Southampton to London Pipeline Project

Volume 6

Environmental Statement (Volume D) Appendix 8.4: Groundwater Abstraction Assessment

Application Document: 6.4

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

May 2019

(This page is intentionally left blank)

Contents

Appendix 8.4 Groundwater Abstraction Assessment

1.1 Introduction

1.1.1 Esso Petroleum Company, Limited (Esso) is making an application for development consent to replace 90km (56 miles) of its existing 105km (65 miles) aviation fuel pipeline that runs from the Fawley Refinery near Southampton, to the Esso West London Terminal storage facility in Hounslow. The replacement is referred to as the project within this report.

1.1.2 The Groundwater Abstraction Conceptual Site Models have been produced to support the application for a Development Consent Order (DCO) and the accompanying Environmental Statement (ES) under the Planning Act 2008.

1.2 Approach

1.2.1 A source-pathway-receptor approach has been applied to review potential effects on groundwater quality in relation to the unlikely event of pollution incidents. This appendix focusses on potential pathway-receptor linkages which relate to the geological/hydrogeological natural settings between the Order Limits and identified groundwater abstractions. The potential pathways have been subdivided into vertical recharge pathways (infiltration) from below the Order Limits to the water table, and horizontal flows below the water table to the abstraction point. The risks of a complete pathway-receptor linkage between the Order Limits and an abstraction point have been defined as very high, high, moderate and low, based on *in situ* conditions. The potential likelihood and nature of a source of contamination being present during construction or operation is discussed in Chapter 8 Water combined with the outcome of this appendix risk assessment on potential pathway-receptor linkages.

1.2.2 Infiltration risks take into account the following properties and data sources/sets:

- geology, focusing on any drift cover, and the permeability of superficial and bedrock deposits (British Geological Society (BGS), 2018a);
- soil assemblage thickness and type (Cranfield University, 2018);
- thickness of unsaturated zone from: groundwater flooding potential (BGS, 2018b), groundwater modelling contours and groundwater level monitoring records; and
- karst features comprising dolines, stream sinks and rock solubility class, where appropriate (Farrant and Cooper, 2008).

1.2.3 Flow risks take into account the following properties and data sources/sets:

- geology, with particular consideration of permeability and characteristic flow type;
- Source Protection Zones (SPZ);
- FlowSource 50-day, 70% Catchment and Total Catchment Zone (TCZ) modelling, showing alternative travel time of 50 days, the area from which 70%

of abstracted water is derived and the area from which all water abstracted may potentially be derived. Data provided by the water companies;

- regional groundwater flow from groundwater modelling contours, where available;
- degree of karstification from rock solubility class, where appropriate; and
- borehole construction information where available.

1.2.4 Overall risks are defined by the matrix in Table 8.4.1.

Table 8.4.1: Matrix for Assessing the Overall Risk Posed to a Groundwater Abstraction

Flow / Infiltration	Low	Moderate	High	Very High
Low	Negligible	Low	Low	Low
Moderate	Low	Moderate to low	Moderate	Moderate
High	Low	Moderate	Moderate to high	High
Very High	Low	Moderate	High	Very high

1.2.5 This appendix focuses on geological/hydrogeological pathways only. The potential and likelihood for a source of pollution to be present or absent is covered in Chapter 8 Water.

1.2.6 The following abstractions are included in the assessment and are shown on Figure A8.1.6:

- all abstractions where the Order Limits cross a defined SPZ;
- all licensed abstractions from the Chalk Group within 1km of the Order Limits;
- all licensed abstractions from either the Bracklesham Group or the Thames Catchment Sub-group within 500m of the Order Limits; and
- all identified active unlicensed private water supplies within 250m of the Order Limits.

1.2.7 The assessment is structured as per the Groundwater Study Areas GWSA-A to GWSA-D defined in Chapter 8 Water.

1.2.8 No additional account has been taken of the relative importance of the different abstractions in this exercise. However, this is captured in Chapter 8 Water.

1.2.9 Consultation and engagement were undertaken with the Environment Agency (EA), water supply companies, local authorities and relevant landowners for the purposes of identifying groundwater abstractions and obtaining additional information.

1.2.10 The public water supplies and other licensed abstractions are referred to by name, where known, throughout this report. Private water supplies are referred to by name and, where available, reference number provided by the local authority.

1.3 Limitations

1.3.1 The conceptual site models for the abstractions have been constructed based on the information available at the time of the assessment. Ground Investigation and groundwater monitoring are ongoing. Data available up to February 2019 has been included.

1.3.2 Reliance has been made on third-party data, and these are assumed to be accurate. Any inaccuracies within the data will affect the robustness of the assessment. Further, there are gaps in the third-party data which prevent a detailed site-specific assessment at some locations.

1.3.3 No response has been received from Surrey Heath Borough Council or Hart District Council. There may therefore be additional private water supplies within the study area that are not currently known about and have not been included. Only the water supplies provided in consultation responses have been incorporated into this assessment.

1.3.4 At time of writing, responses have not been received from two of the landowners individually contacted regarding private water supplies. Where this is the case, uncertainties are recorded within the individual abstraction assessment.

1.3.5 A precautionary approach has been taken to ensure a robust assessment despite the above limitations.

1.4 GWSA-A

Netherhill and Greywood Abstractions (PW000033 to PW000037)

Geographic Location

1.4.1 There are five private water abstractions recorded by Winchester City Council (2018) less than 1.5km northeast of Boorley Green in the Netherhill area. The Order Limits pass within 245m to the northwest of the Greywood abstraction (PW000033), and between 130m and 250m west of the four Netherhill abstractions (PW000034 to PW000037). The location of these abstractions is shown on sheet 1 of Figure A8.4.1.

Abstraction Characteristics

1.4.2 No well design or source information is available for the abstractions. Abstraction rates are not known, although any abstraction exceeding 20m^3/d would require a licence, providing an upper bound to potential rates. Greywood is assumed to abstract from the River Terrace Deposits, whilst the Netherhill abstractions are assumed to abstract from the Wittering Formation, based on the geological conditions recorded below.

Settings

Soils

1.4.3 The abstractions and the Order Limits are mostly on slowly permeable seasonally waterlogged fine loamy over clayey and coarse loamy over clayey soils and similar more permeable soils with slight waterlogging (Cranfield University, 2018). The Order Limits also briefly cross deep stoneless well-drained silty soils and similar soils.

Superficial Deposits

1.4.4 Superficial deposits around Greywood consist of River Terrace Deposits and the Netherhill abstractions are not underlain by any superficial deposits (Figure A8.1.2). There are further areas of River Terrace Deposits crossed by the Order Limits including at the level of the Netherhill abstractions, along with alluvium in the valley bases.

Bedrock Deposits

1.4.5 Bedrock geology close to the abstraction is shown on Sheet 1 of Figure A8.1.1. Greywood is on bedrock of the London Clay Formation, whilst the Netherhills abstractions are on outcrop of the Wittering Formation (BGS, 2018a).

Surface Water

1.4.6 The River Hamble dominates the hydrology close to the abstractions, which are located on the sides of the valley. A small drainage channel runs close to the Wittering abstractions, with the plotted course beginning close to one of the Netherhill abstractions. This may represent a spring point. Greywood is close to the River Hamble and Ford Lake confluence.

Groundwater Flow Pathway

Groundwater Catchment

1.4.7 Greywood is assumed to abstract from the River Terrace Deposits aquifer which is expected to generally drain downslope towards either the River Hamble or Ford Lake.

1.4.8 The Wittering Formation is geographically limited in this area. A small hill to the northeast of the Netherhill abstractions likely represents the bulk of the recharge zone for the Wittering Formation abstractions.

Water Levels and Flow

1.4.9 Water level associated with the abstractions is not known. There are also no EA monitoring boreholes within the relevant aquifer units, no groundwater modelling, and no publicly available BGS borehole records in the relevant area.

1.4.10 The London Clay forms Unproductive Strata. The area associated with the Wittering Formation has only a limited groundwater flooding susceptibility (BGS, 2018b).

However, the area associated with the River Terrace Deposits has potential for flooding below ground, indicating a relatively shallow water table and thinner unsaturated zone, but without the variability to reach the ground surface.

Aquifer Characteristics

1.4.11 The Wittering Formation has a low to high intergranular permeability and is designated a Secondary A aquifer. The River Terrace Deposits have a high to very high intergranular permeability and are designated a Secondary A aquifer.

Conceptual Site Model

1.4.12 The infiltration potential is presented on Sheet 1 of Figure A8.4.1 and the flow pathway potential presented on Sheet 1 of Figure A8.4.2.

Conclusions

1.4.13 Greywood has been rated as a moderate overall risk, due to the presence of a moderate flow path potential and high infiltration potential. The Netherhill private water supplies are at an overall moderate to low risk. This is due to a moderate flow path potential and a moderate infiltration potential.

1.5 GWSA-B

Northbrook

Geographic Location

1.5.1 The Northbrook abstraction is located 650m to the north of Bishop's Waltham, Hampshire, and the location is shown on Figure A8.4.1. The Order Limits pass within 1.45km of the abstraction point at its closest. The Order Limits pass through the associated SPZ2 for 4.1km, and through SPZ3 for 3.4km. It runs through the FlowSource 70% catchment for 7.3km, and the TCZ for 1.8km.

Abstraction Characteristics

1.5.2 The Northbrook abstraction is a complex of three boreholes (Table 8.4.2), owned and operated by Portsmouth Water for public water supply purposes.

Table 8.4.2: Summary of Boreholes at Northbrook

BH No.	Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
BH1	41.6mAOD	26mAOD	-30mAOD	71.94m	56.7-60mbgl*	7.1-8.83mbgl
BH2	40.1mAOD	26.8mAOD	-61.5mAOD	101.7m	50-54mbgl	7.78mbgl
BH3	42.4mAOD	29mAOD	-63.3mAOD	105.69m	51-44.8mbgl	8.85-9.1mbgl

* mbgl – metres below ground level

1.5.3 In total, the Northbrook abstraction yields about 250l/s to 260l/s (21.6Ml/d).

Setting

Soils

1.5.4 The Northbrook abstraction is situated on shallow lime-rich soils (Cranfield University, 2018). These extend most of the way across the area of interest for Northbrook. The Order Limits also cross some slightly acid loamy soils in the south of the area of interest.

Superficial Deposits

1.5.5 Superficial deposits close to the abstraction are shown on Sheets 1 and 2 of Figure A8.1.2. Clay-with-Flints Formation is recorded on the hilltops to the northwest and southeast (BGS, 2018a). Small areas of alluvium and head are recorded in the base of the valley forms. A small area of worked ground is recorded underlying the pumping station.

1.5.6 The nearest boreholes to the Order Limits with geological records show that the Clay-with-Flints Formation is between 2m and 4m thick.

Bedrock

1.5.7 Bedrock geology close to the abstraction is shown on Sheets 1 and 2 of Figure A8.1.1. The abstraction boreholes are located on the unconfined Tarrant Chalk Member, relatively close to where the Chalk passes into the confined section. Maximum thicknesses of the Tarrant Chalk Member are generally around 35m. It is likely that the construction of the boreholes supporting the Northbrook abstraction is mostly cased out (i.e. solid steel tubing preventing water ingress) through the Tarrant Chalk Member, which belongs to the Culver Chalk Formation. The abstraction is likely to be mostly derived from the Newhaven Chalk Formation and may also potentially be partly supported by some water from the Seaford Chalk Formation.

1.5.8 The bedrock geology dips towards the southwest over a regional scale. There are also a number of inferred faults within the Chalk.

1.5.9 Close circuit television (CCTV) surveys down the three boreholes have shown that the formation is generally competent white Chalk (European Geophysical Services, 2018a; 2018b; 2018c). Some flint nodules are observed in the side walls, although these are not as frequent as some of the other Chalk formations. Some zones of fracturing/breakout have been observed, with BH1 generally being the most heavily affected. All boreholes showed a zone of fracturing less than 20m below datum (mbdat), which is likely to be cross-correlated. Marl bands, which may restrict vertical flow, were not identified from the CCTV log, although their presence cannot be discounted.

Surface Water

1.5.10 The River Hamble is located within 200m of the abstraction, although the area around the abstraction has been noted to contain ephemeral streams. There are no recorded springs in the immediate vicinity of the abstraction. The springs are mostly

further downslope of the abstraction. However, whilst it is not recorded or marked as a spring, the end of the reach of the River Hamble designated as Main River is located in proximity to the abstraction (approximately 275m to the east).

Groundwater Flow Pathway

Groundwater Catchment

1.5.11 SPZ1, 2 and 3 have been defined by the EA (2018).

1.5.12 An alternative capture zone derived from FlowSource modelling was provided by Portsmouth Water. The output consists of defining 70% of the catchment and the total catchment area for the abstraction, as shown on Figure A8.4.2. This is aligned in a northeasterly direction, and whilst it is in total smaller, it extends to the south of the SPZ into the confined Chalk.

Water Levels and Flow

1.5.13 Two EA groundwater models cover the area: East Hampshire and Chichester Chalk (Entec, 2007) and the Test and Itchen Chalk (Amec, 2013). For the available time slice (April 2001 maximum) water levels at the abstraction are modelled between 35 and 40mAOD. Both indicate that the regional groundwater flow is towards the southwest, although this gets heavily deflected by some of the dry valleys in the area, particularly towards the edge of the outcropping Chalk. A mound of groundwater is recorded in both models to the north of the abstraction, which would fit approximately with the region of deflection observed in the SPZ. This groundwater mound is co-located with the local topographic high.

1.5.14 Overall depth to groundwater increases to the north, with depths of over 30mbgl observed. This falls to less than 5mbgl at the edge of the Chalk outcrop, and generally to less than 10mbgl in the base of the dry valleys.

1.5.15 Water level records in the local observation boreholes (Sheet 1 of Figure A8.1.6) show that absolute water levels decrease when moving approximately towards the southwest. However, depth to groundwater becomes shallower in the same direction. The amount of temporal water level variation increases in the upgradient location, although this is the area where water levels are also deeper. All locations, however, show variation in excess of 5m.

1.5.16 Pumped water levels are not available for the abstraction boreholes.

Aquifer Characteristics

1.5.17 Groundwater flow within the Chalk is generally within the secondary porosity, i.e. fractures and fissures (Allen *et al*, 1997). The BGS solubility mapping shows that the Chalk beneath the abstraction is class B, suggesting only a limited karstification (Farrant and Cooper, 2008) (Sheets 1 and 2 of Figure A8.1.9). However, the wider catchment shows areas of higher solubility. Further, the aquifer is known to be moderately karstified in this area.

1.5.18 Calculated transmissivities within the abstraction are above average compared to those reported for the aquifer as a whole (Allen *et al*, 1997).

Conceptual Site Model

1.5.19 The conceptual site model for infiltration is presented on Sheet 2 of Figure A8.4.1 and flow pathways are presented on Sheet 2 of Figure A8.4.2.

Conclusions

1.5.20 About 1.9km of the Order Limits have been identified as having a very high risk infiltration potential, with a further 1.0km with a high risk. The remainder of the unconfined Chalk catchment has a moderate risk, and the confined Chalk a low risk. About 1.7km of the Order Limits have been identified as having a very high risk flow pathway potential, with a further 4.1km having a high risk.

1.5.21 Some of these flow and infiltration very high risk pathways overlap. Northbrook abstraction is therefore considered to be at overall very high risk from any potential pollution event.

Lower Upham

Geographic Location

1.5.22 The Lower Upham abstraction is located south of the village of Lower Upham, northwest of Bishop's Waltham, as shown on Figure A8.4.1. The Order Limits pass within 1.35km of the abstraction at its closest point. The SPZ3 overlaps with SPZs associated with other abstractions such as Northbrook, making exact delineation impossible. However, the Order Limits may pass through up to 760m of the SPZ3. The Order Limits pass however through 200m of the FlowSource and adjacent to TCZ as shown on Sheet 3 of Figure A8.4.2.

Abstraction Characteristics

1.5.23 The Lower Upham abstraction consists of a single borehole (Table 8.4.3) and is owned by Portsmouth Water and licensed for public water supply. It is understood the abstraction is not currently being used.

Table 8.4.3: Summary of Boreholes at Lower Upham

Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
48.9mAOD	-11.1mAOD	-84.1mAOD	133mbgl	unknown	17.4mbdat

Setting

Soils

1.5.24 The soils around the Lower Upham source are characterised by slowly permeable, deep loamy clay soils (Cranfield University, 2018). Along the Order Limits, the soils are described as thin, calcareous soil assemblages which are highly permeable above the Chalk.

Superficial Deposits

1.5.25 Superficial deposits close to the abstraction are shown on Sheet 2 of Figure A8.1.2. Clay-with-Flints Formation is recorded on the hilltops towards the northeast (BGS, 2018a). Small areas of alluvium and head are recorded in the base of the valley forms.

Bedrock

1.5.26 Bedrock geology close to the abstraction is shown on Sheet 2 of Figure A8.1.1. The abstraction borehole is located on outcrop of the London Clay Formation, comprising clay, silt and sand. The London Clay is cased out, and the borehole is open to the confined Chalk. The abstraction is likely to be mostly derived from the Tarrant Chalk Member (Culver Chalk Formation), with partial support from the Newhaven Chalk Formation.

1.5.27 The bedrock geology dips towards the southwest over a regional scale. There are also a few inferred faults mapped on the Chalk outcrop.

Surface Water

1.5.28 There are a number of small streams and ditches crossing the SPZ close to the abstraction. However, the London Clay will act as an aquiclude to hydraulically separate them from the abstraction. There are no surface water features recorded within the SPZ where it overlies the unconfined Chalk aquifer.

Groundwater Flow Pathway

Groundwater Catchment

1.5.29 SPZ1, 2 and 3 have been defined by the EA (2018) and are shown on Sheets 1 and 2 of Figure A8.1.6. The SPZs for Lower Upham are orientated close to north-south.

1.5.30 An alternative capture zone derived from FlowSource modelling was provided by Portsmouth Water. The outline of this catchment defines 70% and total catchment area for the abstraction. This is aligned in a northeasterly direction and is much narrower than the SPZs.

Water Levels and Flow

1.5.31 Two EA groundwater models cover the area: the East Hampshire and Chichester Chalk (Entec, 2007) and the Test and Itchen Chalk (Amec, 2013). For the available time slice (April 2001 maximum) water levels at the abstraction are around 42mAOD. The regional groundwater flow is towards the southwest. However, locally there is substantial deflection to both west and east, likely caused either by interactions with major rivers, or by structural features of the Chalk aquifer.

1.5.32 Overall depth to groundwater increases to the north, with depths of over 30mbgl observed. The groundwater models suggest a depth to groundwater less than 5mbg at the edge of the Chalk and less than 10mbgl at the base of the dry valleys.

1.5.33 Water level records in the Wintershill observation borehole (Sheet 1 of Figure A8.1.7) contain water levels in the confined Chalk 1.55km east of the abstraction (Environment Agency, 2018). This shows about 8m of variation over the available record, but the upper limit of this range appears to be restricted by the fact it reaches artesian conditions.

1.5.34 Operational pumped water levels are not available but results from a pumping test undertaken by Portsmouth Water (2002) shows maximum drawdowns to 56.8mbdat for 40l/s flow rate.

Aquifer Characteristics

1.5.35 Groundwater flow within Chalk is generally within the secondary porosity, i.e. fractures and fissures. The aquifer is known to be moderately karstified in the unconfined Chalk, although it becomes less so when it is confined.

1.5.36 Pumping tests in the borehole indicate transmissivities of 70m^2/d to 101m^2/d, and a storativity of 2.85E-4 (Portsmouth Water, 2002). These are substantially lower than typical values reported for the aquifer as a whole (Allen *et al*, 1997), although this can be explained by the change in nature of the Chalk when it becomes confined.

1.5.37 The London Clay Formation has a very low intergranular permeability, although it can be fissured. This means that it may act as a leaky layer, particularly in areas where it is thinner.

Conceptual Site Model

1.5.38 The conceptual site model for infiltration is presented on Sheet 2 of Figure A8.4.1 and flow pathways are presented on Sheet 3 of Figure A8.4.2.

Conclusions

1.5.39 The FlowSource pathway indicates the Order Limits passing briefly through the TCZ, and the flow pathway potential is therefore rated moderate. This coincides with an area of moderate infiltration potential. However, there is only a low flow pathway potential associated between the abstraction and the Order Limits running through the SPZ3. This area is associated with a moderate infiltration risk, due to it having a thick unsaturated zone and moderate solubility.

1.5.40 Overall risk is therefore assessed as being moderate to low.

Twyford Pumping Station

Geographic Location

1.5.41 Twyford Pumping Station is located north of Eastleigh, in a side valley from the River Itchen. The pumping station is located approximately 10km from the Order Limits at its closest point. The Order Limits pass through the SPZ3 for 2.7km of its length, as can be seen on Sheet 4 of Figure A8.4.2. It does not cross the FlowSource TCZ.

Abstraction Characteristics

1.5.42 Twyford Pumping Station is licensed for public water supply and is operated by Southern Water Services. Specific information on the abstraction was not available for Twyford.

Setting

Soils

1.5.43 The abstraction is located in an area of well-drained calcareous soil assemblages (Cranfield University, 2018). The Order Limits are also located on well-drained calcareous soils, although thicker clayey subsoils can also be found in some areas, mostly associated with the Clay-with-Flints Formation.

Superficial Deposits

1.5.44 Head deposits are found at the bottom of the small valley that the abstraction is located in (BGS, 2018a). Large amounts of alluvium and River Terrace Deposits associated with the River Itchen are recorded to the west of the abstraction.

