(l)

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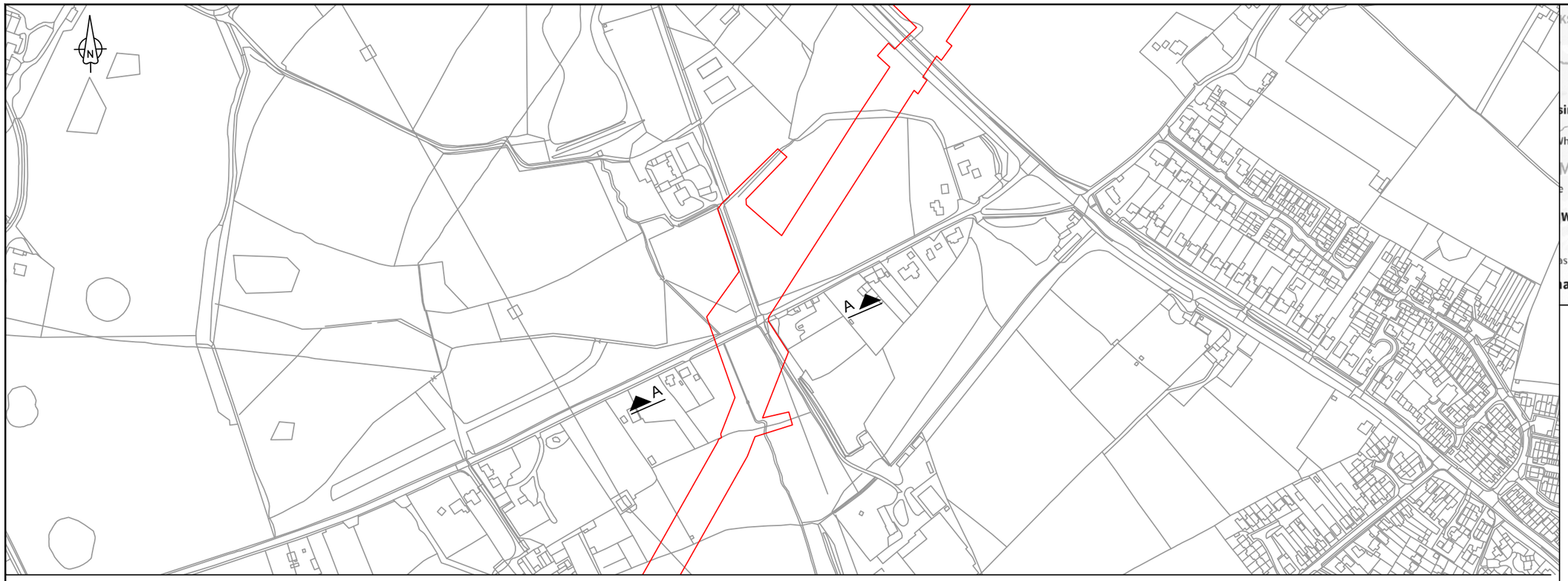
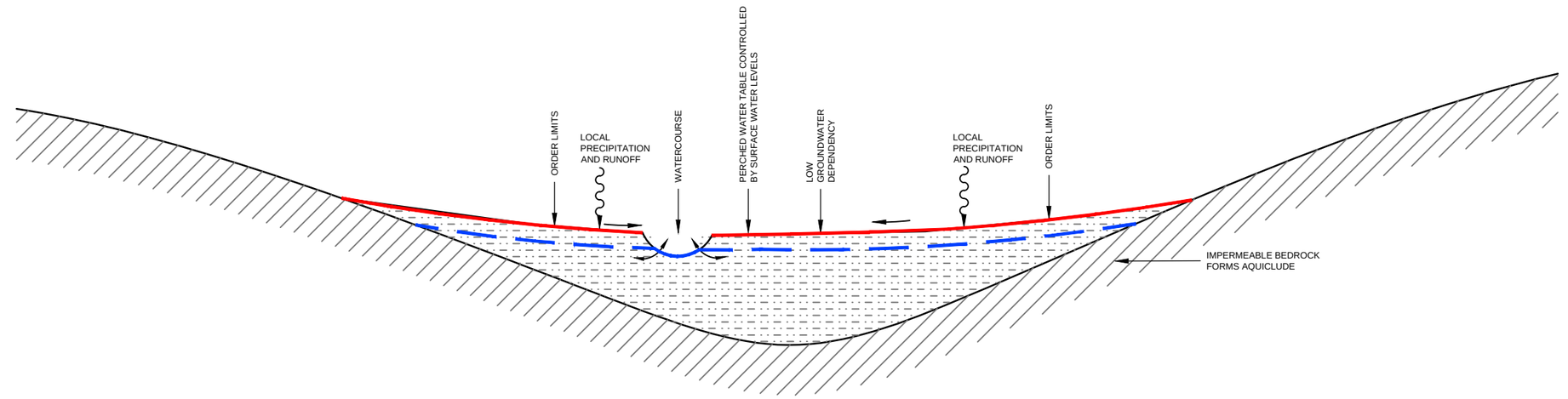



WINTERSHILL LOCATION PLAN

Scale 1:5000




TYPICAL SECTION A-A

Scale NTS


KEY PLAN

LEGEND

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- DEEP CLAY-RICH SOILS AND ALLUVIUM
- BEDROCK - LONDON CLAY FORMATION
- EXTRAPOLATED GROUNDWATER LEVEL
- ORDER LIMITS
- CROSS SECTION ALIGNMENT

0 50 100 150 200 250 m

SCALE 1 : 5000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
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JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

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# WINTERSHILL FLOODPLAIN CSM FIGURE A8.3.6

Drawing status: Initial Status or WIP

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Drawing number: B2325300-JAC-000-ENV-DRG-001536



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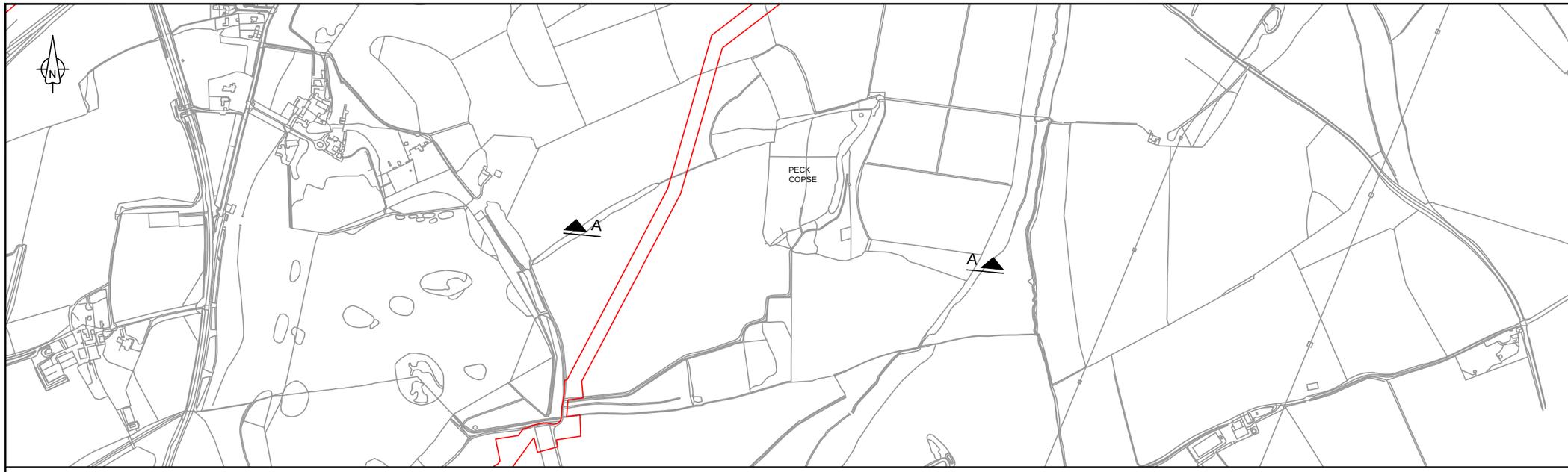
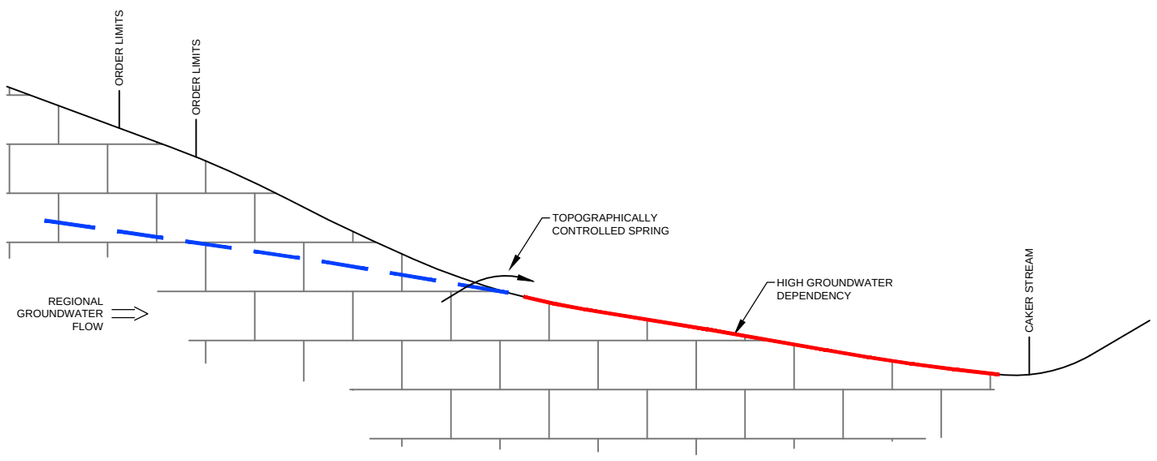



PECK COPSE LOCATION PLAN

Scale 1:10000




TYPICAL SECTION A-A

Scale NTS


KEY PLAN

LEGEND

VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY

GROUNDWATER FLOWS SUPPORTING THE VEGETATION FROM WIDER HYDROGEOLOGICAL CATCHMENT

EXTRAPOLATED GROUNDWATER LEVEL

ORDER LIMITS

WEST MELBURY MARLY CHALK

CROSS SECTION ALIGNMENT



0 100 200 300 400 500 m

SCALE 1 : 10000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Appv'd |
|---|---|---|---|---|---|---|
| P01.1 | 31/01/19 | DESIGN FREEZE DCO | PM | JW | JW | SH |

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

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PECK COPSE
CSM
FIGURE A8.3.7

Drawing status: Initial Status or WIP

| | | |
|---|---|---|
| Scale | AS SHOWN | DO NOT SCALE |
| Jacobs No. | B2325300 | Rev P01.1 |
| Client no. | | |

Drawing number: B2325300-JAC-000-ENV-DRG-001537



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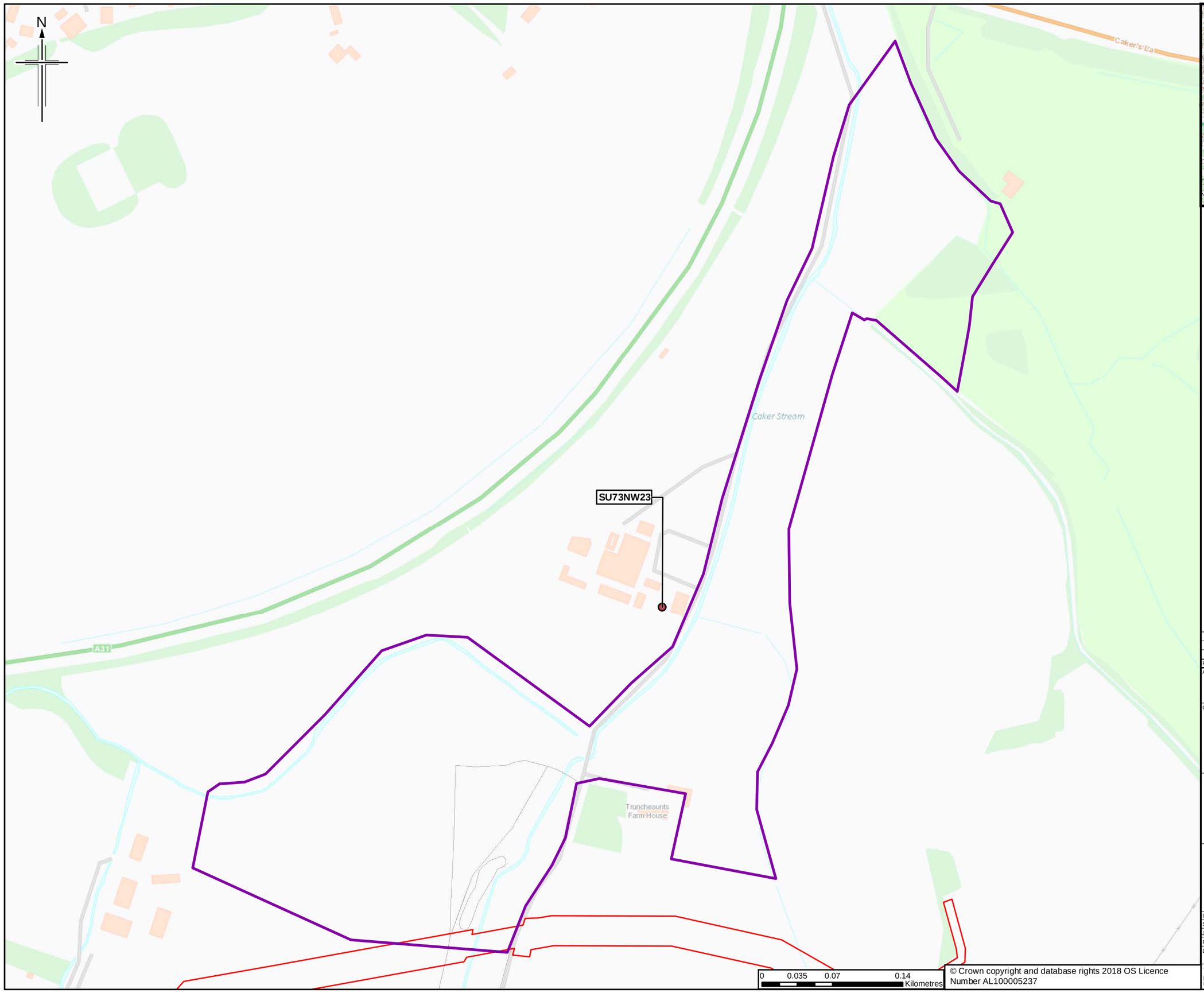
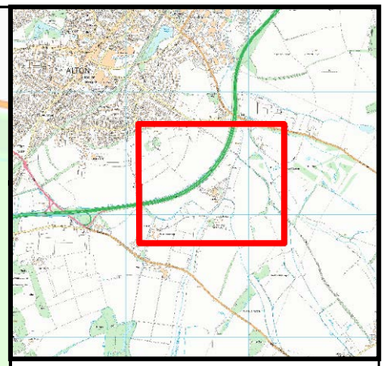



**Legend**

- Order Limits
- Potential GWDTE site
- Boreholes

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section C

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| 0 | 6/03/2019 | For Issue | HM | JW | VSM | SH |

Author

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

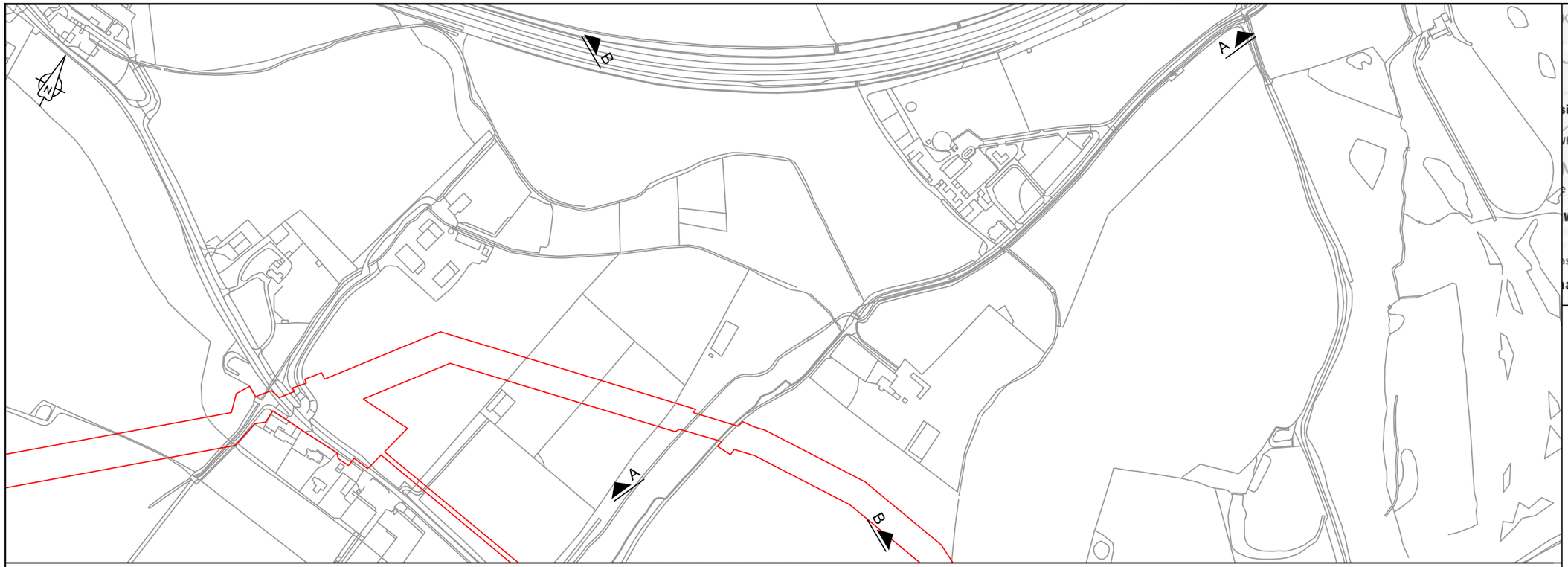
Project

Esso | Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND GROUNDWATER DEPENDENCY - CAKER AND LAVANT STREAMS FLOODPLAIN
APFP Reg. (2009) 5(2)(l)

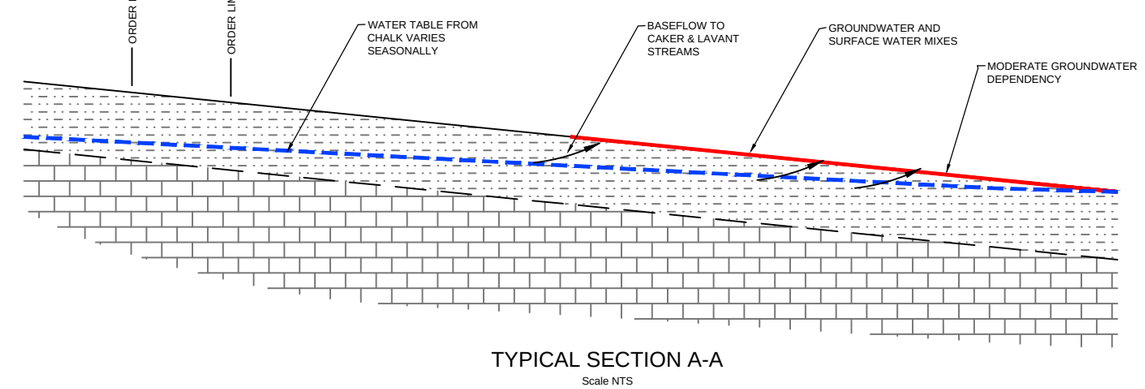
| | | | |
|---|---|---|---|
| Drawing Status | For Issue | | |
| Scale | 1:3,500 @ A3 | DO NOT SCALE | |
| Jacobs No. | B2325300 | | |
| ProjectWise No. | B2325300-JAC-000-ENV-DRG-001538 | | |
| Drawing number | Figure A8.3.8 Sheet 1 of 1 | Rev | 0 |




# CAKER & LAVANT STREAM FLOODPLAIN LOCATION PLAN

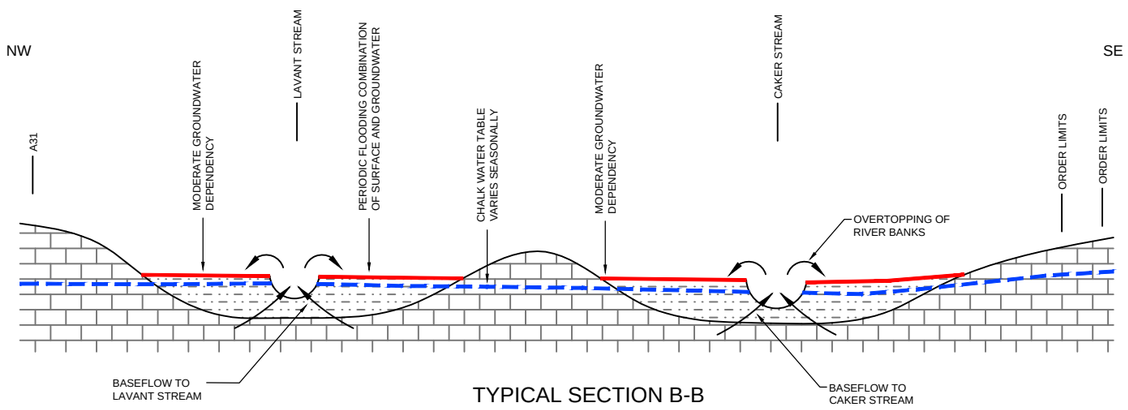
Scale 1:5000


KEY PLAN




TYPICAL SECTION A-A

Scale NTS




TYPICAL SECTION B-B

Scale NTS

LEGEND

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- SANDY SILTY CLAY - ALLUVIUM OR HEAD
- WEST MELBURY MARLY CHALK FORMATION
- EXTRAPOLATED GROUNDWATER LEVEL
- ORDER LIMITS
- CROSS SECTION ALIGNMENT



0 50 100 150 200 250 m

SCALE 1 : 5000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
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JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey.
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Drawing title

CAKER & LAVANT STREAM CSM
FIGURE A8.3.9

Drawing status: Initial Status or WIP

| | | |
|---|---|---|
| Scale | AS SHOWN | DO NOT SCALE |
| Jacobs No. | B2325300 | Rev P01.1 |
| Client no. | | |

Drawing number: B2325300-JAC-000-ENV-DRG-001539



DRAFT

N

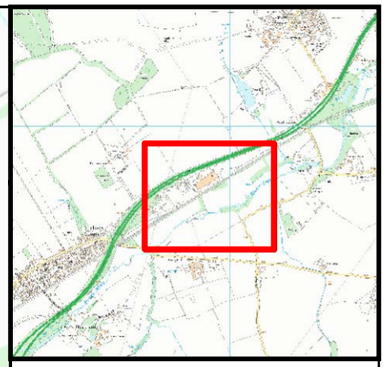
A31

BH69

BH98

0 0.025 0.05 0.1 Kilometres





**Legend**

- Order Limits
- Potential GWDTE site
- Boreholes
- Trenchless Crossing

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section C

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| 0 | 6/03/2019 | For Issue | HM | JW | VSM | SH |

Author
JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client
Esso Petroleum Company, Limited
Ermyn House,
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Surrey,
KT22 8UX

Project
Esso | Southampton to London Pipeline Project

Drawing title
ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND GROUNDWATER DEPENDENCY
- FLOOD PLAIN OF RIVER WEY
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | For Issue | |
| Scale | 1:2,500 @ A3 | DO NOT SCALE |
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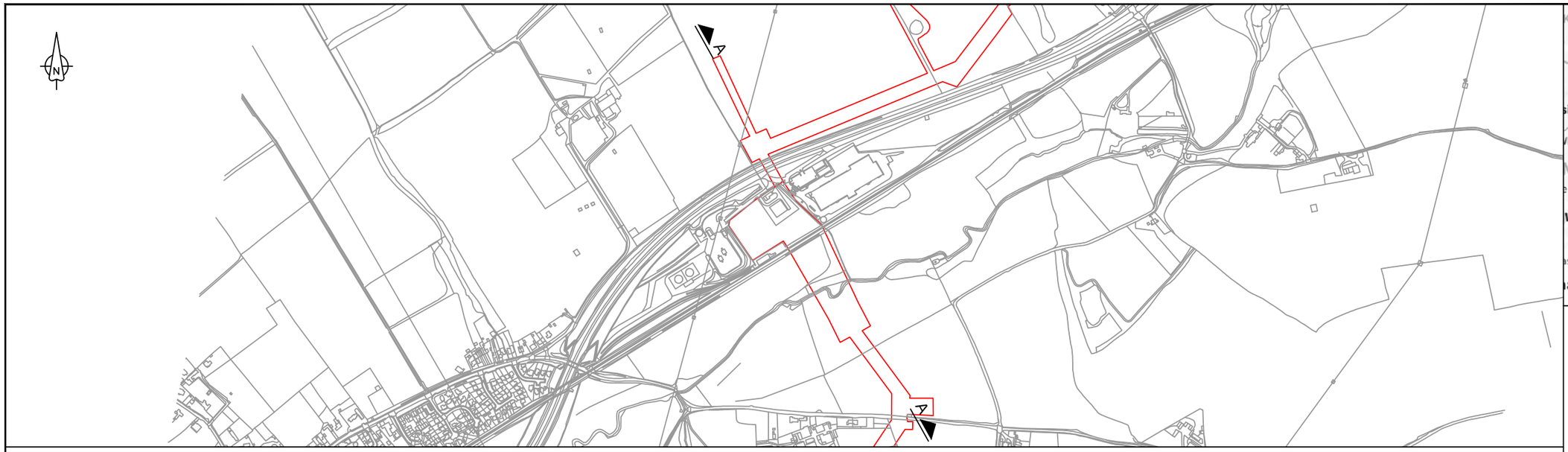
| ProjectWise No. | B2325300-JAC-000-ENV-DRG-001540 | |

Drawing number: Figure A8.3.10 Sheet 1 of 1 — Rev 0



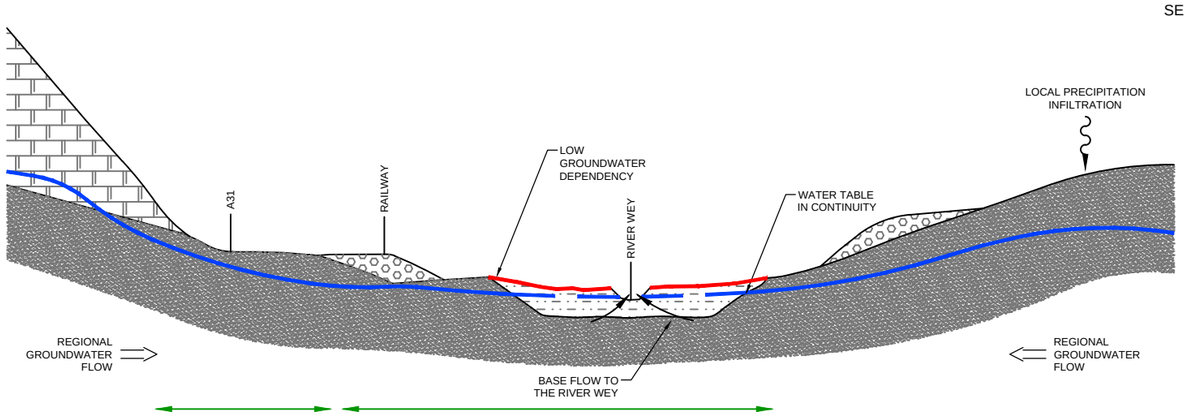

FLOODPLAIN OF THE RIVER WEY LOCATION PLAN

Scale 1:10,000


KEY PLAN

LEGEND

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- GROUNDWATER FLOWS SUPPORTING THE VEGETATION FROM WIDER HYDROGEOLOGICAL CATCHMENT
- SANDY SILTY CLAY -ALLUVIUM
- SAND AND GRAVEL - RIVER TERRACE DEPOSITS
- WEST MELBURY MARLEY CHALK FORMATION
- SILTY SAND - UPPER GREENSAND FORMATION
- EXTRAPOLATED GROUNDWATER LEVEL
- TRENCHLESS PORTIONS
- CROSS SECTION ALIGNMENT




TYPICAL SECTION A-A

Scale NTS



0 100 200 300 400 500 m

SCALE 1 : 10,000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
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JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

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Drawing title

# FLOODPLAIN OF RIVER WEY CSM FIGURE A8.3.11

Drawing status: Initial Status or WIP

| | | |
|---|---|---|
| Scale | AS SHOWN | DO NOT SCALE |
| Jacobs No. | B2325300 | Rev P01.1 |
| Client no. | | |