1.5.45 Head deposits are also found in the dry valleys where the Order Limits cross the SPZ3.

1.5.46 Clay-with-Flints Formation can be found on the hilltops in the area.

Bedrock

1.5.47 The Twyford pumping station is located on the Seaford Chalk Formation outcrop, although it is unclear which Chalk formation is being abstracted from.

1.5.48 The Order Limits mostly runs across the Newhaven Chalk Formation outcrop, with some areas of Seaford Chalk Formation outcrop also crossed. Some small inferred faults are recorded in the wider area, but not where the Order Limits pass through the SPZ3.

Surface Water

1.5.49 The Twyford pumping station is not located close to any recorded surface water feature, as it is within a dry valley. However, it is only 1.3km from the River Itchen. Similarly, there are no substantial surface water features recorded in the vicinity of the Order Limits where it passes through the relevant SPZ3.

Groundwater Flow Pathway

Groundwater catchment

1.5.50 SPZ1, 2 and 3 have been defined by the EA (2018), and part of SPZ2 and 3 is shown on Sheet 2 of Figure A8.1.6. The FlowSource modelled capture zone was supplied by Southern Water Services, and unlike the SPZs, indicates that the Order Limits do not cross the capture zone for Twyford pumping station (Sheet 4 of Figure A8.4.2).

Water Levels and Flow

1.5.51 The Twyford pumping station itself is located in an area not considered to be susceptible to groundwater flooding. However, it is very close to groundwater flooding areas located further downslope within the valley. This suggests that groundwater levels are getting shallower down towards the River Itchen.

1.5.52 Both the East Hampshire and Chichester Chalk and Test and Itchen Chalk models show groundwater flows to be towards the north and the springs that make the source of the Itchen. The derived flow paths in these models do not agree with the SPZ and would indicate there is no pathway to the abstraction. This observation also aligns better with the FlowSource catchment provided.

Aquifer Characteristics

1.5.53 The Chalk is a dual porosity aquifer, with flow in fractures, fissures and conduits dominating over any flow within the low permeability matrix. This creates additional preferential pathways that may allow flow against the hydraulic gradient.

Conceptual Site Model

1.5.54 The conceptual site model for infiltration is presented on Sheet 3 of Figure A8.4.1, although the abstraction itself is located beyond the limits of the figure, and flow pathways are presented on Sheet 4 of Figure A8.4.2.

Conclusions

1.5.55 There is a low risk that there is a pathway between the Order Limits and the abstraction.

1.5.56 Infiltration risk ranges from moderate to localised very high in the dry valleys, where the unsaturated zone thins substantially.

1.5.57 Overall risk to Twyford is considered to be low.

Windmill Hill

Geographic Location

1.5.58 Windmill Hill Water Treatment Works is located on the edge of Alton in Hampshire, as shown on sheet 6 of Figure A8.4.1. It is located on the side of the small hill, also known as Windmill Hill. It is 1.2km from the Order Limits at its closest point. The Order Limits pass through the SPZ3 for 250m as shown on sheet 5 of Figure A8.4.2. The A31/A32 Junction Northfield Lane logistics hub is located within the SPZ3, 2.25km southwest of the abstraction.

Abstraction Characteristics

1.5.59 Windmill Hill is licensed for public water supply and is operated by South East Water. The abstraction consists of a single borehole, construction details of which are presented in Table 8.4.4.

Table 8.4.4: Borehole Construction Details of Well 1 at Windmill Hill

Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
137.3mAOD	119.3mAOD	79.7mAOD	58	Unknown	Unknown

1.5.60 It is licensed for a maximum of 4,610m^3/d, and an average annual limit of 2,050m^3/d. The Peak Deployable Output (PDO) of the source is reported to be 3.20Ml/d, which is less than the peak licence (South East Water, 2018). Average Deployable Output (ADO) is 2.05Ml/d, limited by the annual licence.

Setting

Soils

1.5.61 Soil assemblages in the area are generally freely draining lime-rich loamy soils (Cranfield University, 2018). Soils in the valley bottoms may be slightly more acidic but remain freely draining.

Superficial Deposits

1.5.62 Superficial deposits close to the abstraction are shown on Sheet 6 of Figure A8.1.2. Head deposits are found quite extensively in the valley bases across the wider area, whilst some limited areas of alluvium and River Terrace Deposits are also present (BGS, 2018a). Clay-with-Flints Formation can be found on some of the hilltops. There are no superficial deposits recorded to be immediately underlying the abstraction.

Bedrock

1.5.63 Bedrock geology close to the abstraction is shown on Sheet 6 of Figure A8.1.1. The abstraction is located on outlier outcrop of the Holywell Nodular Chalk Formation of the White Chalk sub-group. It is underlain by the Zig Zag Chalk Formation and West Melbury Marly Chalk Formation, which make up the Grey Chalk sub-group. The Holywell Nodular Chalk is likely to be quite thin in the area, and the source of the water is considered to be primarily the Grey Chalk sub-group formations.

1.5.64 The West Melbury Marly Chalk Formation and Upper Greensand Formation outcrop to the east, and all units become thinner in this direction, pinching out towards the outcrop of the Gault Formation. There are some small inferred faults recorded within the Chalk, whilst the Upper Greensand Formation is considered to be mildly deformed, thickening the deposits and giving a wider outcrop than would otherwise be present.

Surface Water

1.5.65 There are no surface water features immediately adjacent to the abstraction; however, the River Wey is located downgradient, around 320m north. The Caker Stream is located about 600m east and Kings Pond, on the Wey channel, is about 350m away to the north. Two springs are recorded within 1.4km of the abstraction, both supporting the River Wey.

Groundwater Flow Pathway

Groundwater Catchment

1.5.66 SPZ1, 2 and 3 have been defined by the EA (2018) and are shown on Sheet 2 of Figure A8.1.6. The SPZ indicates that most of the water is drawn from the southwest of the abstraction. Groundwater contours from the Mole Chalk groundwater model (Amec Foster Wheeler, 2015) generally confirm this capture zone, although potentially give a narrower shape close to the abstraction itself, and a broader one at a greater distance.

1.5.67 It is not clear if the abstraction is also drawing water from the Upper Greensand Formation. However, the Mole Upper Greensand (UGS) model suggests a much broader catchment for the Upper Greensand Formation, and particularly bringing in water from the outcrop to the east.

Water Levels and Flow

1.5.68 Water levels within the abstraction are not currently available. Modelling shows that water levels can be around 104mAOD to 107mAOD (approximately 30mbgl), suggesting a relatively thick unsaturated zone at the abstraction point which is supported by the low groundwater flooding susceptibility recorded at this location (BGS, 2018b). However, groundwater levels are expected to be near the surface within the valleys, as shown by the presence of springs and high groundwater flooding susceptibility.

1.5.69 Modelled groundwater levels along the Order Limits are generally within 3m of the ground surface and exceed it in some places. The model shows groundwater during a period of extremely high water levels, so normal water levels would be expected to be lower. Nonetheless this shows there is a very thin unsaturated zone beneath the Order Limits.

1.5.70 The Woodside observation boreholes record water levels in both the Chalk and Upper Greensand Formation (Environment Agency, 2018), and are located within the SPZ3 3.5km to the southwest (Sheet 2 of Figure A8.1.7). The Upper Greensand Formation shows a variation over the available record of around 10m, whilst the Chalk shows variation of 15m. The aquifer with higher water levels changes through the record, but they show a close association which would suggest a high degree of hydraulic connection.

1.5.71 Alton Town and Weyspring Chalk observation boreholes are located 600m and 1.2km from the abstraction respectively (Environment Agency, 2018), although they are within the valley bottom outside Windmill Hill's capture zone. They show substantially less variation, only around 1.5m and 3.5m respectively.

Aquifer Characteristics

1.5.72 Flow in the Chalk aquifer is dominated by the secondary porosity, whilst the Upper Greensand Formation tends to have a composite of flow between intergranular and fractures, depending on the precise local conditions (Allen *et al*, 1997). The Chalk can be karstified and is noted to be more soluble in the base of the valleys than on

the interfluves (Farrant and Cooper, 2008). A number of dolines are observed further up the slope, but still within the SPZ3.

Conceptual Site Model

1.5.73 The conceptual site model for infiltration is presented on Sheet 6 of Figure A8.4.1 and flow pathways are presented on Sheet 5 of Figure A8.4.2.

Conclusions

1.5.74 Only a short section of the Order Limits have a moderate potential flow pathway risk to the abstraction, with groundwater flow in the area mostly directed away from the abstraction along the Order Limits. There are large areas with a thin unsaturated zone and soluble rocks, resulting in a very high infiltration potential. Most of the section with moderate flow pathway potential coincides with only a high infiltration potential.

1.5.75 Overall risk for Windmill Hill has been rated as moderate.

Boxalls Lane Pumping Station

Geographic Location

1.5.76 Boxalls Lane Pumping Station is located on the south side of Aldershot, Hampshire, and its location is shown on Sheet 6 of Figure A8.4.2. It is located approximately 5km from the Order Limits at its closest point. The Order Limits pass through the associated SPZ3 for 350m, as shown on Sheet 6 of Figure A8.4.2. It is over 10km from the abstraction at this point.

Abstraction Characteristics

1.5.77 Boxalls Lane Pumping Station is licensed for public water supply and is operated by South East Water. It comprises six Chalk boreholes, and four Lower Greensand boreholes. The Lower Greensand boreholes are licensed separately, and are not considered further, as there would be no impact on this aquifer from the scheme. Construction details of the Chalk boreholes are presented in Table 8.4.5, where known.

Table 8.4.5: Known Borehole Construction Details at Boxalls Lane

BH No.	Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
BHA – 12	Unknown	60.6mbdat	95.2mbdat	96m	Unknown	Unknown
BHB – 13	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
BHC – 14	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
BHD – 21	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
BHE – 22	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
BHF – 23	Unknown	Unknown	Unknown	81m	Unknown	Unknown

1.5.78 The PDO of the Chalk source is reported to be 12.85Ml/d and the ADO is 10.59Ml/d (South East Water, 2018).

Setting

Soils

1.5.79 The pumping station is surrounded by slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils, with some loamy and clayey floodplain soils associated with surface water features (Cranfield University, 2018). The Order Limits pass over freely draining lime-rich loamy soils.

Superficial Deposits

1.5.80 Head, alluvium and River Terrace Deposits are all recorded in proximity of the pumping station (BGS, 2018a). There are no superficial deposits recorded where the Order Limits pass through the SPZ.

Bedrock

1.5.81 The pumping station is located on outcrop of the London Clay Formation.

1.5.82 The bedrock is highly deformed in the area, being part of the Hog's Back monocline, with a steeply dipping limb to the north. The area is also quite heavily faulted, with a long east-west trending fault, and a number of smaller cross-cutting faults. These could act either as pathways or barriers to groundwater flow, depending on the exact characteristics.

Surface Water

1.5.83 The pumping station is located adjacent to the River Blackwater, not far downstream from its source. There are also some ponds very close to the pumping station. There are relatively few surface water features along the Order Limits in the area, although there are two streams that ultimately feed into the River Wey to the south.

Groundwater Flow Pathway

Groundwater Catchment

1.5.84 SPZ1, 2 and 3 have been defined by the EA (2018) and are shown on Sheets 2 and 3 of Figure A8.1.6. It is unclear how the SPZs are divided between the different abstractions in the area, meaning it is not certain whether the Order Limits cross the Boxalls Lane capture zone. Additionally, the edge of the Chalk outcrop creates edge effects within the groundwater models, meaning the contours are likely to be less reliable in this area. For the purpose of this assessment, it is assumed as a worst case that the Order Limits cross the SPZ3 associated with Boxalls Lane at its extreme.

Water Levels and Flow

1.5.85 There are no pumped or rest water levels available from the pumping station abstractions.

1.5.86 Regional groundwater flow contours indicate a general flow towards the north, and towards the edge of the outcrop where the Chalk becomes confined (Amec, 2013, Amec Foster Wheeler, 2015). There is some distortion around the edge the outcrop in the east, where the Chalk thins and the Upper Greensand Formation outcrops. It is also distorted by the structure within the Chalk associated with the Hog's Back monocline.

1.5.87 Based on these groundwater contours, groundwater levels typically range from 10 to 30mbgl along the Order Limits. The shallowest groundwater conditions are expected on the edge of the Chalk outcrop as well as more localised in various valleys, based on areas susceptible to groundwater flooding (BGS, 2018b). This correlates with the groundwater modelling, as the contours show little response to the elevation, which therefore provides the strongest control on depth to groundwater.

Aquifer Characteristics

1.5.88 The Chalk is a dual porosity aquifer, with flow in fractures, fissures and conduits dominating over any flow within the matrix (Allen *et al*, 1997). This creates additional preferential pathways that may allow flow across the hydraulic gradient.

Conceptual Site Model

1.5.89 The conceptual site model for infiltration is presented on Sheets 7 and 8 of Figure A8.4.1, although the abstraction itself is located beyond the limits of the figure, and flow pathways are presented on Sheet 6 of Figure A8.4.2.

Conclusions

1.5.90 The maximum pathway risk was identified to be moderate, which overlapped with small areas of high infiltration potential. Areas with very high infiltration potential were considered to have a low flow pathway potential. As a result, the risk to the Boxalls Lane abstraction is overall considered to be moderate.

Itchel Pumping Station

Geographic Location

1.5.91 Itchel Pumping Station is located southwest of Church Crookham in Hampshire (sheet 8 of Figure A8.4.1). The Order Limits pass within around 2km at its closest point. The Order Limits pass through the associated SPZ3 for 900m of its length.

Abstraction Characteristics

1.5.92 Itchel is licensed for public water supply and is operated by South East Water. The abstraction comprises three boreholes, details of which are presented in Table 8.4.6.

Table 8.4.6: Borehole Construction Details at Itchels Pumping Station

BH No.	Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
BH 1	78.3mAOD	42.4mAOD	-20.7mAOD	99m	Unknown	Unknown
BH 2	80.2mAOD	42.4mAOD	-26.1mAOD	106m	Unknown	Unknown
BH Well	80.4mAOD	43.1mAOD	26.7mAOD	53.7m	Unknown	Unknown

1.5.93 Two adits have been identified connecting the boreholes, with bases at 28.5mAOD and -11.6mAOD.

1.5.94 The PDO of the abstraction is reported to be 7.96Ml/d and the ADO is 5.60Ml/d (South East Water, 2018).

Setting

Soils

1.5.95 Soils along the Order Limits are freely draining lime-rich loamy soil type assemblages (Cranfield University, 2018).

Superficial Deposits

1.5.96 Superficial deposits close to the abstraction are shown on Sheet 8 of Figure A8.1.2. Alluvium is recorded at the base of the valley close to the pumping station, with only a limited width within the valley (BGS, 2018a). Head and Clay-with-Flints Formation is recorded in the area where the Order Limits pass through the SPZ3, although with only limited geographical spread. Site-specific information is not available, but Clay-with-Flints deposits rarely exceed 5m thickness. Everywhere else, no superficial deposits are recorded.

Bedrock

1.5.97 Bedrock geology close to the abstraction is shown on Sheets 8 of Figure A8.1.1. The pumping station is located on outcrop of the London Clay Formation, very close to the edge of the Chalk outcrop. It is therefore assumed that the abstraction is from the confined Chalk aquifer beneath a thin layer of London Clay formation aquiclude, and the Lambeth Group, which is a Secondary-A aquifer. The Chalk at the edge of the outcrop is recorded as being the Seaford Chalk Formation. The Order Limits primarily run along the outcrop of Seaford Chalk formation within the SPZ, although it also crosses onto the underlying New Pit Chalk Formation.

Surface Water

1.5.98 No notable surface water features are present in the vicinity of the Order Limits. There are a number of ponds close to the pumping station, whilst some springs are also noted close to the transition to semi-confined Chalk, where the London Clay starts outcropping.

Groundwater Flow Pathway

Groundwater Catchment

1.5.99 SPZ1, 2 and 3 have been defined by the EA (2018) and are shown on Sheet 3 of Figure A8.1.6.

1.5.100 Groundwater models for the Mole (Amec Foster Wheeler, 2015) and the Itchen and Test (Amec, 2013) cover the area of interest. They define a slightly different capture zone to the SPZ. In particular, there appears to be a slight deflection in the north towards the River Hart to the east of the abstraction. The capture zone may slightly expand further towards the west than currently defined by the SPZ, particularly in the southern part. Overall however, the contours generally support the SPZ defined capture zone for Itchel.

Water Levels and Flow

1.5.101 There are no pumped or rest water levels available from the pumping station abstractions.

1.5.102 Water levels where the Order Limits cross the SPZ are very deep, with modelling indicating levels lower than 40mbgl. Water levels at the abstraction are indicated to be very shallow with the groundwater models showing water levels to be less than 5mbgl, and often approaching ground level. The area is also recorded as being susceptible to groundwater flooding (BGS, 2018b), corroborating the other data.

Aquifer Characteristics

1.5.103 The Chalk is a dual porosity aquifer, with flow in fractures, fissures and conduits dominating over any flow within the matrix (Allen *et al*, 1997). This creates additional preferential pathways that may allow flow across the hydraulic gradient.

Conceptual Site Model

1.5.104 The conceptual site model for infiltration is presented on Sheets 7 and 8 of Figure A8.4.1 and flow pathways are presented on Sheet 7 of Figure A8.4.2.

Conclusions

1.5.105 High and very high potential for infiltration has been identified along most of the Order Limits in the area of interest. Only a moderate potential flow pathway has been identified for the Itchel abstraction along the SPZ3, with springs acting to intercept a lot of the groundwater in the area. Overall, the abstraction is considered to only be at moderate risk.

New Alresford Watercress Beds

Geographic Location

1.5.106 New Alresford is surrounded by a number of watercress beds on all sides of the town (Sheet 5 of Figure A8.4.1). These are located 4.2km or more from the Order Limits at its closest. The Order Limits pass through the associated SPZ2 for 4.3km

of its length, and SPZ3 for an additional 2.3km of its length as shown on Sheet 8 of Figure A8.4.2. The A31 Ropley Dean logistics hub is located immediately adjacent to an SPZ1 associated with the watercress bed abstractions.

Abstraction Characteristics

1.5.107 Limited information is available on these abstractions. A number of boreholes are indicated on the BGS GeoIndex (BGS, 2018a), although it is not clear which are currently licensed and in use for the watercress beds. However, the available information indicates that these boreholes are artesian in the area and are generally naturally overflowing at relatively high rates.

Setting

Soils

1.5.108 Soils around the watercress beds are shallow, well drained and silty (Cranfield University, 2018). They are also flinty in the base of the valleys, and calcareous on the valley slopes. Soil assemblages are similar along the Order Limits, although thicker clayey subsoils can be found, particularly in areas of Clay-with-Flints Formation. The A31 Ropley Dean logistics hub is located on well drained flinty fine silty soils.

Superficial Deposits

1.5.109 The abstractions are mostly located at the valley bottoms on alluvium (BGS, 2018a). Above the springline, the point at which water emerges from the ground, the valleys have head deposits along the base. Head deposits are also found higher up the valley sides around the abstractions.

1.5.110 Head deposits are found at the base of the valleys along the relevant sections of the Order Limits, whilst Clay-with-Flints Formation is found on the hilltops.

1.5.111 Most of the A31 Ropley Dean logistics hub is located on an area with no recorded superficial deposits, although the southern edge is underlain by head deposits.

Bedrock

1.5.112 The watercress beds are located on Newhaven Chalk or Seaford Chalk Formations. It is considered likely that most of the abstraction is derived from water in the Seaford Chalk.

1.5.113 The Order Limits are also located on Newhaven Chalk and Seaford Chalk Formations for most of the relevant section. However, they also run along a small amount of Lewes Nodular Chalk and New Pit Chalk Formation outcrop.

1.5.114 The A31 Ropley Dean logistics hub is located on mapped outcrop of the Seaford Chalk Formation.

Surface Water

1.5.115 There are a large number of ponds supporting watercress beds around New Alresford. The River Alre, a tributary of the Itchen, also rises in the area. A large number of springs are also recorded in the same area, likely supporting flows within the River Alre. There are no surface water features close to the Order Limits in the relevant sections.

Groundwater Flow Pathway

Groundwater Catchment

1.5.116 SPZ1, 2 and 3 have been defined by the EA (2018) and are shown on Sheet 2 of Figure A8.1.6.

Water Levels and Flow

1.5.117 Water levels are very close to the surface in the area around the abstractions. Many of the publicly available borehole logs indicate that there are artesian pressures locally (BGS, 2018a). However, groundwater levels are expected to be deep along the Order Limits.

1.5.118 This is verified by the groundwater flooding susceptibility mapping (BGS, 2018b), which has only a limited potential for flooding along the Order Limits, but a potential for flooding at surface around the abstractions themselves.

1.5.119 Groundwater levels are between 95mAOD and 120mAOD along the Order Limits within the capture zone of the Watercress Beds (Entec, 2007, Amec, 2013, Amec Foster Wheeler, 2015). This relates to about 30mbgl to 40mbgl average, although this is shallower where the local topography forms a valley. The water table is also generally deeper in the north.

Aquifer Characteristics

1.5.120 Groundwater flow within Chalk is generally within the secondary porosity, i.e. fractures and fissures (Allen *et al*, 1997). The area along the Order Limits indicates that there are a lot of recorded solution features, and that the bedrock is generally considered to be highly soluble (Farrant and Cooper, 2008). The solubility is greater at the base of the dry valleys compared to the hilltops. Rock solubility class is lower around the abstractions, although there are still notably soluble features in the valley bottoms.

Conceptual Site Model

1.5.121 The conceptual site models for infiltration are presented on Sheets 4 and 5 of Figure A8.4.1, although the abstractions themselves are located beyond the limits of the figure, and flow pathways are presented on Sheet 8 of Figure A8.4.2.

1.5.122 There appears to be a topographic springline where the water table intercepts with the ground surface (Ordnance Survey, 2015). However, the junction between the

two Chalk formations could also be a controlling factor in the behaviour of the water through the watercress beds.

Conclusions

1.5.123 The deep water table means that a lot of the area is only categorised as a high infiltration potential, although the exception to this is the locations with known dolines which are rated very high. Small areas of less soluble rock have only a moderate potential. The superficial cover coincides with the more soluble areas, so whilst they could impede infiltration, there is also an increased likelihood of rapid pathways.

1.5.124 There is thought to be hydraulic separation between the main Chalk formations in the area, as evidenced by the artesian pressures observed in the abstractions. This presents a strong control on the assumed potential pathway risk, which results in a lot of variability. Changes in the outcropping formation therefore changes the assessed flow pathway potential.

1.5.125 Overall the risk is considered to be very high for the watercress beds. This is due to the overlap of very high infiltration potential with very high flow pathway potential.

Selborne Road

Geographic Location

1.5.126 Selborne Road abstraction is located south of Alton, Hampshire (Sheet 6 of Figure A8.4.1). It is 750m from the Order Limits at its closest point. The Order Limits pass through the SPZ3 for 200m as shown on Sheet 9 of Figure A8.4.2. The A31/A32 Junction Northfield Lane logistics hub is located within the SPZ3, 1.3km southwest of the abstraction.

Abstraction Characteristics

1.5.127 Selborne Road abstraction is part of a cumulative licence with Turk Street, and is licensed for industrial use at the Alton Brewery. It has a daily licence limit of 5.45Ml/d, and an annual average limit of 2.86Ml/d (Environment Agency, 2018). It is understood that the Alton Brewery has closed, and that the licence is not currently utilised. However, it is possible that either the current licence holder or a new party (following a licence trade) will resume abstraction.

1.5.128 Based on the borehole records (BGS, 2018a), the abstraction is at an elevation of 104.5mAOD and is 61m deep, lined to 16mbgl. The borehole is then open hole to the full depth, taking in the Chalk and Upper Greensand aquifers.

Setting

Soils

1.5.129 Soil assemblages in the area are generally freely draining lime-rich loamy soils (Cranfield University, 2018). Soils in the valley bottoms may be slightly more acidic but remain freely draining.

Superficial Deposits

1.5.130 Superficial deposits close to the abstraction are shown on Sheet 6 of Figure A8.1.2 (BGS, 2018a). The abstraction is recorded by BGS mapping to be immediately underlain by head deposits, which are located in the base of the valley. It is also adjacent to made ground, associated with embankments for the A31.

1.5.131 Head deposits are found quite extensively in the valley bases across the wider area, whilst some limited areas of alluvium and River Terrace Deposits are also present. Clay-with-Flints formation can be found on some of the hilltops.

Bedrock Deposits

1.5.132 Bedrock geology close to the abstraction is shown on Sheet 6 of Figure A8.1.1. The abstraction is located on outcrop of the West Melbury Marly Chalk Formation, very close to the mapped boundary with the overlying Zig Zag Chalk Formation; both formations being part of the Grey Chalk Sub-Group. The Upper Greensand Formation outcrops to the east of the abstraction.

Surface Water

1.5.133 The Lavant Stream is adjacent to the abstraction.

Groundwater Flow Pathway

Groundwater Catchment

1.5.134 The EA (2018) defined SPZs for the Selborne Road abstraction are shown in Sheet 2 of Figure A8.1.6. The SPZ3 overlaps with the Windmill Hill abstraction, and it is not possible to differentiate between them. Whilst the SPZ1 has a near-circular shape, both the SPZ2 and SPZ3 are strongly elongated towards the southwest and are notably restricted across the short axis.

Water Levels and Flow

1.5.135 Natural rest water levels are at shallow depth in the area. This is shown by the groundwater flood susceptibility dataset (BGS, 2018b), as well as historical rest water levels within the borehole itself reaching a shallowest level of 4mbgl (BGS, 2018a).

1.5.136 The available Chalk and Mole UGS groundwater models overlap within the study area groundwater levels indicated to be just above or below 105mAOD (Amec Foster Wheeler, 2015).

1.5.137 The East Hampshire and Chichester Chalk model which is at the boundary of the area of interest gives elevations of around 108mAOD (Entec, 2007).

1.5.138 The Woodside boreholes, located 2.35km away (Sheet 2 of Figure A8.1.7), record water levels in both the Chalk and Upper Greensand (Environment Agency, 2018). The Upper Greensand shows a variation over the available record of around 10m, whilst the Chalk shows variation of 15m. The above suggests that both aquifers have a high degree of hydraulic linkage.

Aquifer Characteristics

1.5.139 Flow in the Chalk aquifer is dominated by the secondary porosity, whilst the Upper Greensand tends to have a composite of flow between intergranular and fractures, depending on the local conditions (Allen *et al*, 1997). The Chalk can be karstified and is noted to be more soluble at the base of the valleys than on the interfluves (Farrant and Cooper, 2008). A number of dolines are observed further up the slope, within the SPZ3 and at the base of the valleys.

Conceptual Site Model

1.5.140 The conceptual site model for infiltration is presented on Sheet 6 of Figure A8.4.1 and flow pathways are presented on Sheet 9 of Figure A8.4.2.

Conclusions

1.5.141 About 2.0km of the Order Limits have been identified as having a very high infiltration risk, primarily due to the very shallow water table, whilst a further 3.2km is high risk. About 200m of the Order Limits have been identified as having a high flow pathway risk, whilst a further 1.65km has a moderate risk. The high flow pathway risk area overlaps with a high infiltration risk, giving an overall risk of moderate to high.

Belmore House and Bigpath Farm

Geographic Location

1.5.142 Belmore House and Bigpath Farm are situated in the Parish of Upham, in the Winchester City Council area of Hampshire (Sheet 2 of Figure A8.4.1 and Sheet 10 of A8.4.2). Belmore House is located 550m from the Order Limits at its closest point, whilst Bigpath Farm is located 820m from the Order Limits at its closest point. Bigpath Farm is in the base of a valley-form.

Abstraction Characteristics

1.5.143 Construction details, where known, for each abstraction are presented in Table 8.4.7 (BGS, 2018a). Belmore House and Bigpath Farm are licensed to abstract a maximum of 55m^3/d and 27m^3/d respectively for general farming and domestic use. Actual abstraction rates are not known.

Table 8.4.7: Belmore House and Bigpath Borehole Details

Location	Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
Belmore House	97.5mAOD	Unknown	-1.5mAOD	99m	Unknown	Unknown
Bigpath Farm	61mAOD	Unknown	14mAOD	47m	Unknown	21mbgl

1.5.144 The available statutory service plans do not show any water mains within the area, so it is likely that both abstractions are currently used for potable water supply.

Settings

Soils

1.5.145 Shallow well drained calcareous soils cover most of the area, although deeper fine silty soils can be found in the base of the valleys (Cranfield University, 2018).

Superficial Deposits

1.5.146 Superficial deposits close to the abstraction are shown on Sheet 2 of Figure A8.1.2 (BGS, 2018a). Bigpath Farm is located on recorded head deposits, whilst Belmore Farm is not underlain by any recorded superficial deposits. Further small areas of head deposits are recorded in the base of the valleys.

Bedrock

1.5.147 Bedrock geology close to the abstractions is shown on Sheet 2 of Figure A8.1.1. Belmore House is located on the outcrop of Seaford Chalk Formation, whilst Bigpath Farm is located on the outcrop of the overlying Newhaven Chalk Formation. The Chalk in the area is dipping towards the south, and some small faults have been inferred within the wider area. It is likely that the water table at Bigpath Farm is sourced from the Newhaven Chalk, as the abstraction is located on the very edge of the outcrop, and the Seaford Chalk will be thin.

Surface Water

1.5.148 There are no surface water features in the vicinity of the abstractions.

Groundwater Flow Pathway

Groundwater Catchment

1.5.149 SPZs have not been defined by the EA for these abstractions. Groundwater contours from the East Hampshire and Chichester Chalk groundwater model (Entec, 2007) show groundwater to be flowing from northeast to southwest, with a groundwater high defining the limits of the catchment boundary 3km upgradient from the abstractions.

Water Levels and Flow

1.5.150 The East Hampshire and Chichester Chalk model suggests that water levels at Bigpath Farm may come up to a level of only 5mbgl, although there is only a limited potential for groundwater flooding at the site (BGS, 2018b). However, water levels at Belmore House are deeper based on the East Hampshire and Chichester Chalk model at around 40mbgl. Bigpath Farm is located downslope, and within a dry valley, whilst Belmore House is located on an interfluve, which would explain the difference in respective depths to groundwater.

1.5.151 The nearest monitoring borehole is Street End (Sheet 2 of Figure A8.1.7), located 1.25km from Bigpath Farm, and 2km from Belmore House (Environment Agency, 2018). Maximum recorded water levels in this location are similar to those modelled.

Aquifer Characteristics

1.5.152 Groundwater flow within Chalk is generally within the secondary porosity, i.e. fractures and fissures (Allen *et al*, 1997). Bigpath Farm is located on an area of moderately soluble rock, and more developed karstic features would be expected naturally due to its location in the base of a dry valley (Farrant and Cooper, 2008). Rapid flow paths may therefore be present.

1.5.153 Belmore House is located on less soluble rock, which is normally associated with interfluves.

1.5.154 Transmissivities would therefore be expected to be closer to the upper end of normal values at Bigpath Farm, but at the lower end of reported range for Belmore House.

Conceptual Site Model

1.5.155 The conceptual site model for infiltration is presented on Sheet 2 of Figure A8.4.1 and flow pathways are presented on Sheet 10 of Figure A8.4.2.

Conclusions

1.5.156 Overall risk has been assessed as moderate to high at Bigpath Farm, due to the small overlap of high flow pathway potential and high infiltration; most of the high flow pathway is overlapping with moderate infiltration potential.

1.5.157 There is only a low risk at Belmore House, as there is not considered to be a flow pathway to the abstraction.

Lomer Farm, Stanmore Farm and Wheely Farm

Geographic Location

1.5.158 The abstractions are situated within the South Downs, in a remote and rural area of Hampshire. Lomer Farm is located 160m from the Order Limits, Stanmore Farm is located 540m from the Order Limits, and Wheely Farm is located 560m from the Order Limits, at the points where they pass closest to each abstraction.

1.5.159 These supplies are shown on Sheet 3 of Figure A8.4.1 and Sheet 11 of Figure A8.4.2.

Abstraction Characteristics

1.5.160 Construction details, where known, are presented in Table 8.4.8 (BGS, 2018a). All abstractions are licensed for general farming and domestic use for a maximum rate of 36m^3/d for Lomer Farm, 30m^3/d for Stanmore Farm and 205m^3/d for Wheely Farm. Actual abstraction rates are not known.

Table 8.4.8: Lomer Farm, Stanmore Farm and Wheely Farm Borehole Details

Location	Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
Lomer Farm	153mAOD	Unknown	102mAOD	51m	Unknown	42mbgl

Location	Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
Stanmore Farm	125mAOD	122mAOD	58mAOD	67m	Unknown	48mbgl
Wheely Farm	121mAOD	Unknown	31mAOD	90m	Unknown	45mbgl

1.5.161 The statutory service plans of the area do not show any water mains, suggesting that these abstractions are still currently used for potable supply.

Settings

Soils

1.5.162 Soils consist of shallow well drained calcareous silty soils, with deeper soils in the valley bottoms (Cranfield University, 2018). Clayey subsoils are also associated with the areas where Clay-with-Flints Formation is present.

Superficial Deposits

1.5.163 Superficial deposits close to the abstraction are shown on Sheet 3 of Figure A8.1.2. The Wheely Farm abstraction is recorded to be underlain by Clay-with-Flints Formation, whilst the other two abstractions have no recorded superficial deposits (BGS, 2018a). Further Clay-with-Flints Formation is found across much of the hilltops in the area, whilst small amounts of head deposits can be found at the base of the dry valleys.

1.5.164 The Order Limits are mostly located on areas where no superficial deposits have been recorded; however, they do cross small areas of head deposits located in the base of the valleys.

Bedrock

1.5.165 Bedrock geology close to the abstraction is shown on Sheet 3 of Figure A8.1.1. Lomer Farm and Stanmore Farm are located on outcrop of Seaford Chalk Formation, whilst Wheely Farm is underlain by Newhaven Chalk Formation. The area is close to an axial trace of a major anticline, which is situated just to the south of the abstractions. Bedrock therefore dips to the north beneath the abstractions.

1.5.166 The bedrock has been subject to tectonic deformation, with the axial trace of a major anticline mapped 0.15km to the north of Lomer Farm. Some minor inferred faults are also recorded across the area.

Surface Water

1.5.167 There are no notable surface water features in the vicinity of the abstractions.

Groundwater Flow Pathway

Groundwater Catchment

1.5.168 SPZs have not been defined by the EA for these abstractions. Groundwater contours are available from the East Hampshire and Chichester Chalk groundwater model (Entec, 2007). These show that the groundwater catchment starts to the southwest of the abstractions, with a major groundwater divide located not far from Lomer Farm, trending northwest-southeast. This is likely to be driven by the axial trace of the anticline, although the modelled divide is slightly south of the mapped anticline. It should be noted that the groundwater contours represent a modelled high-water stand, and the groundwater divide may move in either direction during lower water levels; it is considered more likely to shift northward, to more closely align with the anticline.

1.5.169 Within this main groundwater catchment, Wheely Farm belongs to a different sub-catchment from the other two abstractions. The sub-divide trends approximately southwest to northeast.

Water Levels and Flow

1.5.170 Model results show groundwater levels to be between 25mbgl and 40mbgl in the area of interest (Entec, 2007; Amec, 2013).

1.5.171 Two groundwater monitoring boreholes are located close to the abstraction sites (Sheet 2 of Figure A8.1.7): Kilmeston Roadside and Parrs Barn (Environment Agency, 2018). Comparing the groundwater levels between the two locations outlines a hydraulic gradient that is inverted from the modelled levels. This increases the likelihood that the groundwater divide moves seasonally. Normal interannual variation in the area is expected to be in excess of 10m. Overall, this casts some doubt over the validity of the groundwater model in this region in terms of groundwater flow directions and maximum groundwater levels, although in any case expected to be deep.

Aquifer Characteristics

1.5.172 Groundwater flow within Chalk is generally within the secondary porosity, i.e. fractures and fissures (Allen *et al*, 1997). Wheely Farm is located in an area assessed as being highly soluble, and there is also a large concentration of recorded individual solution features in the vicinity of the abstraction (Farrant and Cooper, 2008). This suggests that the karstic secondary porosity is well developed in this area, with strong preferential flow paths.

1.5.173 The area where the other abstractions are located is assessed as having a moderate solubility, and as such, the karstic nature of the Chalk is likely to be less well developed, and preferential pathways less extensive, and/or less connected. Nonetheless there are some individual dolines recorded in the area, evidence of a degree of karstic development.

Conceptual Site Model

1.5.174 The conceptual site model for infiltration is presented on Sheet 3 of Figure A8.4.1 and flow pathways are presented on Sheet 11 of Figure A8.4.2.

Conclusions

1.5.175 Lomer Farm has a high overall risk, due to the presence of high infiltration potential and very high flow pathway potential.

1.5.176 Stanmore Farm has a moderate to low overall risk, due to the presence of overlapping moderate infiltration and moderate flow pathway potential.

1.5.177 There is no potential flow path for Wheely Farm; as a result, no impact is expected at this abstraction.

Brockwood Park and Brockwood Park Estate

Geographic Location

1.5.178 Brockwood Park and Brockwood Park Estate abstractions are situated around 2km southeast of Bramdean in Hampshire. The Order Limits are located within 525m of Brockwood Park, and 590m of Brockwood Park Estate at its closest point.

1.5.179 These supplies are shown on sheet 3 of Figure A8.4.1 and sheet 12 of Figure A8.4.2.

Abstraction Characteristics

1.5.180 Construction details for abstractions are presented in Table 8.4.9 (BGS, 2018a). The Brockwood Park and Brockwood Park Estate abstractions are licensed to abstract a maximum of 32m^3/d and 20m^3/d respectively for general farming and domestic purposes.

Table 8.4.9: Brockwood Park and Brockwood Park Estate Borehole Details

Location	Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
Brockwood Park	140mAOD	130mAOD	33mAOD	107m	79mbgl	55mbgl
Brockwood Park Estate	137mAOD	127mAOD	30mAOD	107m	Unknown	73mbgl

Settings

Soils

1.5.181 Soils are generally very fine, with only thin layers on the hilltops and thicker fine well drained deposits in the valley bottoms (Cranfield University, 2018). Clayey sub-soils are associated with the Clay-with-Flints areas.

Superficial Deposits

1.5.182 Superficial deposits close to the abstraction are shown on Sheet 3 of Figure A8.1.2. Clay-with-Flints Formation is recorded beneath both abstractions, overlying the bedrock (BGS, 2018a).

1.5.183 The Order Limits cross areas of recorded Clay-with-Flints Formation, generally on the top of the hills, with areas of head deposits also crossed in the base of the dry valleys.

Bedrock

1.5.184 Bedrock geology close to the abstractions is shown on Sheet 3 of Figure A8.1.1. The Brockwood Park and Brockwood Park Estate abstractions are located on the Newhaven Chalk Formation outcrop, as are the Order Limits.

Surface Water

1.5.185 There are no surface water features in the vicinity of the abstractions.

Groundwater Flow Pathway

Groundwater Catchment

1.5.186 SPZs have not been defined by the EA for these abstractions. Groundwater contours from the East Hampshire and Chichester Chalk groundwater model show the catchment to be derived from up to 8km to the east (Entec, 2007).

Water Levels and Flow

1.5.187 The East Hampshire and Chichester Chalk groundwater model indicates that the water table is generally likely to be around 40mbgl.

1.5.188 The closest groundwater level monitoring record is 1.75km from the abstractions (Environment Agency, 2018). It shows water levels below those from the East Hampshire and Chichester Chalk model, which means that 40mbgl is an upper bound on levels.

1.5.189 Variation in water levels is around 5m to 10m between years. There is a limited groundwater flooding susceptibility, indicating that water levels are deep.

1.5.190 Whilst flow immediately local to the abstractions is from east to west, it is also close to a regional flow divide, with the flowlines splitting towards the northwest and southeast.

Aquifer Characteristics

1.5.191 Groundwater flow within Chalk is generally within the secondary porosity, i.e. fractures and fissures (Allen *et al*, 1997). The abstractions are located in an area characterised by highly soluble rock classification (Farrant and Cooper, 2008). This indicates that there is likely to be a well-developed karstic network with lots of secondary porosity to provide rapid preferential flow pathways for groundwater flow.

Conceptual Site Model

1.5.192 The conceptual site model for infiltration is presented on Sheet 3 of Figure A8.4.1 and flow pathways are presented on Sheet 12 of Figure A8.4.2.

Conclusions

1.5.193 Both Brockwood Park and Brockwood Park Estate abstraction are located upstream of the Order Limits and there is no potential pathway identified. As a result, no impact is expected on these abstractions.

Bramdean, Manor Farm and Wood Farm

Geographic Location

1.5.194 The three abstractions are situated in the parish of West Tisted, East Hampshire. Manor Farm is located within 350m of the Order Limits at its closest point, whilst both Bramdean and Wood Farm are located about 850m from the Order Limits at their closest point.

1.5.195 The abstractions are shown on sheet 3 of Figure A8.4.1 and sheet 13 of Figure A8.4.2.

Abstraction Characteristics

1.5.196 Construction details, where known, for each abstraction are presented in Table 8.4.10 (BGS, 2018a). Manor Farm is licensed to abstract a maximum of 136m^3/d for general farming and domestic use. Both Bramdean and Wood Farm are licensed to abstract a maximum of 36m^3/d each for general farming and domestic use. Actual abstraction rates are not known.

Table 8.4.10: Bramdean, Manor Farm and Wood Farm Borehole Details

Location	Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
Bramdean	149mAOD	136mAOD	58mAOD	91m	80mbgl	70mbgl
Manor Farm	179mAOD	Unknown	72mAOD	107m	Unknown	94mbgl
Wood Farm	121mAOD	Unknown	60mAOD	61m	Unknown	39mbgl

1.5.197 The statutory service plans of the area do not show any water mains, suggesting that these abstractions are still used for potable supply.

Settings

Soils

1.5.198 Soils within the area are generally well drained, and often very thin (Cranfield University, 2018). They are predominantly calcareous in nature. Deeper silty soils may be found in the base of the valleys, whilst a clayey sub-soil may be associated with the areas of Clay-with-Flints Formation. The soils are not considered to present a restriction on infiltration rates.

Superficial Deposits

1.5.199 Superficial deposits close to the abstractions are shown on Sheet 4 of Figure A8.1.2. Wood Farm and Manor Farm are both located on Clay-with-Flints Formation, whilst there are no superficial deposits recorded beneath Bramdean (BGS, 2018a).

1.5.200 The Order Limits also pass through areas of recorded head deposits, generally concentrated within the valley bottoms, and to a lesser degree up the sides of the dry valleys. They also pass through further areas of Clay-with-Flints Formation, located on the higher ground and hilltops.

Bedrock

1.5.201 Bedrock geology close to the abstractions is shown on Sheet 4 of Figure A8.1.1. Manor Farm is located on outcrop of the Newhaven Chalk, whilst Bramdean and Wood Farm are located on the outcrop of underlying Seaford Chalk.