Drawing number: B2325300-JAC-000-ENV-DRG-001541



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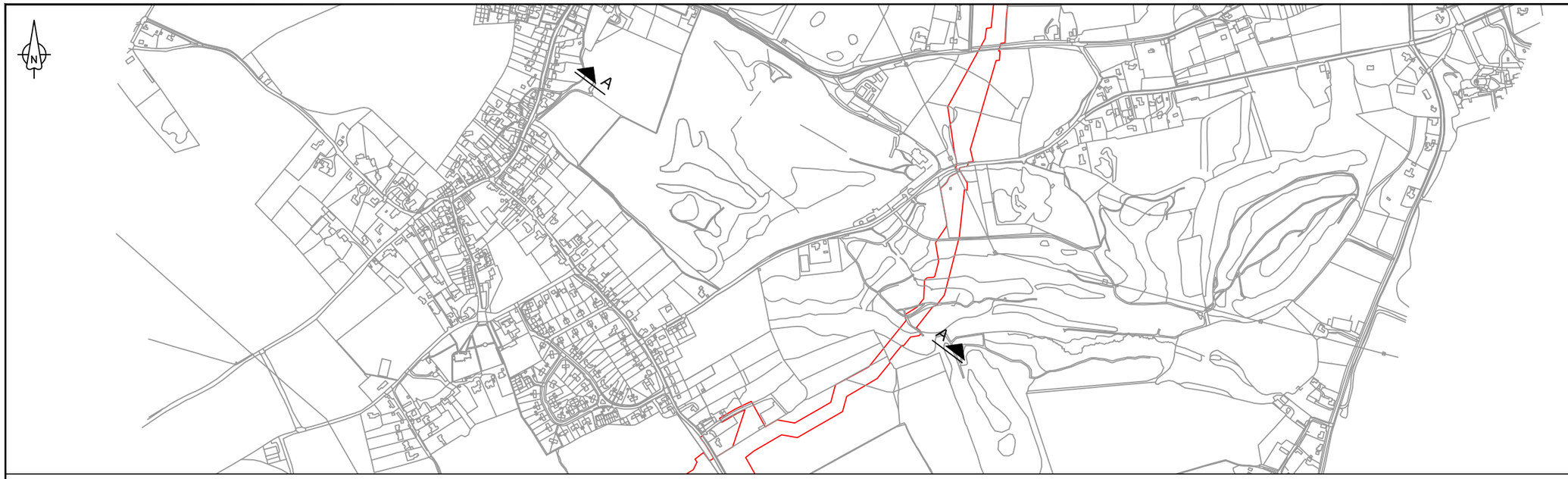
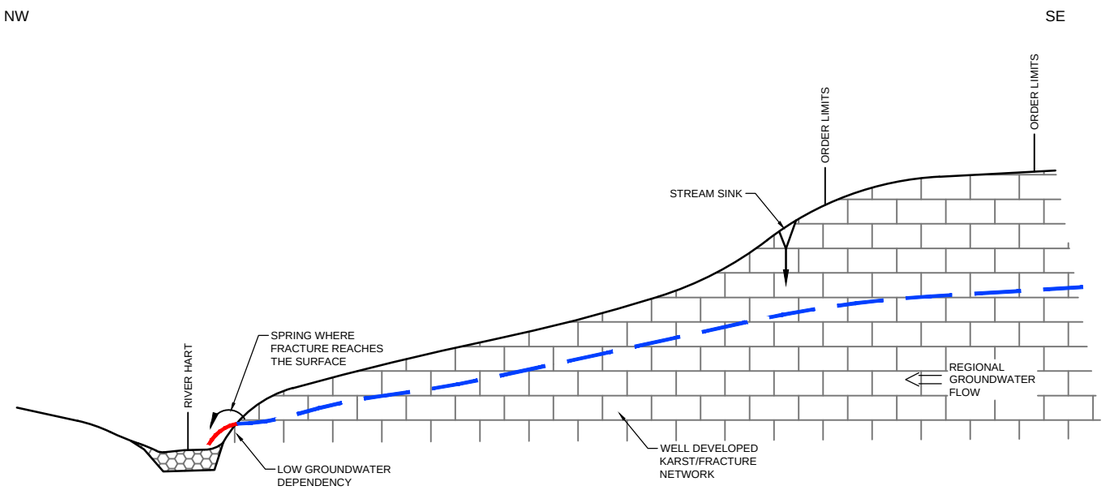



ASHLEY HEAD SPRING LOCATION PLAN

Scale 1:10,000




TYPICAL SECTION A-A

Scale NTS


KEY PLAN

LEGEND

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- GROUNDWATER FLOWS SUPPORTING THE VEGETATION FROM WIDER HYDROGEOLOGICAL CATCHMENT
- EXTRAPOLATED GROUNDWATER LEVEL
- SAND & GRAVEL - RIVER TERRACE DEPOSITS
- CHALK
- ORDER LIMITS
- CROSS SECTION ALIGNMENT



0 100 200 300 400 500 m

SCALE 1 : 10,000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
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JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
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Client: Esso Petroleum Company, Limited
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ASHLEY HEAD SPRING
CSM
FIGURE A8.3.12

Drawing status: Fit for Internal Review and Comment

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|---|---|---|
| Jacobs No. | B2325300 | Rev P01.1 |
| Client no. | | |

Drawing number: B2325300-JAC-000-ENV-DRG-001543



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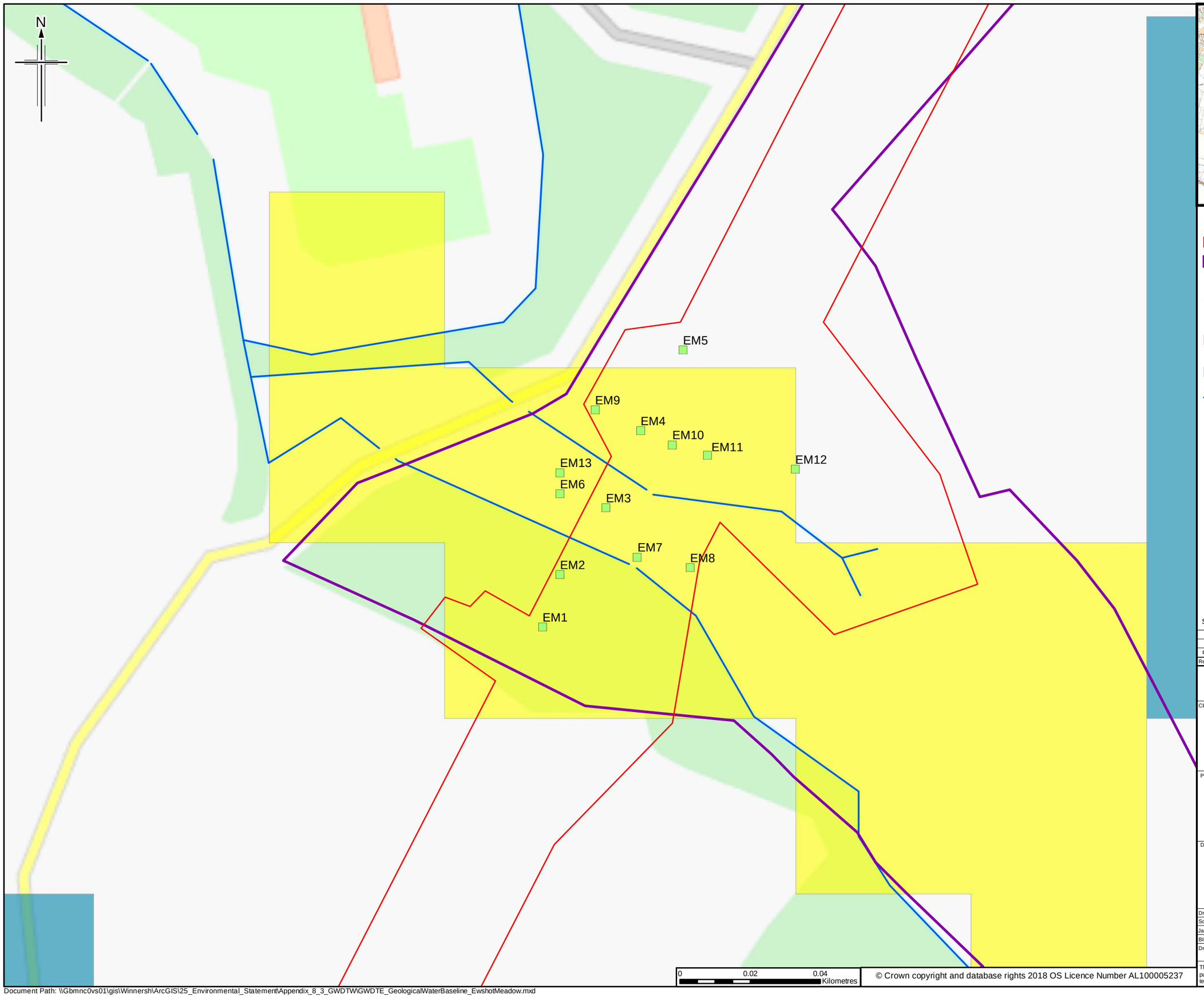


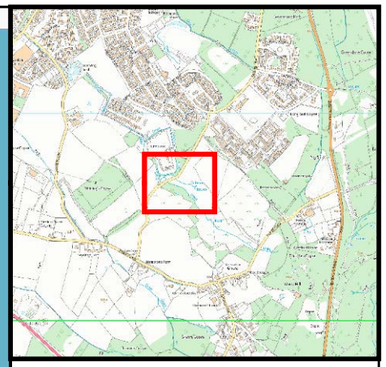

**Legend**

- Order Limits
- Potential GWDTE site
- Soil coring

**Groundwater Flooding Susceptibility**

- Limited potential for groundwater flooding to occur
- Potential for groundwater flooding to occur at surface
- Surface Water

Sheet displays part of Section D

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| 0 | 1/04/2019 | Initial Draft | HM | MB | VSM | SH |

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
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Ermyn House,
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Leatherhead,
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GEOLOGICAL AND GROUDNWATER BASELINE INFORMATION
EWSHOT MEADOWS
APFP Reg.(2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | Draft | |
| Scale | 1:1,000 @ A3 | DO NOT SCALE |
| Jacobs No. | B2325300 | |
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| Drawing number | Figure A8.3.13 Sheet 1 of 1 | Rev 0 |



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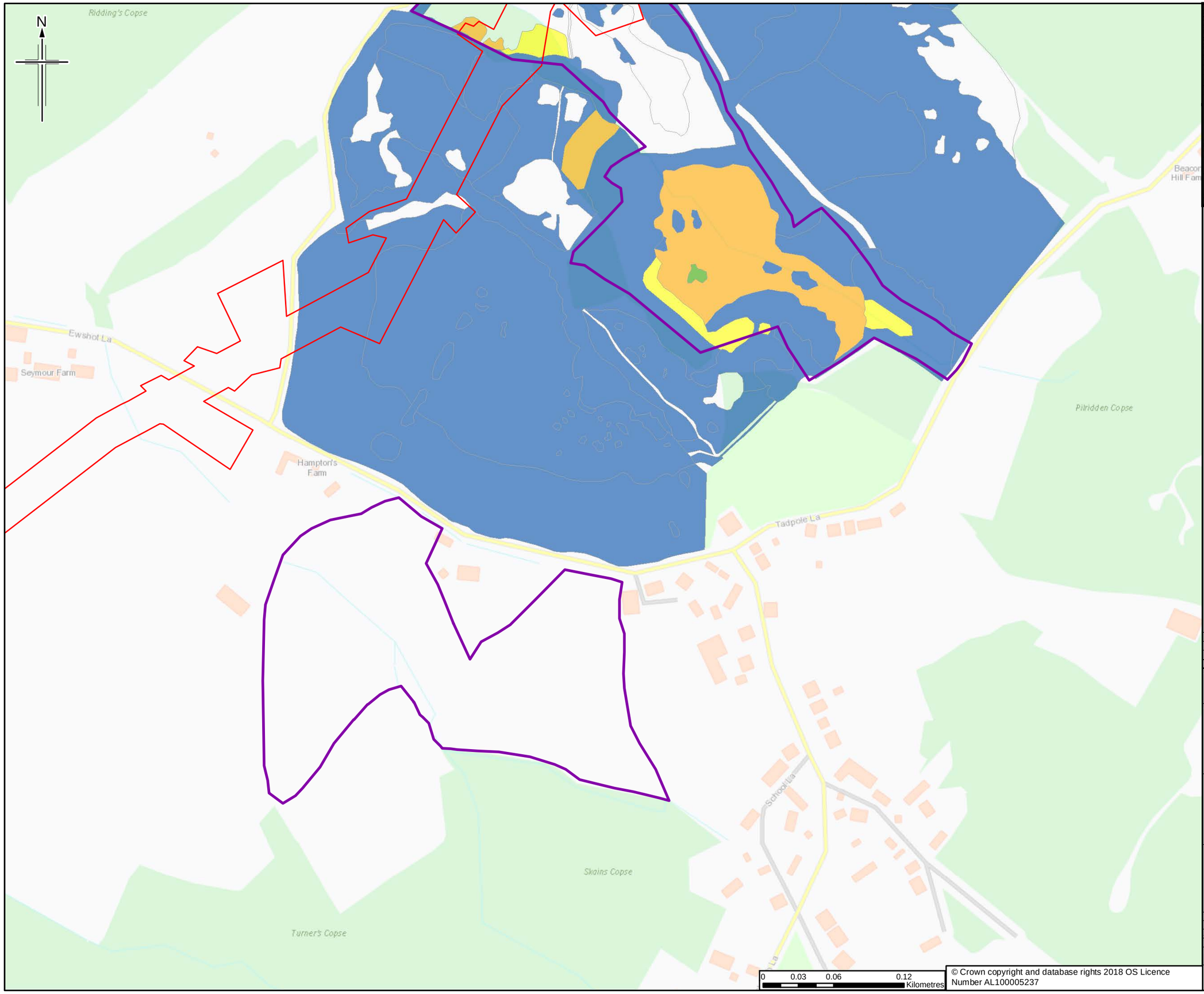


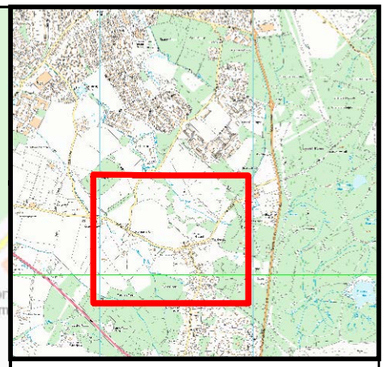

**Legend**

- Order Limits
- Potential GWDTE site

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays part of Section D

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| 0 | 6/03/2019 | For Issue | HM | MB | VSM | SH |

Author

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

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Drawing title

ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND
GROUNDWATER DEPENDENCY
- EWSHOT MEADOWS
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | **For Issue** | |
| Scale | **1:3,000 @ A3** | **DO NOT SCALE** |
| Jacobs No. | **B2325300** | |
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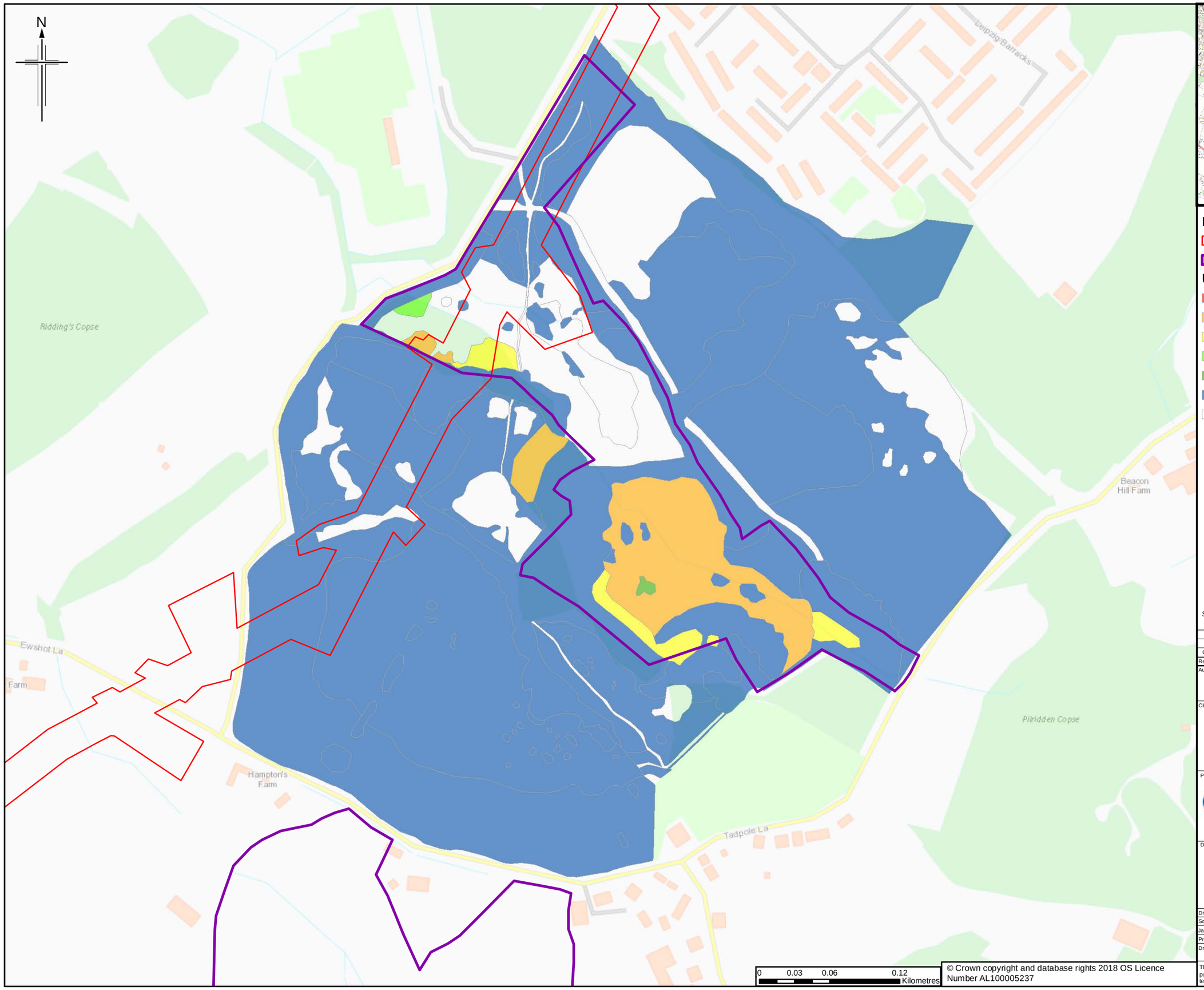
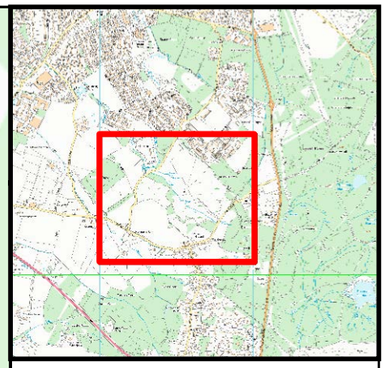
Drawing number: Figure A8.3.14 Sheet 1 of 2 — Rev 0



**Legend**

- Order Limits
- Potential GWDTE site

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays part of Section D

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| 0 | 6/03/2019 | For Issue | HM | MB | VSM | SH |

Author

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
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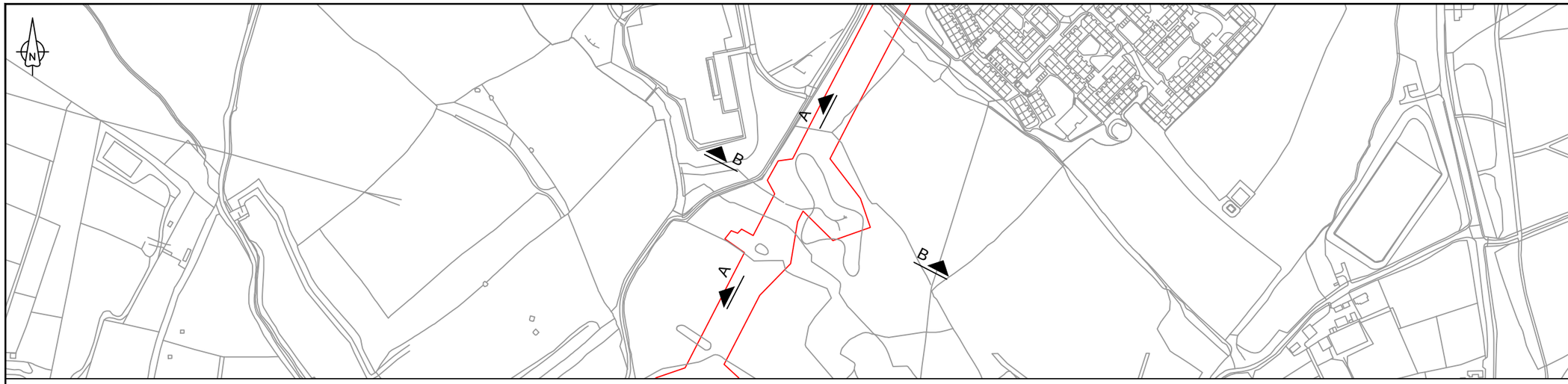
Drawing title

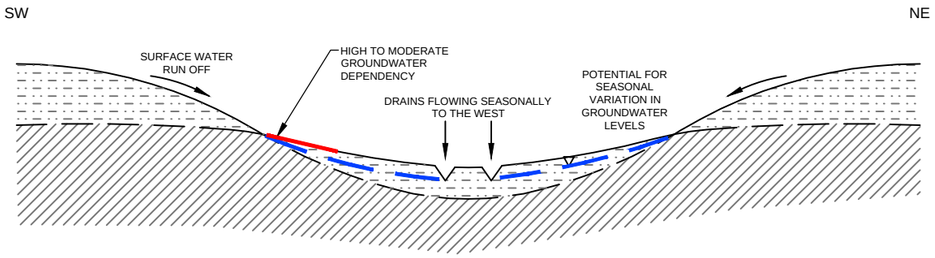
ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND
GROUNDWATER DEPENDENCY
- EWSHOT MEADOWS
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | **For Issue** | |
| Scale | **1:3,000 @ A3** | **DO NOT SCALE** |
| Jacobs No. | **B2325300** | |
| ProjectWise No. | **B2325300-JAC-000-ENV-DRG-001545** | |
| Drawing number | Figure A8.3.14 Sheet 2 of 2 | Rev 0 |



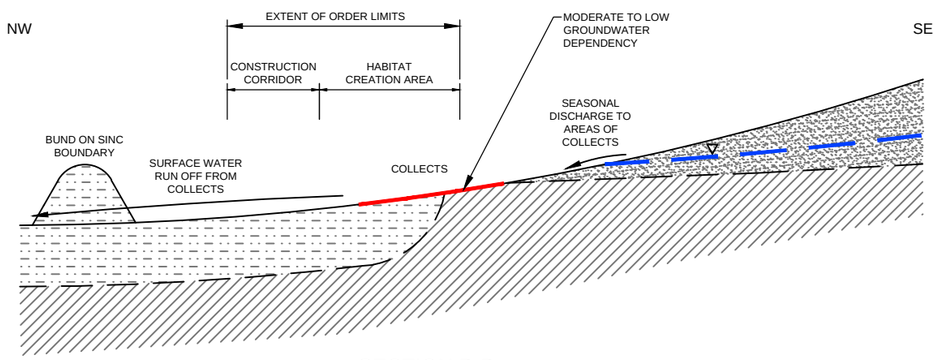

EWSHOT MEADOW LOCATION PLAN

Scale 1:5000




SECTION A-A

Scale NTS




SECTION B-B

Scale NTS


KEY PLAN

LEGEND

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- GROUNDWATER FLOWS SUPPORTING THE VEGETATION FROM WIDER HYDROGEOLOGICAL CATCHMENT
- SUPERFICIAL LAYER: MEDIUM TO FINE CLAYEY SAND TO MEDIUM TO FINE SANDY CLAY. REASONABLY HOMOGENEOUS.
- BEDROCK - BAGSHOT FORMATION (SANDS)
- BEDROCK - LONDON CLAY FORMATION
- EXTRAPOLATED GROUNDWATER LEVEL
- ORDER LIMITS
- CROSS SECTION ALIGNMENT



0 50 100 150 200 250 m

SCALE 1 : 5000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Appr'd |
|---|---|---|---|---|---|---|
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JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
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Client: Esso Petroleum Company, Limited
Ermyn House,
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Project: Esso — Southampton to London Pipeline Project

Drawing title

EWSHOT MEADOW
CSM
FIGURE A8.3.15

DRAFT

Drawing status: Initial Status or WIP

| | | |
|---|---|---|
| Scale | AS SHOWN | DO NOT SCALE |
| Jacobs No. | B2325300 | Rev P01.1 |
| Client no. | | |

Drawing number

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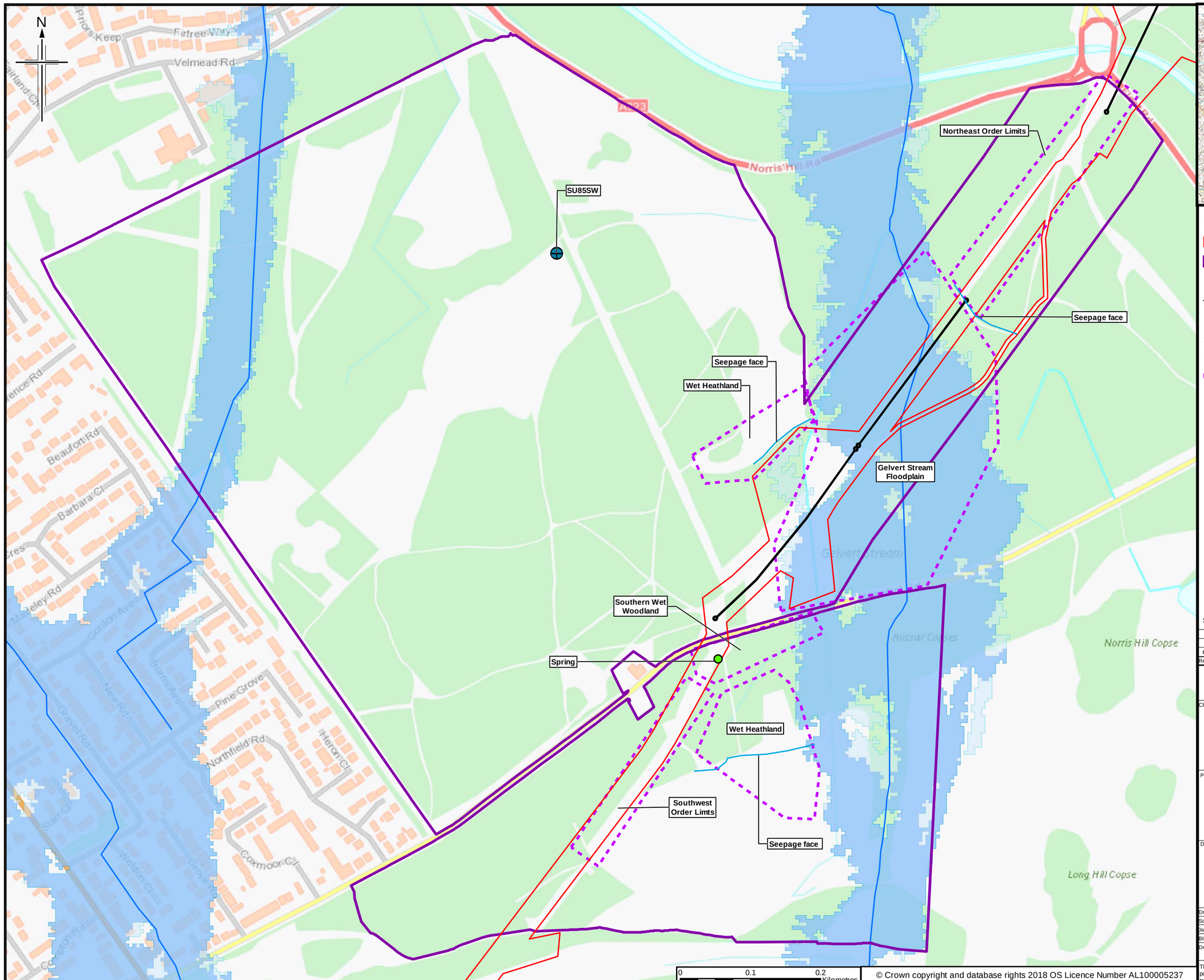




**Legend**

- Order Limits
- Potential GWDTE site
- BGS boreholes
- Trenchless crossing

**Hydrologic Features**

- Seepage face
- Main Rivers
- Sub-site
- Flood Zone 2
- Flood Zone 3

Sheet displays part of Section D

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| 0 | 2/04/2019 | Initial Draft | LM | JW | VSM | SH |

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax:+44(0)118 946 7001
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Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
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Project