Surface Water

1.5.202 Surface water features are limited to a few small scattered farmland ponds. These are not connected to any surface drainage and are therefore likely to be almost exclusively fed by direct precipitation. They are likely to be lined, as they are perched a long way above the saturated zone.

Groundwater Flow Pathway

Groundwater Catchment

1.5.203 SPZs have not been defined by the EA for these abstractions. Groundwater contours from the East Hampshire and Chichester Chalk groundwater model show groundwater to be flowing from east to west (Entec, 2007), with the hydrogeological catchment extending 7.5km to the east.

Water Levels and Flow

1.5.204 Water strikes recorded in the borehole logs (70mbgl at Bramdean) suggest that the water table may be sitting in the Lewes Nodular Chalk Formation (BGS, 2018a). However, the modelled EA water levels would suggest that it most likely sits in the Seaford Chalk Formation, although near the base of this stratum.

1.5.205 Three monitoring boreholes (Environment Agency, 2018) have been identified within the vicinity of the abstractions: West Tisted, Long Houses and Parsonage Farm (Sheet 2 of Figure A8.1.7). These boreholes show very similar water levels, with the recorded range showing from 75mAOD to 90mAOD, with seasonal changes regularly reaching around 10m in each individual borehole. These water levels are all lower than the East Hampshire and Chichester Chalk groundwater model output within the area but do corroborate the values recorded in the abstraction boreholes (79mAOD in Bramdean, 86mAOD in Manor Farm, 81mAOD in Wood Farm).

Aquifer Characteristics

1.5.206 Groundwater flow within Chalk is generally within the secondary porosity, i.e. fractures and fissures (Allen *et al*, 1997). The Manor Farm abstraction is located on an area of high solubility (Farrant and Cooper, 2008), and there could therefore be extensive secondary porosity creating rapid flow paths. The other abstractions are located in areas of lower solubility, and as such the karstic secondary porosity would not be expected to be as well developed.

Conceptual Site Model

1.5.207 The conceptual site model for infiltration is presented on Sheet 4 of Figure A8.4.1 and flow pathways are presented on Sheet 13 of Figure A8.4.2.

Conclusions

1.5.208 There is no flow connection to the Bramdean abstraction, and therefore no expected impact on this supply.

1.5.209 Both Manor Farm and Wood Farm have an overall moderate risk; Manor Farm overlaps high infiltration with moderate flow pathway potential, whilst Wood Farm overlaps very high infiltration with moderate flow pathway potential and moderate infiltration with high flow pathway potential.

Oak Park

Geographic Location

1.5.210 The Oak Park abstraction is located in Crondall, Hampshire. The Order Limits are located within 425m at its closest point.

1.5.211 This supply is shown on Sheet 8 of Figure A8.4.1 and sheet 14 of Figure A8.4.2.

Abstraction Characteristics

1.5.212 Construction details for Oak Park abstraction are presented in Table 8.4.11 (BGS, 2018a). The abstraction is licensed to abstract a maximum of 69m^3/d for irrigation of a golf course.

Table 8.4.11: Oak Park Borehole Details

Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
105mAOD	92mbgl	58.7mAOD	46.3m	Unknown	9.8mbgl

Setting

Soils

1.5.213 The areas of Chalk outcrop are overlain by freely draining lime-rich loamy soils (Cranfield University, 2018). The edges of the Chalk outcrop, and the areas of

subcrop are overlain by slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils.

Superficial Deposits

1.5.214 Superficial deposits are shown on Sheet 8 of Figure A8.1.2. There are no superficial deposits recorded in the area close to this abstraction and the relevant portion of the Order Limits (BGS, 2018a).

Bedrock

1.5.215 Bedrock geology close to the abstraction is shown on Sheet 8 of Figure A8.1.1. The abstraction is located on outcrop of the Seaford Chalk Formation. The Chalk passes into subcrop beneath the Lambeth Group and London Clay Formation close to the abstraction location.

Surface Water

1.5.216 A number of small ditches and streams are recorded in the vicinity of the abstraction, mostly along the edge of the outcrop. The source of the River Hart is supported by a selection of karstic springs located less than 500m downgradient from the abstraction.

Groundwater Flow Pathway

Groundwater Catchment

1.5.217 SPZs have not been defined by the EA for this abstraction. Groundwater contours from the Mole groundwater model (Amec Foster Wheeler, 2015) show the catchment starting to the south of the abstraction; the edge of the Chalk outcrop 2.7km away forms the limit of the hydrogeological catchment.

Water Levels and Flow

1.5.218 Most of the Chalk outcrop close to the abstraction shows a high susceptibility to groundwater flooding (BGS, 2018b), showing that the water table is likely to be shallow within the area, however the water table is expected to be locally deeper where the local topographic surface rises.

1.5.219 This is supported by the modelled groundwater contours, which show levels approaching ground level over much of the area of interest.

Aquifer Characteristics

1.5.220 The Chalk is a dual porosity aquifer, with flow in fractures, fissures and conduits dominating any flow within the low permeability matrix (Allen *et al*, 1997). This creates preferential pathways that may allow flow across the hydraulic gradient. A lot of karstic features have been recorded in the area around the abstraction, whilst the rocks are indicated to be very soluble (BGS, 2018b). This means there is likely to be a high density of preferential flowpaths.

Conceptual Site Model

1.5.221 The conceptual site model for infiltration is presented on Sheet 8 of Figure A8.4.1 and flow pathways are presented on Sheet 14 of Figure A8.4.2.

Conclusions

1.5.222 The overall risk for the Oak Park abstraction has been assessed as very high. There is a zone of very high infiltration potential overlapping with the areas also assessed as having a very high flow pathway potential.

Betty Mundy's Cottage (PW000202)

Geographic Location

1.5.223 Betty Mundy's Cottage is a private water supply identified by Winchester City Council (2018) (PW000202). It is located in the rural South Downs. The Order Limits pass around 250m from the recorded abstraction at its closest point.

1.5.224 This supply is shown on Sheet 2 of Figure A8.4.1 and Sheet 10 of Figure A8.4.2.

Abstraction Characteristics

1.5.225 The abstraction borehole has been identified in the BGS (2018a) records, and construction details are present in Table 8.4.12.

Table 8.4.12: Betty Mundy's Cottage Borehole Details

Location	Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
Betty Mundy's Cottage	Unknown	6mbgl	61mbgl	61mbgl	Unknown	27mbgl

1.5.226 A pump test result is included in the borehole log showing pumping rates of around 1.45l/s. This is above the threshold for the requirement to have an abstraction licence (20m^3/d), so actual abstraction rates must either be below this, or the pump only runs for part of the day.

Setting

Soils

1.5.227 The abstraction and local area is recorded to lie on shallow well drained calcareous silty soils over Chalk on slopes and crests; deep calcareous and non-calcareous fine silty soils in valley bottoms (Cranfield University, 2018).

Superficial Deposits

1.5.228 Superficial deposits close to the abstraction are shown on Sheet 2 of Figure A8.1.2. There are no superficial deposits recorded directly beneath the abstraction (BGS, 2018a). Much of the surrounding area also have no superficial deposits recorded, although there are some minor head deposits in some of the valleys crossed by the

Order Limits. The borehole log for the abstraction records 2.4m of clay and flints overlying the bedrock, suggesting that the mapping is not capturing all of the superficial deposits locally.

Bedrock Deposits

1.5.229 Bedrock geology close to the abstraction is shown on Sheet 2 of Figure A8.1.1. The abstraction is located on the outcrop of Seaford Chalk Formation. The base of the borehole may penetrate into the underlying Lewes Nodular Chalk Formation.

Surface Water

1.5.230 There is a pond immediately adjacent to the recorded location of the abstraction well. There are no other notable surface water features.

Groundwater Flow Pathway

Groundwater Catchment

1.5.231 There is no defined catchment boundary that has been provided for this abstraction. The topographic catchment extends some 2km to the northeast.

Water Levels and Flow

1.5.232 Rest water levels recorded in the abstraction well are relatively deep (26.8mbgl), giving a thick unsaturated zone.

1.5.233 There is only limited groundwater flooding susceptibility under the site (BGS, 2018b), with the exception of a small area with a higher susceptibility located in a valley bottom close by, which indicates that water levels must be closer to the surface in this area.

1.5.234 The East Hampshire and Chichester Chalk (Entec, 2018) and the Test and Itchen Chalk (Amec, 2018) groundwater models both cover the area around the abstraction. They indicate that water levels are approaching or are above ground level in the valley bottom north of the abstraction, corresponding to the area of groundwater flooding. Modelled water levels deepen quickly into the interfluves and towards the south of the abstraction; these are contours representing a groundwater highstand.

1.5.235 There are no nearby EA groundwater monitoring boreholes.

Aquifer Characteristics

1.5.236 The Chalk is a dual-porosity medium with a high secondary permeability focused within the fractures and fissures, which can be opened out into karstic conduits in more soluble areas (Allen *et al*, 1997). The Chalk around the abstraction is moderately soluble, with more soluble areas located in some of the valleys and associated with the superficial cover (Farrant and Cooper, 2008). There are some dolines that have been mapped close to the Order Limits in the vicinity of the abstraction.

Conceptual Site Model

1.5.237 The conceptual site model for infiltration is presented on Sheet 2 of Figure A8.4.1 and flow pathways are presented on Sheet 10 of Figure A8.4.2.

Conclusions

1.5.238 The overall risk to the abstraction is moderate to high, due to a small area of high infiltration potential overlapping with high flow path potential.

Rooksgrove Farm (PW000111)

Geographic Location

1.5.239 Rooksgrove Farm is situated within the South Downs, in a remote and rural area of Hampshire. The Order Limits pass within 330m of the abstraction at its closest.

1.5.240 This supply is shown on Sheet 3 of Figure A8.4.1 and Sheet 11 of Figure A8.4.2.

Abstraction Characteristics

1.5.241 The private water supply was identified by Winchester City Council (2018) (PW000111). The borehole record has been identified among the publicly available BGS records and is presented in Table 8.4.13. Whilst actual abstraction rates are not known, as an unlicensed supply, abstraction is assumed to be less than 20m^3/d.

Table 8.4.13: Borehole Construction Details at Rooksgrove Farm

Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
161.4mAOD	155.3mAOD	62.2mAOD	99.1m	91.4mbgl	53.0mbgl

Setting

Soils

1.5.242 Soils are well drained calcareous silt, thin on the crests and valley sides, but deeper in the valley bottoms (Cranfield University, 2018). Soils can also be less calcareous in the base of the valleys.

Superficial Deposits

1.5.243 Superficial deposits close to the abstraction are shown on Sheet 3 of Figure A8.1.2. There are no superficial deposits recorded beneath the abstraction (BGS, 2018a). This is confirmed in the log of the abstraction borehole, which shows less than 0.5m of topsoil directly over the bedrock. The Order Limits mostly cross exposed bedrock, although there are some head deposits crossed in the valley bottoms in some of the potential area of interest.

Bedrock

1.5.244 Bedrock geology close to the abstraction is shown on Sheet 3 of Figure A8.1.1. The abstraction is located on the Seaford Chalk Formation. The Order Limits are also mostly on the Seaford Chalk Formation, although they also cross a small area of the underlying Lewes Nodular Chalk Formation outcrop.

1.5.245 The bedrock has been subject to tectonic deformation, with the axial trace of a major anticline mapped 250m to the south of the abstraction.

Surface Water

1.5.246 There are no surface water features close to the abstraction.

Groundwater Flow Pathway

Groundwater Catchment

1.5.247 The East Hampshire and Chichester (Entec, 2007) and Test and Itchen Chalk (Amec, 2013) groundwater models show the capture zone to be located to the south and southwest of Rooksgrove Farm. The regional groundwater divide is located not far upgradient (650m southwest), likely caused by the geological structure in the area.

Groundwater Levels and Flow

1.5.248 The groundwater models show water levels to be at least 30mbgl beneath the abstraction, which is confirmed by the BGS borehole record indicating rest water levels between 50mbgl and 60mbgl.

1.5.249 Groundwater flood risk mapping shows only a limited groundwater flooding susceptibility (BGS, 2018b), suggesting that water levels are relatively deep.

1.5.250 Groundwater levels in the Chalk are monitored at Lomer Farm, 650m west of Rooksgrove Farm (Environment Agency, 2018). This showed a highest water level of 32.5mbgl and large seasonal variation often in excess of 10m.

Aquifer Characteristics

1.5.251 The Chalk aquifer is a dual-porosity medium, with a very low intergranular permeability, but a high secondary permeability within the fractures and fissures (Allen *et al*, 1997). Where the rock is more soluble, these can be opened out into an extensive karstic network of conduits and caves.

1.5.252 The Chalk beneath the abstraction is in solubility class B, suggesting that there is likely to be some development of the secondary porosity, but that it is less than is found in other parts of the Chalk aquifer (Farrant and Cooper, 2008).

Conceptual Site Model

1.5.253 The conceptual site model for infiltration is presented on Sheet 3 of Figure A8.4.1 and flow pathways are presented on Sheet 11 of Figure A8.4.2.

Conclusions

1.5.254 The overall risk to the Rooksgrove Farm abstraction from a potential leakage has been assessed as moderate, due to the overlap between a high infiltration potential and a moderate flow path potential.

Blackhouse Farm (PW000021)

Geographic Location

1.5.255 Blackhouse Farm is situated in an isolated location close to the village of Kilmeston, Hampshire, and is located 225m from the closest point where the Order Limits pass.

1.5.256 This supply is shown on Sheet 3 of Figure A8.4.1 and Sheet 11 of Figure A8.4.2.

Abstraction Characteristics

1.5.257 The abstraction at Blackhouse Farm (PW000021) was identified by Winchester City Council (2018). Borehole construction details have not been identified for this abstraction. The rates of abstraction are not known, although any abstraction above 20m^3/d requires a licence. This therefore provides an upper limit to the potential rate of abstraction.

Setting

Soils

1.5.258 The abstraction is located on well drained flinty fine silty soils in valley bottoms; calcareous fine silty soils over Chalk or Chalk rubble on valley sides, sometimes shallow (Cranfield University, 2018). Most of the Order Limits' length locally is positioned on well drained fine silty over clayey, clayey and fine silty soils, often very flinty.

Superficial Deposits

1.5.259 Superficial deposits close to the abstraction are shown on Sheet 3 of Figure A8.1.2. The abstraction is recorded in the mapping to be underlain by head deposits, which extend along the length of the valley (BGS, 2018a). The Order Limits also cross areas of head deposits, along with mapped Clay-with-Flints Formation.

Bedrock Deposits

1.5.260 Bedrock geology close to the abstraction is shown on Sheet 3 of Figure A8.1.1. The bedrock geology beneath the abstraction is recorded to be the Newhaven Chalk Formation.

Surface Water

1.5.261 Blackhouse Pond is located close to the abstraction but is likely to be perched above the water table and not in continuity. There are no other surface water features of interest.

Groundwater Flow Pathway

Groundwater Catchment

1.5.262 The abstraction is located very close to the local groundwater divide that has been modelled in both the East Hampshire and Chichester Chalk (Entec, 2007) and the Test and Itchen Chalk (Amec, 2013) models (approximately 650m southeast in both models). Groundwater in the area is sourced from both northeast and southwest of the abstraction, before the groundwater divide sees flows split towards the northwest and southeast.

Water Levels and Flow

1.5.263 There are no EA monitoring boreholes sufficiently close to the abstraction to verify levels, and no rest water level for the abstraction is known. Groundwater modelling suggests that water levels local to the abstraction are around 15mbgl to 20mbgl; the model shows a groundwater highstand, so normal water levels would be deeper than this. This is verified by the limited groundwater flooding susceptibility recorded across the area (BGS, 2018b).

Aquifer Characteristics

1.5.264 The Chalk aquifer is a dual-porosity medium, with a very low intergranular permeability, but a high secondary permeability within the fractures and fissures (Allen *et al*, 1997). Where the rock is more soluble, these can be opened out into an extensive karstic network of conduits and caves.

1.5.265 The Chalk beneath the abstraction is solubility class C, suggesting a relatively soluble rock, with a well-developed secondary porosity (Farrant and Cooper, 2008). This extends up and down the dry valley from the abstraction and provides a preferential flow path to draw water from further afield than otherwise.

Conceptual Site Model

1.5.266 The conceptual site model for infiltration is presented on Sheet 3 of Figure A8.4.1 and flow pathways are presented on Sheet 11 of Figure A8.4.2.

Conclusions

1.5.267 The overall risk to PW000021 has been assessed as high, due to the overlapping high infiltration potential, and very high flow pathway potential.

Joan's Acre

Geographic Location

1.5.268 Joan's Acre is located 1.3km south of Bramdean, Hampshire. A private water supply is not registered at this location; however, Winchester City Council (2018) identified this as a property without a mains water supply connection. The Order Limits pass within 100m to the east of the property.

1.5.269 This supply is shown on Sheet 3 of Figure A8.4.1 and Sheet 12 of Figure A8.4.2

Abstraction Characteristics

1.5.270 No details about the abstraction are known, and there is no BGS (2018a) borehole record associated with the property. As an unlicensed abstraction, flow rates must be less than 20m^3/d.

Setting

Soils

1.5.271 The base of the valleys contains well drained fine soils with many flints (Cranfield University, 2018). The hilltops have a similar topsoil but may have a clay-rich subsoil below this, which would impede deeper drainage.

Superficial Deposits

1.5.272 Superficial deposits close to the abstraction are shown on Sheet 3 of Figure A8.1.2. Head Deposits are recorded beneath Joan's Acre on BGS mapping and are widespread in the base of the valleys (BGS, 2018a). Clay-with-Flints Formation can be found on the hilltops, whilst the valley sides between are often recorded as having no superficial deposits present. The nearest BGS borehole indicates that Clay-with-Flints Formation can be in excess of 6m thick.

1.5.273 The Order Limits cross all three areas of cover in the vicinity.

Bedrock

1.5.274 Bedrock geology close to the abstraction is shown on Sheet 3 of Figure A8.1.1. Joan's Acre is located on outcrop of the Newhaven Chalk Formation. The Order Limits are also on the Newhaven Chalk Formation in the vicinity.

Surface Water

1.5.275 There are no surface water features close to Joan's Acre.

Groundwater Flow Pathway

Groundwater Catchment

1.5.276 Both the East Hampshire and Chichester (Entec, 2007) and the Test and Itchen (Amec, 2013) groundwater models show the capture zone for Joan's Acre to be derived from the east and could extend up to 9km to the regional groundwater divide. There are, however, a number of other flow divides relatively close (within 1.2km), which complicate the derivation of the capture zone. The position and distance of these may change as water levels rise and fall.

Water Levels and Flow

1.5.277 Modelled groundwater levels are around 10mbgl beneath Joan's Acre, becoming deeper towards the east as the surface elevation rises, and is closer to 15mbgl beneath the Order Limits.

1.5.278 The BGS (2018b) groundwater flood risk map shows only a limited susceptibility to groundwater flooding beneath both Joan's Acre and the Order Limits. However, this increases to a below ground susceptibility less than 100m west downslope. This confirms the groundwater modelling of water levels becoming shallower in this direction.

1.5.279 There are no EA groundwater monitoring boreholes close to Joan's Acre.

Aquifer Characteristics

1.5.280 The Chalk is a dual-porosity medium, with flow concentrated into discrete fractures and fissures, with a very low matrix permeability (Allen *et al*, 1997).

1.5.281 The Chalk beneath Joan's Acre is rated as solubility class C, suggesting that it is relatively soluble and likely to be partially karstified (Farrant and Cooper, 2008). There are also a large number of individual dolines recorded nearby, creating rapid vertical flow pathways in the area.

Conceptual Site Model

1.5.282 The conceptual site model for infiltration is presented on Sheet 3 of Figure A8.4.1 and flow pathways are presented on Sheet 12 of Figure A8.4.2.

Conclusions

1.5.283 The overall risk from potential spillage at Joan's Acre has been assessed as very high, due to the coincident very high infiltration potential and very high flow pathway potential.

Parsonage Farm and Wolfhanger Farm (PW000092 and PW000191)

Geographic Location

1.5.284 The abstractions are located to the east of Bramdean, and southwest of West Tisted. Parsonage Farm (PW000092) is located approximately 50m from the Order Limits at its closest point, whilst Wolfhanger Farm (PW000191) is located approximately 110m from the Order Limits at its closest point.

1.5.285 These supplies are shown on Sheet 4 of Figure A8.4.1 and flow pathways are presented on Sheet 13 of Figure A8.4.2.

Abstraction Characteristics

1.5.286 The private abstractions were identified by Winchester City Council (2018). The borehole construction details are presented in Table 8.4.14.

Table 8.4.14: Parsonage Farm and Wolfhanger Farm Borehole Details

Location	Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
PW000092	102mAOD	Unknown	72mAOD	30m	Unknown	24mbgl
PW000191	125mAOD	Unknown	49mAOD	76m	Unknown	Unknown

1.5.287 The rate of abstraction for either borehole is not known. However, abstractions of greater than 20m^3/d require a licence, and so this provides an upper limit on the possible abstraction rates.

Settings

Soils

1.5.288 Parsonage Farm is situated on well drained flinty fine silty soils in valley bottoms; calcareous fine silty soils over Chalk or Chalk rubble on valley sides (Cranfield University, 2018). Wolfhanger Farm is situated on shallow well drained calcareous silty soils over Chalk on slopes and crests; deep calcareous and non-calcareous fine silty soils in valley bottoms. These are also the principal assemblages the Order Limits cross locally.

Superficial Deposits

1.5.289 Superficial deposits close to the abstraction are shown on Sheet 4 of Figure A8.1.2. Both abstractions are located on superficial deposits comprising head (BGS, 2018a). The Order Limits also cross the head deposits, and areas where no superficial deposits have been recorded.

Bedrock Deposits

1.5.290 Bedrock geology close to the abstraction is shown on Sheet 4 of Figure A8.1.1. The abstractions are located on the outcrop of the Seaford Chalk Formation. Wolfhanger Farm may penetrate into the top of the underlying Lewes Nodular Chalk Formation, but it is highly unlikely that Parsonage Farm is open to any other formations.

Surface Water

1.5.291 There are no surface water features close to the abstractions.

Groundwater Flow Pathway

Groundwater Catchment

1.5.292 Both the East Hampshire and Chichester Chalk (Entec, 2007) and Test and Itchen Chalk (Amec, 2013) groundwater models show flows to be from the east towards the west, and the hydrogeological catchment extends up to 8.5km to the east.

Water Levels and Flow

1.5.293 The EA (2018) monitor groundwater levels at their Parsonage Farm observation borehole, located next to the Parsonage Farm abstraction. This location has a median water level of 21.6mbgl with a seasonal variation of up to 10m, indicating a relatively thick unsaturated zone. However, this may include some drawdown effect from the adjacent abstraction, but without abstraction rates this cannot be quantified.

1.5.294 Groundwater modelling suggests water levels at Parsonage Farm, unlike in the monitoring borehole, are only around 10mbgl. Water levels in Wolfhanger Farm are

more than 20mbgl. However, this represents a groundwater highstand, and therefore normal water levels would be lower than this.

1.5.295 According to the BGS (2018b) groundwater flooding susceptibility map, both abstractions are located in an area of a limited groundwater flooding susceptibility which aligns with the EA groundwater modelling results.

Aquifer Characteristics

1.5.296 The Chalk aquifer is a dual-porosity medium, with a very low intergranular permeability, but a high secondary permeability within the fractures and fissures (Allen *et al*, 1997). Where the rock is more soluble, these can be opened out into an extensive karstic network of conduits and caves.

1.5.297 The Chalk beneath the abstractions is solubility class C, suggesting a relatively soluble rock, with a well-developed secondary porosity (Farrant and Cooper, 2008). This extends up and down the dry valley and provides a preferential flow path to draw water from further afield than otherwise.

Conceptual Site Model

1.5.298 The conceptual site model for infiltration is presented on Sheet 4 of Figure A8.4.1 and flow pathways are presented on Sheet 13 of Figure A8.4.2.

Conclusions

1.5.299 Parsonage Farm (PW000092) has been assessed as having an overall moderate to high risk, due to the presence of a high infiltration potential and a high flow pathway potential.

1.5.300 Wolfhanger Farm (PW000191) has been assessed as having an overall very high risk, due to the presence of a very high infiltration potential and a very high flow pathway potential.

Beech Farm (1110)

Geographic Location

1.5.301 Beech Farm is located around 1.5km southeast of Four Marks in Hampshire. The abstraction (referenced as 1110) was identified as part of the landowner consultation; the exact location is not known, only which land parcel it is situated in. Without an exact location of the abstractions, the worst-case possibility will generally be assumed for this assessment.

1.5.302 The abstraction is shown on Sheet 5 of Figure A8.4.1 and Sheet 15 of Figure A8.4.2.

Abstraction Characteristics

1.5.303 The borehole construction details are not known, but it is understood there is both a private (potable) water supply, and a ground source heat pump within the land parcel. The rate of abstraction is not known for either. However, abstractions of

greater than 20m^3/d require a licence, and so this provides an upper limit on the possible abstraction rates.

Setting

Soils

1.5.304 The land parcel and the Order Limits in the area are both situated on well drained fine silty over clayey, clayey and fine silty soils, often very flinty (Cranfield University, 2018).

Superficial Deposits

1.5.305 Superficial deposits close to the abstraction are shown on Sheet 5 of Figure A8.1.2. The land parcel associated with the abstraction is underlain primarily by head deposits, located within the valley bottom and sides (BGS, 2018a). Two small areas of higher ground are associated with the Clay-with-Flints Formation. Some of the land parcel has no superficial deposits recorded. The Order Limits also cross all of these different local superficial deposits.

Bedrock Deposits

1.5.306 Bedrock geology close to the abstraction is shown on Sheet 5 of Figure A8.1.1. The land parcel is underlain by the Seaford Chalk Formation.

Surface Water

1.5.307 There are no surface water features in the vicinity of the land parcel.

Groundwater Flow Pathway

Groundwater Catchment

1.5.308 The EA groundwater models for the East Hampshire and Chichester Chalk (Entec, 2007), the Test and Itchen Chalk (Amec, 2013) and the Mole Chalk (Amec Foster Wheeler, 2015) all cover the area of the abstraction. The flow towards the abstraction is derived from the east and northeast, with the hydrogeological catchment extending up to 1.75km to 2.9km northeast, depending on the groundwater model.

Water Levels and Flow

1.5.309 The EA (2018) monitor groundwater levels within the Chalk close to the supply showing groundwater levels around 50mbgl for the available monitoring record and generally less than 0.5m seasonal variations.

1.5.310 The Mole Chalk groundwater model shows water levels to be around 10m deeper than the other models. Modelled water levels are around 40mbgl to 65mbgl, with the change in elevation across the valley proving more important than the changes in groundwater level.

1.5.311 According to the BGS (2018b) groundwater flooding susceptibility map, the area has only a limited susceptibility to groundwater flooding, confirming groundwater is not expected to be shallow in this area.

Aquifer Characteristics

1.5.312 The Chalk aquifer is a dual-porosity medium, with a very low intergranular permeability, but a high secondary permeability within the fractures and fissures (Allen *et al*, 1997). Where the rock is more soluble, these can be opened out into an extensive karstic network of conduits and caves.

1.5.313 The Chalk beneath the abstraction's land parcel is classed as a mixture of solubility class B, C, and D, suggesting a relatively soluble rock in some parts, with a well-developed secondary porosity (Farrant and Cooper, 2008). The Order Limits also cross these classes where they are contiguous, suggesting that there may be some preferential flow paths connecting to the abstraction.

Conceptual Site Model

1.5.314 The conceptual site models for infiltration are presented on Sheet 5 of Figure A8.4.1 and flow pathways are presented on Sheet 15 of Figure A8.4.2.

Conclusions

1.5.315 The overall risk for Beech Farm has been assessed as high. This is due to the high infiltration potential, and the very high flow pathway potential. This may be refined if additional information on the abstractions becomes available.

Hawbridge Farm

Geographic Location

1.5.316 Hawbridge Farm is located around 3.4km northeast of the centre of Alton, Hampshire. The presence of an unlicensed private water supply was identified by East Hampshire District Council (2018).

1.5.317 The exact location of the abstraction was not provided by East Hampshire District Council, and BGS (2018a) records indicated multiple boreholes on the site; a request to the landowner for further information was therefore made. The information provided was inconclusive but suggested that the abstraction could be within 10m of the Order Limits.

1.5.318 The abstraction is shown on Sheet 6 of Figure A8.4.1 and flow pathways are presented on Sheet 16 of Figure A8.4.2.

Abstraction Characteristics

1.5.319 As discussed above, two borehole records have been identified in the BGS database which may be associated with this abstraction. The consultation response stated the supply was 7-8 years old, and it is therefore assumed that the younger of the two available borehole records (2014 against 1932) is the one currently in use. Details are presented in Table 8.4.15.

Table 8.4.15: Assumed Borehole Construction Details for Hawbridge Farm

Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
102mAOD	90mAOD	78mAOD	24m	Unknown	Unknown

1.5.320 The abstraction is unlicensed, meaning that it must be abstracting less than 20m^3/d. The exact abstraction rate is not known.

Setting

Soils

1.5.321 The Chalk outcrop is associated with well drained fine calcareous soils, thickening towards the base of the valleys (Cranfield University, 2018). The Upper Greensand Formation outcrop is associated with well drained loamy soils, with slight seasonal waterlogging a possibility.

Superficial Deposits

1.5.322 Superficial deposits close to the abstraction are shown on Sheet 6 of Figure A8.1.2. Hawbridge Farm is located on an area of Second River Terrace Deposits, comprising sand and gravel (BGS, 2018a). The Order Limits pass across the edge of this outcrop. Publicly available BGS borehole logs indicate the superficial deposits to be around 3m thick.

Bedrock

1.5.323 Bedrock geology close to the abstraction is shown on Sheet 6 of Figure A8.1.1. Hawbridge Farm is located on the transition from the West Melbury Marly Chalk Formation outcrop to the underlying Upper Greensand Formation outcrop. The abstraction is drawing water from the Upper Greensand Formation. The publicly available borehole logs do not record any Chalk.

1.5.324 A small fault within the Chalk and sand is recorded in the BGS mapping. This may act as a barrier or a preferential pathway to flow, dependent on the orientation and properties.

Surface Water

1.5.325 The River Wey is located 250m northwest of Hawbridge Farm. The River Wey is a Chalk fed stream with a high baseflow component. A smaller tributary lies 250m to the west of Hawbridge Farm, which is crossed by the Order Limits to the south.

Groundwater Flow Pathway

Groundwater Catchment

1.5.326 The River Wey is likely to be the principal groundwater discharge point, and flow is expected to be towards the river. This places the hydrogeological catchment upslope towards the southeast. The edge of the Upper Greensand Formation outcrop is 2km away in this direction, providing the limit on the possible catchment.

1.5.327 This catchment is confirmed by the Mole UGS (Amec Foster Wheeler, 2015) and the Test and Itchen (Amec, 2015) groundwater models. These also show that the catchment is towards the southeast, although the contours are slightly deflected by the tributary of the Wey.

Water Levels and Flow

1.5.328 The Mole UGS and Test and Itchen groundwater models show a depth to groundwater between 5mbgl and 10mbgl beneath Hawbridge Farm.

1.5.329 The EA (2018) groundwater monitoring borehole Malm's Farm is located 400m east of Hawbridge Farm, and records water levels in the Upper Greensand Formation. Water levels in this area are generally greater than 15mbgl, with about 2-3m of seasonal variation. This is substantially deeper than the groundwater model at the same location (approximately 3mbgl).

1.5.330 The BGS (2018b) groundwater flood susceptibility map shows that the Chalk outcrop is associated with a susceptibility to groundwater flooding at surface, whilst the Upper Greensand Formation outcrop has only a limited susceptibility to groundwater flooding (within the resolution of the flood mapping grid cells). This would indicate that groundwater is shallower within the Chalk than the Upper Greensand Formation, although the different properties of the two aquifers may also influence their respective classifications.

Aquifer Characteristics

1.5.331 The Chalk is a dual-porosity medium, with flow concentrated into discrete fractures and fissures, with a very low matrix permeability (Allen *et al*, 1997). The Upper Greensand Formation is relatively heterogeneous, with a mixture of fracture and matrix flow, often dependent on the degree of cementation locally.

1.5.332 The Chalk immediately below Hawbridge Farm is rated as solubility class B, whilst the Upper Greensand is solubility A (Farrant and Cooper, 2008). This means that there is a limited potential for the development of karstic features, both within the horizontal and vertical planes.

Conceptual Site Model

1.5.333 The conceptual site model for infiltration is presented on Sheet 6 of Figure A8.4.1 and flow pathways are presented on Sheet 16 of Figure A8.4.2.

Conclusions

1.5.334 The overall risk from potential spillage at Hawbridge Farm has been assessed as very high, due to the coincident very high infiltration potential and very high flow pathway potential. This may be refined if additional information on the abstraction from the landowner is obtained.

1.6 GWSA-C

Woodcock Lane and Foxhills

Geographic Location

1.6.1 Woodcock Lane is located northwest of Chobham. The Order Limits pass within 165m of the abstraction at its closest.

1.6.2 Foxhills is located northwest of Ottershaw. The Order Limits pass within 640m of the abstraction at its closest point.

1.6.3 These supplies are shown on Sheets 11 and 12 of Figure A8.4.1 and Sheet 17 of Figure A8.4.2.

Abstraction Characteristics

1.6.4 Construction details for Woodcock Lane abstraction are not known. The abstraction is licensed to abstract a maximum of 68m^3/d for horticultural irrigation.

1.6.5 Foxhills is licensed to abstract a maximum of 100m^3/d for irrigation of a golf course. Construction details are presented in Table 8.4.15 (BGS, 2018a).

Table 8.4.16: Foxhills Borehole Details

Elevation	Base of Casing	Base of Open Hole	Depth of Borehole	Pump Depth	Rest Water Level
Unknown	34mbgl	40mbgl	40mbgl	Unknown	17.2mbgl

Settings

Soils

1.6.6 Soils in the vicinity of Woodcock Lane are mixed, with areas of loamy soils with naturally high groundwater, slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils, and fen peat soils (Cranfield University, 2018).

1.6.7 Soils in the vicinity of Foxhills are also relatively mixed but are generally relatively permeable and acidic. Some areas are recorded to either be wet or affected by groundwater.

Superficial Deposits

1.6.8 Superficial deposits close to the abstractions are shown on Sheet 3 of Figure A8.1.2. Superficial deposits in the area are relatively discontinuous (BGS, 2018a). There are some small areas of alluvium and River Terrace Deposits close to Woodcock Lane, which are crossed by the Order Limits. There are no recorded superficial deposits in the vicinity of Foxhills, and the Order Limits are directly above the bedrock.

Bedrock

1.6.9 Bedrock geology close to the abstractions are shown on Sheets 11 and 12 of Figure A8.1.1. Woodcock Lane is located on outcrop of the Bagshot Formation, whilst Foxhills is located on outcrop of the Windlesham Formation. Both are understood to abstract from the underlying Bagshot Formation.

Surface Water

1.6.10 Two small ponds are located adjacent to the Woodcock abstraction. There are also a number of drains in the vicinity, whilst Clappers Brook is only 550m to the west.

1.6.11 The Foxhills abstraction is located next to a drain, not far from where the start of its course is mapped. There are a lot of issues mapped in the vicinity of the Foxhills abstraction, feeding into small drains.

Groundwater Flow Pathway

Groundwater Catchment

1.6.12 SPZs have not been defined by the EA for these abstractions and there are no EA groundwater contours available for these aquifers. There is only one EA groundwater level monitoring location, which is discussed below.

1.6.13 In the absence of groundwater levels or contours, the next best approximation relates to assuming that groundwater flows follow the topography. The hydrological catchment associated with Woodcock stretches 1.1km to the north.

1.6.14 The hydrological catchment at Foxhills draws from the northwest for 250m, and it is located near to a local topographical divide which elongates the catchment east and west. A number of stream issues have been identified on both sides of the topographical divide.

Water Levels and Flow

1.6.15 Groundwater level records are available from only one location in the Bracklesham Group, located 600m east of Woodcock Lane (Environment Agency, 2018). Variation was only around 1.5m over the available record, with average groundwater levels around 7mbgl.

1.6.16 According to the BGS (2018b) groundwater flooding susceptibility map, Woodcock Lane is located in an area susceptible to groundwater flooding at surface, suggesting that water levels are expected, at least seasonally, to be close to ground surface. Foxhills is located in an area classified as not susceptible to groundwater flooding.

Aquifer Characteristics

1.6.17 The Bagshot formation consists of fine sands. They are generally only semi-consolidated. Flow within this aquifer is dominated by intergranular flow (Jones *et al*, 2000). The aquifer is not susceptible to dissolution (Farrant and Cooper, 2008); there is no substantial secondary porosity to provide preferential flow paths.

Conceptual Site Model

1.6.18 The conceptual site model for infiltration is presented on Sheets 11 and 12 of Figure A8.4.1 for Woodcock Lane and Foxhills respectively, and flow pathways are presented on Sheet 17 of Figure A8.4.2.

Conclusions

1.6.19 The Woodcock Lane abstraction has been assessed as an overall moderate risk, with a high infiltration risk overlying a moderate flow pathway risk.

1.6.20 The Foxhills abstraction has been assessed as having a negligible overall risk, with low infiltration and low flow pathway risk.

1.6.21 It should be noted that in the absence of data on the capture zone, a conservative case has been taken. The assessment of Woodcock Lane could therefore be overestimating the risk posed.

1.7 GWSA-D

Chertsey

Geographic Location

1.7.1 The Chertsey abstraction is located to the north of Chertsey, Surrey. The Order Limits pass within approximately 500m of the abstraction at the nearest point. The Order Limits pass through the SPZ2 for 1.25km of its total length, and through SPZ3 for 6.45km of its total length.

1.7.2 This abstraction is shown on Sheet 13 of Figure A8.4.1 and Sheet 18 of Figure A8.4.2.

Abstraction Characteristics

1.7.3 The Chertsey abstraction comprises eight abstraction boreholes (Table 8.4.17). It should be noted that BHs A-C are connected by a collector drain set at approximately 8mbgl, with BHs D, E acting as inspection points for the drain, rather than being used for abstraction.

Table 8.4.17: Chertsey Borehole Details

BH No.	Elevation (mAOD)	Top of Screen (mAOD)	Base of Screen (mAOD)	Depth of Borehole (mAOD)	Pump Intake (mAOD)	Rest Water Level (mAOD)
BH A	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
BH B	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
BH C	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
BH F	12.11	9.11	4.11	12.00	1.61	Unknown
BH G	11.83	7.82	2.82	13.11	0.22	Unknown
BH H	12.24	8.24	3.24	13.00	0.74	Unknown
BH I	12.00	9.50	4.50	11.50	2.00	Unknown

BH No.	Elevation (mAOD)	Top of Screen (mAOD)	Base of Screen (mAOD)	Depth of Borehole (mAOD)	Pump Intake (mAOD)	Rest Water Level (mAOD)
BH J	12.00	10.00	6.00	11.00	1.60	Unknown

1.7.4 The Chertsey groundwater abstraction is licensed for an average daily abstraction of 27.35Ml/d, and a peak daily abstraction of 40.91Ml/d. Historical abstraction records show that abstraction regularly approaches the annual maximum permitted from the abstraction (Affinity Water, 2015). However, deployable output is restricted by the deepest advisable pumped water level rather than licence under both average and peak demand scenarios. It is known that the boreholes interfere with each other, meaning that the total abstraction available at the pumping station is less than the sum of the individual boreholes (Three Valleys Water, 2007).

1.7.5 There is a separate licence for abstracting surface water from the River Thames at the same site.

Setting

Soils

1.7.6 Soils immediately under the abstraction are deep, stoneless calcareous clays (Cranfield University, 2018). Across the broader capture zone, soils are generally quite deep, but the composition can vary substantially. Deep sandy loams with variable permeabilities are, however, the other predominant soil type. This will affect the distribution of recharge across the capture zone.

Superficial Deposits

1.7.7 Superficial deposits close to the abstraction are shown on Sheet 4 of Figure A8.1.2. The abstraction is shown to be underlain by alluvium over Shepperton Gravel Member, a River Terrace Deposit consisting of sand and gravel (BGS, 2018a). This can be up to 10m thick in some locations, with 8m the maximum recorded in any of the abstraction boreholes. Whilst it is geographically extensive, the Shepperton Gravel Member has been heavily worked for aggregate deposits. Areas of both made ground and infilled ground are reported under the pumping station.

1.7.8 In the wider area and along the Order Limits, Langley Silt Member and Kempton Park Gravel Member have also been recorded. The Kempton Park Gravel and Shepperton Gravel Members are likely to be in some degree of hydraulic continuity. The Langley Silt Member will act as an aquitard to slow water flow in both the vertical and horizontal direction.

1.7.9 Alluvium along the Order Limits is between 1.7m and 2.5m thick according to the publicly available borehole records (BGS, 2018a), although it is mapped as absent along some parts of the Order Limits. Gravel thicknesses are highly variable along the Order Limits, with them being absent in some boreholes, and in excess of 8m thick in other locations.

1.7.10 The screened section of all the abstraction boreholes is within the Shepperton Gravel Member.

Bedrock Deposits

1.7.11 Bedrock geology close to the abstraction is shown on Sheet 4 of Figure A8.1.1. The abstraction is recorded by the BGS to be underlain by bedrock of the Bagshot Formation (sand). However, information provided by Affinity Water (2015) suggests that the bedrock beneath the site is the Claygate Beds, part of the London Clay Formation, and described as '*a sand and stiff clay aquiclude*'.

1.7.12 Inspection of borehole records suggest that the Bagshot Formation probably is present over some of the pumping station site (BGS, 2018a). However, it is likely to be thin (<3.5m), hard to distinguish from the sand and gravel of the Shepperton Formation, and in hydraulic continuity with the superficial deposits. The Bagshot Formation is underlain by the London Clay Formation, the presence of which is also confirmed in the borehole records.

1.7.13 The Order Limits are recorded to be underlain by the Bagshot Formation, before transitioning onto London Clay Formation outcrop in the north. The presence of the Bagshot Formation under some of the Order Limits has been confirmed by Ground Investigation.

Surface Water

1.7.14 The abstraction site is adjacent to the River Thames (abstraction boreholes are between 30 and 375m away), which flows from north to south in the area. The site is just upstream of the confluence between the River Thames and the Abbey River. A number of drainage ditches, including the Burway Ditch cut across the site. The Burway Ditch is noted to be dry most of the time, only containing water when the River Thames is in flood (Three Valleys Water, 2007).

1.7.15 Three notable lakes are observed, one on the opposite side of the River Thames, one between the abstraction and the Abbey River, and one on the far side of the Abbey River. These are likely to be former gravel pits that have been restored to open water.