Esso | Southampton to London Pipeline Project

Drawing title

# GEOLOGICAL AND GROUNDWATER BASELINE INFORMATION BOURLEY AND LONG VALLEY APFP Reg.(2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | Draft | |
| Scale | 1:5,000 @ A3 | DO NOT SCALE |
| Jacobs No. | B2325300 | |
| BIM No. | B2325300-JAC-000-ENV-DRG-001542 | |
| Drawing number | Figure A8.3.16 Sheet 1 of 1 | Rev 0 |



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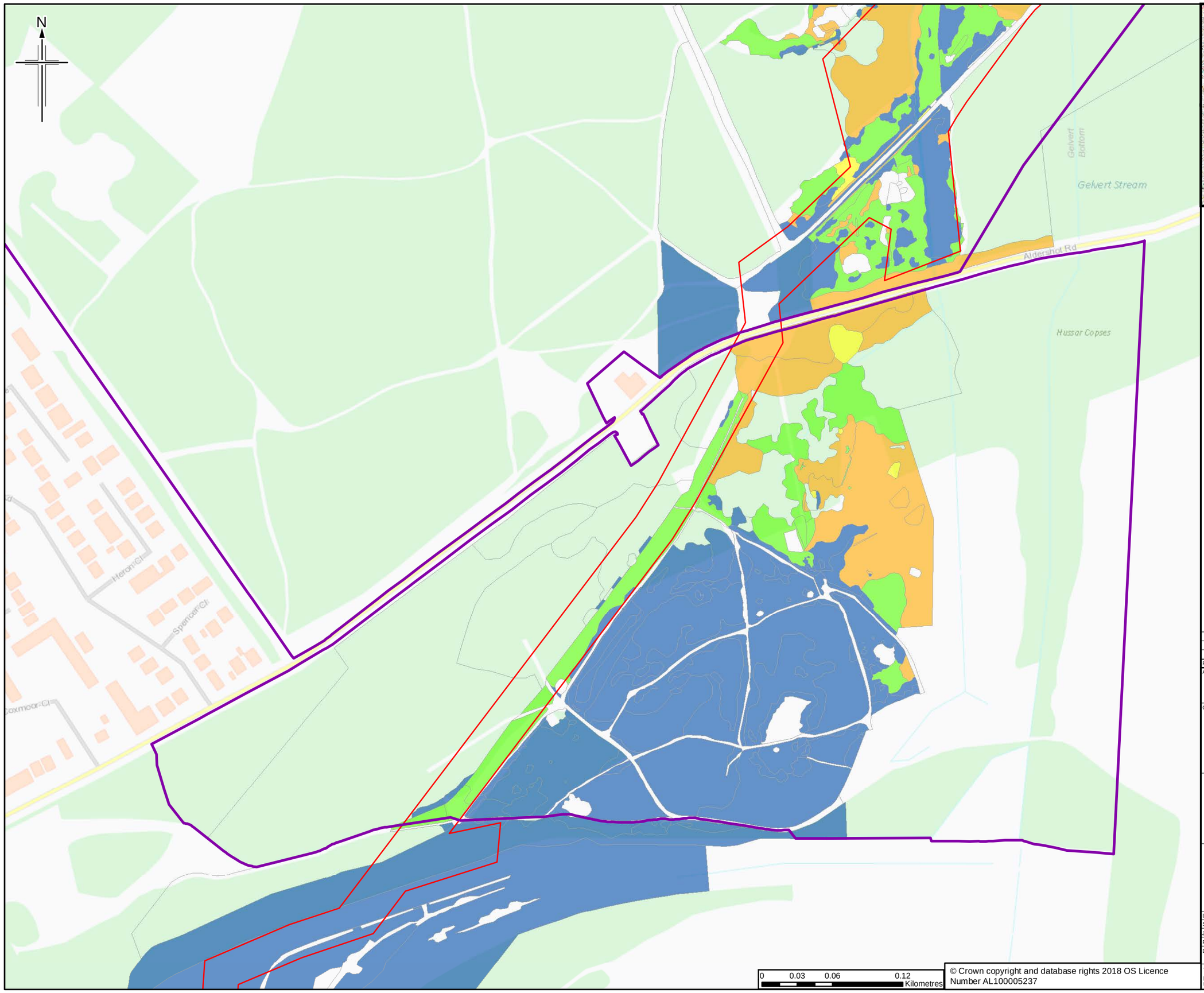
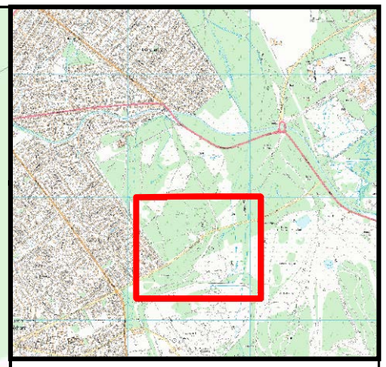


**Legend**

- Order Limits
- Potential GWDTE site

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section D

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| 0 | 6/03/2019 | For Issue | HM | JW | VSM | SH |

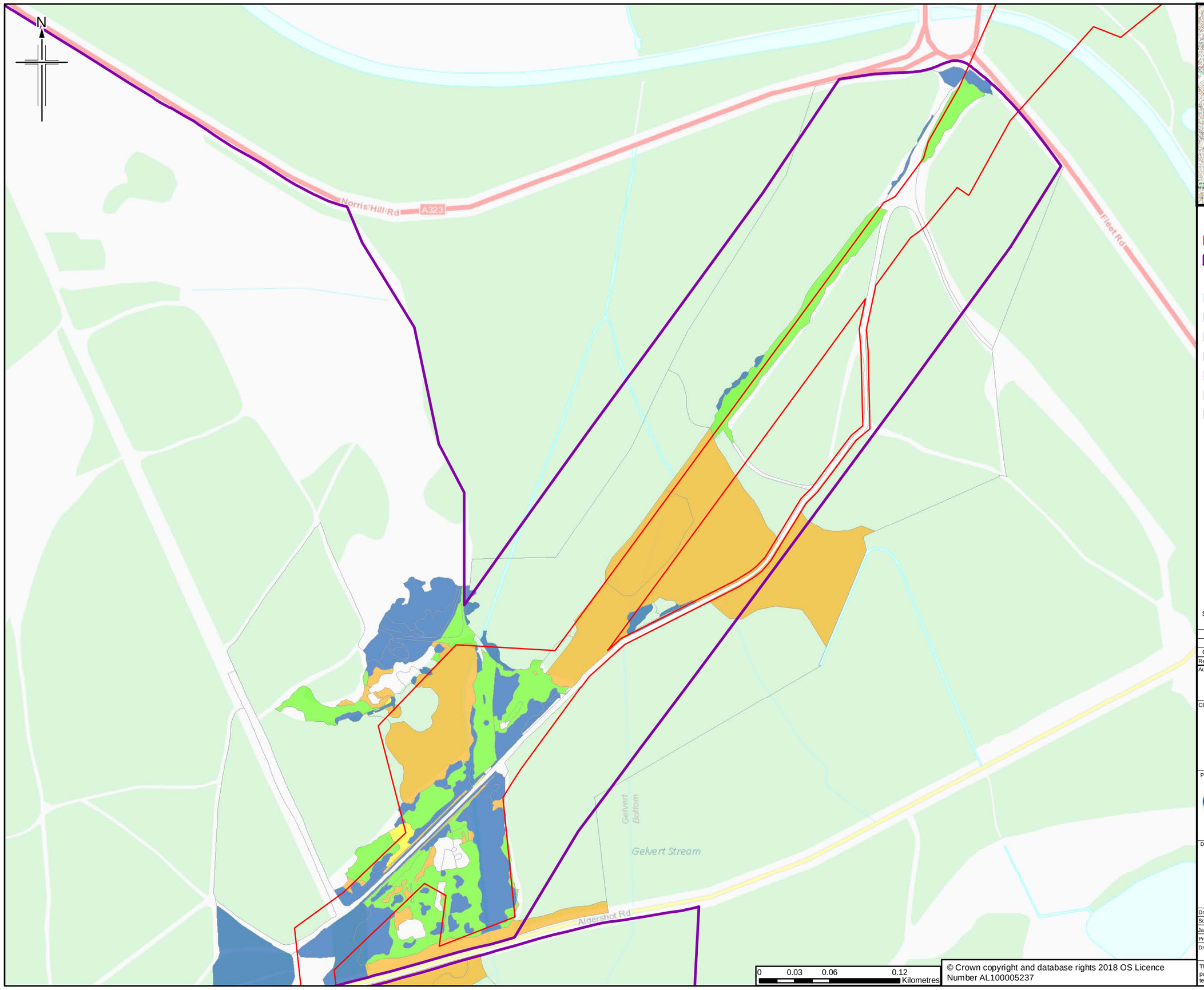
Author
JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

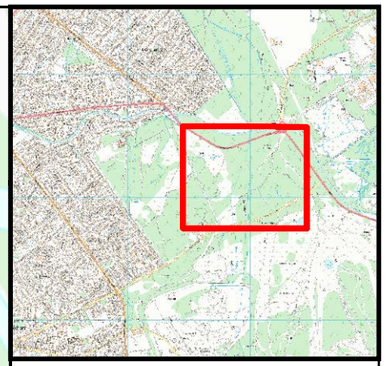
Client
Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project
Esso | Southampton to London Pipeline Project

Drawing title
ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND GROUNDWATER DEPENDENCY
- BOURLEY AND LONG VALLEY
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | For Issue | |
| Scale | 1:3,000 @ A3 | DO NOT SCALE |
| Jacobs No. | B2325300 | |
| ProjectWise No. | B2325300-JAC-000-ENV-DRG-001547 | |
| Drawing number | Figure A8.3.17 Sheet 1 of 2 | Rev 0 |



**Legend**

- Order Limits
- Potential GWDTE site

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section D

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Author

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project

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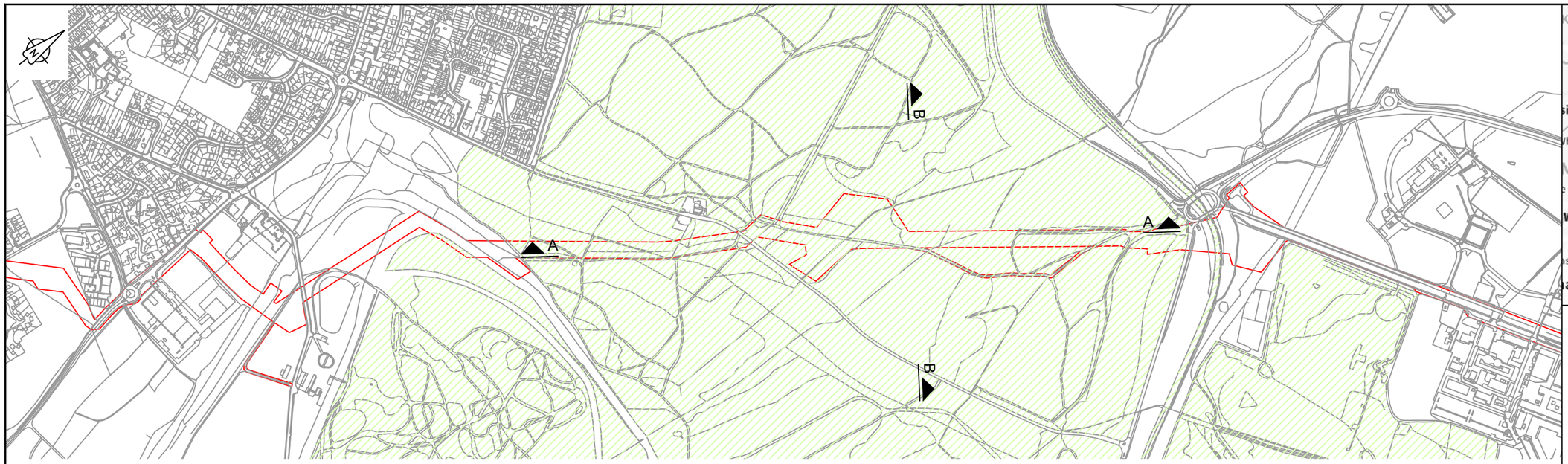
Drawing title

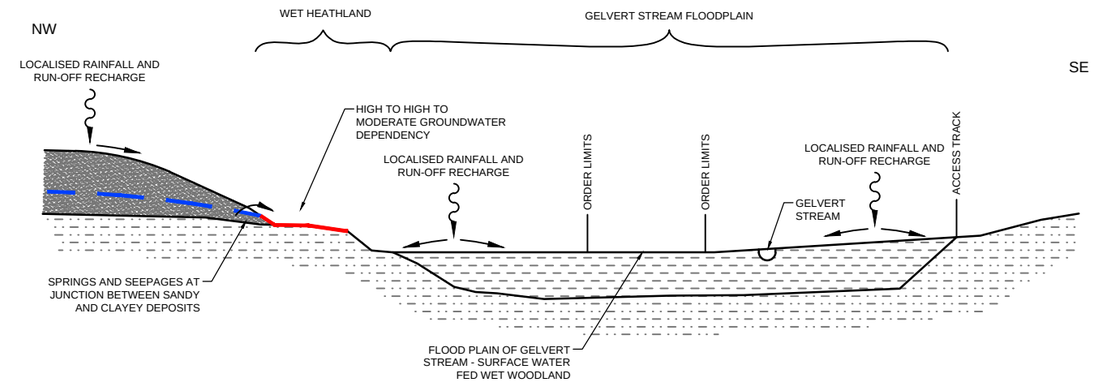
ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND
GROUNDWATER DEPENDENCY
- BOURLEY AND LONG VALLEY
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | For Issue | |
| Scale | 1:3,000 @ A3 | DO NOT SCALE |
| Jacobs No. | B2325300 | |
| ProjectWise No. | B2325300-JAC-000-ENV-DRG-001547 | |
| Drawing number | Figure A8.3.17 Sheet 2 of 2 | Rev 0 |



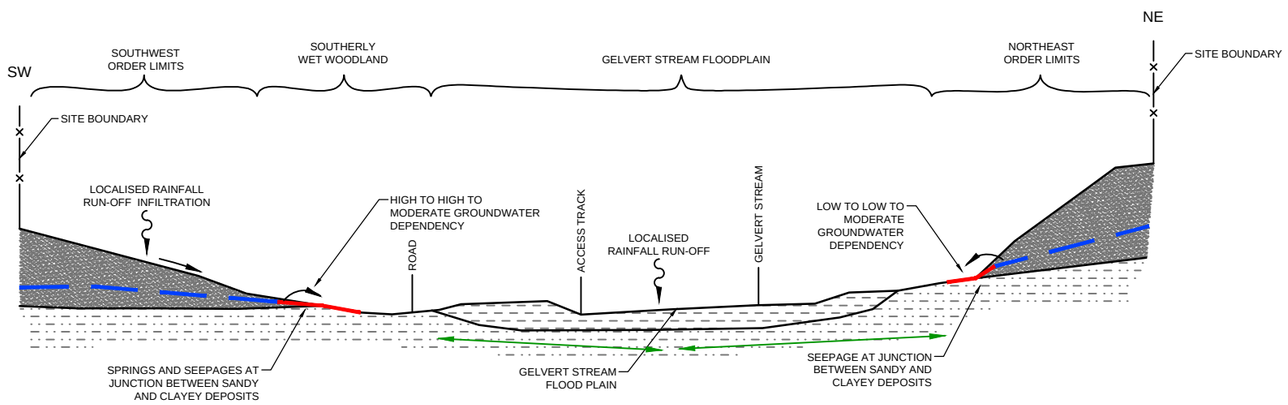

BOURLEY AND LONG VALLEY LOCATION PLAN

SCALE 1:10,000




TYPICAL SECTION B-B

Scale NTS




TYPICAL SECTION A-A

Scale NTS


KEY PLAN

LEGEND

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- GROUNDWATER FLOWS SUPPORTING THE VEGETATION FROM WIDER HYDROGEOLOGICAL CATCHMENT
- CLAY RICH DRIFT LAYERS
- SANDY CLAY - WINDLESHAM FORMATION
- SAND - CAMBERLEY SAND FORMATION
- SITE OF SPECIAL SCIENTIFIC INTEREST (SSSI)
- EXTRAPOLATED GROUNDWATER LEVEL
- TRENCHLESS PORTIONS
- ORDER LIMITS
- CROSS SECTION ALIGNMENT
- SUB-SITES



0 100 200 300 400 500 m

SCALE 1 : 10,000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
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| P01.1 | 31/01/19 | DESIGN FREEZE DCO | PM | JW | JW | SH |

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited, Ermyn House, Ermyn Way, Leatherhead, Surrey, KT22 8UX

Project: Esso | Southampton to London Pipeline Project

Drawing title

BOURLEY AND LONG VALLEY CSM
FIGURE A8.3.18

Drawing status: Initial Status or WIP

| | | |
|---|---|---|
| Scale | AS SHOWN | DO NOT SCALE |
| Jacobs No. | B2325300 | Rev P01.1 |
| Client no. | | |

Drawing number: B2325300-JAC-000-ENV-DRG-001548



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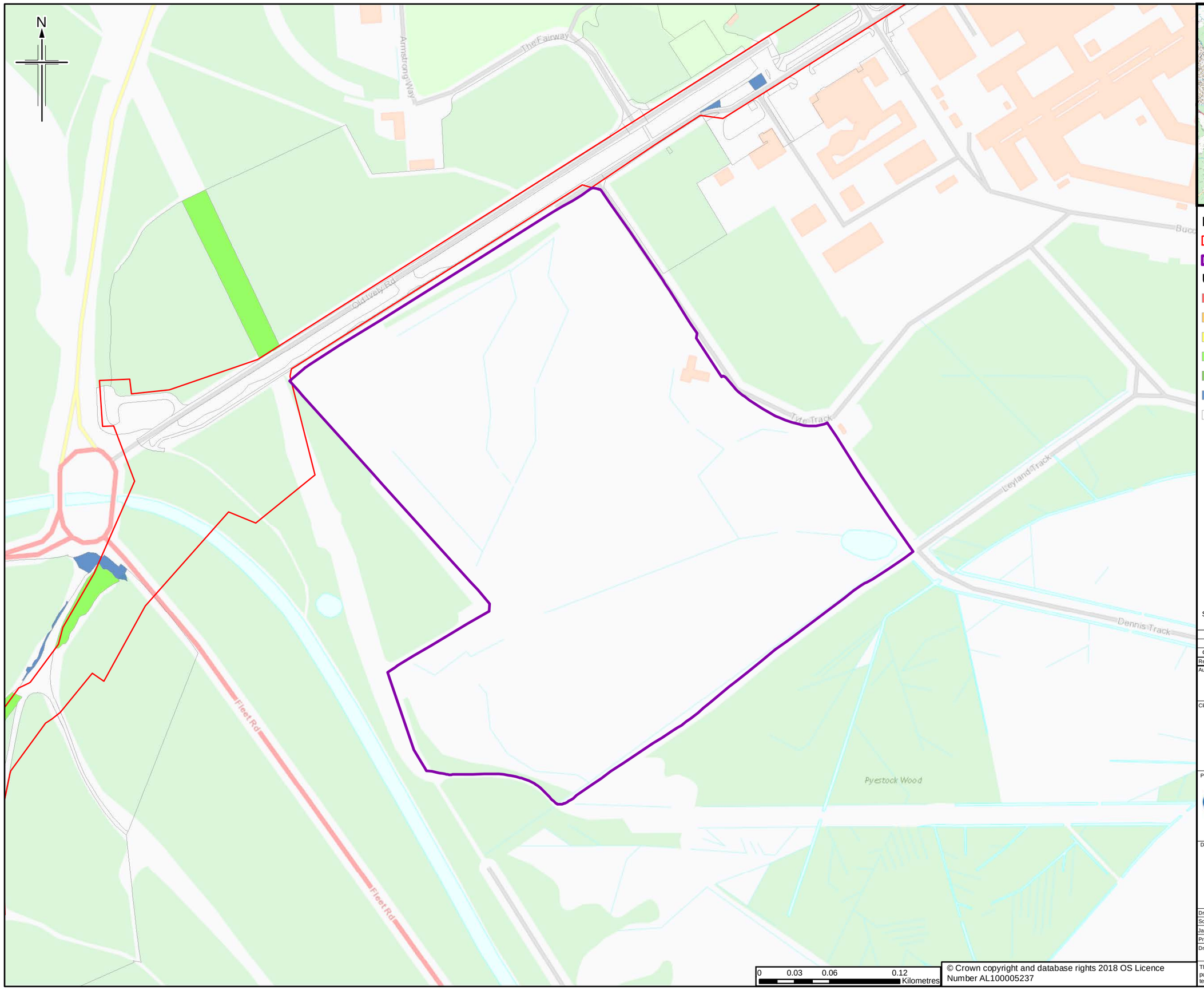


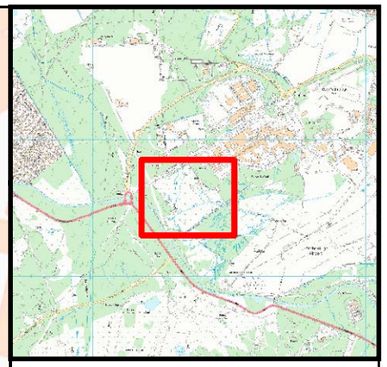

**Legend**

- Order Limits
- Potential GWDTE site

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section D

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| 0 | 6/03/2019 | For Issue | HM | JW | VSM | SH |

Author

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project

Esso | Southampton to London Pipeline Project

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ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND GROUNDWATER DEPENDENCY
- EELMOOR MARSH
APFP Reg. (2009) 5(2)(l)

| | | | |
|---|---|---|---|
| Drawing Status | For Issue | | |
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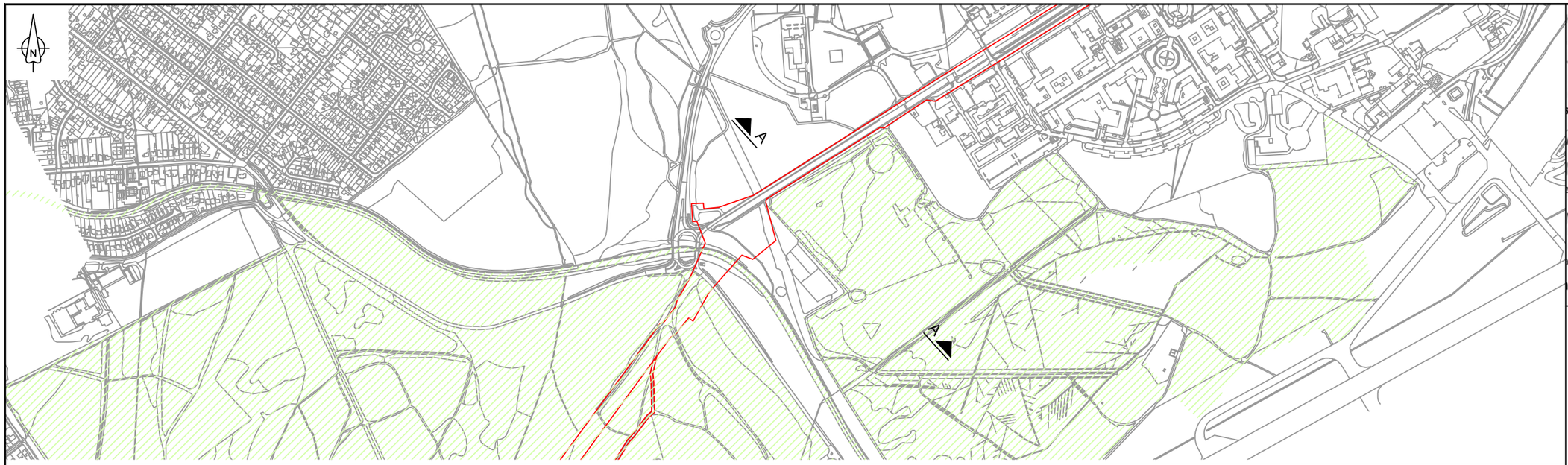
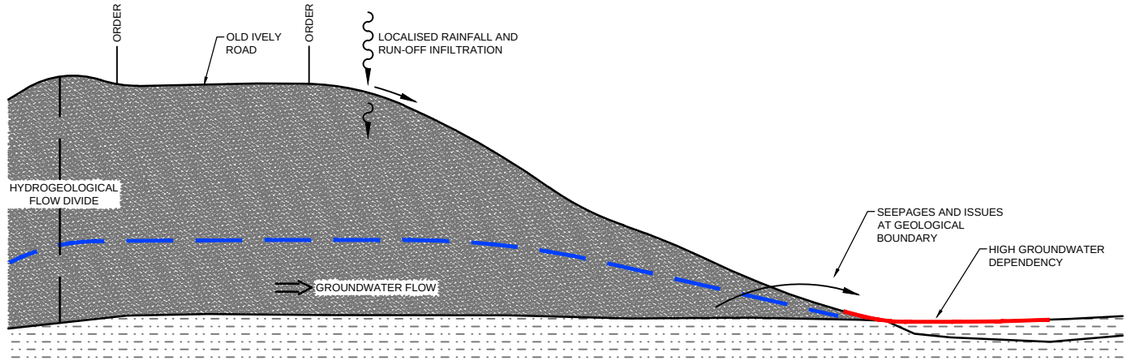
| ProjectWise No. | B2325300-JAC-000-ENV-DRG-001549 | | |
| Drawing number | Figure A8.3.19 Sheet 1 of 1 | Rev | 0 |




EELMOOR MARSH LOCATION PLAN

SCALE 1:10,000

NW SE




TYPICAL SECTION A-A

Scale NTS


LEGEND

KEY PLAN

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- GROUNDWATER FLOWS SUPPORTING THE VEGETATION FROM WIDER HYDROGEOLOGICAL CATCHMENT
- SANDY SILTY CLAY - HEAD DEPOSITS
- SAND - CAMBERLEY SAND FORMATION
- SANDY CLAY - WINDLESHAM FORMATION
- SITE OF SPECIAL SCIENTIFIC INTEREST (SSSI)
- EXTRAPOLATED GROUNDWATER LEVEL
- ORDER LIMITS
- CROSS SECTION ALIGNMENT



0 100 200 300 400 500 m

SCALE 1 : 10,000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
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JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

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Drawing title

EELMOOR MARSH
CSM
FIGURE A8.3.20

Drawing status: Initial Status or WIP

| | | |
|---|---|---|
| Scale | AS SHOWN | DO NOT SCALE |
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| Client no. | | |

Drawing number: B2325300-JAC-000-ENV-DRG-001550



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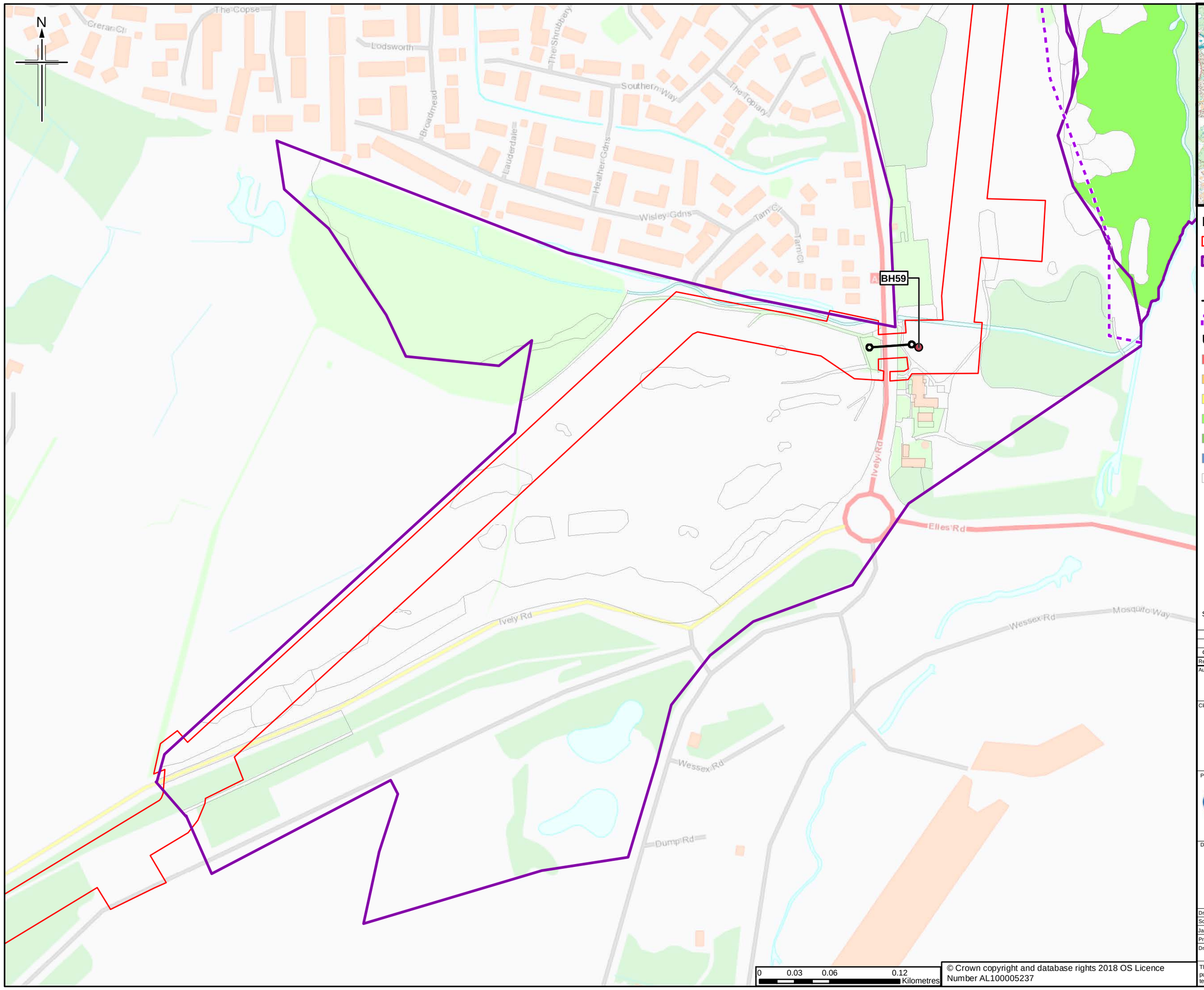
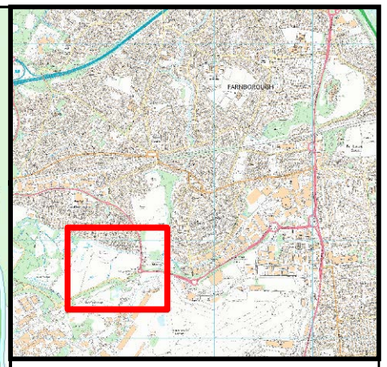