1.7.16 Following borehole pumping tests, it was concluded that the River Thames is not in continuity with the groundwater. Instead it is higher than the surrounding groundwater and acting as a leaky source due to the low permeability river bed (Affinity Water, 2015). The lakes were also noted to be groundwater fed and therefore in continuity. The Abbey River was noted to be in hydraulic continuity with groundwater and the primary control on the local groundwater levels.

<u>Groundwater Flow Pathway</u>

Groundwater Catchment

1.7.17 The defined SPZs for the Chertsey abstraction (Environment Agency, 2018) are shown in Sheet 4 of Figure A8.1.6. The SPZ1 is approximately circular in shape, whilst SPZ2 is elongated along the north-south axis. The SPZ3 is further stretched, particularly towards the northeast. The shapes of the SPZs are likely to be influenced by the geographical extent of the Shepperton Gravel formation and other river terrace gravels, as well as the local and wider surface water features. The

SPZs continue beneath the River Thames, indicating that the gravel aquifer is contiguous across both banks. This is confirmed by the response in groundwater levels observed in the observation borehole on the far side of the river to changes in pumping at the Chertsey abstraction (Affinity Water, 2015).

1.7.18 Consultation and engagement with Affinity Water suggested that during low groundwater conditions, the capture zone for the abstraction may be wider. During these times, demand would be higher whilst water availability is less, forcing the abstraction to greater drawdown and a wider capture zone; during such times, the SPZ may not be an accurate reflection of the source of groundwater. It is considered that this expansion would be most prevalent within the Shepperton Gravel Member outcrop, being the same unit as the abstraction horizon.

Water Levels and Flow

1.7.19 There are no EA operated monitoring boreholes within the gravel aquifer. However, a number of piezometers have been installed by Affinity Water to support the licence at Chertsey (Three Valleys Water, 2007). The water levels from these piezometers suggest that the general regional flow is towards the south. However, flows are also substantially distorted by the cone of depression caused by the abstraction. A review of available groundwater level monitoring suggests that 'natural' water levels would be around 10.5mAOD in the area around the abstraction, which equates to about 1.5mbgl to 2mbgl. Pumped water levels vary between approximately 8mAOD and 10mAOD.

1.7.20 The Order Limits pass through areas classified as below ground groundwater flooding susceptible, and smaller areas of above ground groundwater flooding susceptibility (BGS, 2018b). There are also areas of limited groundwater flooding susceptibility, generally associated with the lower permeability geologies. Overall, this indicates that groundwater is generally quite shallow, and can approach ground level.

1.7.21 This was confirmed by limited groundwater monitoring data associated with landfills along the Order Limits to the east of the Chertsey abstraction. These show that the absolute water level rises towards the north, from 10.5mAOD in the south to 11.4mAOD, equating to water levels of approximately 1.5mbgl to 2mbgl.

1.7.22 As discussed earlier, the River Thames is understood to be 1m higher than the surrounding groundwater levels, acting as a leaky source into the aquifer (Affinity Water, 2015).

Aquifer Characteristics

1.7.23 The Shepperton Gravel is a granular aquifer, with flow occurring between the grains. There would be no fracture flow. No transmissivities or storage coefficients have been made available. The shape of the SPZ suggests a degree of anisotropy in hydraulic conductivity over a large scale.

1.7.24 Pumping test analysis shows that the aquifer is efficient, with 90-96% of the drawdown within the wells due to well losses, rather than drawdown within the

aquifer (Three Valleys Water, 2007). This shows that there is a high storage and specific capacity.

Conceptual Site Model

1.7.25 The conceptual site model for infiltration is presented on Sheets 13 and 14 of Figure A8.4.1 and flow pathways are presented on Sheet 18 of Figure A8.4.2.

Conclusions

1.7.26 Infiltration potential is either very high, high or moderate throughout the area of interest, due to the high water table, and the fact the aquifer of interest is shallow. The difference between areas of high and very high risks is primarily a function of where alluvium deposits are present, which may provide some retardation to the infiltration rates, and the lower groundwater flooding susceptibility indicating a slightly thicker unsaturated zone.

1.7.27 Due to the relatively homogeneous nature of the gravel, the SPZ is the primary controlling factor to define pathway risks to the abstraction, although it is noted that further investigation of the abstraction has been undertaken since it was defined. However, it is considered that the capture zone may be increased, and the length of flow pathway reduced, during times of drought when there is a high demand on the abstraction.

1.7.28 The overall risk is considered to be high because very high infiltration potential aligns with a high flow pathway potential, whilst there is also overlap between high infiltration and high flow pathway potentials.

Thames Gravels Abstractions

Geographic Location

1.7.29 There are eight currently licensed abstractions from the River Thames Gravel aquifer, all located north of the River Thames itself. Six are located close to Laleham; the remaining two are located further north in Ashford. These two locations have been grouped separately for the purposes of assessment.

1.7.30 These abstractions are shown on sheet 13 of Figure A8.4.1 and sheets 19 and 20 of Figure A8.4.2.

Abstraction Characteristics

1.7.31 The information available on the abstraction licences are presented in Table 8.4.18.

Table 8.4.18: Thames Gravels Borehole Details

Licence Point	'Group'	Distance from Order Limits (m)	Licensed Volume (m^3/d)	Use
Shepperton Lane, Laleham - Borehole B	Laleham	110	400	Spray irrigation

Licence Point	'Group'	Distance from Order Limits (m)	Licensed Volume (m^3/d)	Use
Shepperton Lane, Laleham - Wet Pit C	Laleham	15	400	Spray irrigation
Well 'A' at Laleham Road, Shepperton	Laleham	310	305	Spray irrigation
Littleton Lane, Shepperton-Point A	Laleham	30	50	Process washing
Point B, Gravel Pit at Littleton Lane, Shepperton, Middlesex	Laleham	40	4,819	Mineral washing
Point A, Gravel Pit at Littleton Lane, Shepperton, Middlesex	Laleham	20	4,819	Mineral washing
Mayfield Farm, Staines Road, Bedfont (Well)	Ashford	440	218	Spray irrigation
Gravels at Ashford Road Laleham Staines	Ashford	250	5,730	Mineral washing

1.7.32 The Shepperton Lane abstractions and the Gravel Pit at Littleton Lane abstractions are part of a group licence, with the licence volume being from the two abstraction points combined. The Shepperton C, Gravel Pit A and B, and Gravels at Ashford Road are licensed to abstract groundwater from the gravel pit lakes. No construction details are known for the other abstractions. Actual abstractions rates are not known for the licences.

Settings

Soils

1.7.33 Both the Laleham and Ashford abstractions are recorded as having well drained coarse loamy and some sandy soils, which can be affected by groundwater (Cranfield University, 2018). These are unlikely to present an impediment to infiltration.

Superficial Deposits

1.7.34 Superficial deposits close to the abstractions are shown on Sheets 4 of Figure A8.1.2. Superficial deposits consist of the Shepperton Gravel, Kempton Park Gravel and Langley Silt Members (BGS, 2018a). Some alluvium is also found at the base of the small watercourse valleys and associated with the modern River Thames course.

1.7.35 The area around the Laleham abstractions is part of ongoing mineral extraction, with subsequent backfill by landfill. The fill material is understood to be inert.

1.7.36 The Laleham abstractions are located on Shepperton Gravel, with the exception of abstraction Well A at Laleham Road, which is located on Langley Silt. The Ashford abstractions are both located on the Kempton Park Gravel.

Bedrock Deposits

1.7.37 Bedrock geology close to the abstractions are shown on Sheet 4 of Figure A8.1.1. Bedrock in the area of Laleham consists of Bagshot Formation outcrop in the south, transitioning to the underlying Claygate Member; Laleham Road and Shepperton Lane B are located on Claygate outcrop, the others on the Bagshot Formation. The London Clay Formation then outcrops further to the north, where the Ashford abstractions are located.

Surface Water

1.7.38 The Laleham abstractions are all located close to the River Thames, between 300m and 1,000m away to the west and south. The River Ash also passes close to the abstractions, and is only 250m northeast of the Well A, Laleham Road abstraction. There are two sizeable gravel pit lakes, one to the east and one to the west of the abstractions. These are most likely to be in continuity with the groundwater. A number of cross-cutting small drainage ditches are also recorded.

1.7.39 The River Thames is thought to be hydraulically separated from the gravels, providing a low level of leakage through a low permeability river bed (Affinity Water, 2015).

1.7.40 The Ashford Road abstraction is located adjacent to gravel pit lakes, and 150m from the River Ash. The Queen Mary Reservoir is located adjacent to the far bank of the River Ash but is likely to be lined with an impermeable barrier.

1.7.41 The Mayfield Farm abstraction is located close to some small drainage ditches, as well as some ponds. The ponds appear to be associated with a recorded waterworks. There are also gravel pit lakes around 400m south of the abstraction.

<u>Groundwater Flow Pathway</u>

Groundwater Catchment

1.7.42 The groundwater catchment is assumed to align with topography and is derived from up to 1km to the north and northeast. The individual capture zones of each abstraction would likely be quite limited in size; this is especially true of the wells as opposed to lake abstractions. The presence of open water in continuity would naturally distort the catchments to drain towards these locations. This means the lake abstractions would capture from a greater area, although it may be subject to greater mixing.

Water Levels and Flow

1.7.43 There are no EA operated monitoring boreholes within the gravel aquifer. Information provided by Affinity Water (2015) suggested that regional flow within the gravel aquifer was generally towards the south. This follows the general surface elevation drop. However, the topography in the area is relatively flat, and the hydraulic gradient is likely to be very shallow.

1.7.44 Groundwater levels from monitoring of landfills were made available (Environment Agency, 2018). The average groundwater level in the vicinity of the Laleham abstractions varies from around 10mAOD to 11mAOD across the boreholes, with the maximum recorded groundwater levels no more than 1m higher than average in each borehole. This indicates that there is a relatively limited seasonal variation, and even extreme events do not raise water levels massively. The hydraulic gradient is relatively flat, as is the topography. Local ground surface is between 12mAOD and 13mAOD, suggesting water levels are around 2mbgl.

1.7.45 Available levels around the Ashford Road abstraction show an average of around 12.2mAOD. Ground level is around 14mAOD, giving a depth to the water table of 1.8mbgl. There are no water levels in the vicinity of Mayfield Farm.

1.7.46 The River Thames level is understood to be above the local gravel groundwater (Affinity Water, 2015), although it may be leaky through the base.

1.7.47 It is assumed that the aquifer is in close hydraulic continuity with the various gravel pit lakes in the area (Affinity Water, 2015), and that the superficial water table feeds these. The flow field is therefore expected to be distorted where it approaches the edges of surface water features.

Aquifer Characteristics

1.7.48 The Shepperton gravel is a granular aquifer, with flow occurring between the grains. No transmissivities or storage coefficients have been made available, although gravel aquifers are generally highly permeable, dependent on the amount of fines they contain.

1.7.49 The Bagshot Formation is a sandy aquifer, and may be in continuity with the gravels, whilst the Claygate and London Clay are more clay-rich, and do not support significant amounts of groundwater.

1.7.50 The Langley Silt, alluvium and landfill deposits are all lower permeability due to the higher concentration of clay and other fine particles. Flow rates will therefore be slower where these deposits impede water entry into the aquifer, and flowlines will be deflected around the edges.

Conceptual Site Model

1.7.51 The conceptual site model for infiltration is presented on Sheets 13 and 14 of Figure A8.4.1. The flow pathways for Laleham and Ashford are presented on Sheets 19 and 20 of Figure A8.4.2 respectively.

1.7.52 The Shepperton C, Gravel Pit A and B, and Gravels at Ashford Road abstractions are taking groundwater via the gravel lakes. The surface water mixing within the lakes would mean that any surface contamination has the potential to quickly spread throughout the water body and reach the abstraction.

Conclusions

1.7.53 A summary of the outcomes of the assessment of the Thames Gravel abstractions is presented in Table 8.4.19.

Table 8.4.19: Assessment of Thames Gravel Abstractions

Licence Point	Infiltration Potential	Flow Potential	Risk Rating
Shepperton Lane, Laleham - Borehole B	Very high	High	High
Shepperton Lane, Laleham - Wet Pit C	Very high	Very high	Very high
Well 'A' at Laleham Road, Shepperton	Very high	Low	Low
Littleton Lane, Shepperton - Point A	Very high	Very high	Very high
Point B, Gravel Pit at Littleton Lane, Shepperton, Middlesex	Very high	Very high	Very high
Point A, Gravel Pit at Littleton Lane, Shepperton, Middlesex	Very high	Very high	Very high
Mayfield Farm, Staines Road, Bedfont (Well)	Very high	Low	Low
Gravels at Ashford Road Laleham Staines	Very high	Very high	Very high

Highlands and Delicia (P3100004 and P3100005)

Geographic Location

1.7.54 Two private abstractions were identified by Runnymede Borough Council, Highlands (P3100004) and Delicia (P3100005). The abstractions are located in Chertsey. The Order Limits pass within 200m and 150m of the two abstractions respectively.

1.7.55 These abstractions are shown on sheet 13 of Figure A8.4.1 and sheet 21 of Figure A8.4.2.

Abstraction Characteristics

1.7.56 The borehole construction details are not known. The abstraction rates of the water supplies are not known, although abstractions greater than 20m^3/d require a licence, which provides the upper limit on potential rates. Consultation with the landowner identified Delicia as used for domestic potable supply and with no mains alternative.

Settings

Soils

1.7.57 The abstractions and Order Limits are situated on stoneless mainly calcareous clayey soils affected by groundwater (Cranfield University, 2018).

Superficial Deposits

1.7.58 Superficial deposits close to the abstractions are shown on Sheet 4 of Figure A8.1.2. The site and Order Limits are underlain by alluvium (BGS, 2018a). The alluvium is likely to be underlain by River Terrace Deposits comprising gravels, which are assumed to be the source of the abstracted water.

Bedrock Deposits

1.7.59 Bedrock geology close to the abstractions is shown on Sheet 4 of Figure A8.1.1. The site is recorded to be underlain by bedrock of the Bagshot Formation. The Bagshot Formation is a clayey sand.

Surface Water

1.7.60 The River Thames is located immediately to the north of the abstractions. The gravels are likely to be in hydraulic continuity with the river, as this location is downstream of the Chertsey Weir.

Groundwater Flow Pathway

Groundwater Catchment

1.7.61 The groundwater catchment is not clearly defined, and the surface topography is almost flat. However, it is expected that groundwater generally flows north towards the River Thames in this area.

Water Levels and Flow

1.7.62 No groundwater levels are available for the area, and no groundwater modelling has been undertaken. Based on the BGS (2018b) groundwater flooding susceptibility map, the area has a limited groundwater flooding susceptibility.

1.7.63 However, the nearest publicly available boreholes, 180m east and 250m south, encountered groundwater at 0.8mbgl and 1.4mbgl respectively (BGS, 2018a). This suggests that there are shallow water conditions within the alluvium layers for at least part of the year. Further, this also indicated a slight fall in the hydraulic gradient towards the River Thames in the north.

Aquifer Characteristics

1.7.64 The gravel is a highly permeable aquifer with primarily intergranular flow. The permeability and storativity is strongly influenced by the presence of fines in the deposits, however no local knowledge is available on this supply.

1.7.65 The alluvium itself is also rated as a secondary A aquifer, with very low to high intergranular permeability. This variety is due to the high heterogeneity of the deposits. This may be in continuity with the gravels, or could be isolated, depending on the clay content locally.

1.7.66 The Bagshot Formation, an aquifer with moderate storage and good intergranular permeability, is considered likely to be in continuity with the overlying superficial deposits.

Conceptual Site Model

1.7.67 The conceptual site model for infiltration is presented on Sheet 13 of Figure A8.4.1 and flow pathways are presented on Sheet 21 of Figure A8.4.2.

Conclusions

1.7.68 Both abstractions have been assessed as having a high overall risk, due to a high infiltration potential and a very high flow pathway potential.

References

Affinity Water (2015). Application for the Renewal of the Abstraction Licence at Chertsey Water Treatment Works – Well 4 (28/39/27/33).

Allen, D J, Brewerton, L J, Coleby, L M, Gibbs, B R, Lewis, M A, MacDonald, A M, Wagstaff, S J, and Williams, A T. (1997). The physical properties of major aquifers in England and Wales. British Geological Survey Technical Report WD/97/34. 312pp. Environment Agency R&D Publication 8.

Amec (2013). Test and Itchen Groundwater Model Refinement.

Amec Foster Wheeler (2015). River Mole Groundwater Model, Model Update 2015.

BGS (2018a). GeoIndex Onshore, British Geological Society, available at: http://mapapps2.bgs.ac.uk/geoindex/home.html Accessed October 2018.

BGS (2018b). Susceptibility to Groundwater Flooding. Available from: https://www.bgs.ac.uk/research/groundwater/datainfo/GFSD.html Accessed January 2018.

Cranfield University (2018). *The Soils Guide*. Available: www.landis.org.uk. Cranfield University, UK. Accessed October 2018.

Entec (2007). East Hampshire and Chichester Chalk Numerical Modelling Project, Phase 2A – Model Construction and Refinement.

Environment Agency (2018). Environmental data. Accessed April 2018. http://environment.data.gov.uk.

East Hampshire District Council (2018). List of Private Water Supplies. Provided 1 November 2018.

European Geophysical Services (2018a). Report on the Video Survey and Geophysical Logging of Northbrook Pumping Station Borehole 1. Report prepared for Portsmouth Water.

European Geophysical Services (2018b). Report on the Video Survey and Geophysical Logging of Northbrook Pumping Station Borehole 2. Report prepared for Portsmouth Water.

European Geophysical Services (2018c). Report on the Video Survey and Geophysical Logging of Northbrook Pumping Station Borehole 3. Report prepared for Portsmouth Water.

Farrant, A. and Cooper, A. (2008). Karst geohazards in the UK: the use of digital data for hazard management. Quarterly Journal of Engineering Geology and Hydrogeology, 41 (3). 339-356.

Jones, H. K., Morris, B. L., Cheney, C. S., Brewerton, L. J., Merrin, P. D., Lewis, M. A., MacDonald, A. M., Coleby, L. M., Talbot, J. C., McKenzie, A. A., Bird, M. J., Cunningham, J., and Robinson, V. K. (2000). The physical properties of minor aquifers in England and Wales. British Geological Survey Technical Report WD/00/4. 234pp. Environment Agency R&D Publication 68.

Ordnance Survey (2015). Map of Winchester, New Alresford & East Meon. OL32 - Explorer 1:25 000 scale.

South East Water (2018). Summary of sources. Provided by email November 2018.

Portsmouth Water (2002). Newtown and Lower Upham, Review of Hydrological and Hydrogeological Analysis.

Three Valleys Water (2007). Chertsey Well No. 4 Drilling, Construction and Testing of Water Supply Boreholes.

Winchester District Council (2018). List of Private Water Supplies. Provided 2 October 2018.

Figures

Highly soluble rock along the edge of the outcrop, with shallow unconfined groundwater.

Stream sinks provide rapid pathway for recharge, with implications for water quality.

Lower Upham

Northbrook

River Hamble recorded as ephemeral in the vicinity of the abstraction. Many springs are located downgradient of the source.

London Clay Formation confines the Chalk.

BISHOP'S WALTHAM

Section A

Gravels are permeable and do not restrict the infiltration rate into the underlying Wittering Formation.

Unconfined Wittering Formation has a comparatively thick unsaturated zone impeding the infiltration rate.

PW000035 PW000034 PW000036 PW000037

River Terrace Deposits with a relatively high water table.

PW000033

London Clay Formation outcrop with no superficial cover is considered unproductive, with no groundwater present.

BOORLEY GREEN

Alluvial deposits found in the base of the river valleys.