**Legend**

- Order Limits
- Potential GWDTE site
- Boreholes
- Trenchless crossing
- Flood Storage Area

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section D and Section E

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| 0 | 1/04/2019 | For Issue | HM | JW | VSM | SH |

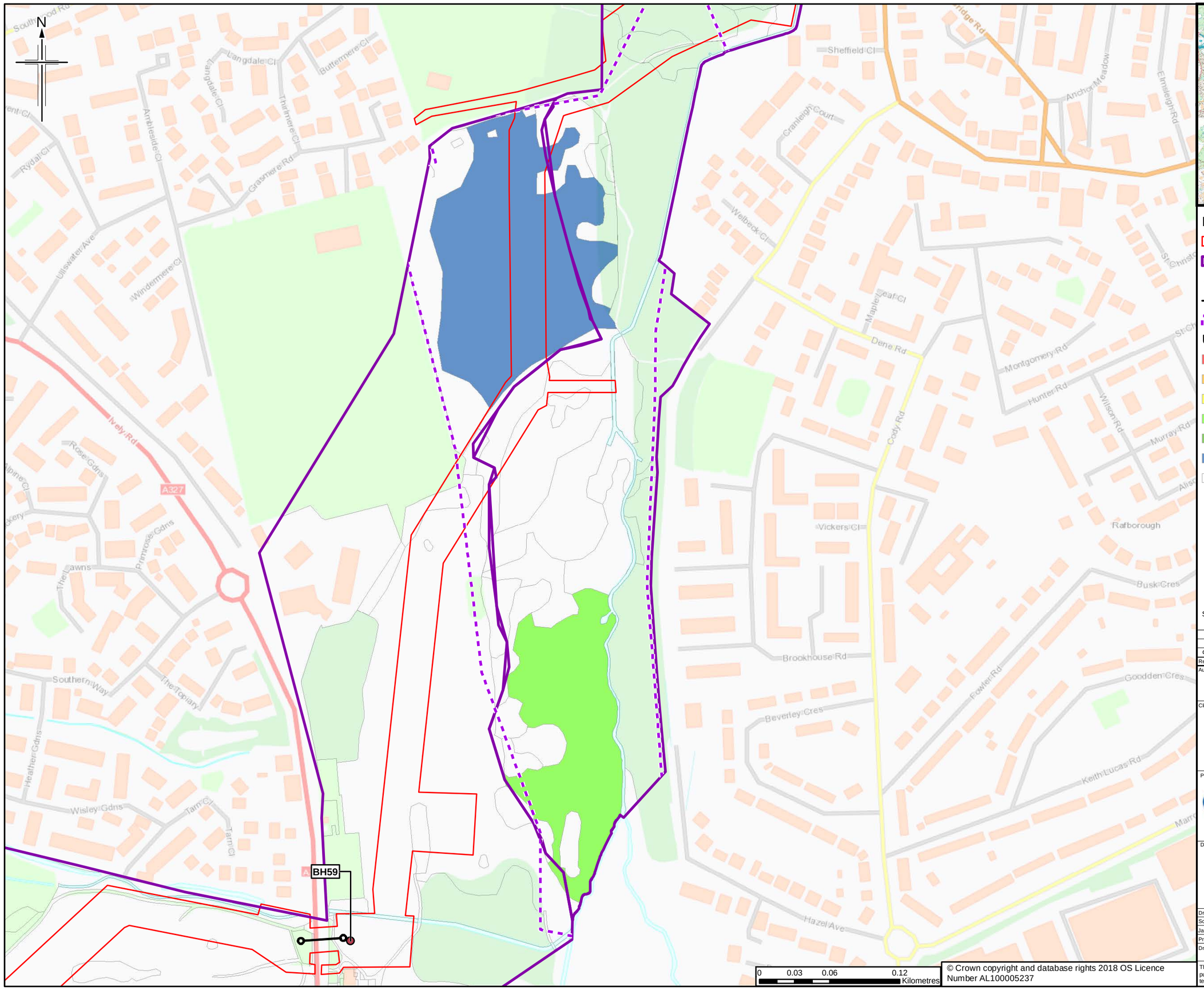
Author
JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

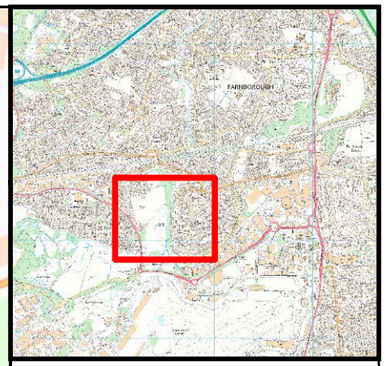
Client
Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project
Esso | Southampton to London Pipeline Project

Drawing title
ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND GROUNDWATER DEPENDENCY
- COVE BROOK AND IVELY ROAD
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | **For Issue** | |
| Scale | **1:3,000 @ A3** | **DO NOT SCALE** |
| Jacobs No. | **B2325300** | |
| ProjectWise No. | **B2325300-JAC-000-ENV-DRG-001551** | |
| Drawing number | Figure A8.3.21 Sheet 1 of 3 | Rev 0 |



**Legend**

- Order Limits
- Potential GWDTE site
- Boreholes
- Trenchless crossing
- Flood Storage Area

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section D and Section E

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| 0 | 1/04/2019 | For Issue | HM | JW | VSM | SH |

Author

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project

Esso | Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND
GROUNDWATER DEPENDENCY
- COVE BROOK AND IVELY ROAD
APFP Reg. (2009) 5(2)(l)

| | | | |
|---|---|---|---|
| Drawing Status | For Issue | | |
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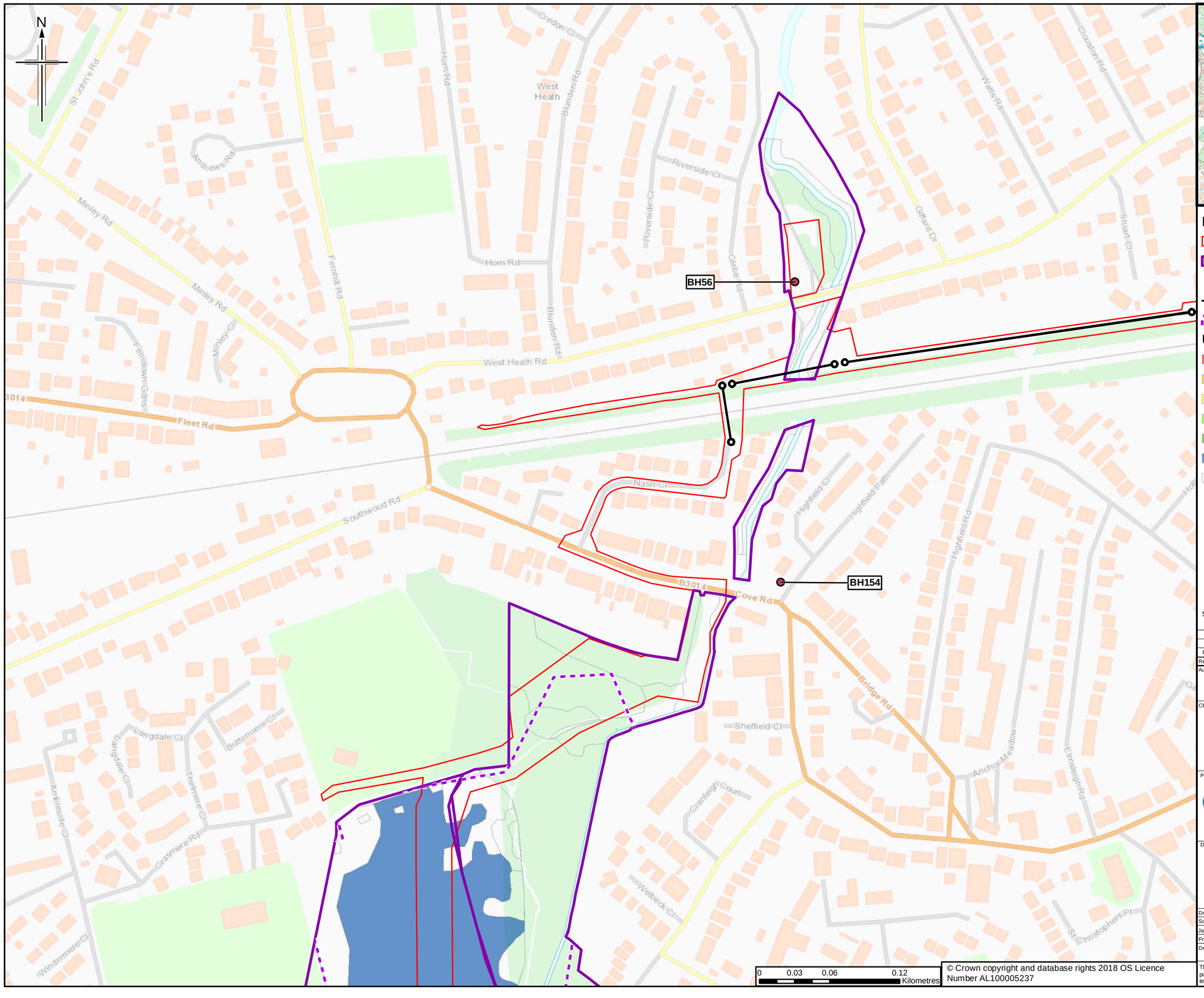
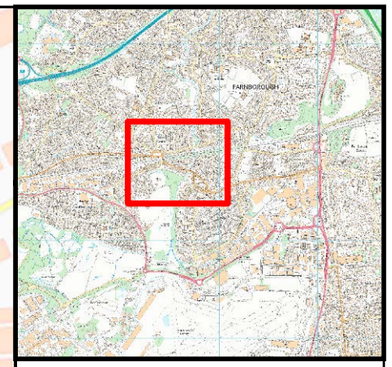
| ProjectWise No. | B2325300-JAC-000-ENV-DRG-001551 | | |
| Drawing number | Figure A8.3.21 Sheet 2 of 3 | Rev | 0 |



**Legend**

- Order Limits
- Potential GWDTE site
- Boreholes
- Trenchless crossing
- Flood Storage Area

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section E

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
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Author

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

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Drawing title

ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND
GROUNDWATER DEPENDENCY
- COVE BROOK AND IVELY ROAD
APFP Reg. (2009) 5(2)(l)

| | | | |
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| Scale | 1:3,000 @ A3 | DO NOT SCALE | |
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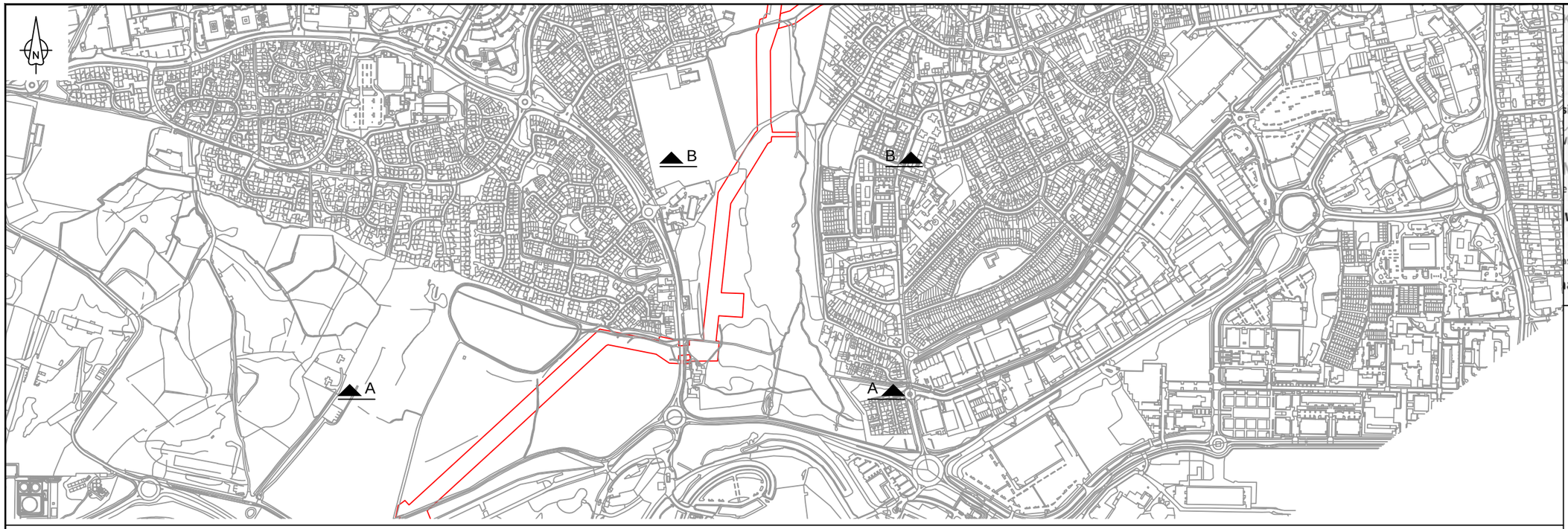
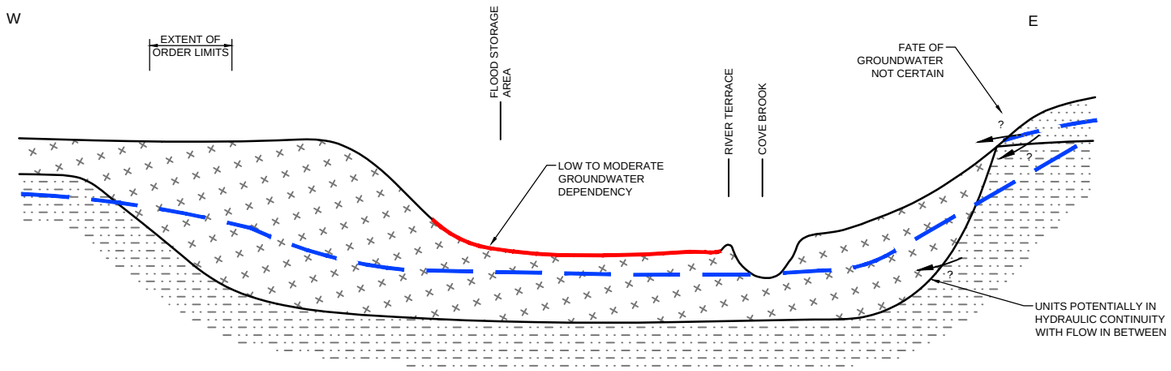
| Drawing number | Figure A8.3.21 Sheet 3 of 3 | Rev | 0 |



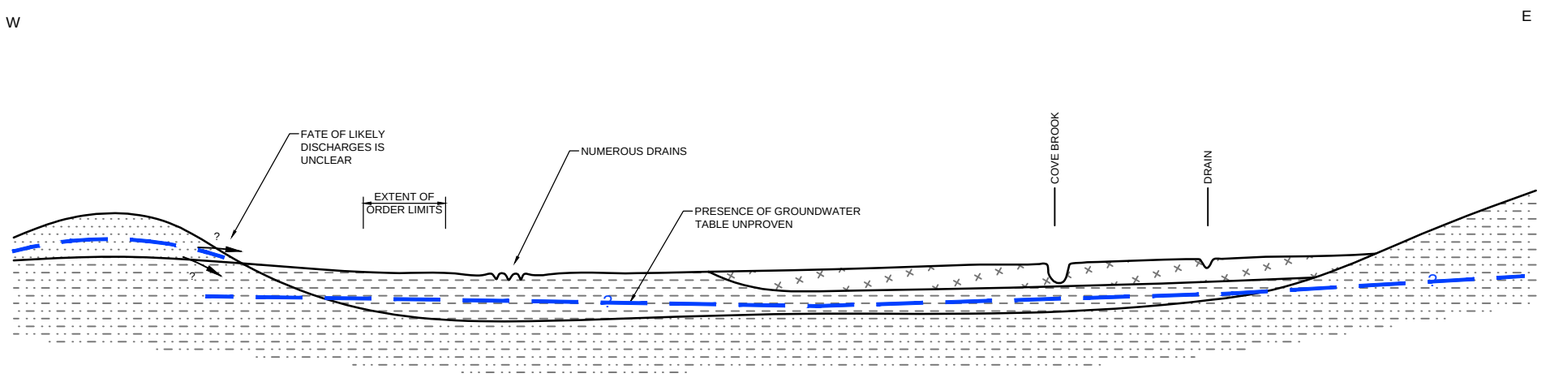

COVE BROOK AND IVELEY ROAD LOCATION PLAN

SCALE 1:10,000




TYPICAL SECTION B-B

Scale NTS




TYPICAL SECTION A-A

Scale NTS


KEY PLAN

LEGEND

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- GROUNDWATER FLOWS SUPPORTING THE VEGETATION FROM WIDER HYDROGEOLOGICAL CATCHMENT
- SANDY SILTY CLAY - ALLUVIUM
- SANDY SILTY CLAY - HEAD
- SAND - CAMBERLEY SAND FORMATION
- SANDY CLAY - WINDLESHAM FORMATION
- EXTRAPOLATED GROUNDWATER LEVEL
- ORDER LIMITS
- CROSS SECTION ALIGNMENT



0 100 200 300 400 500 m

SCALE 1 : 10,000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
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JACOBS

1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

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COVE BROOK AND IVELEY ROAD CSM
FIGURE A8.3.22

Drawing status: Initial Status or WIP

| | | |
|---|---|---|
| Scale | AS SHOWN | DO NOT SCALE |
| Jacobs No. | B2325300 | Rev P01.1 |
| Client no. | | |

Drawing number: B2325300-JAC-000-ENV-DRG-001552



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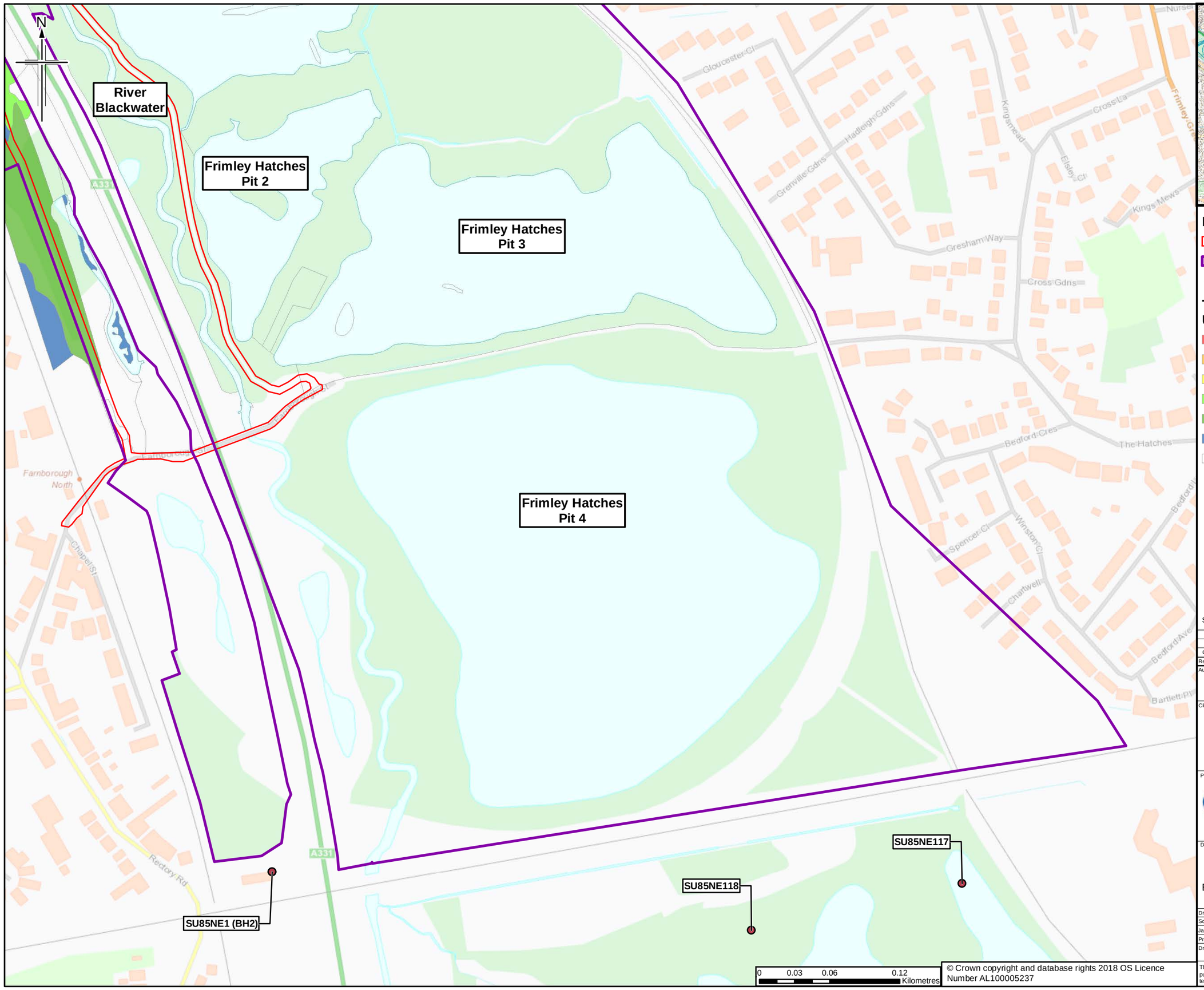




**Legend**

- Order Limits
- Potential GWDTE site
- Boreholes
- Trenchless crossing

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section E

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
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Author
JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client
Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

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Drawing title
ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND GROUNDWATER DEPENDENCY - BLACKWATER VALLEY FRIMLEY HATCHES APFP Reg. (2009) 5(2)(l)

| | | | |
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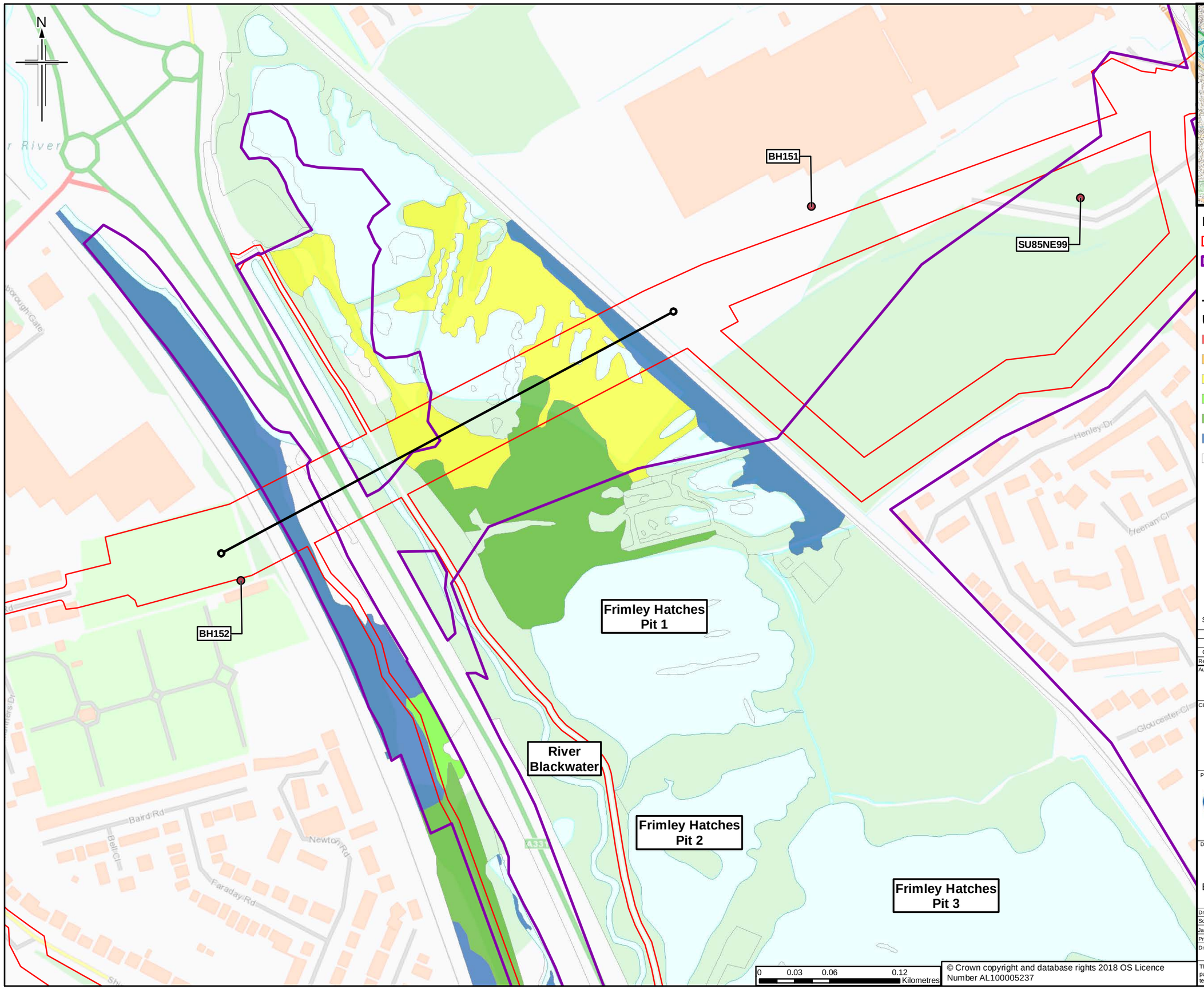


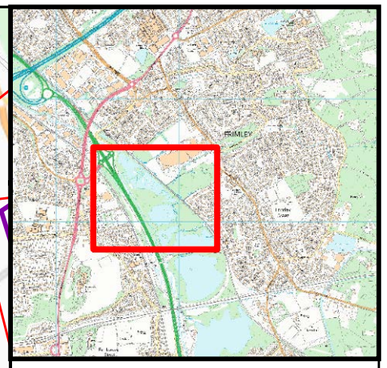

**Legend**

- Order Limits
- Potential GWDTE site
- Boreholes
- Trenchless crossing

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section E

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Author

JACOBS

1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
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Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
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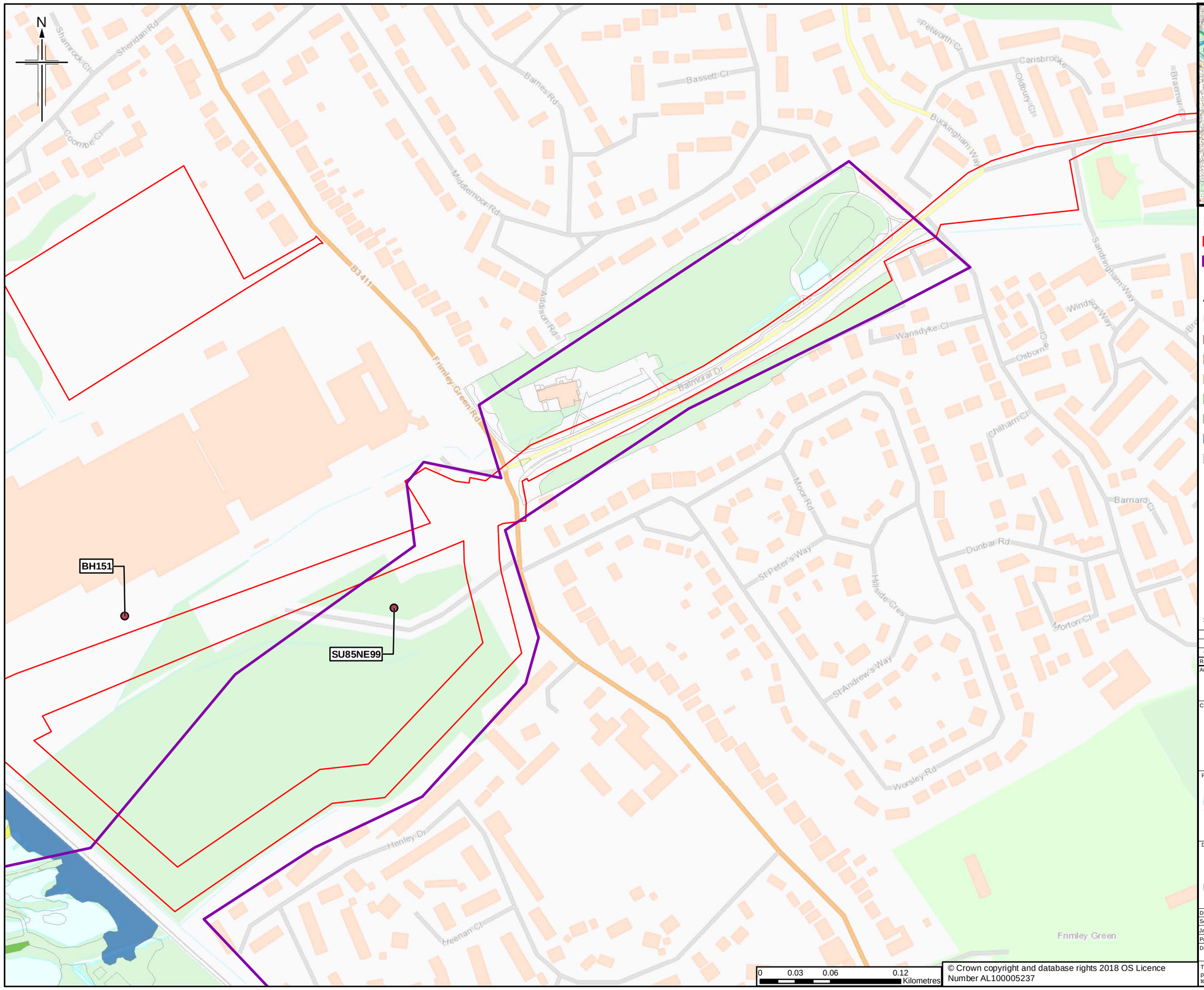
NVC AND HABITAT SURVEY AND GROUNDWATER DEPENDENCY - BLACKWATER VALLEY FRIMLEY HATCHES APFP Reg. (2009) 5(2)(l)

| | | | |
|---|---|---|---|
| Drawing Status | For Issue | | |
| Scale | 1:3,000 @ A3 | DO NOT SCALE | |
| Jacobs No. | B2325300 | | |
| ProjectWise No. | B2325300-JAC-000-ENV-DRG-001553 | | |
| Drawing number | Figure A8.3.23 Sheet 2 of 3 | Rev | 0 |






**Legend**

- Order Limits
- Potential GWDTE site
- Boreholes
- Trenchless crossing

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section E

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| 0 | 1/04/2019 | For Issue | HM | JW | VSM | SH |

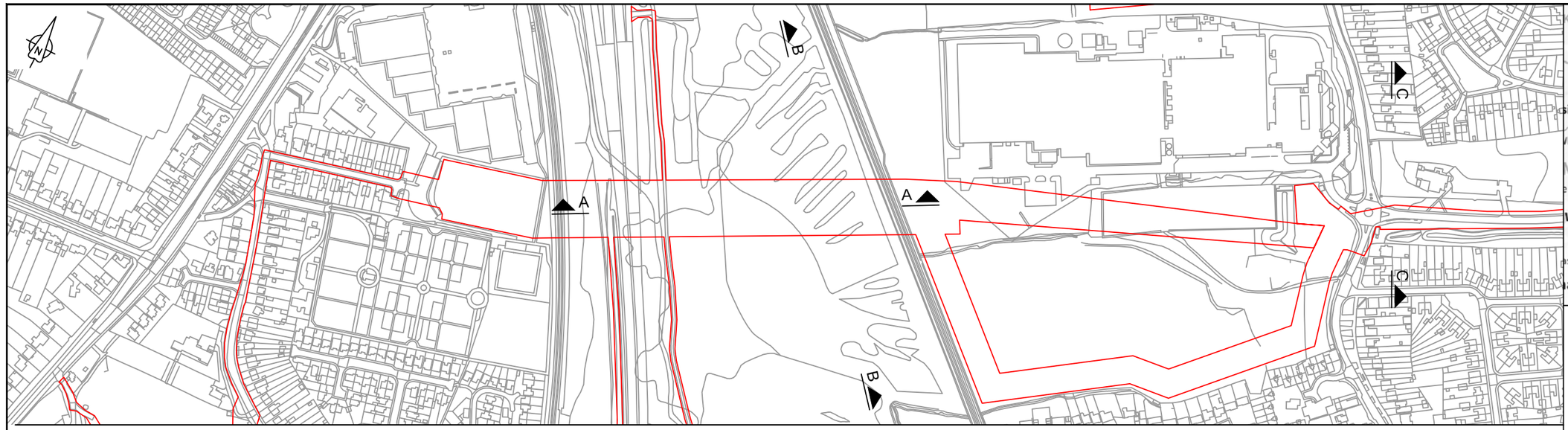
Author
JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client
Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project
Esso | Southampton to London Pipeline Project

Drawing title
ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND GROUNDWATER DEPENDENCY - BLACKWATER VALLEY FRIMLEY HATCHES APFP Reg. (2009) 5(2)(l)

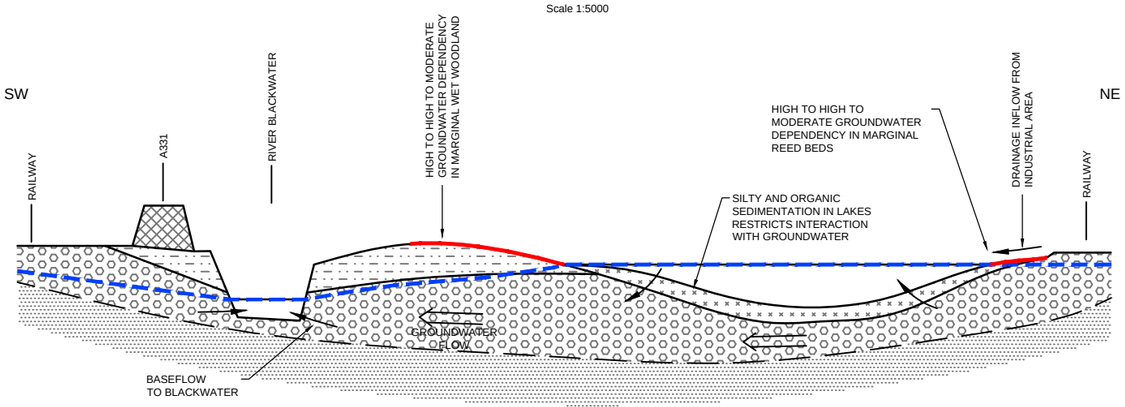
| | | |
|---|---|---|
| Drawing Status | For Issue | |
| Scale | 1:3,000 @ A3 | DO NOT SCALE |
| Jacobs No. | B2325300 | |
| ProjectWise No. | B2325300-JAC-000-ENV-DRG-001553 | |
| Drawing number | Figure A8.3.23 Sheet 3 of 3 | Rev 0 |





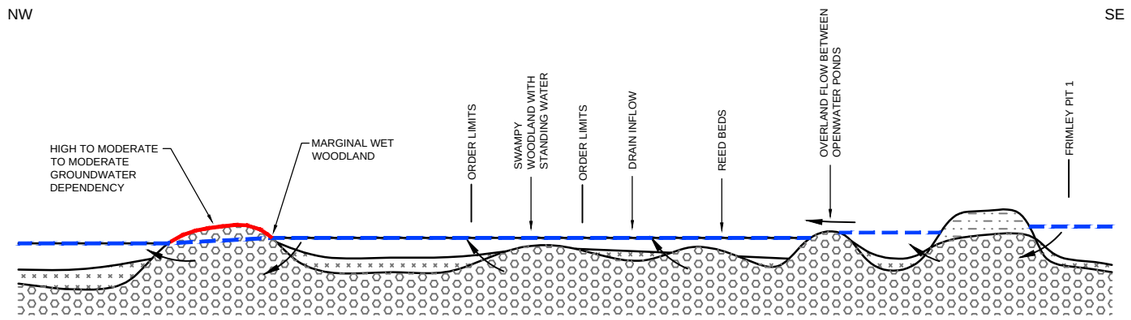
# BLACKWATER VALLEY FRIMLEY HATCHES LOCATION PLAN

Scale 1:5000




## TYPICAL SECTION A-A

Scale NTS




## TYPICAL SECTION B-B

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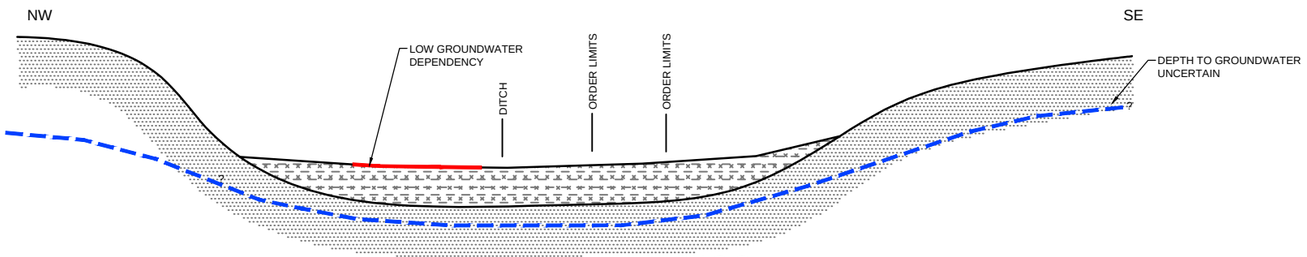


## TYPICAL SECTION C-C

Scale NTS

## KEY PLAN

LEGEND

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- MADE GROUND
- ORGANIC RICH SILT
- SANDY SILTY CLAY - ALLUVIUM
- SAND AND GRAVEL - RIVER TERRACE DEPOSITS
- CLAY, SILT, SAND AND GRAVEL - HEAD DEPOSITS
- SAND - CAMBERLEY SAND FORMATION
- EXTRAPOLATED GROUNDWATER LEVEL
- ORDER LIMITS
- CROSS SECTION ALIGNMENT

0 50 100 150 200 250 m

SCALE 1 : 5000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
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| P01.1 | 31/01/19 | DESIGN FREEZE DCO | PM | JW | JW | SH |

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited, Ermyn House, Ermyn Way, Leatherhead, Surrey, KT22 8UX

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Drawing title: BLACKWATER VALLEY FRIMLEY HATCHES CSM FIGURE A8.3.24

Drawing status: Initial Status or WIP

| Scale | AS SHOWN | DO NOT SCALE |
|---|---|---|
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| Client no. | | |

Drawing number: B2325300-JAC-000-ENV-DRG-001554



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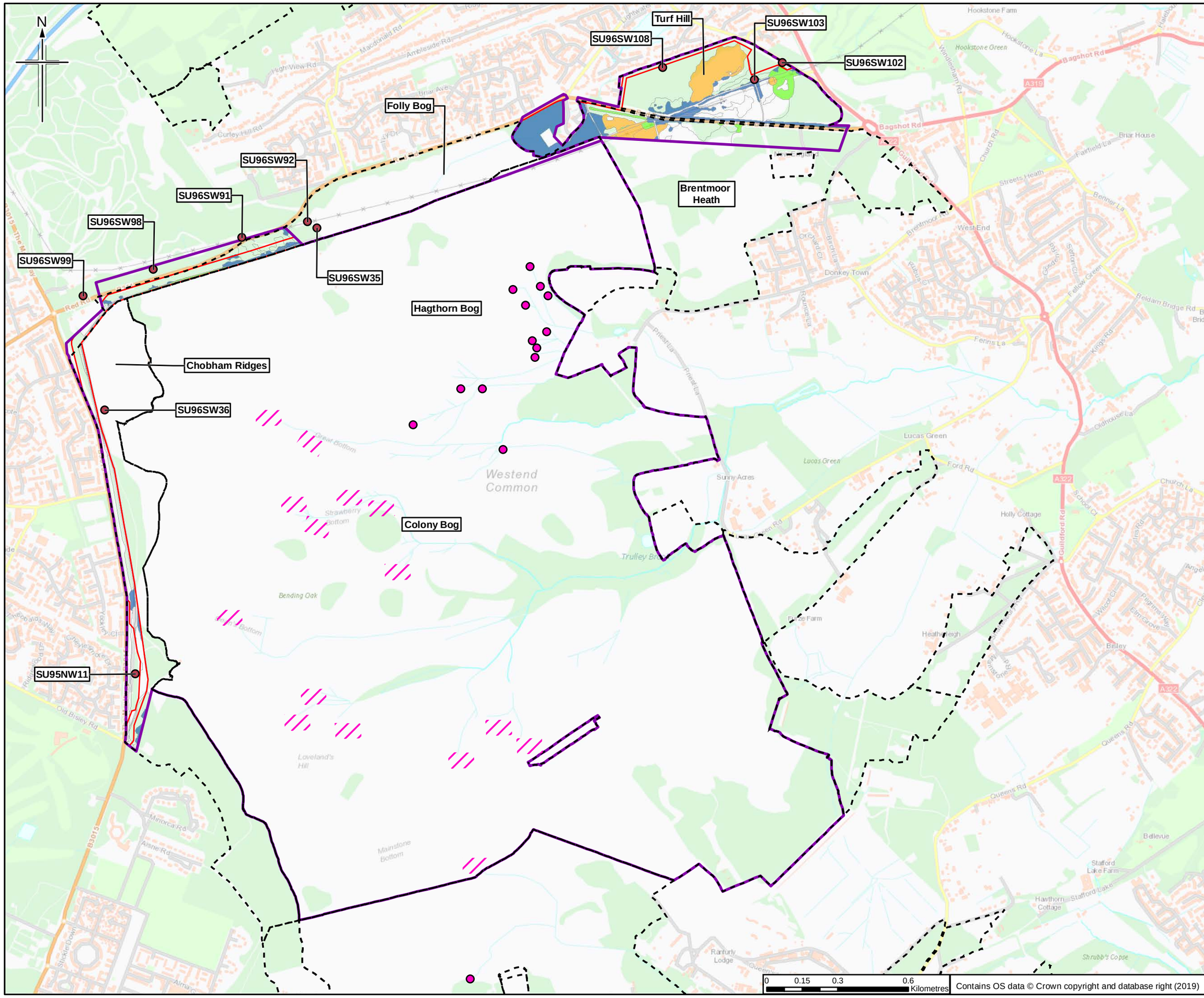




**Legend**

- Order Limits
- Potential GWDTE site
- SSSI units
- Boreholes
- 'Springs' marked on 1;10,000 OS Map
- 'Collects' marked on 1:10,000 OS Map

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

See separate figure for Folly Bog

Sheet displays parts of Section E and Section F

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| 0 | 1/04/2019 | For Issue | HM | JW | VSM | SH |

Author
1/04/2019 JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client
Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project
Esso | Southampton to London Pipeline Project

Drawing title
ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND GROUNDWATER DEPENDENCY
- COLONY BOG AND BAGSHOT HEATH
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | For Issue | |
| Scale | 1:15,000 @ A3 | DO NOT SCALE |
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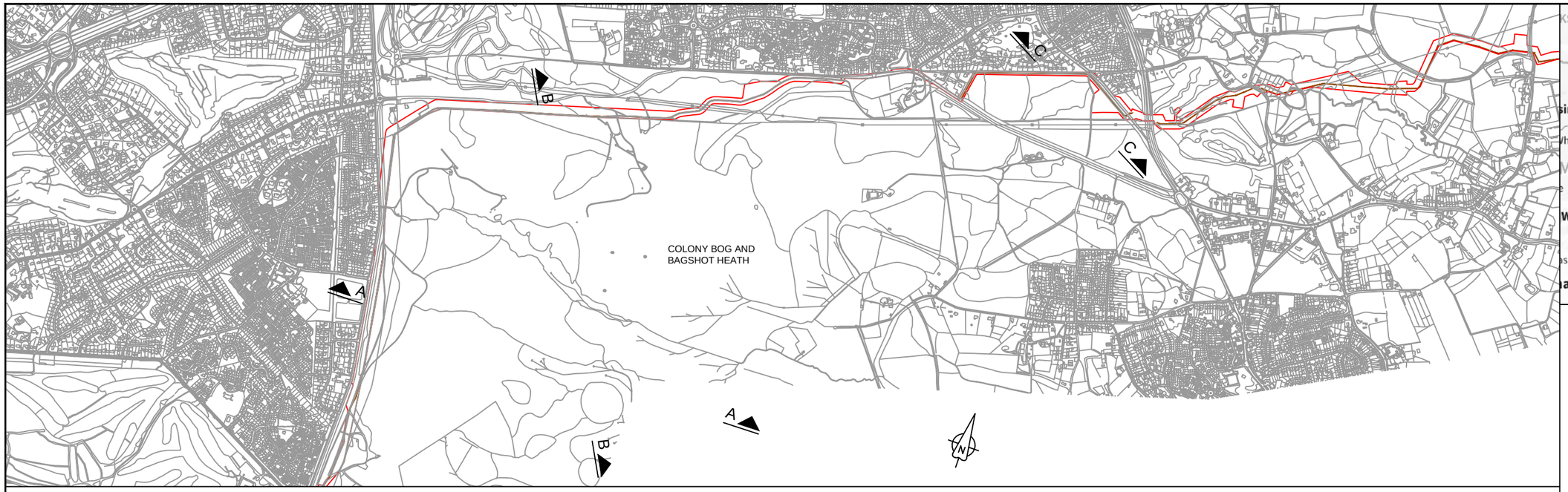
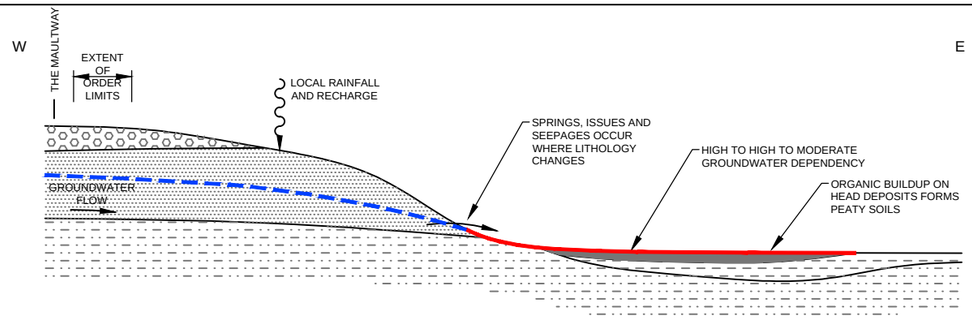
| ProjectWise No. | B2325300-JAC-000-ENV-DRG-001555 | |
| Drawing number | Figure A8.3.25 Sheet 1 of 1 | Rev 0 |



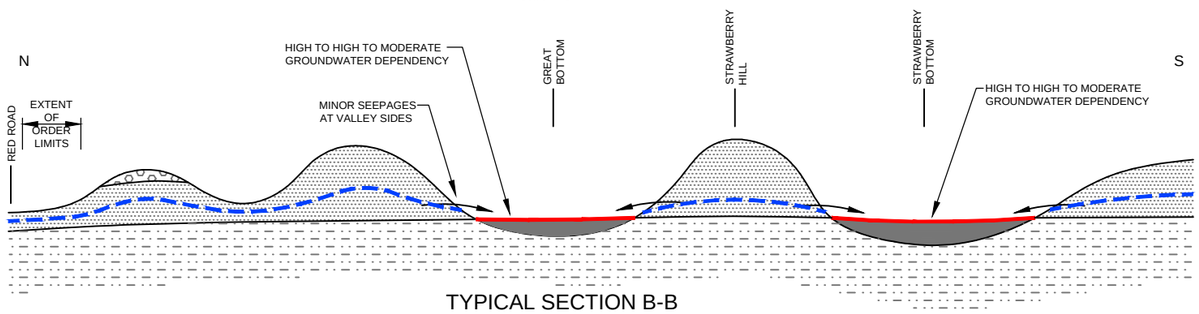

COLONY BOG & BAGSHOT HEATH LOCATION PLAN

Scale 1:20000



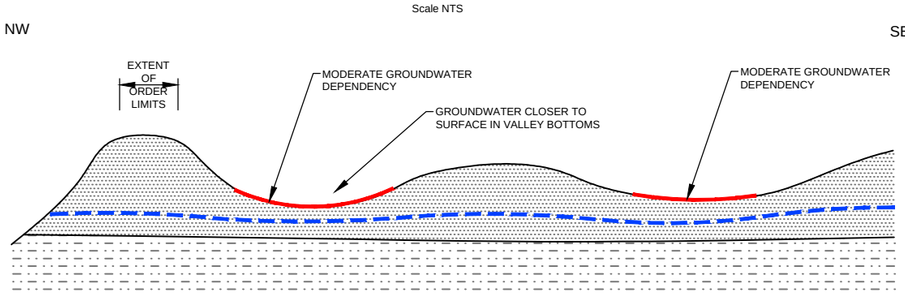

TYPICAL SECTION A-A

Scale NTS




TYPICAL SECTION B-B

Scale NTS




TYPICAL SECTION C-C

Scale NTS


KEY PLAN

LEGEND

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- GROUNDWATER FLOWS SUPPORTING THE VEGETATION FROM WIDER HYDROGEOLOGICAL CATCHMENT
- PEAT OR PEAT-LIKE DEPOSITS
- SANDY SILTY CLAY - HEAD DEPOSITS
- SAND AND GRAVEL - RIVER TERRACE DEPOSITS
- SAND - CAMBERLEY SAND FORMATION
- SANDY CLAY - WINDLESHAM FORMATION
- EXTRAPOLATED GROUNDWATER LEVEL
- ORDER LIMITS
- CROSS SECTION ALIGNMENT



0 100 200 300 400 500 600 700 800 900 1000 m

SCALE 1 : 20000

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JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey.
KT22 8UX

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Drawing title

COLONY BOG & BAGSHOT HEATH CSM
FIGURE A8.3.26

Drawing status: Initial Status or WIP

| | | |
|---|---|---|
| Scale | AS SHOWN | DO NOT SCALE |
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| Client no. | | |

Drawing number: B2325300-JAC-000-ENV-DRG-001556



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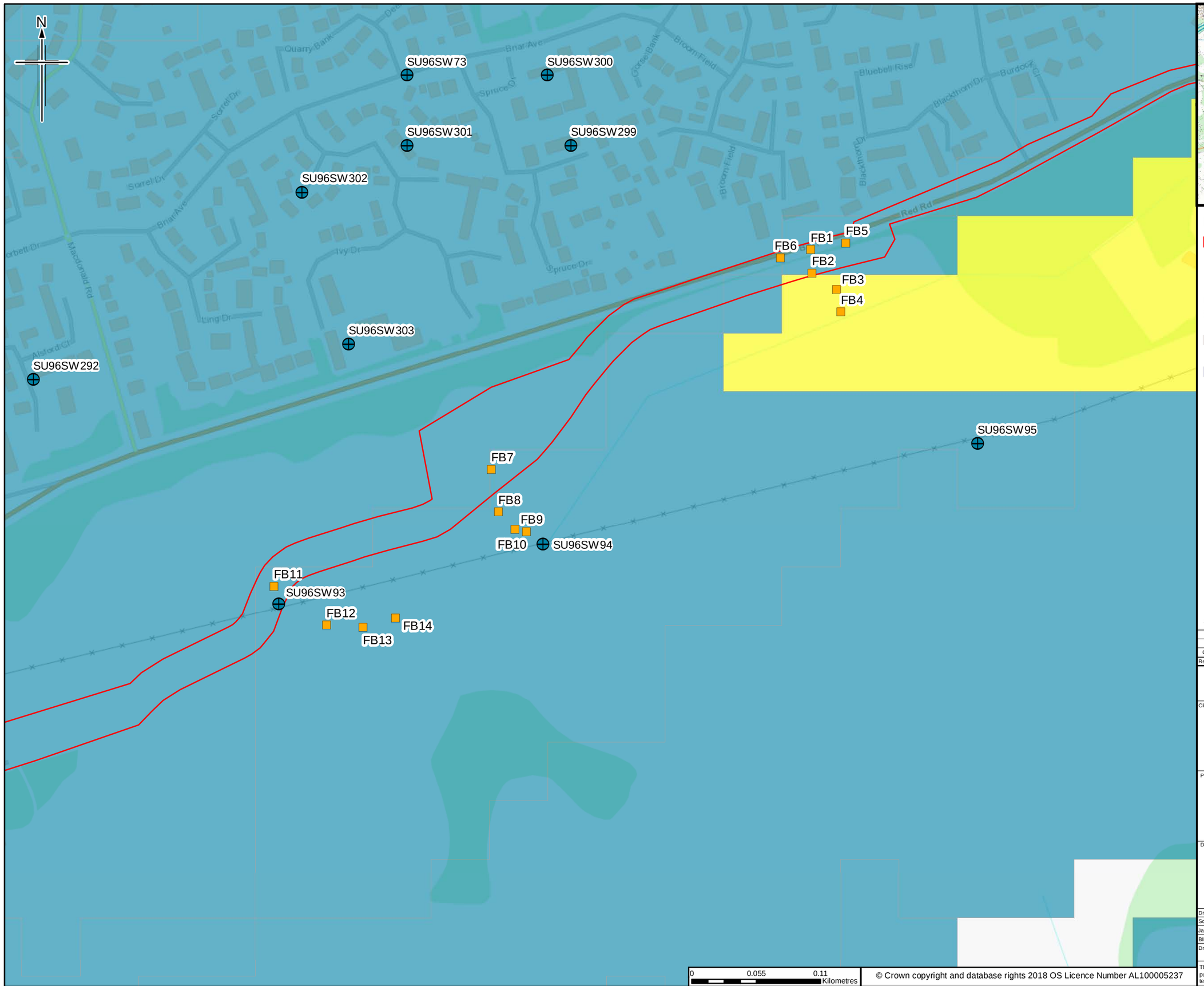




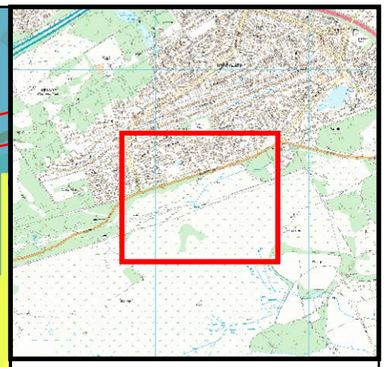

**Legend**

- Order Limits
- Soil coring
- BGS boreholes

**Groundwater Flooding Susceptibility**

- Limited potential for groundwater flooding to occur
- Potential for groundwater flooding to occur at surface

Sheet displays part of Section F

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
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JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project

Esso
Southampton to London Pipeline Project

Drawing title

GEOLOGICAL AND GROUNDWATER BASELINE INFORMATION
FOLLY BOG
APFP Reg.(2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | Draft | |
| Scale | 1:3,000 @ A3 | DO NOT SCALE |
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| BIM No. | B2325300-JAC-000-ENV-DRG-001557 | |
| Drawing number | Figure A8.3.27 Sheet 1 of 1 | Rev 0 |