HEDGE END

BOTLEY

Contains OS data © Crown copyright and database right (2019) Derived from BGS Digital Data under Licence from Groundsure Ltd, under Licence 2018/044 and under Licence 2017/142. British Geological Survey. ©NERC. ©UKRI

0 0.25 0.5 1 Kilometres

Legend

- Order Limits
- Order Limits 1km buffer

Infiltration Potential within Order Limits

- Very high
- High
- Moderate
- Low
- Licenced public water supply groundwater abstraction
- Unlicenced private water supply groundwater abstraction

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

Superficial Geology

- Alluvium - Clay, Silt, Sand and Gravel
- Alluvium - Silt
- Head - Clay, Silt, Sand and Gravel
- Head - Gravel
- River Terrace Deposits (undifferentiated) - Gravel, Sand and Silt
- River Terrace Deposits (undifferentiated) - Sand and Gravel
- River Terrace Deposits, 2 - Sand and Gravel
- River Terrace Deposits, 3 - Gravel, Sand and Silt
- River Terrace Deposits, 3 - Sand and Gravel
- River Terrace Deposits, 5 - Gravel, Sand and Silt
- River Terrace Deposits, 5 - Sand and Gravel

Sheet displays part of Section A

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
0	14/03/2019	For Issue	LM	NS	JW	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

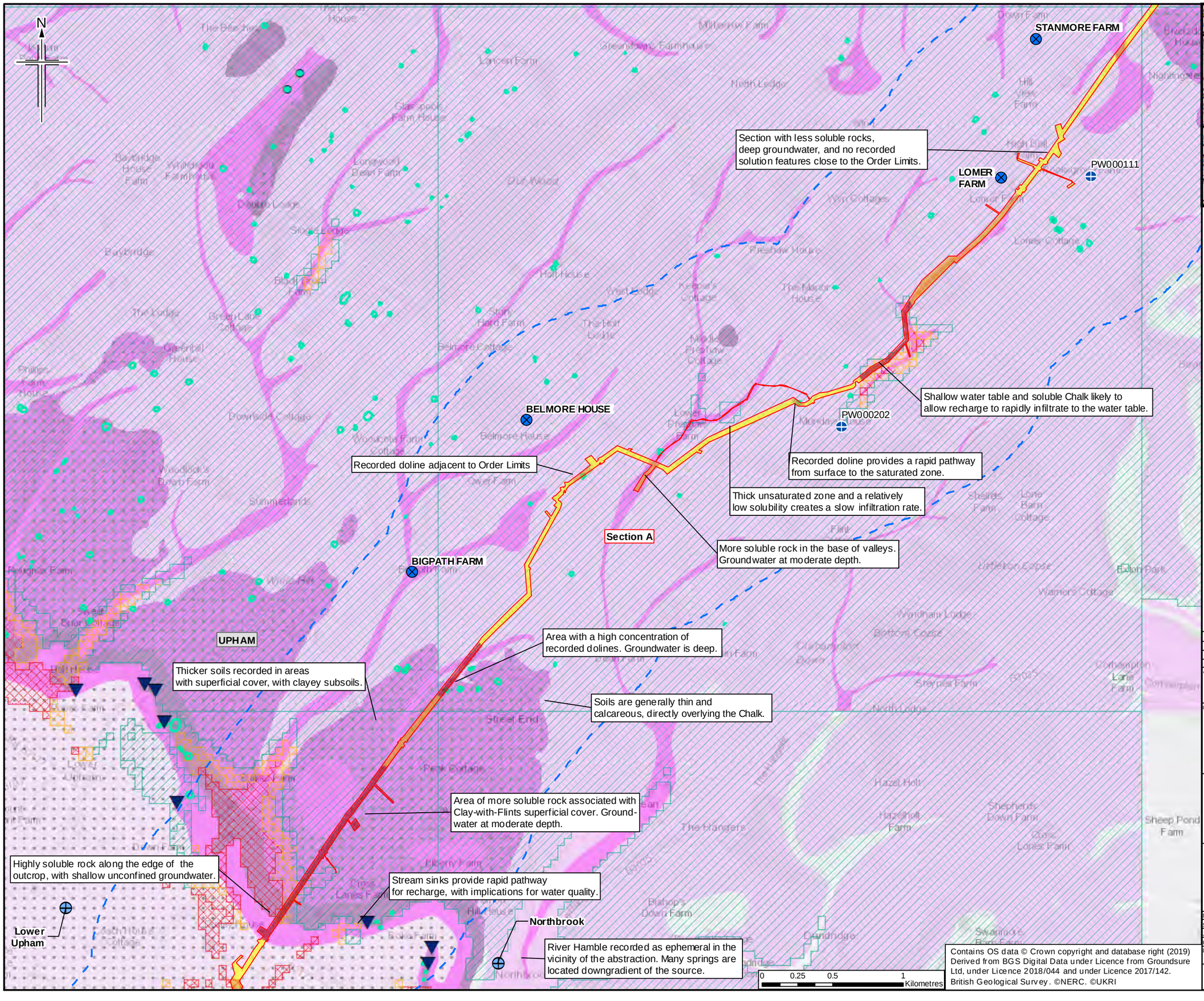
Project

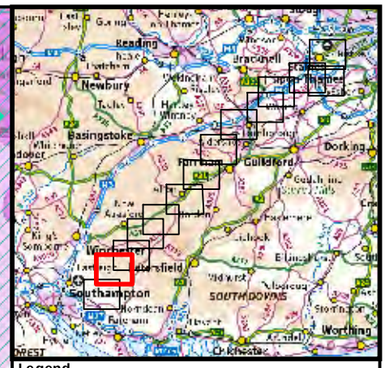
Esso | Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL INFILTRATION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:25,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001120	
Drawing number	Figure A8.4.1 Sheet 1 of 14	Rev 0





Legend

- Order Limits
- Order Limits 1km buffer

Infiltration Potential within Order Limits

- Very high
- High
- Moderate
- Licenced public water supply groundwater abstraction
- Other licenced groundwater abstraction
- Unlicenced private water supply groundwater abstraction
- BGS Karst - stream sinks
- BGS Karst - Dolines (point)
- BGS Karst - Dolines (area)

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

Soluble Rocks Class

- A
- B
- C
- D
- E

Sheet displays part of Section A

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Check'd	Rev'd	Apprv'd
0	14/03/2019	For Issue	LM	NS	JW	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

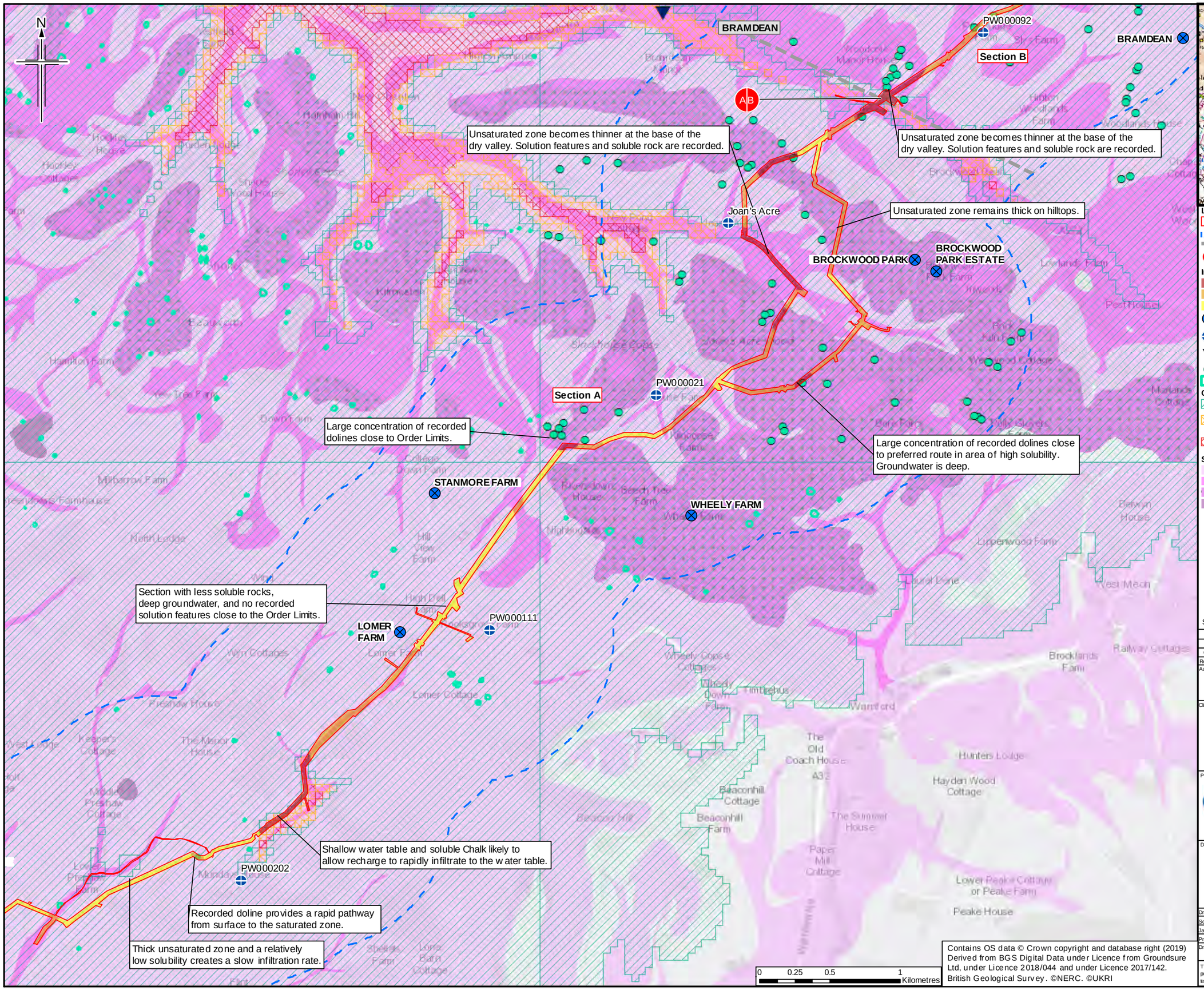
Project

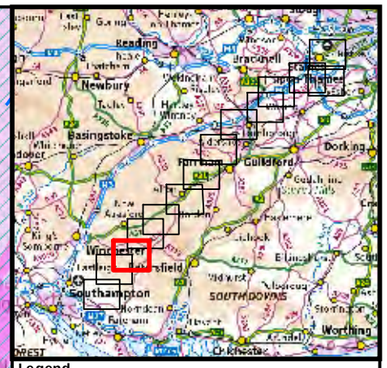
Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL INFILTRATION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:25,000 @ A3	DO NOT SCALE
Jacobs No.	B232300	
ProjectWise No.	B232300-JAC-000-ENV-DRG-001120	
Drawing number	Figure A8.4.1 Sheet 2 of 14	Rev 0





Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Infiltration Potential within Order Limits

- Very high
- High
- Moderate
- Other licenced groundwater abstraction
- Unlicenced private water supply groundwater abstraction
- BGS Karst - stream sinks
- BGS Karst - Dolines (point)
- BGS Karst - Dolines (area)

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

Soluble Rocks Class

- B
- C
- D
- E

Sheet displays parts of Section A and Section B

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
0	14/03/2019	For Issue	LM	NS	JW	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

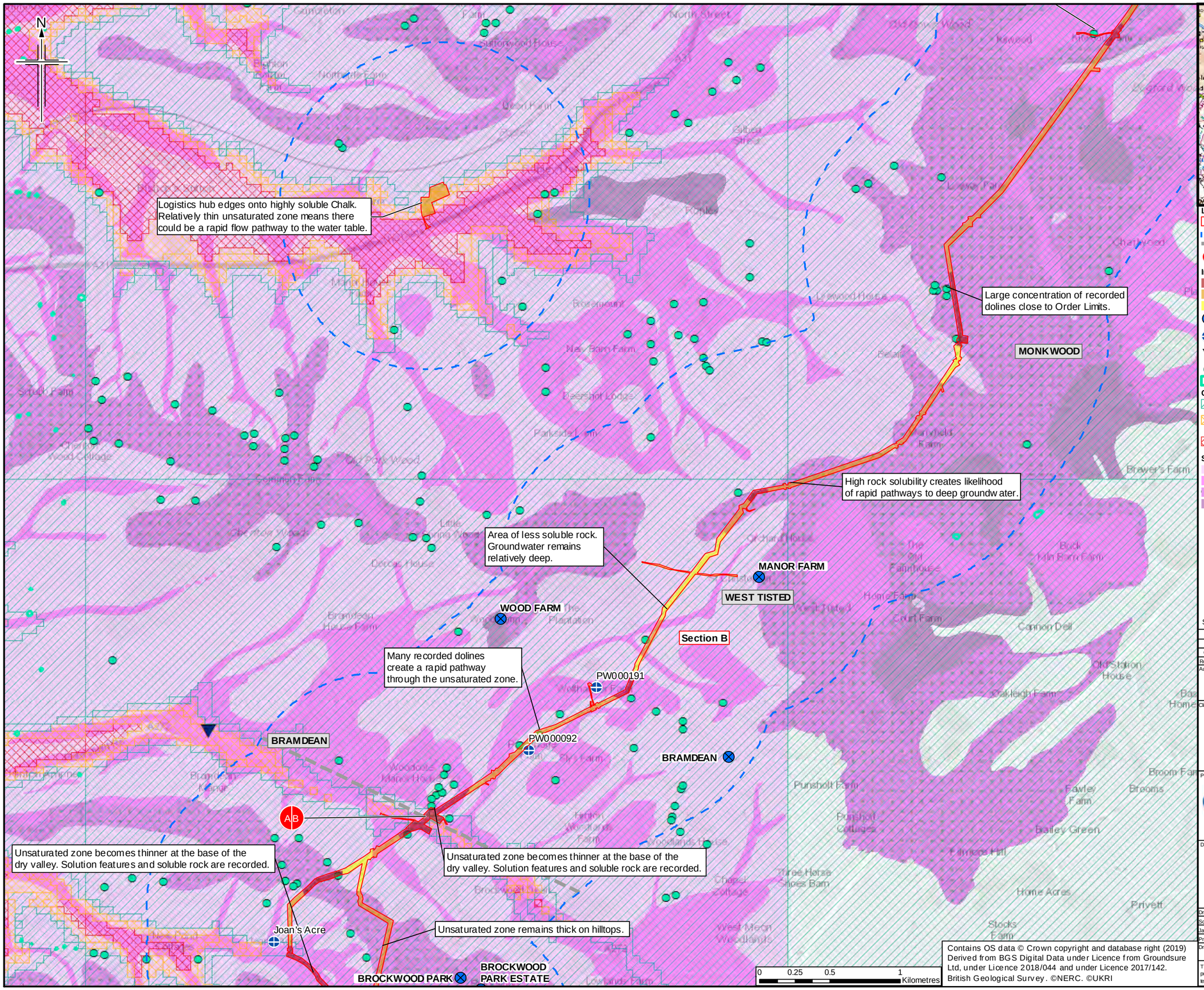
Project

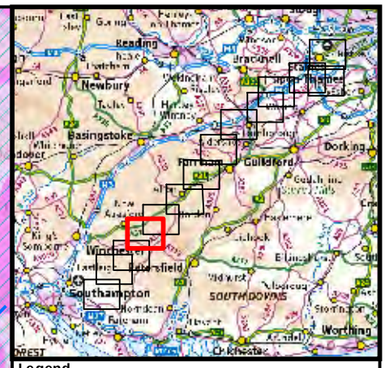
Esso | Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL INFILTRATION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue		
Scale	1:25,000 @ A3		DO NOT SCALE
Jacobs No.	B2325300		
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001120		
Drawing number	Figure A8.4.1 Sheet 3 of 14	Rev	0





Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Infiltration Potential within Order Limits

- Very high
- High
- Moderate
- Other licenced groundwater abstraction
- Unlicenced private water supply groundwater abstraction
- BGS Karst - stream sinks
- BGS Karst - Dolines (point)
- BGS Karst - Dolines (area)

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

Soluble Rocks Class

- B
- C
- D
- E

Sheet displays parts of Section A and Section B

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
0	14/03/2019	For Issue	LM	NS	JW	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

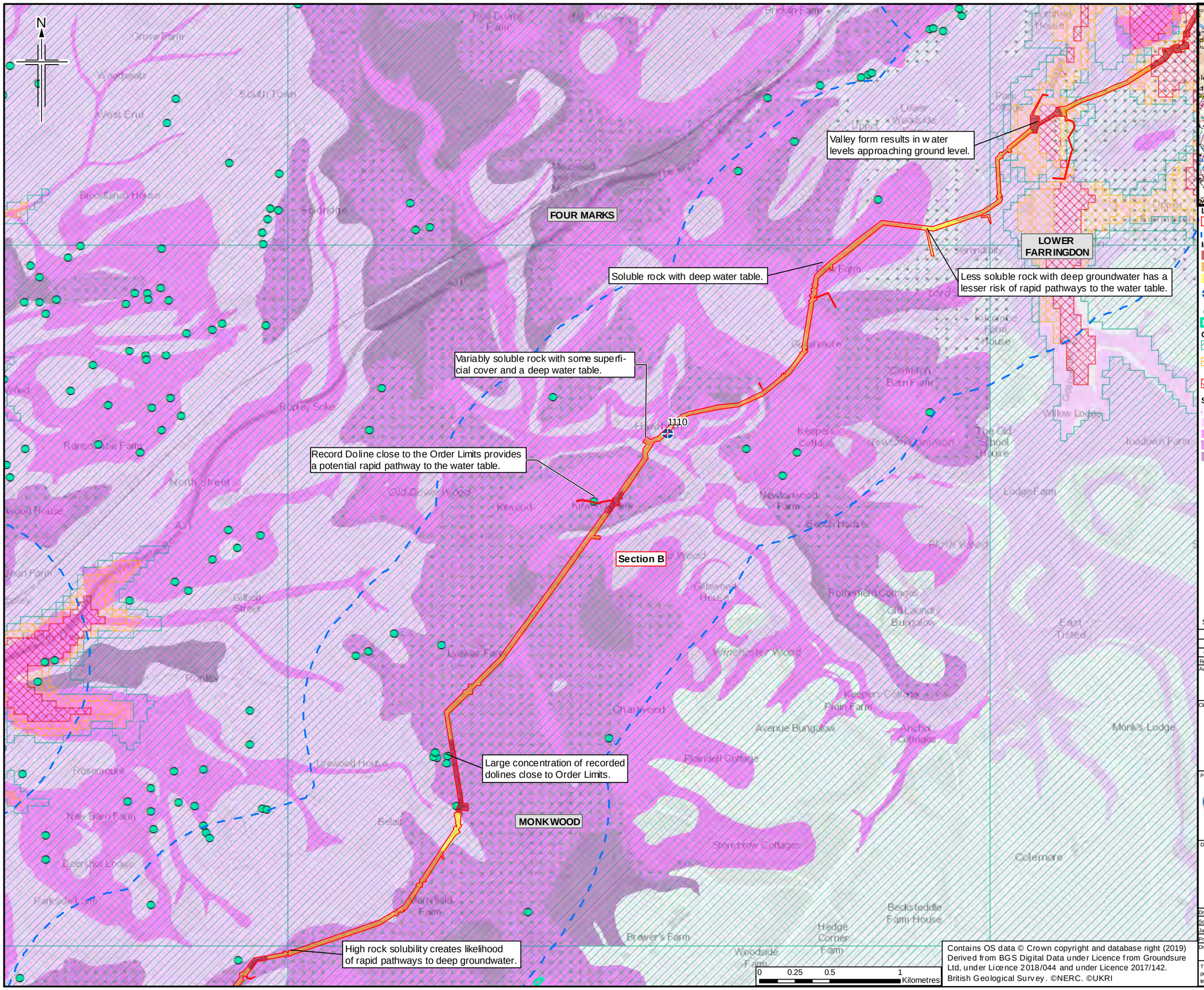
Project

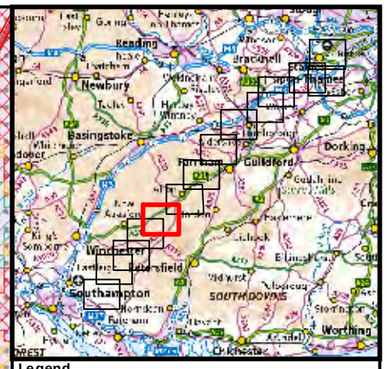
Esso | Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL INFILTRATION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:25,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001120	
Drawing number	Figure A8.4.1 Sheet 4 of 14	Rev 0





Legend

- Order Limits
- Order Limits 1km buffer

Infiltration Potential within Order Limits

- Very high
- High
- Moderate
- Unlicenced private water supply groundwater abstraction
- BGS Karst - Dolines (point)
- BGS Karst - Dolines (area)

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

Soluble Rocks Class

- A
- B
- C
- D
- E

Sheet displays part of Section B

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprvd
0	14/03/2019	For Issue	LM	NS	JW	SH

Author

JACOBS
110 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

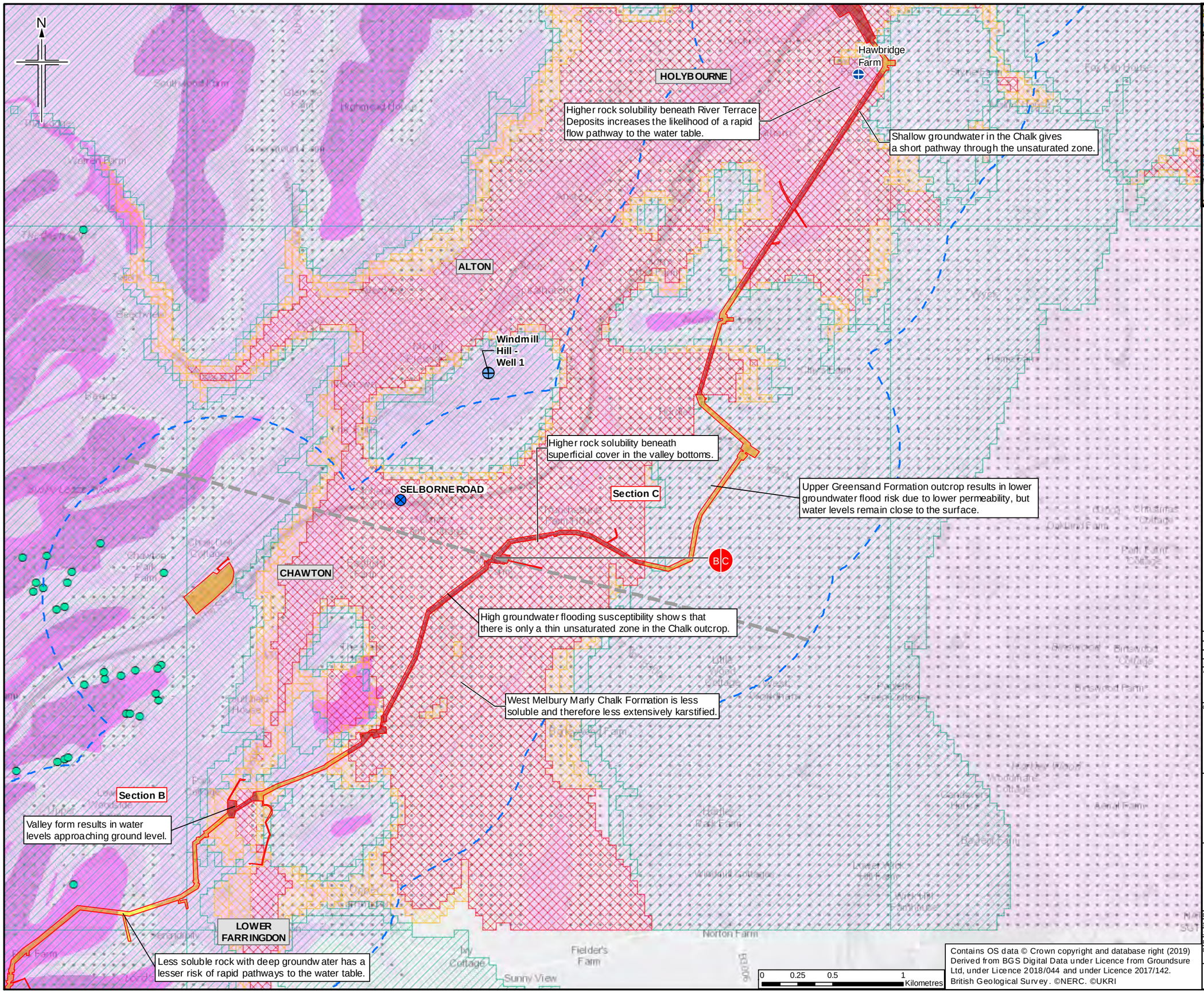
Esso | Southampton to London Pipeline Project