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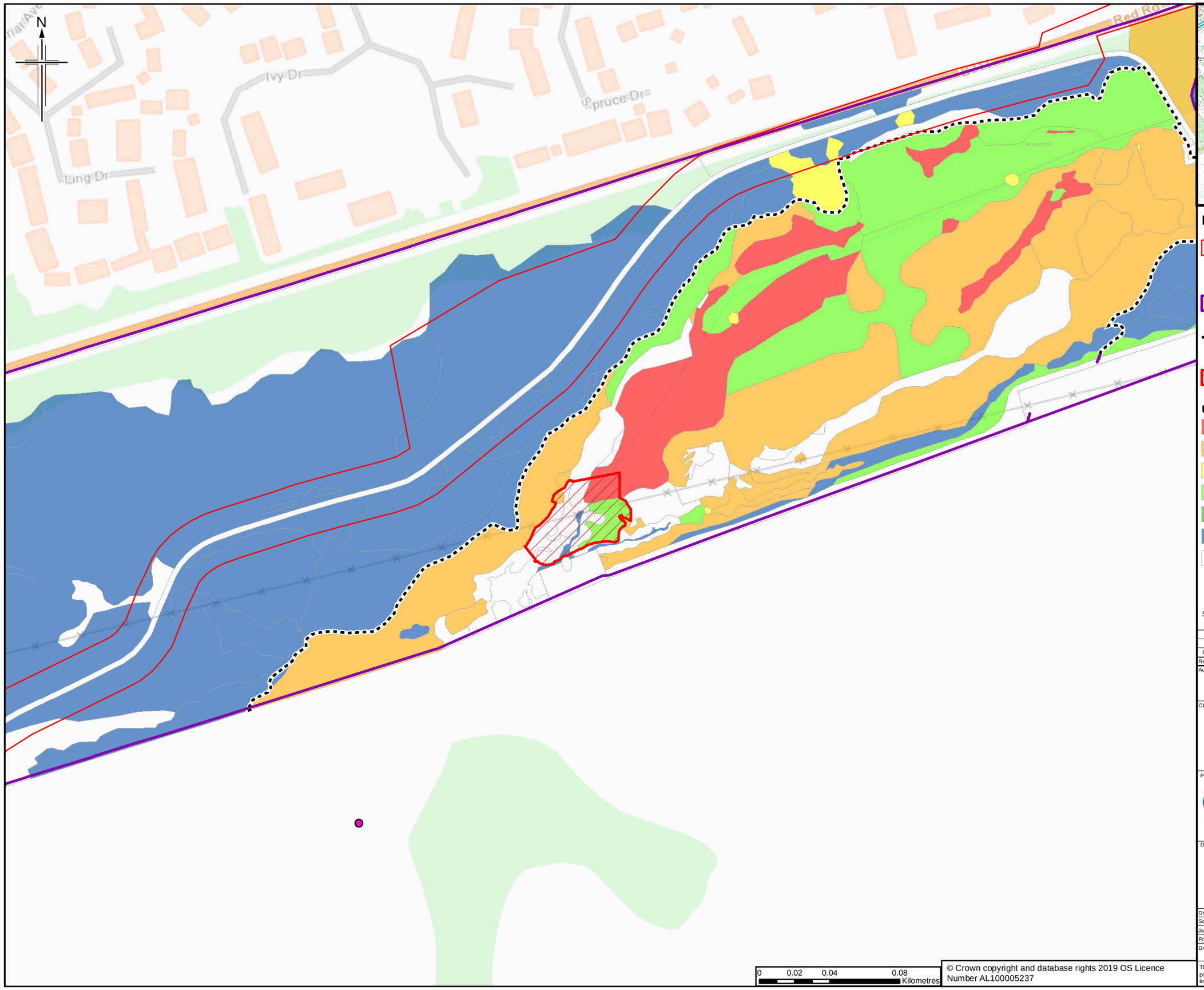


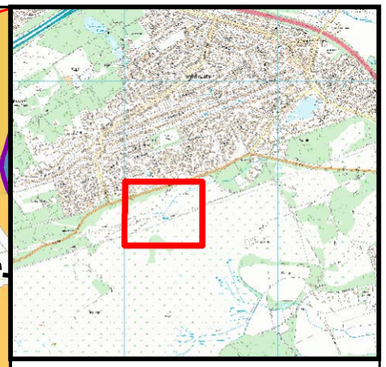

**Legend**

- Order Limits
- Approximate location of spring marked on historical OS maps
- Potential GWDTE site
- Approximate extent of Folly Bog mire based on elevation and vegetation mapping
- Location of "collects" shown on 1:10,000 OS Map

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays part of Section F

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| 0 | 3/04/2019 | For Issue | HM | MB | VSM | SH |

Author

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project

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Drawing title

ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND
GROUNDWATER DEPENDENCY
- FOLLY BOG
APFP Reg. (2009) 5(2)(l)

| | | | |
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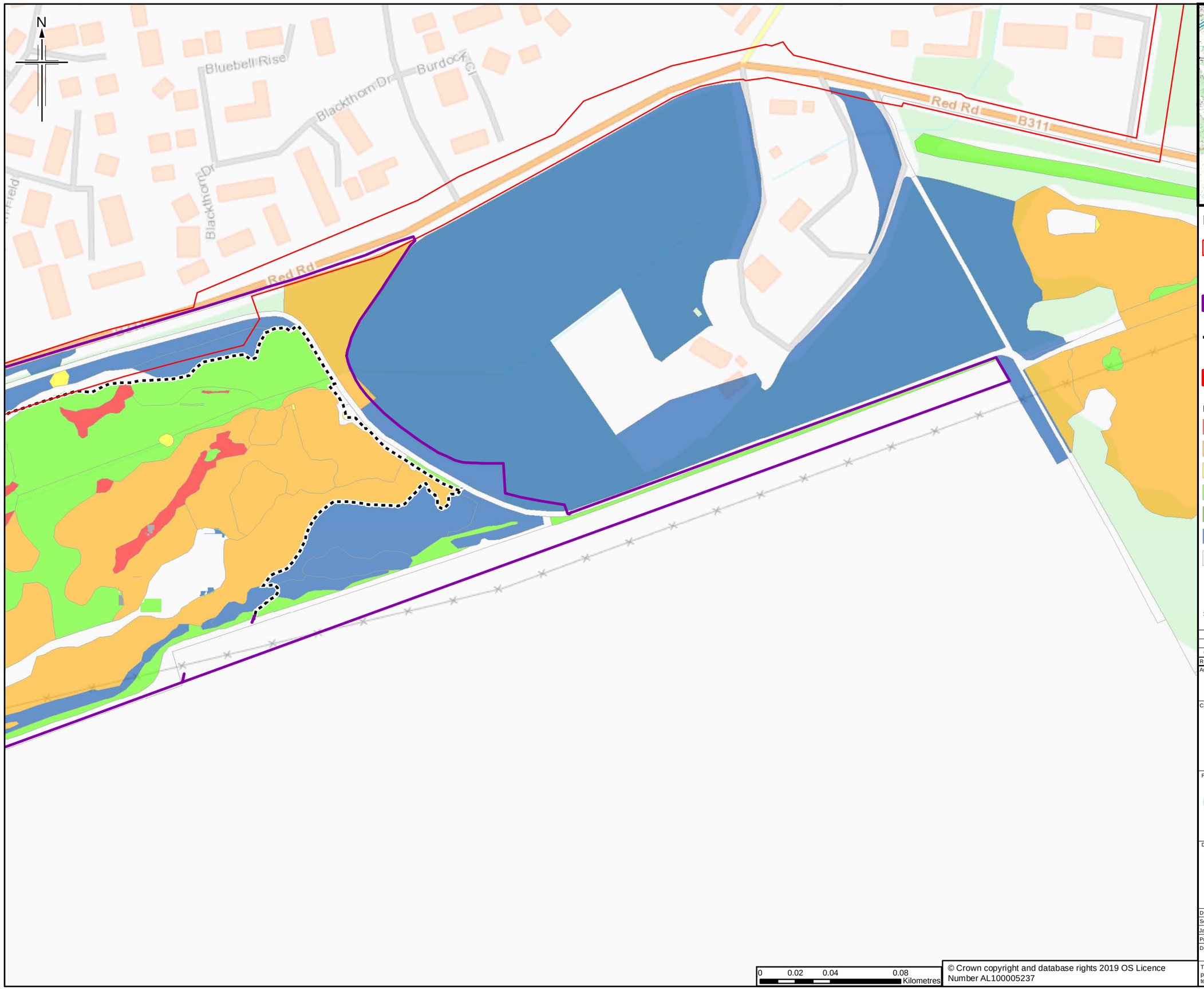
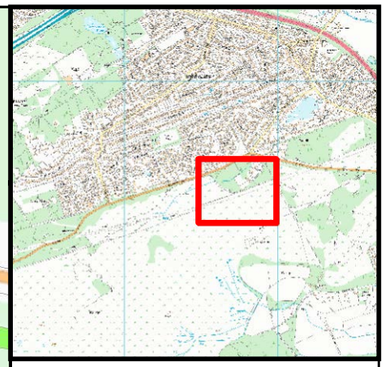
| Jacobs No. | B2325300 | | |
| ProjectWise No. | B2325300-JAC-000-ENV-DRG-001558 | | |
| Drawing number | Figure A8.3.28 Sheet 1 of 2 | Rev | 0 |

0 0.02 0.04 0.08 Kilometres



## Legend

- Order Limits
- Approximate location of spring marked on historical OS maps
- Potential GWDTE site
- Approximate extent of Folly Bog mire based on elevation and vegetation mapping
- Location of "collects" shown on 1:10,000 OS Map

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays part of Section F

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Author
JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client
Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project
Esso | Southampton to London Pipeline Project

Drawing title
ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND
GROUNDWATER DEPENDENCY
- FOLLY BOG
APFP Reg. (2009) 5(2)(l)

| | | |
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| Jacobs No. | B2325300 | |
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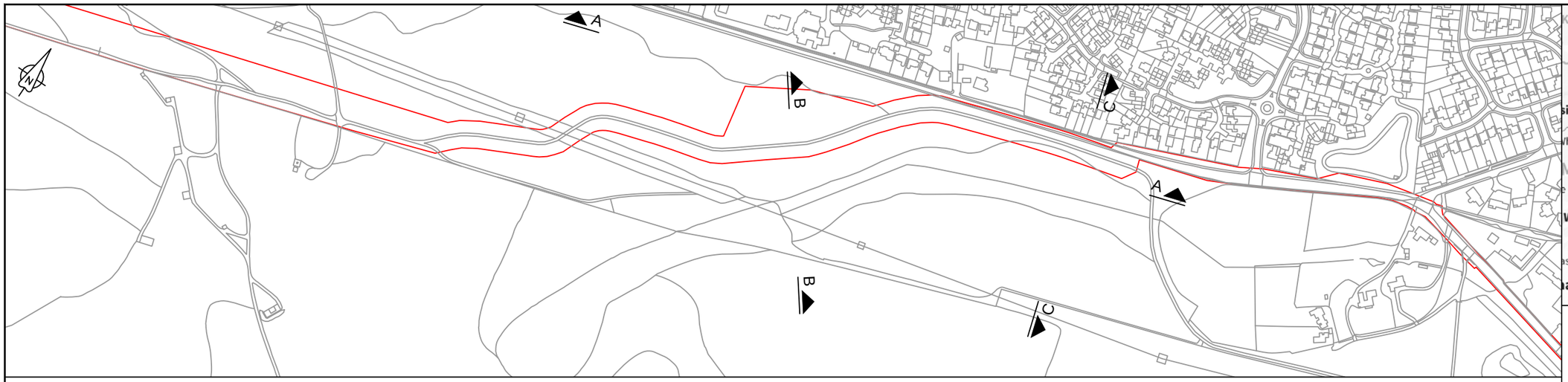
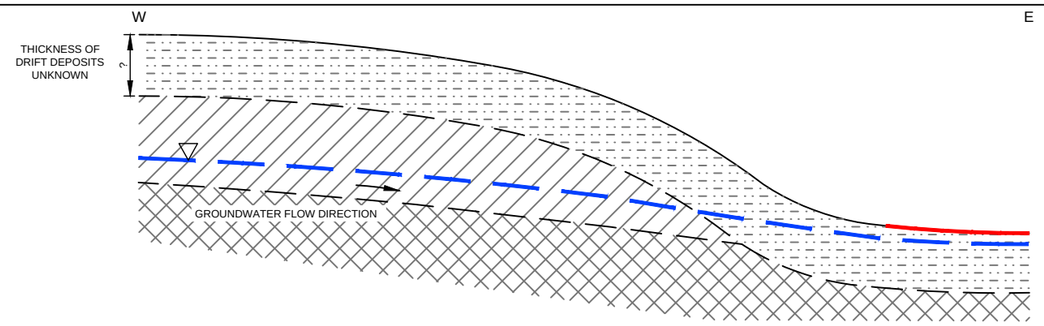
| Drawing number | Figure A8.3.28 Sheet 2 of 2 | Rev 0 |



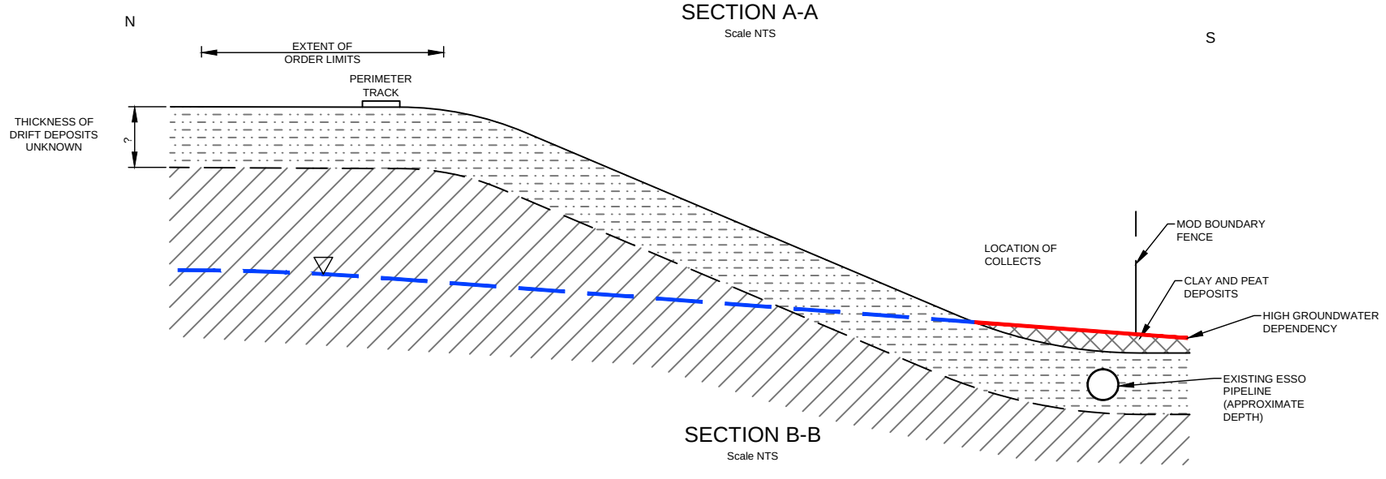

FOLLY BOG LOCATION PLAN

Scale 1:5000



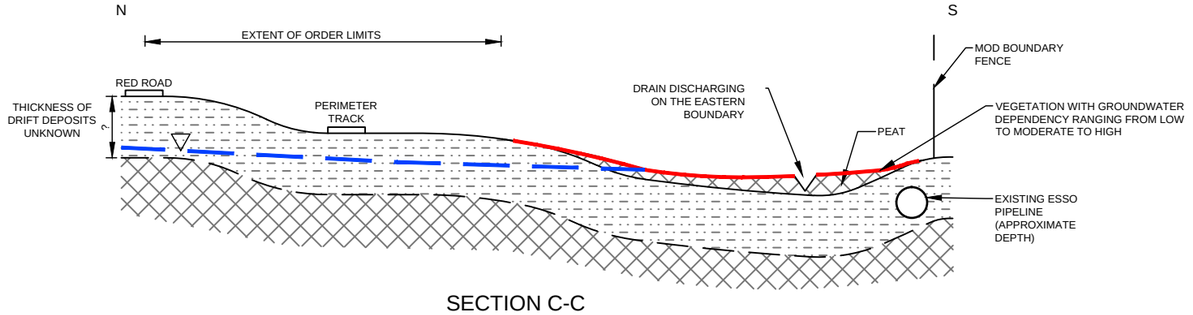

SECTION A-A

Scale NTS




SECTION B-B

Scale NTS




SECTION C-C

Scale NTS


KEY PLAN

LEGEND

- HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- GROUNDWATER FLOWS SUPPORTING THE VEGETATION FROM WIDER HYDROGEOLOGICAL CATCHMENT
- DRIFT LAYER: MEDIUM TO FINE CLAYEY SAND TO MEDIUM TO FINE SANDY CLAY. REASONABLY HOMOGENEOUS. POTENTIALLY >10m THICK
- BEDROCK DOMINANTLY OF SILTY SAND (CAMBERLEY SAND FORMATION)
- BEDROCK DOMINANTLY OF CLAYEY, SILTY SAND (WINDLESHAM FORMATION)
- EXTRAPOLATED GROUNDWATER LEVEL
- ORDER LIMITS
- CROSS SECTION ALIGNMENT



0 50 100 150 200 250 m

SCALE 1 : 5000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
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JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited, Ermyn House, Ermyn Way, Leatherhead, Surrey, KT22 8UX

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FOLLY BOG
CSM
FIGURE A8.3.29

Drawing status: Initial Status or WIP

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|---|---|---|
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| Client no. | | |

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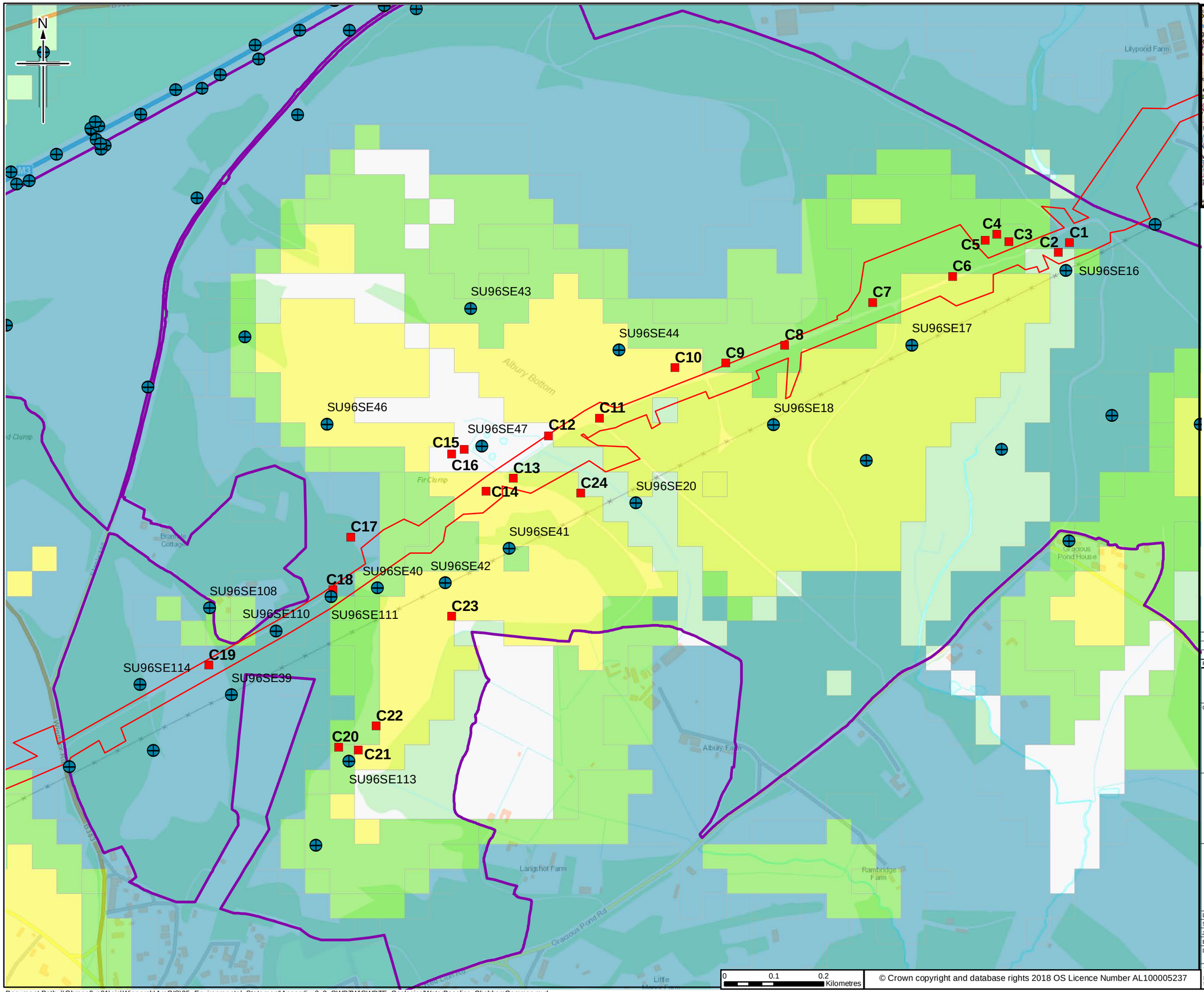


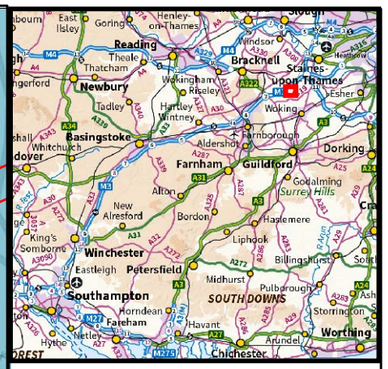


**Legend**

- Order Limits
- Potential GWDTE site
- Hand coring
- BGS boreholes

**Groundwater Flooding Susceptibility**

- Limited potential for groundwater flooding to occur
- Potential for groundwater flooding of property situated below ground level
- Potential for groundwater flooding to occur at surface

Sheet displays part of Section F

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprv'd |
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| 0 | 1/04/2019 | Initial Draft | LM | NS | VSM | SH |

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project

Esso | Southampton to London Pipeline Project

Drawing title

GEOLOGICAL AND GROUNDWATER BASELINE INFORMATION
CHOBHAM COMMON
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | Draft | |
| Scale | 1:7,082 @ A3 | DO NOT SCALE |
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| BIM No. | B2325300-JAC-000-ENV-DRG-001560 | |
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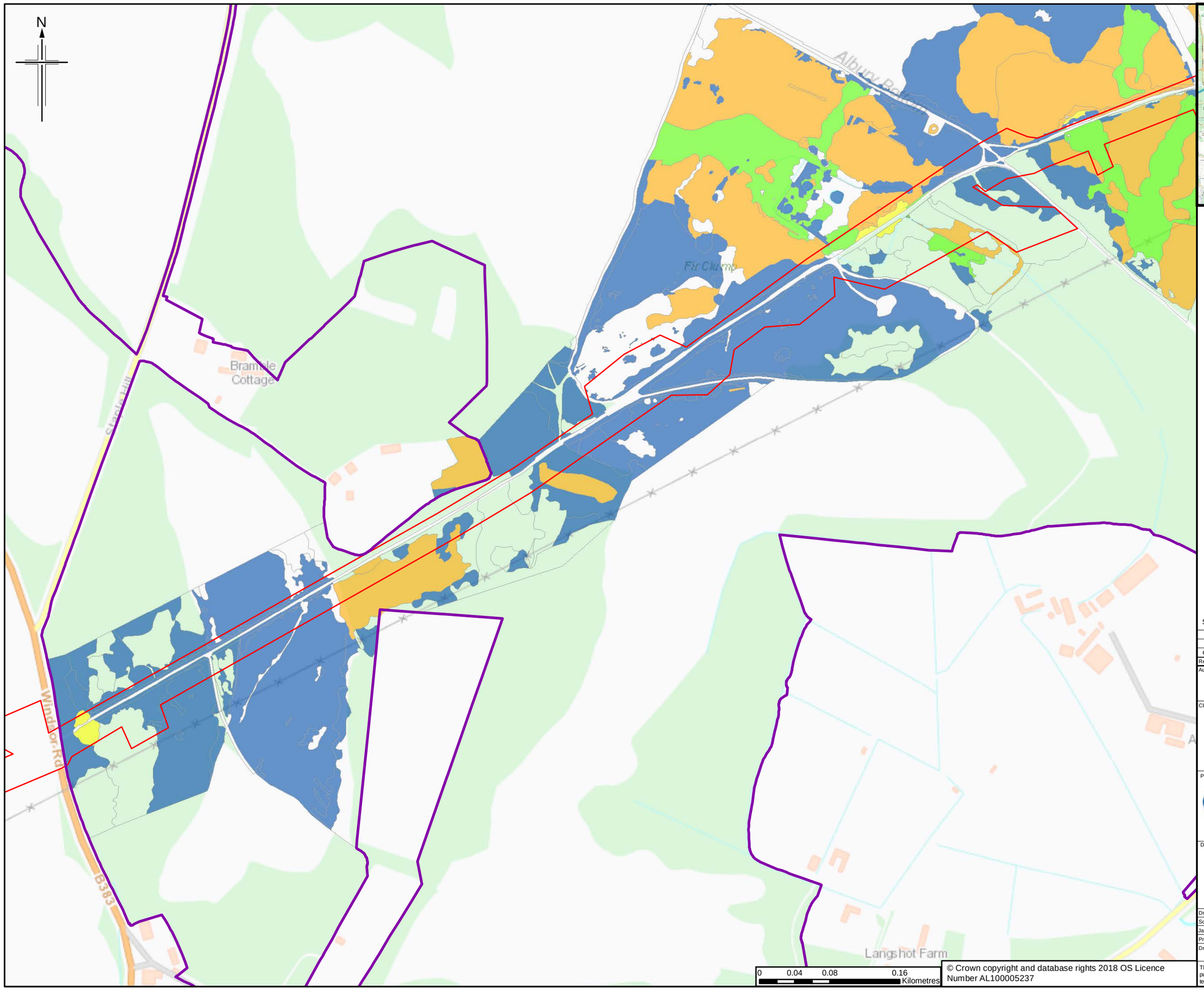


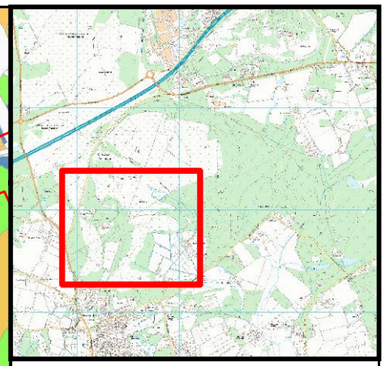

**Legend**

- Order Limits
- Potential GWDTE site

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section F

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Author

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project

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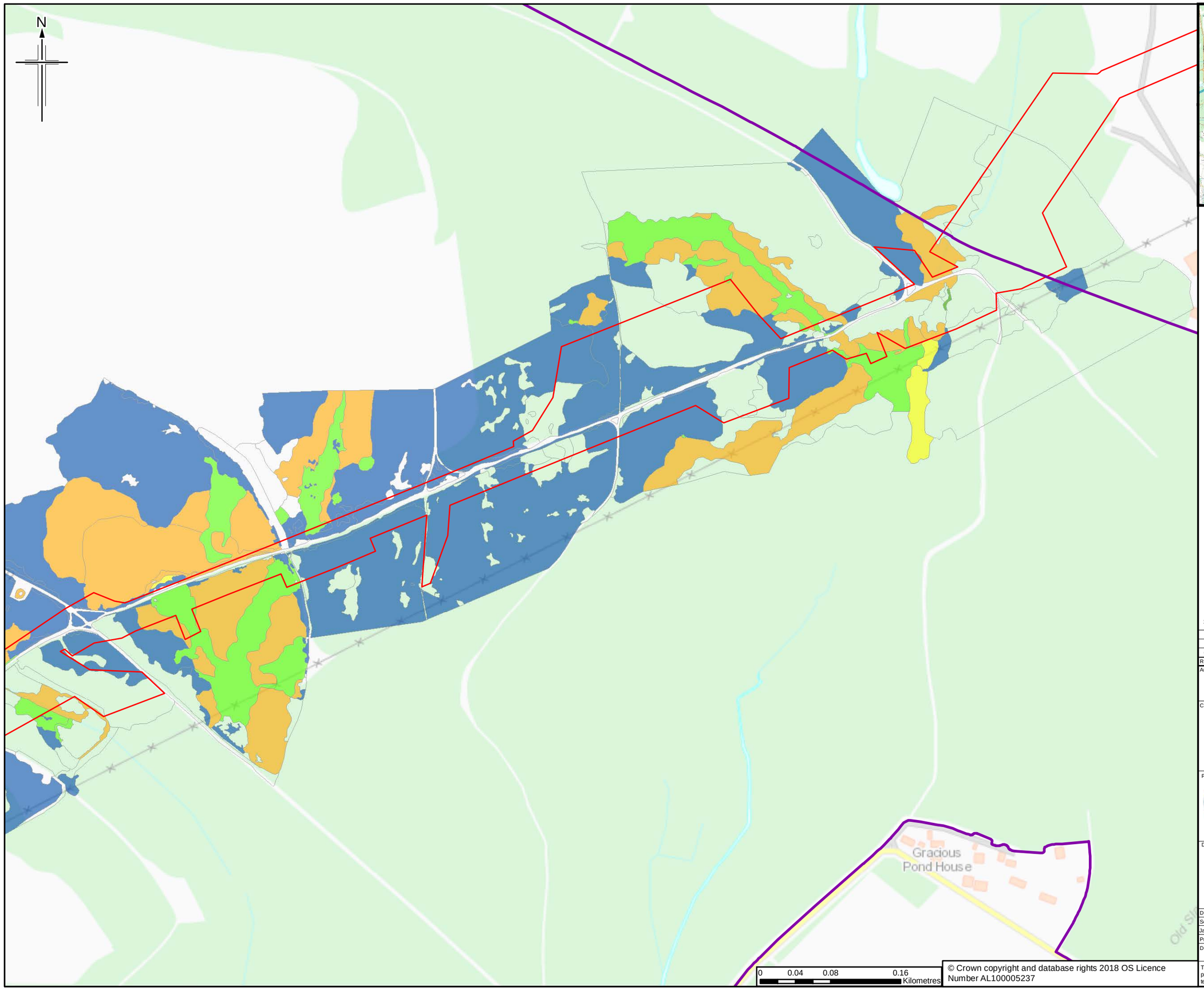
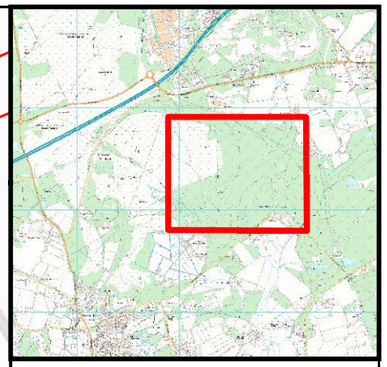
Drawing title

ENVIRONMENTAL STATEMENT
GWDTE ASSESSMENTS
CHOBHAM COMMON
VEGETATION SURVEY
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | For Issue | |
| Scale | 1:4,000 @ A3 | DO NOT SCALE |
| Jacobs No. | B2325300 | |
| ProjectWise No. | B2325300-JAC-000-ENV-DRG-001561 | |
| Drawing number | Figure A8.3.31 Sheet 1 of 2 | Rev 0 |



**Legend**

- Order Limits
- Potential GWDTE site

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section F

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| 0 | 2/04/2019 | For Issue | HM | NS | VSM | SH |

Author

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project

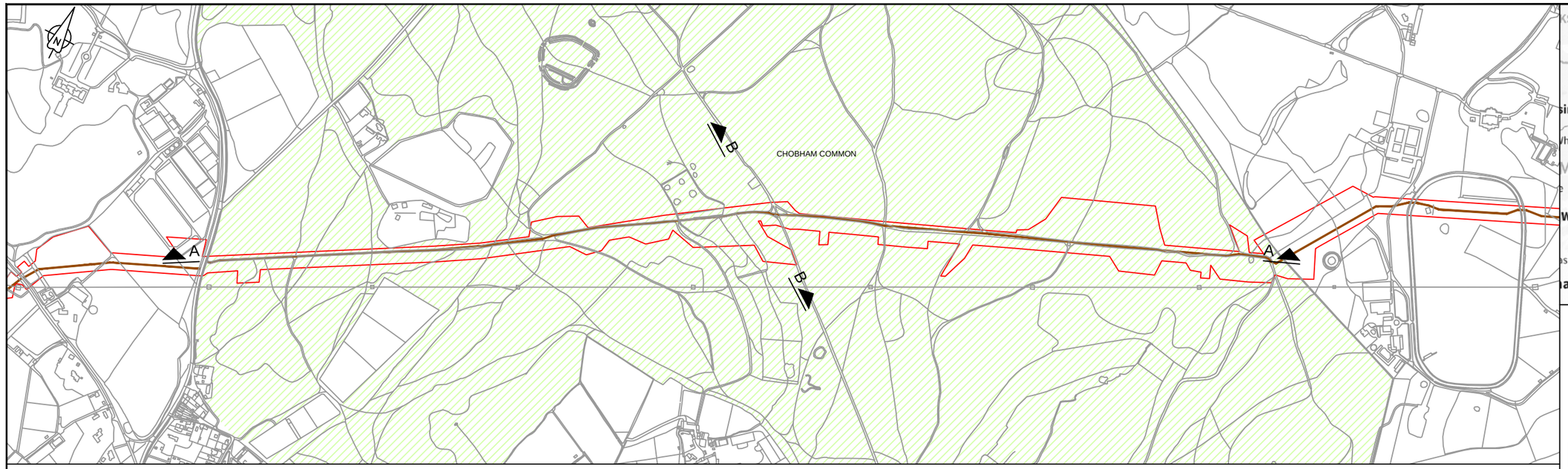
Esso | Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
GWDTE ASSESSMENTS
CHOBHAM COMMON
VEGETATION SURVEY
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | **For Issue** | |
| Scale | **1:4,000 @ A3** | **DO NOT SCALE** |
| Jacobs No. | **B2325300** | |
| ProjectWise No. | **B2325300-JAC-000-ENV-DRG-001561** | |

Drawing number: Figure A8.3.31 Sheet 2 of 2 — Rev 0



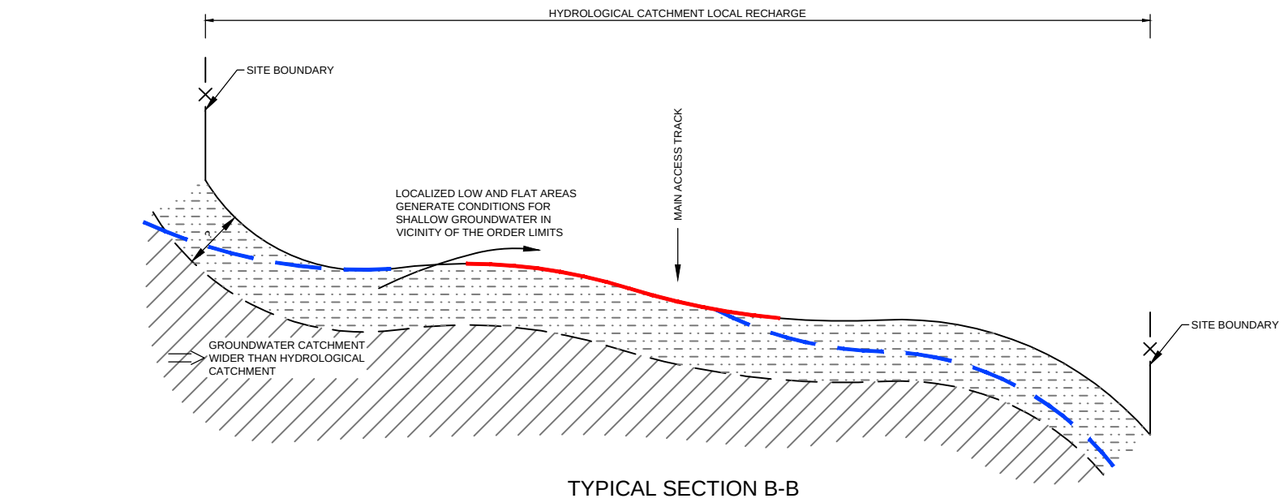

CHOBHAM COMMON LOCATION PLAN

Scale 1:10000


KEY PLAN

LEGEND

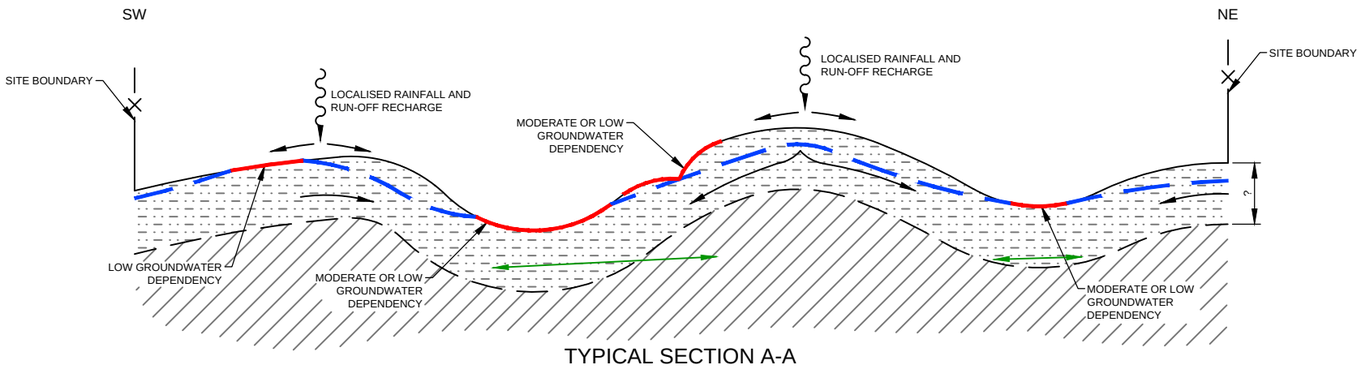
- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- FLOWS
- DRIFT LAYER: MEDIUM TO FINE CLAYEY SAND TO MEDIUM TO FINE SANDY CLAY. REASONABLY HOMOGENEOUS. POTENTIALLY >10m THICK
- BEDROCK
- EXTRAPOLATED GROUNDWATER LEVEL
- TRENCHLESS PORTIONS
- ORDER LIMITS
- SITE OF SPECIAL SCIENTIFIC INTEREST (SSSI)
- CROSS SECTION ALIGNMENT




TYPICAL SECTION B-B

CROSS SECTION PERPENDICULAR TO THE MAIN ACCESS TRACK

Scale NTS




TYPICAL SECTION A-A

LONG SECTION ALONG THE MAIN ACCESS TRACK

Scale NTS

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0 100 200 300 400 500 m

SCALE 1 : 10000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| P01.1 | 04/02/19 | DESIGN FREEZE DCO | DS | VS-M | VS-M | SH |

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey.
KT22 8UX

Project: Southampton to London Pipeline Project

Drawing title

CHOBHAM COMMON
CSM
FIGURE A8.3.32

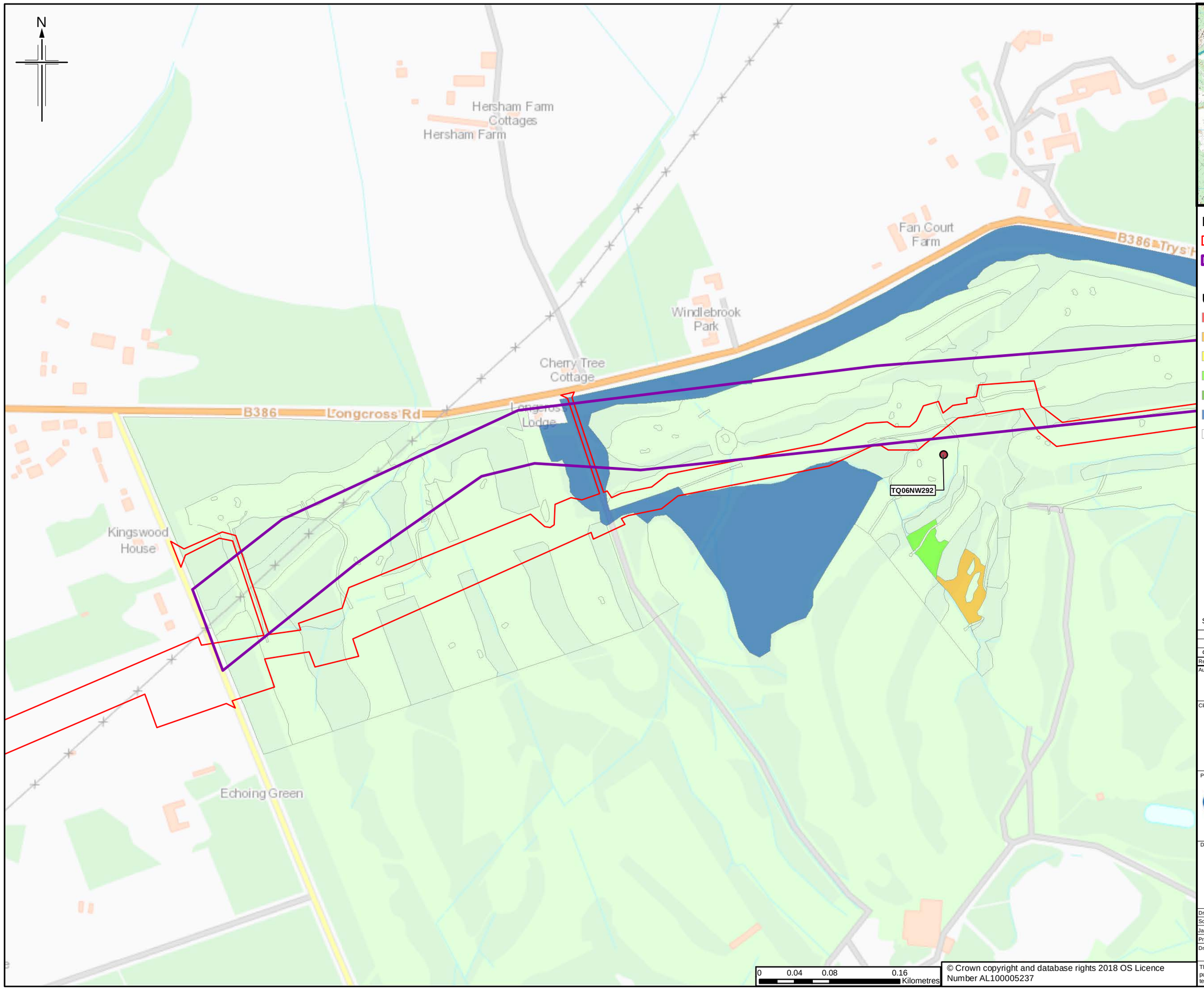
Drawing status: Fit for Internal Review and Comment

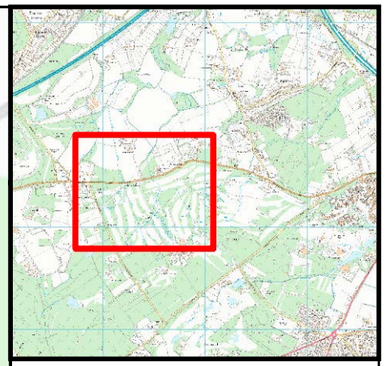
| Scale | AS SHOWN | DO NOT SCALE |
|---|---|---|
| Jacobs No. | B2325300 | Rev P01.1 |
| Client no. | | |

Drawing number: B2325300-JAC-000-ENV-DRG-001562



DRAFT



**Legend**

- Order Limits
- Potential GWDTE site
- Borehole

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section F

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| 0 | 6/03/2019 | For Issue | HM | JW | VSM | SH |

Author

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

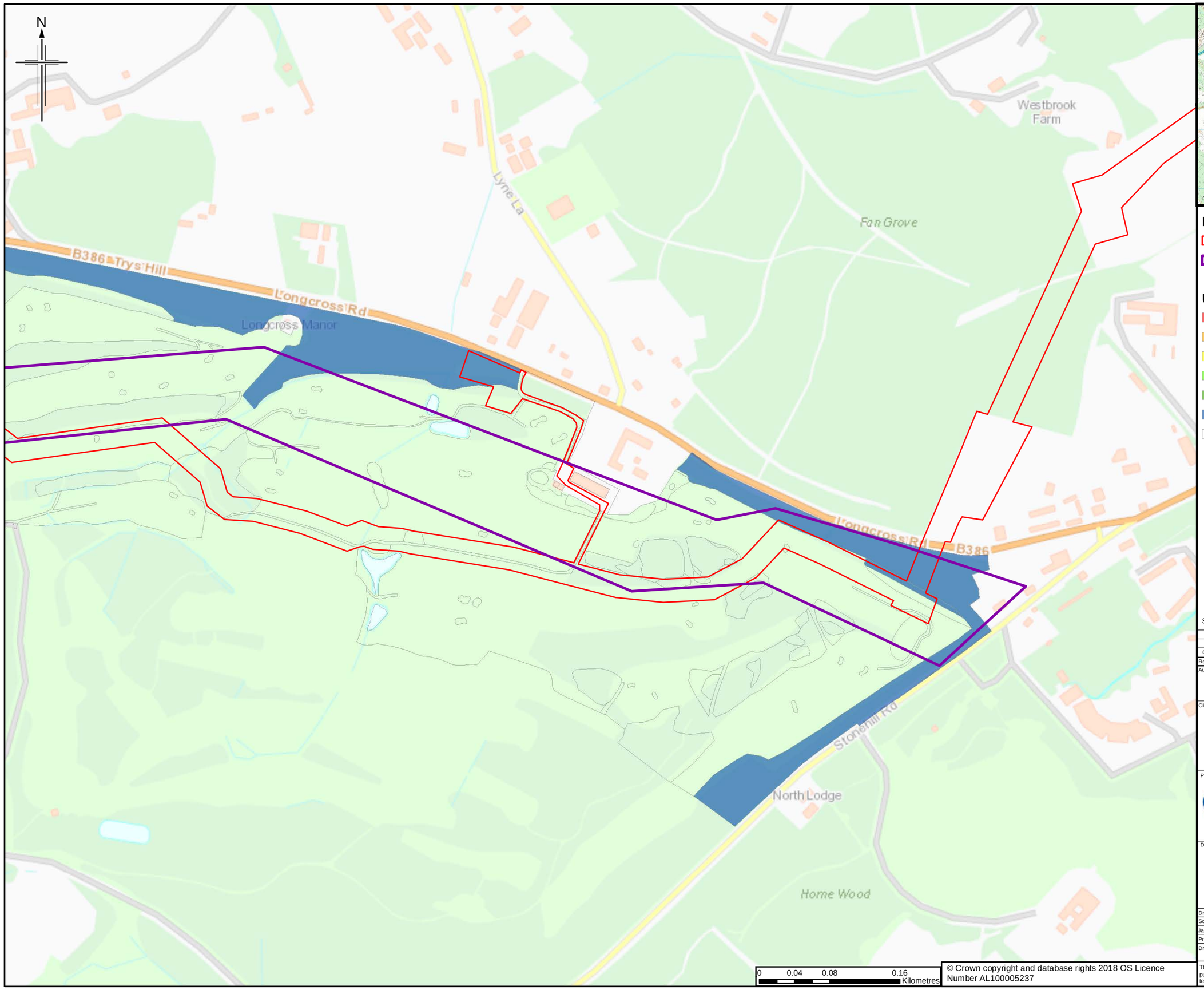
Project

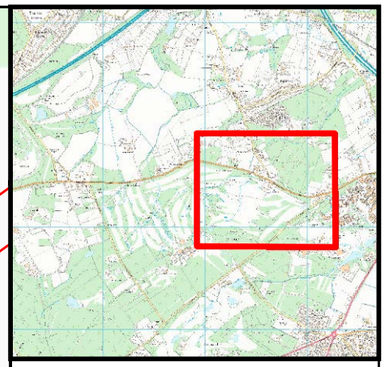
Esso | Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
NVC HABITAT SURVEY AND
GROUNDWATER DEPENDENCY
- FOXHILLS
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | For Issue | |
| Scale | 1:4,000 @ A3 | DO NOT SCALE |
| Jacobs No. | B2325300 | |
| ProjectWise No. | B2325300-JAC-000-ENV-DRG-001563 | |
| Drawing number | Figure A8.3.33 Sheet 1 of 2 | Rev 0 |



**Legend**

- Order Limits
- Potential GWDTE site
- Borehole

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section F

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| 0 | 6/03/2019 | For Issue | HM | JW | VSM | SH |

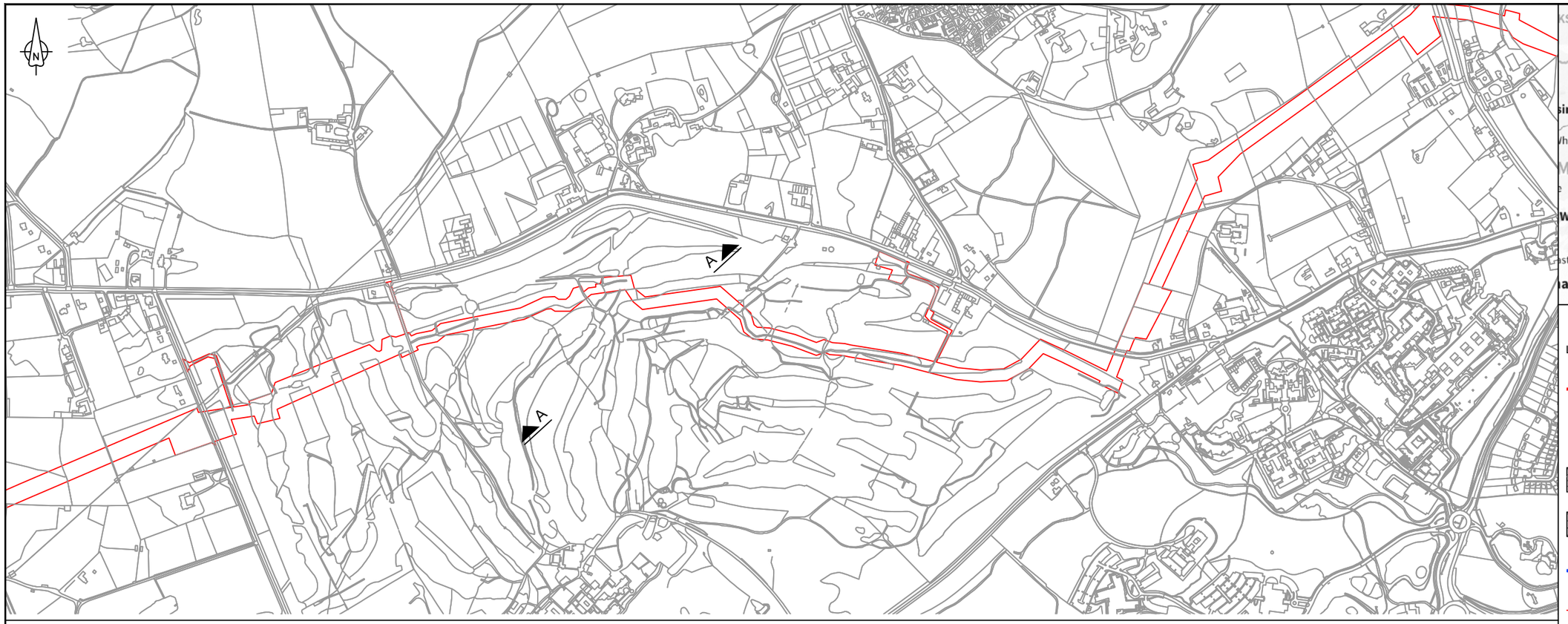
Author
JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client
Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project
Esso | Southampton to London Pipeline Project

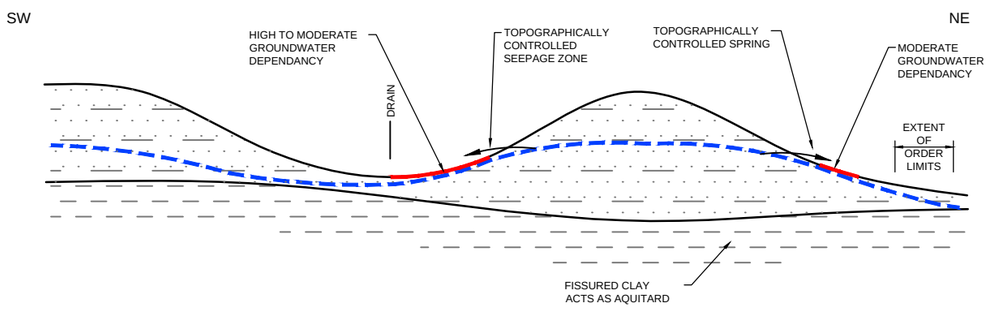
Drawing title
ENVIRONMENTAL STATEMENT
NVC HABITAT SURVEY AND
GROUNDWATER DEPENDENCY
- FOXHILLS
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | **For Issue** | |
| Scale | **1:4,000 @ A3** | **DO NOT SCALE** |
| Jacobs No. | **B2325300** | |
| ProjectWise No. | **B2325300-JAC-000-ENV-DRG-001563** | |
| Drawing number | Figure A8.3.33 Sheet 2 of 2 | Rev 0 |




FOX HILLS LOCATION PLAN

Scale 1:5000




TYPICAL SECTION A-A

Scale NTS


KEY PLAN

LEGEND

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- GROUNDWATER FLOWS SUPPORTING THE VEGETATION FROM WIDER HYDROGEOLOGICAL CATCHMENT
- VERY CLAYEY SAND - WINDLESHAM FORMATION
- CLAY - SWINLEY CLAY MEMBER
- EXTRAPOLATED GROUNDWATER LEVEL
- ORDER LIMITS
- CROSS SECTION ALIGNMENT



0 50 100 150 200 250 m

SCALE 1 : 5000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| P01.1 | 31/01/19 | DESIGN FREEZE DCO | PM | JW | JW | SH |

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
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Surrey,
KT22 8UX

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Drawing title

FOX HILLS
CSM
FIGURE A8.3.34

Drawing status: Initial Status or WIP

| | | |
|---|---|---|
| Scale | AS SHOWN | DO NOT SCALE |
| Jacobs No. | B2325300 | Rev P01.1 |
| Client no. | | |

Drawing number: B2325300-JAC-000-ENV-DRG-001564



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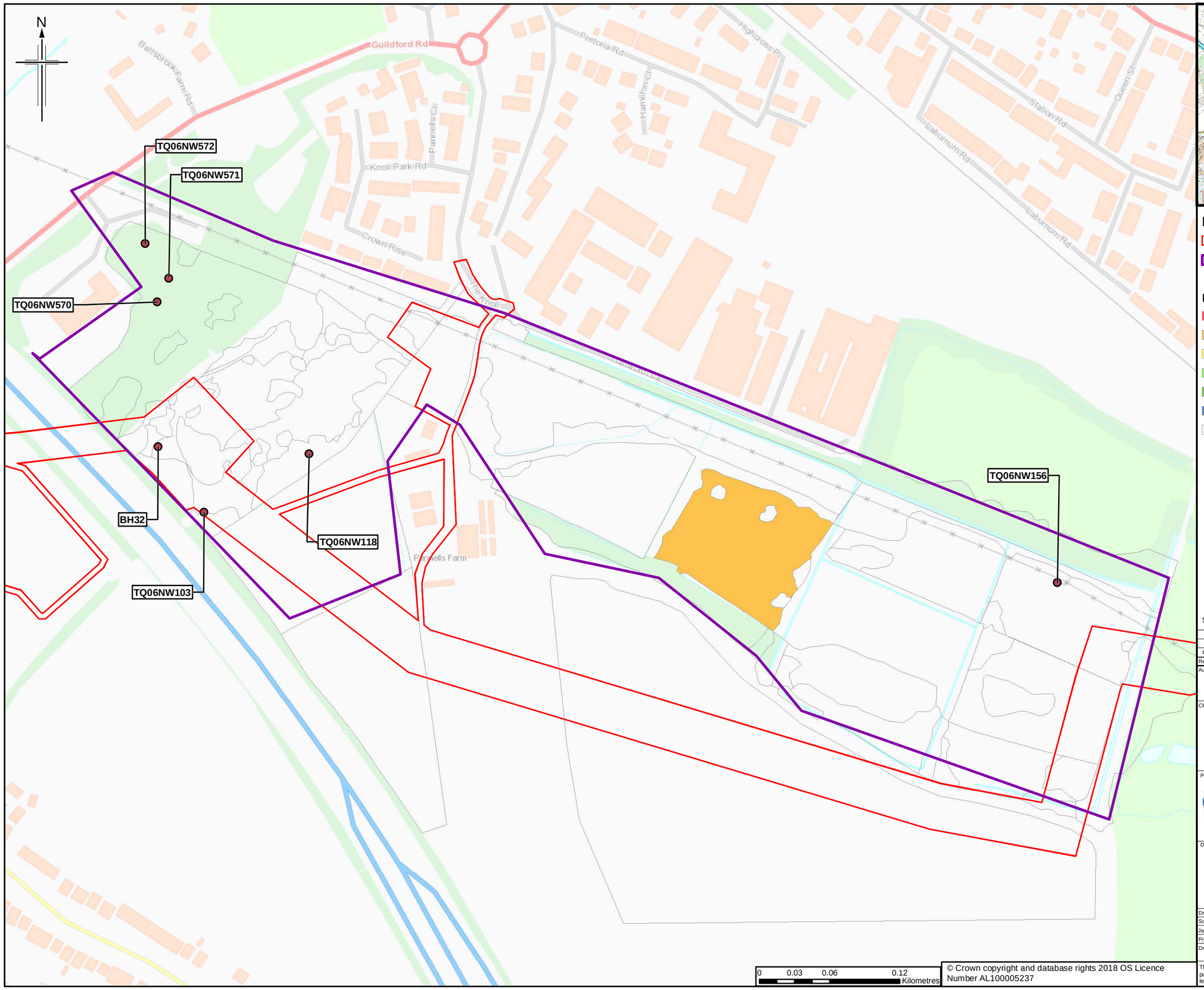
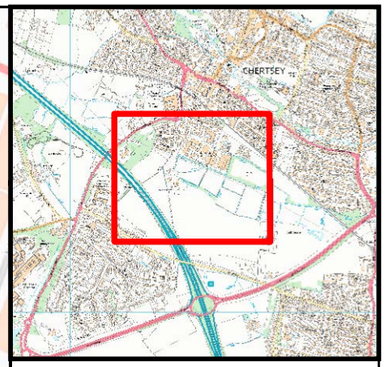



**Legend**

- Order Limits
- Potential GWDTE site
- Boreholes

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section F and Section G

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| 0 | 6/03/2019 | For Issue | HM | JW | VSM | SH |

Author

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

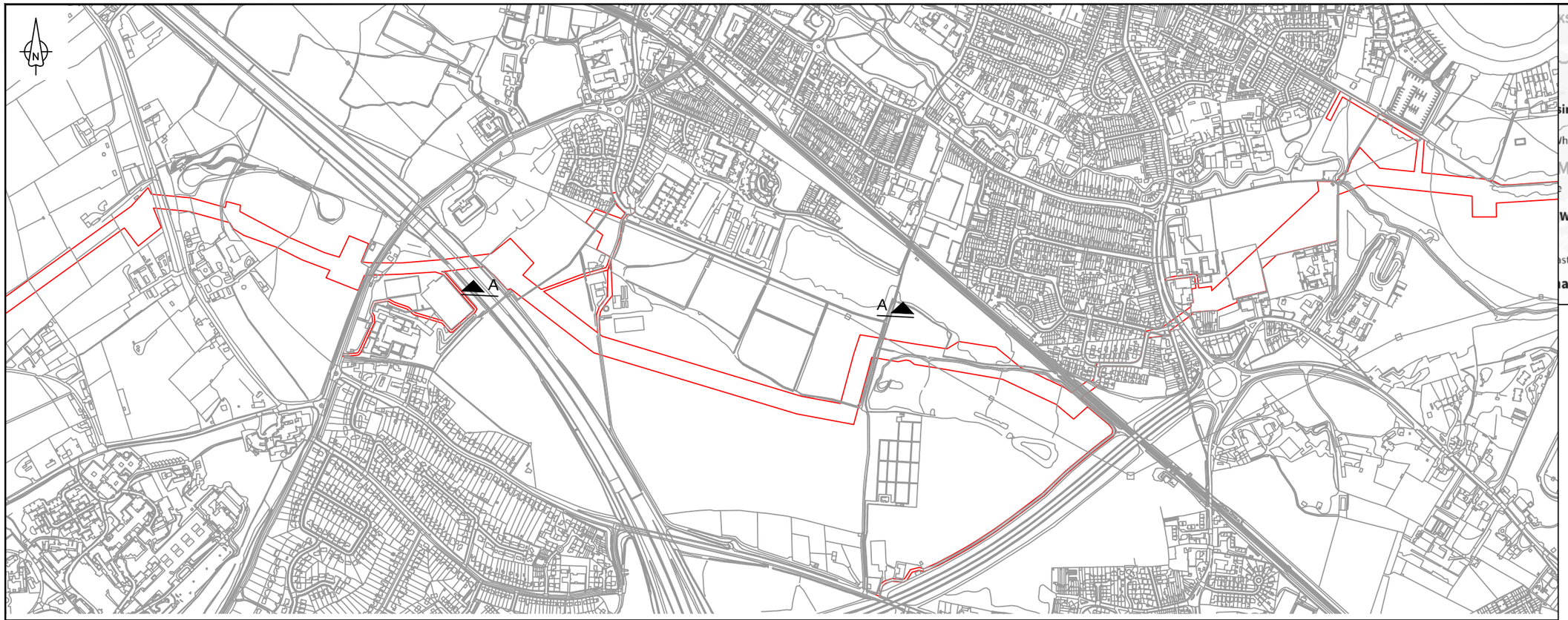
Project

Esso | Southampton to London Pipeline Project

Drawing title

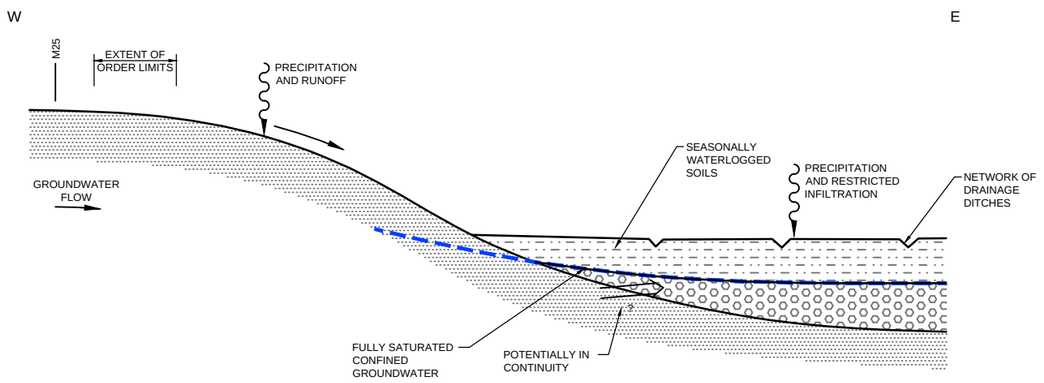
ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND
GROUNDWATER DEPENDENCY
- ADDLESTONE MOOR
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | For Issue | |
| Scale | 1:3,000 @ A3 | DO NOT SCALE |
| Jacobs No. | B2325300 | |
| ProjectWise No. | B2325300-JAC-000-ENV-DRG-001565 | |
| Drawing number | Figure A8.3.35 Sheet 1 of 1 | Rev 0 |




ADDLESTONE MOOR LOCATION PLAN

Scale 1:5000




TYPICAL SECTION A-A

Scale NTS


KEY PLAN

LEGEND

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- GROUNDWATER FLOWS SUPPORTING THE VEGETATION FROM WIDER HYDROGEOLOGICAL CATCHMENT
- SILTY CLAY - THICK SOILS AND ALLUVIUM
- SAND AND GRAVEL - KEMPTON PARK GRAVEL MEMBER
- CLAYEY SAND - BAGSHOT FORMATION
- EXTRAPOLATED GROUNDWATER LEVEL
- ORDER LIMITS
- CROSS SECTION ALIGNMENT



0 50 100 150 200 250 m

SCALE 1 : 5000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| P01.1 | 31/01/19 | DESIGN FREEZE DCO | PM | JW | JW | SH |

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited, Ermyn House, Ermyn Way, Leatherhead, Surrey, KT22 8UX

Project: Esso — Southampton to London Pipeline Project

Drawing title

ADDLESTONE MOOR
CSM
FIGURE A8.3.36

Drawing status: Initial Status or WIP

| | | |
|---|---|---|
| Scale | AS SHOWN | DO NOT SCALE |
| Jacobs No. | B2325300 | Rev P01.1 |
| Client no. | | |

Drawing number: B2325300-JAC-000-ENV-DRG-001566



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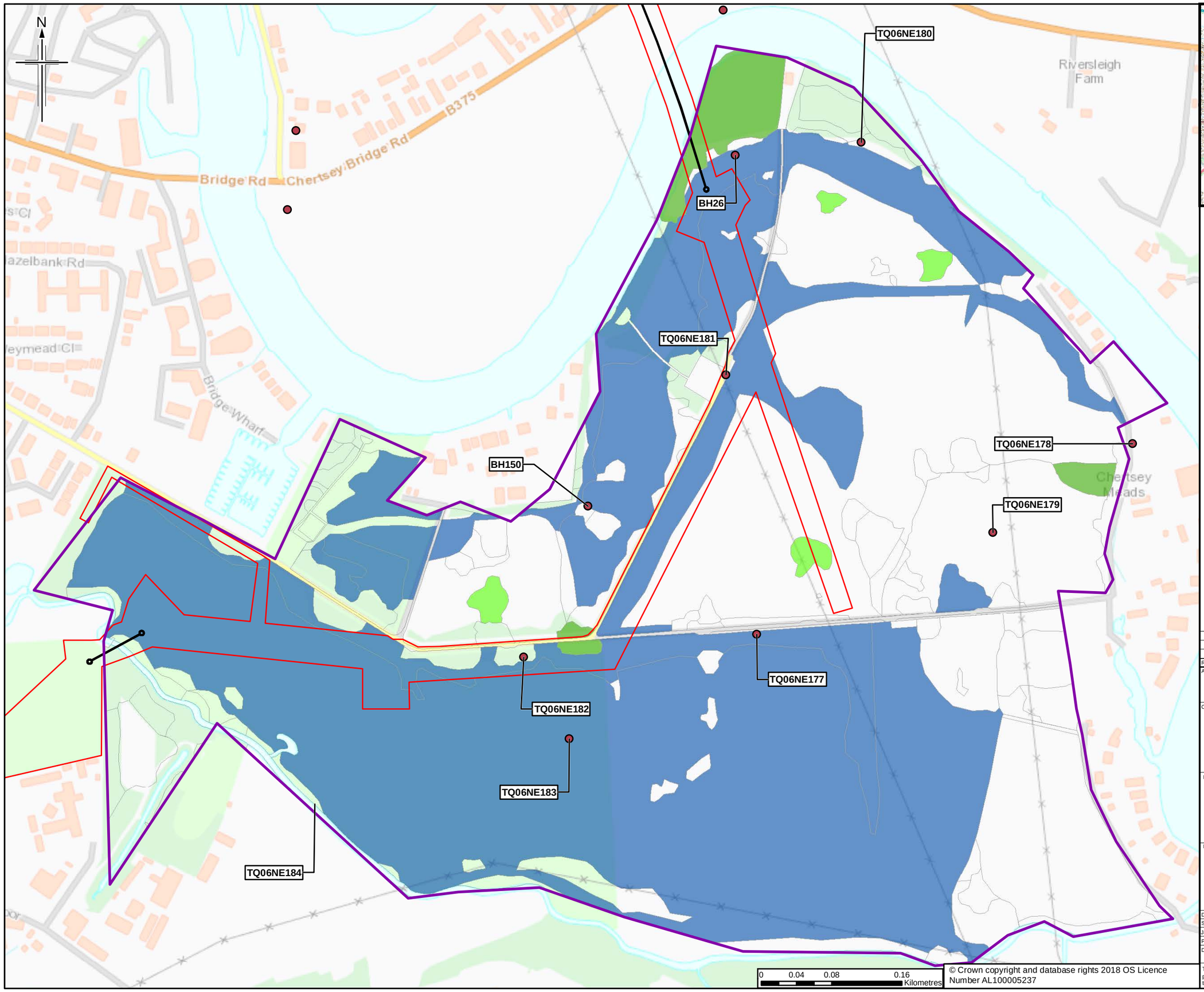
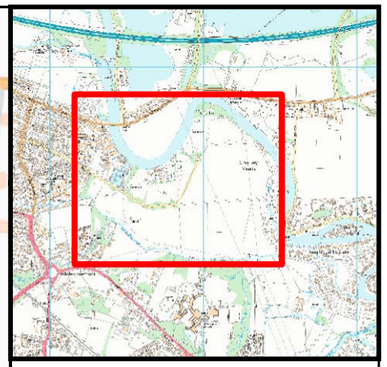


**Legend**

- Order Limits
- Potential GWDTE site
- Trenchless crossing
- Boreholes

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section G

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprvd |
|---|---|---|---|---|---|---|
| 0 | 1/04/2019 | For Issue | HM | JW | VSM | SH |

Author

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client

Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

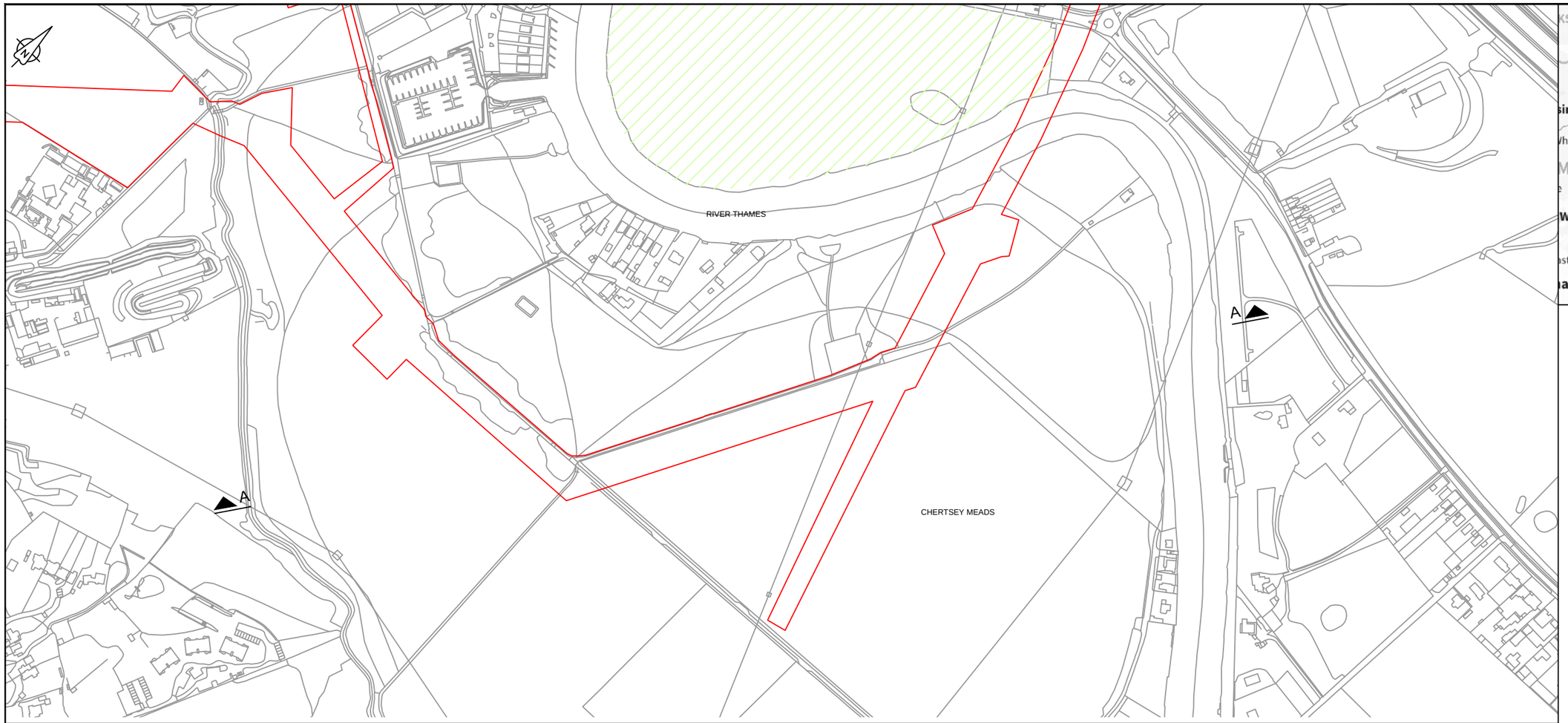
Project

Esso | Southampton to London Pipeline Project

Drawing title

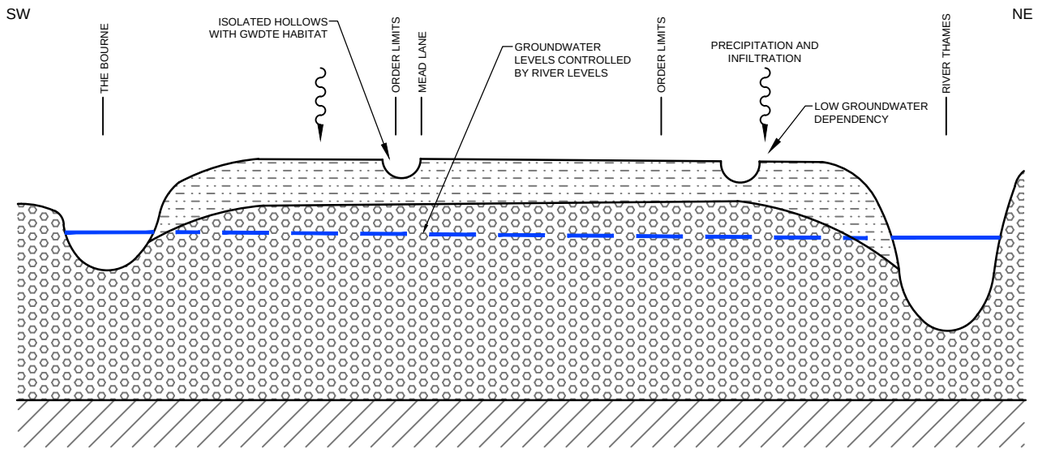
ENVIRONMENTAL STATEMENT
NVC HABITAT SURVEY AND
GROUNDWATER DEPENDENCY
- CHERTSEY MEADS
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | **For Issue** | |
| Scale | **1:4,000 @ A3** | **DO NOT SCALE** |
| Jacobs No. | **B2325300** | |
| ProjectWise No. | **B2325300-JAC-000-ENV-DRG-001567** | |
| Drawing number | Figure A8.3.37 Sheet 1 of 1 | Rev 0 |




## CHERTSEY MEADS LOCATION PLAN

SCALE 1:5000




## TYPICAL SECTION A-A

Scale NTS


KEY PLAN

LEGEND

- SANDY SILTY CLAY - ALLUVIUM
- SAND AND GRAVEL - SHEPPERTON GRAVEL MEMBER
- BEDROCK - BAGSHOT FORMATION
- SITE OF SPECIAL SCIENTIFIC INTEREST (SSSI)
- EXTRAPOLATED GROUNDWATER LEVEL
- ORDER LIMITS
- CROSS SECTION ALIGNMENT



0 50 100 150 200 250 m

SCALE 1 : 5000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| P01.1 | 31/01/19 | DESIGN FREEZE DCO | PM | JW | JW | SH |

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
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Drawing title

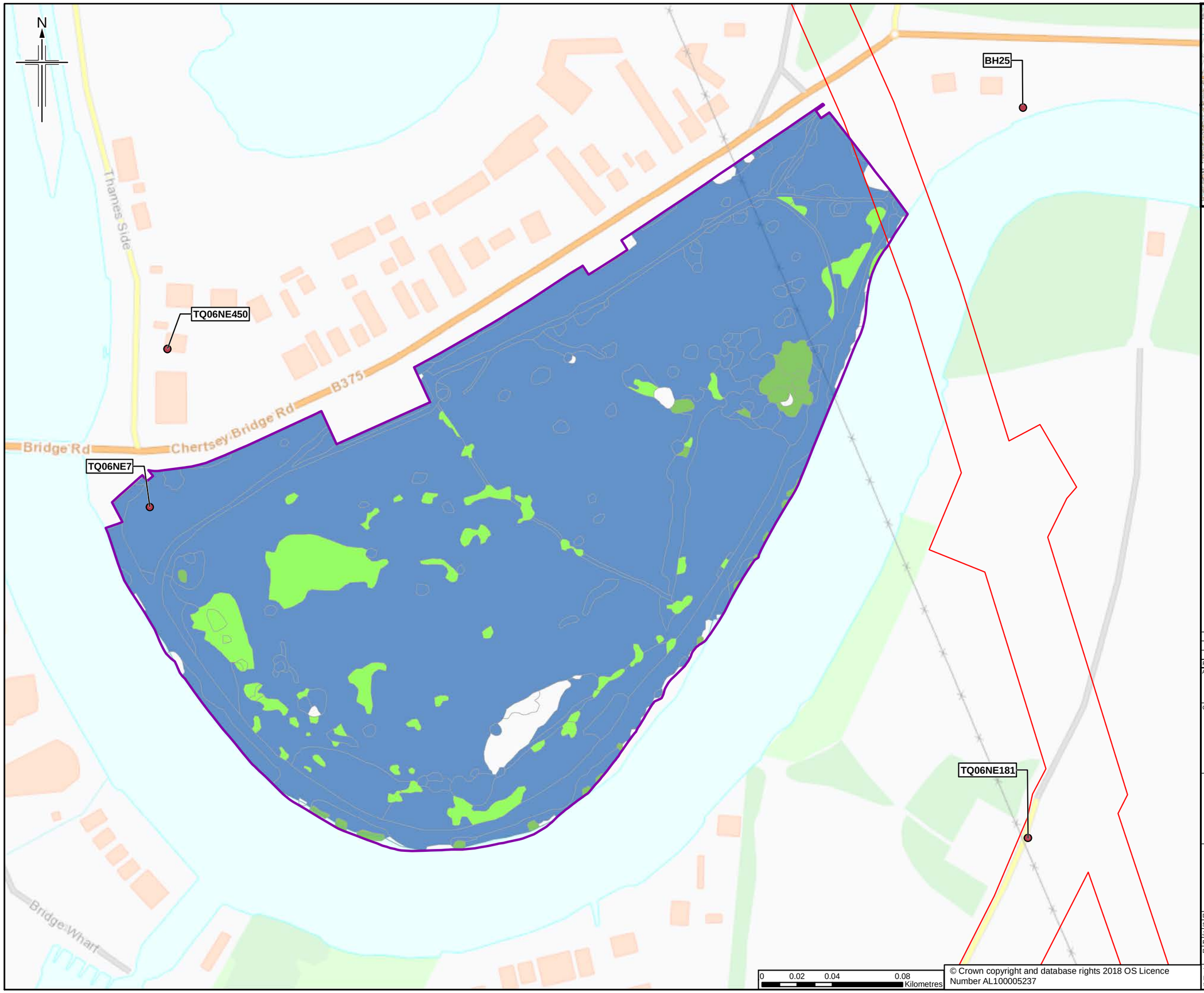
# CHERTSEY MEADS CSM FIGURE A8.3.38

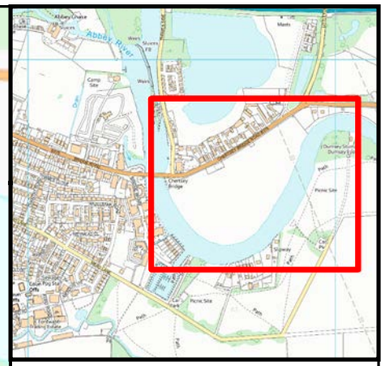


Drawing status: Initial Status or WIP

| | | |
|---|---|---|
| Scale | AS SHOWN | DO NOT SCALE |
| Jacobs No. | B2325300 | Rev P01.1 |
| Client no. | | |

Drawing number: B2325300-JAC-000-ENV-DRG-001568



**Legend**

- Order Limits
- Potential GWDTE site
- Boreholes

**UKTAG rating**

- High
- High to Moderate
- Moderate
- Low to Moderate
- Low
- Not groundwater dependent
- n/a

Sheet displays parts of Section G

| Rev. | Rev. Date | Purpose of revision | Orig/Dwn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| 0 | 12/03/2019 | For Issue | HM | JW | VSM | SH |

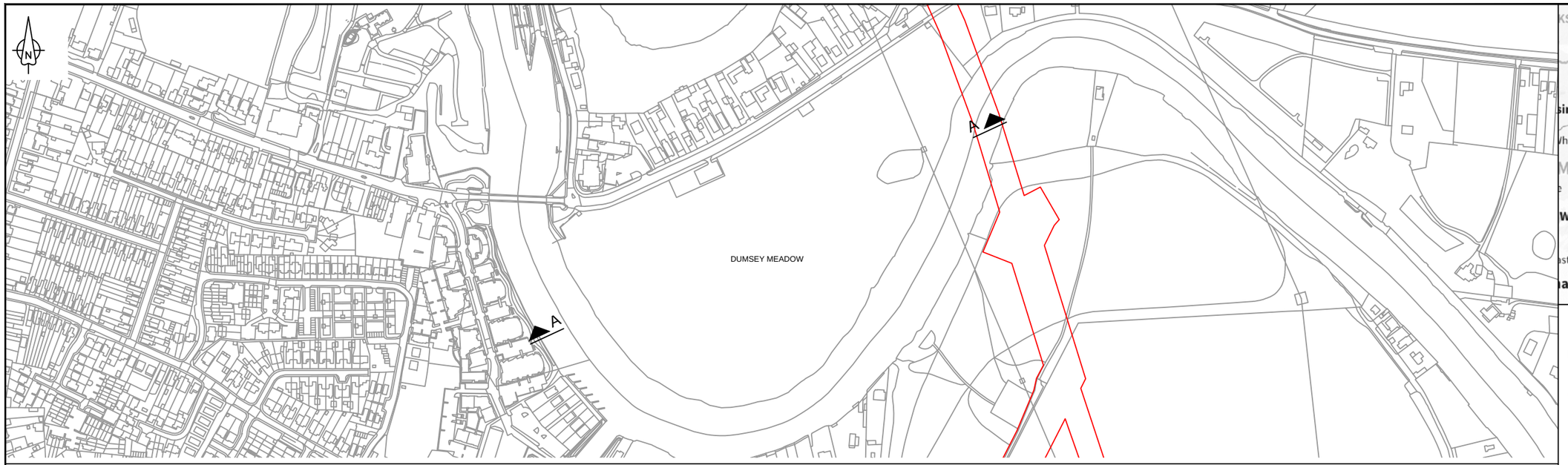
Author
JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU. UK.
Tel: +44(0)118 946 7000 Fax: +44(0)118 946 7001
www.jacobs.com

Client
Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project
Esso | Southampton to London Pipeline Project

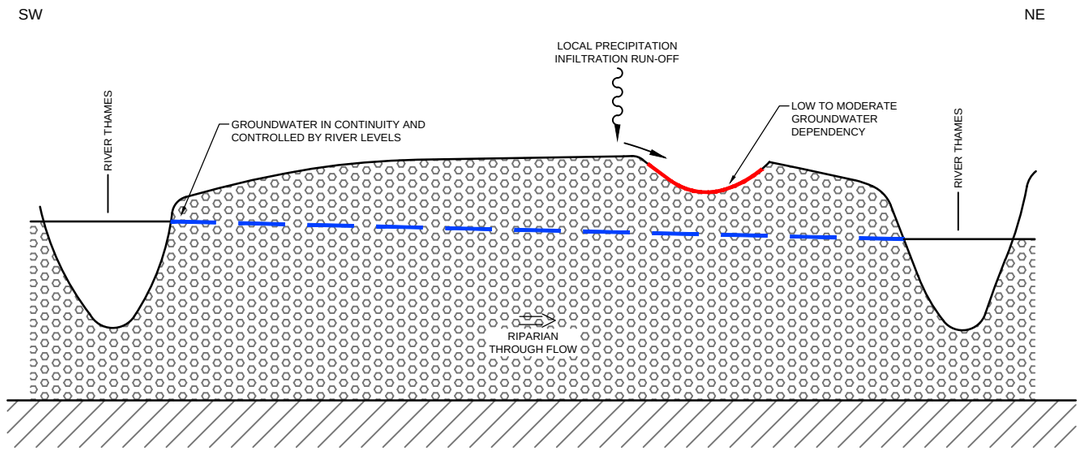
Drawing title
ENVIRONMENTAL STATEMENT
NVC AND HABITAT SURVEY AND
GROUNDWATER DEPENDENCY
- DUMSEY MEADOW
APFP Reg. (2009) 5(2)(l)

| | | |
|---|---|---|
| Drawing Status | **For Issue** | |
| Scale | **1:2,000 @ A3** | **DO NOT SCALE** |
| Jacobs No. | **B2325300** | |
| ProjectWise No. | **B2325300-JAC-000-ENV-DRG-001569** | |
| Drawing number | Figure A8.3.39 Sheet 1 of 1 | Rev 0 |




## DUMSEY MEADOW LOCATION PLAN

SCALE 1:5000




## TYPICAL SECTION A-A

Scale NTS


KEY PLAN

LEGEND

- VARIOUS HABITATS WITH DEGREES OF GROUNDWATER DEPENDENCY
- GROUNDWATER FLOWS SUPPORTING THE VEGETATION FROM WIDER HYDROGEOLOGICAL CATCHMENT
- SAND AND GRAVEL - SHEPPERTON GRAVEL MEMBER
- BEDROCK - BAGSHOT FORMATION
- EXTRAPOLATED GROUNDWATER LEVEL
- ORDER LIMITS
- CROSS SECTION ALIGNMENT



0 50 100 150 200 250 m

SCALE 1 : 5000

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| P01.1 | 07/02/19 | DESIGN FREEZE DCO | PM | JW | JW | SH |

JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU
Tel:+44(0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client: Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project: Esso | Southampton to London Pipeline Project

Drawing title

DUMSEY MEADOW
CSM
FIGURE A8.3.40

Drawing status: Initial Status or WIP

| | | |
|---|---|---|
| Scale | AS SHOWN | DO NOT SCALE |
| Jacobs No. | B2325300 | Rev P01.1 |
| Client no. | | |

Drawing number: B2325300-JAC-000-ENV-DRG-001570



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