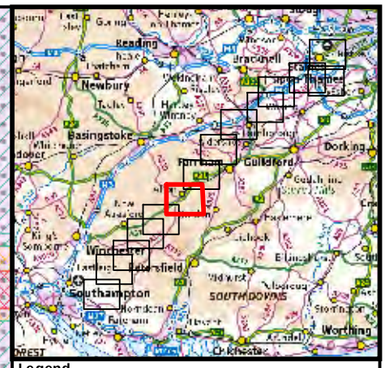
Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL INFILTRATION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:25,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001120	

Drawing number: Figure A8.4.1 Sheet 5 of 14 — Rev 0





Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Infiltration Potential within Order Limits

- Very high
- High
- Moderate
- Licenced public water supply groundwater abstraction
- Other licenced groundwater abstraction
- Unlicenced private water supply groundwater abstraction
- BGS Karst - Dolines (point)

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

Soluble Rocks Class

- A
- B
- C
- D
- E

Sheet displays parts of Section B and Section C

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
0	14/03/2019	For Issue	LM	NS	JW	SH

Author

JACOBS
118 0 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44 (0)1 18 9 46 7000 Fax:+44(0)118 946 7001
www.jacobs.com

Client

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

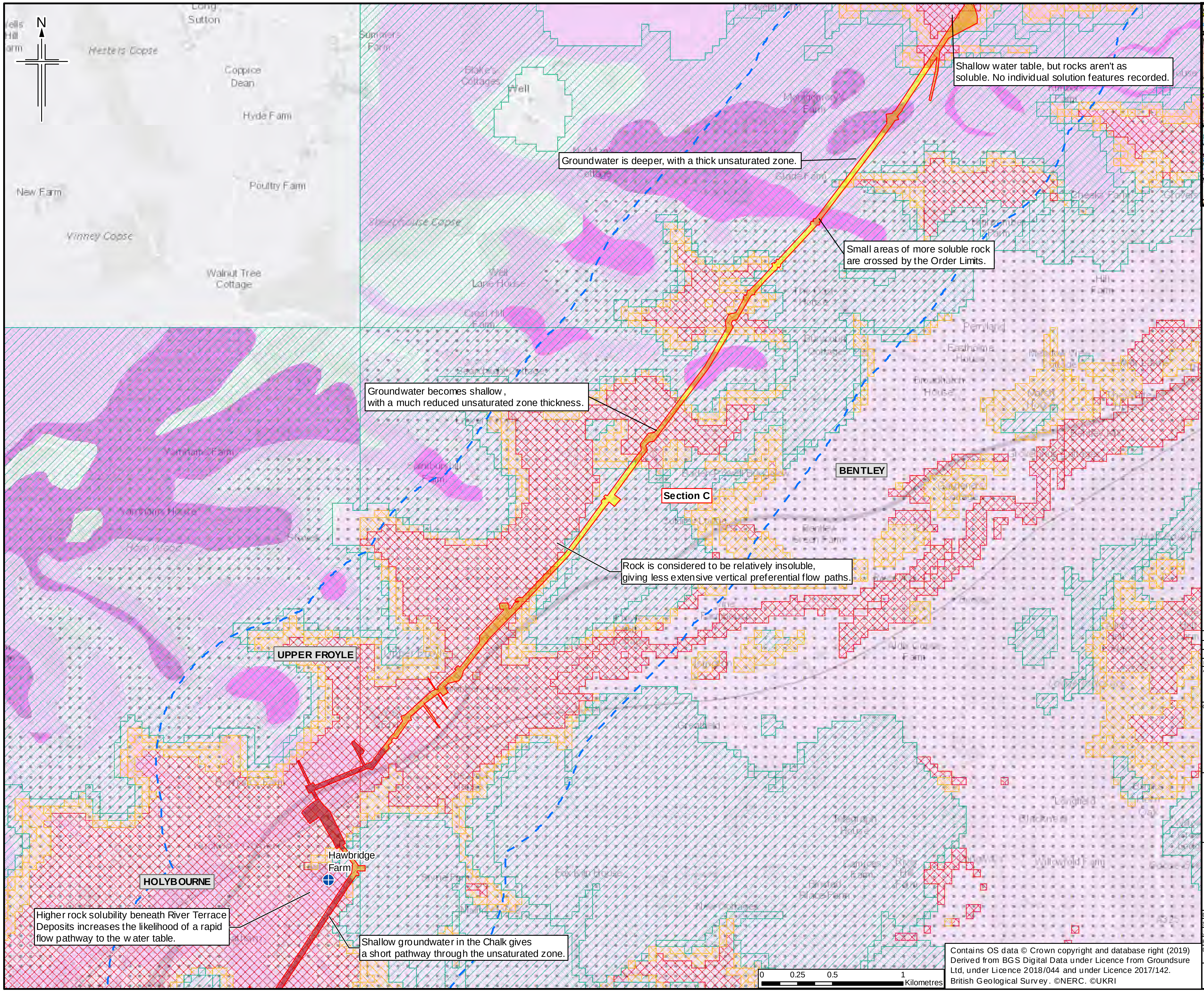
Project

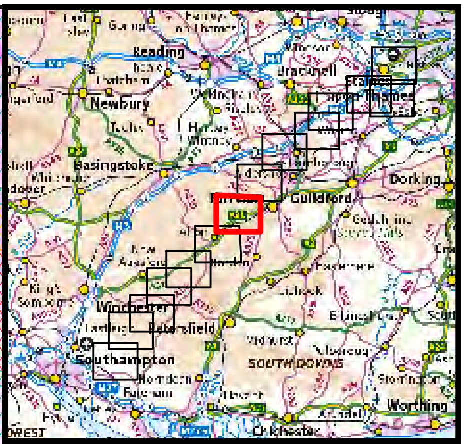
Esso Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL INFILTRATION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:25,000 @ A3	DO NOT SCALE
Jacobs No.	B232300	
ProjectWise No.	B232300-JAC-000-ENV-DRG-001120	
Drawing number	Figure A8.4.1 Sheet 6 of 14	Rev 0





Legend

- Order Limits
- Order Limits 1km buffer

Infiltration Potential within Order Limits

- Very high
- High
- Moderate
- Unlicenced private water supply groundwater abstraction

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

Soluble Rocks Class

- A
- B
- C
- D

Sheet displays part of Section C

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
0	14/03/2019	For Issue	LM	NS	JW	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

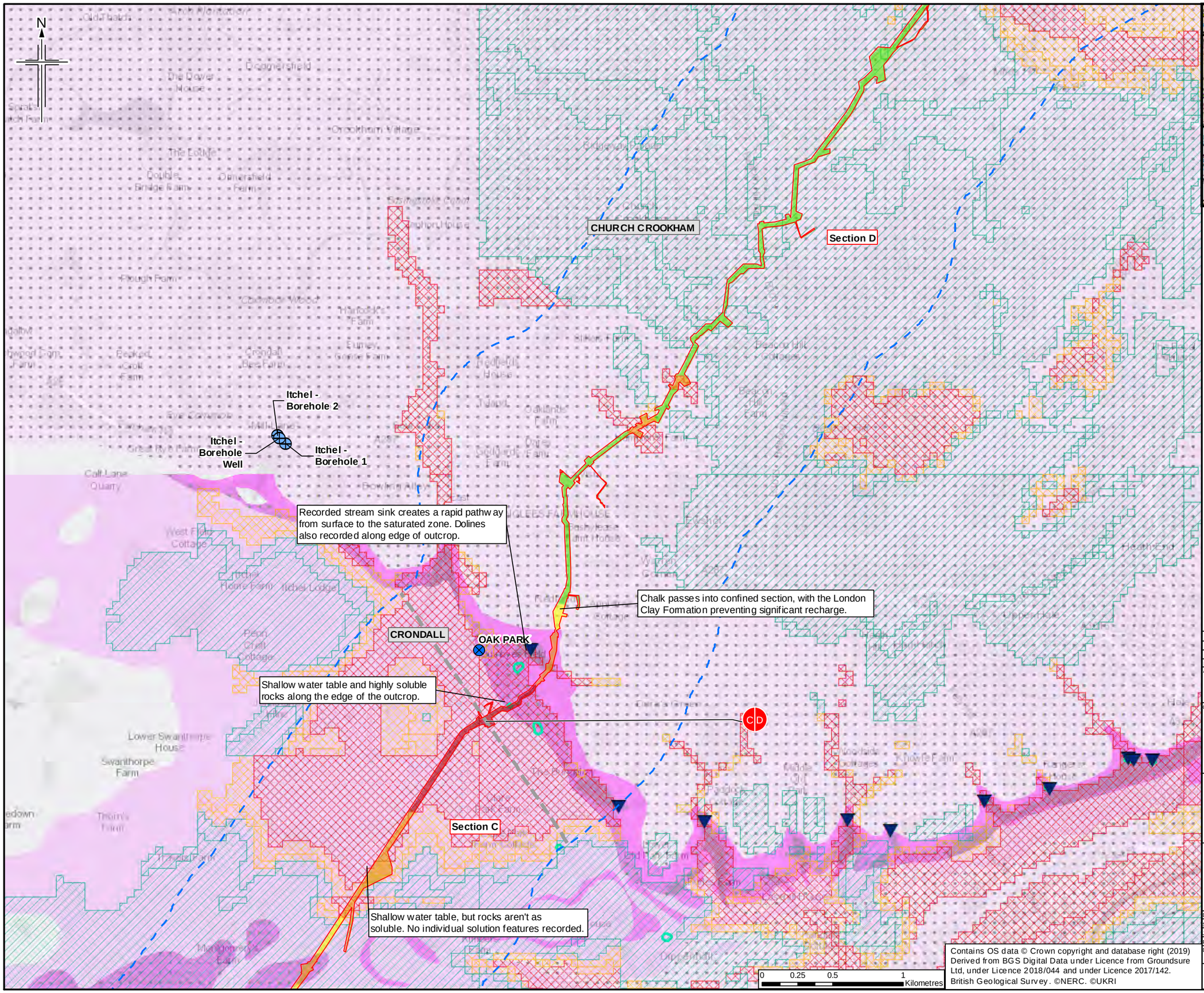
Project

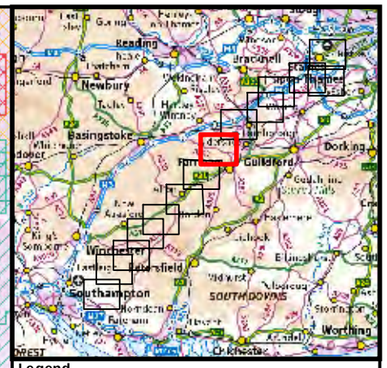
Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL INFILTRATION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:25,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001120	
Drawing number	Figure A8.4.1 Sheet 7 of 14	Rev 0





Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Infiltration Potential within Order Limits

- Very high
- High
- Moderate
- Low
- Licenced public water supply groundwater abstraction
- Other licenced groundwater abstraction
- BGS Karst - stream sinks
- BGS Karst - Dolines (area)

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

Soluble Rocks Class

- A
- B
- C
- D
- E

Sheet displays parts of Section C and Section D

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
0	14/03/2019	For Issue	LM	NS	JW	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

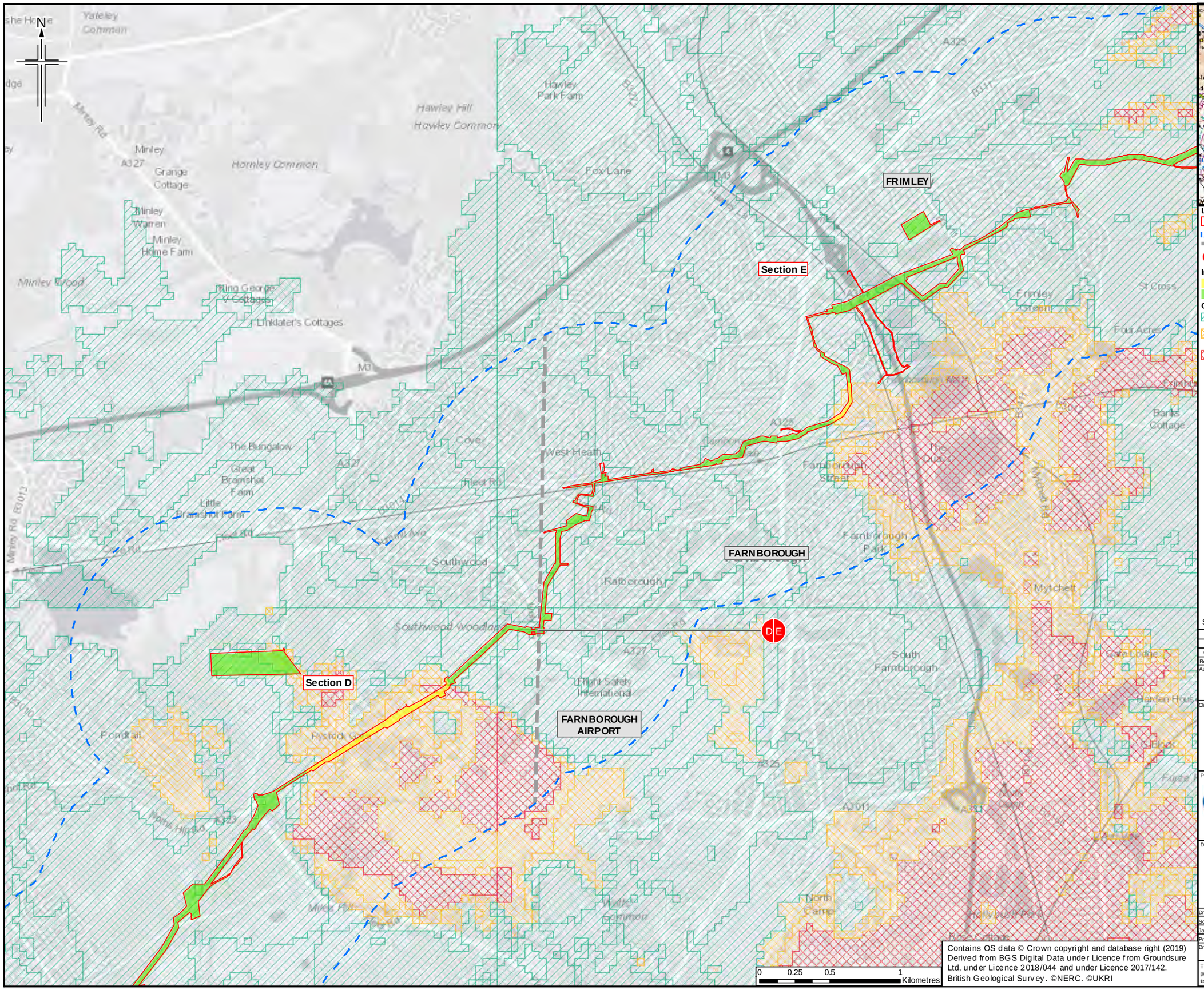
Esso Southampton to London Pipeline Project

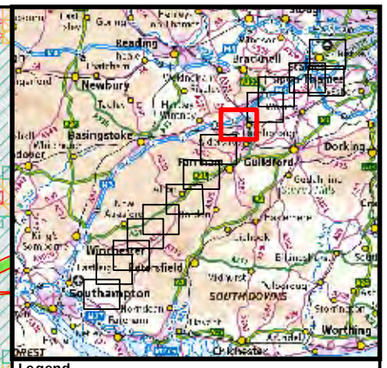
Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL INFILTRATION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:25,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001120	

Drawing number: Figure A8.4.1 Sheet 8 of 14 — Rev 0





Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Infiltration Potential within Order Limits

- Moderate
- Low

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 parts of Section D and Section E

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Check'd	Rev'd	Apprv'd
0	14/03/2019	For Issue	LM	NS	JW	SH

Author

JACOBS
118 0 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

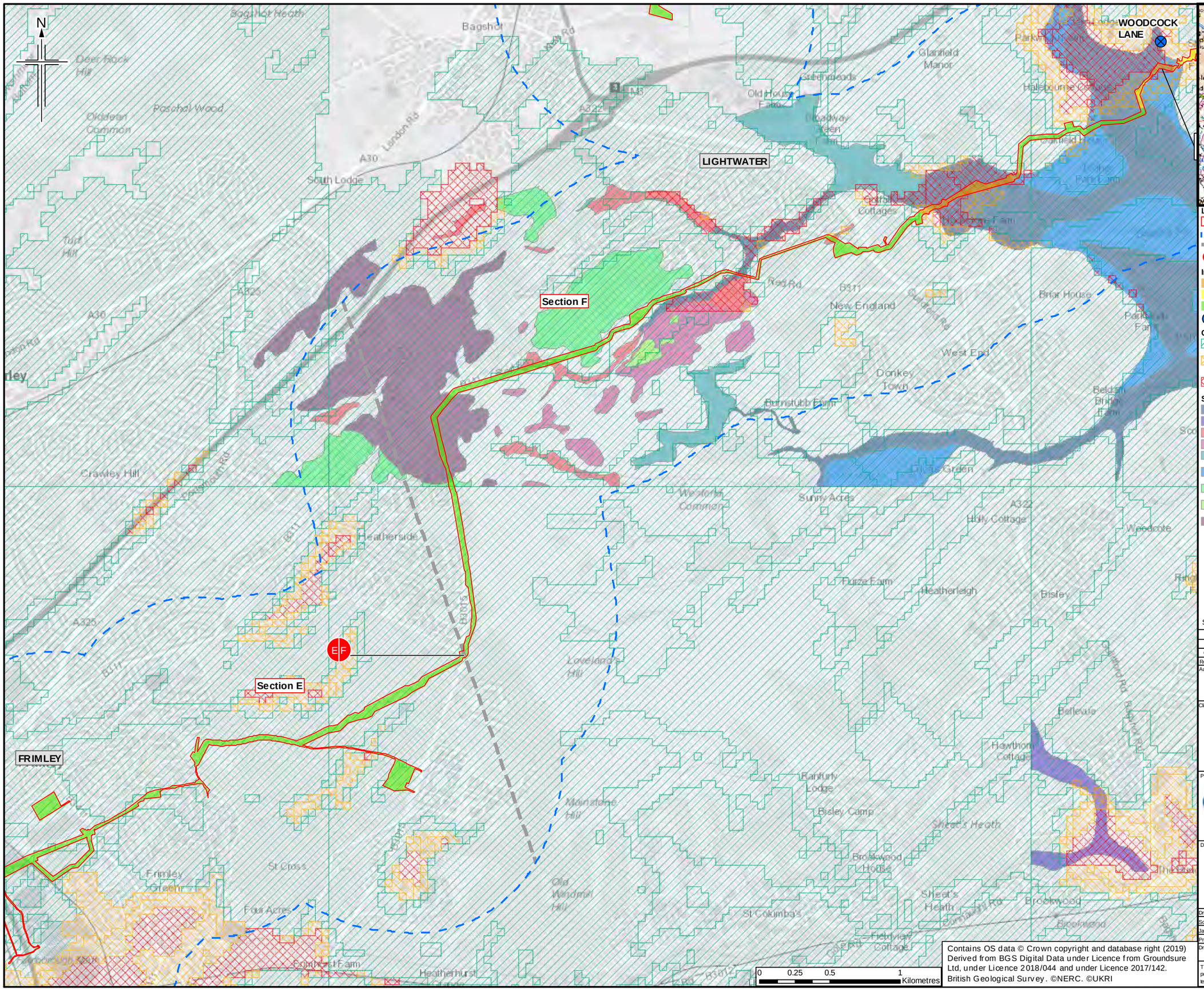
Project

Esso | Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL INFILTRATION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:25,000 @ A3	DO NOT SCALE
Jacobs No.	B232300	
ProjectWise No.	B232300-JAC-000-ENV-DRG-001120	
Drawing number	Figure A8.4.1 Sheet 9 of 14	Rev 0



Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Infiltration Potential within Order Limits

- High
- Moderate
- Low
- Other licenced groundwater abstraction

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

Superficial Geology

- Alluvium - Sand, Silt and Clay
- Head - Clay, Silt, Sand and Gravel
- Head - Diamicton
- Head - Sand and Gravel
- Peat - Peat
- River Terrace Deposits (undifferentiated) - Sand and Gravel
- River Terrace Deposits, 8 - Sand and Gravel
- Sand and Gravel Of Uncertain Age and Origin - Sand and Gravel
- Surrey Hill Gravel Member - Sand and Gravel

Sheet displays parts of Section E and Section F

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
0	14/03/2019	For Issue	LM	NS	JW	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

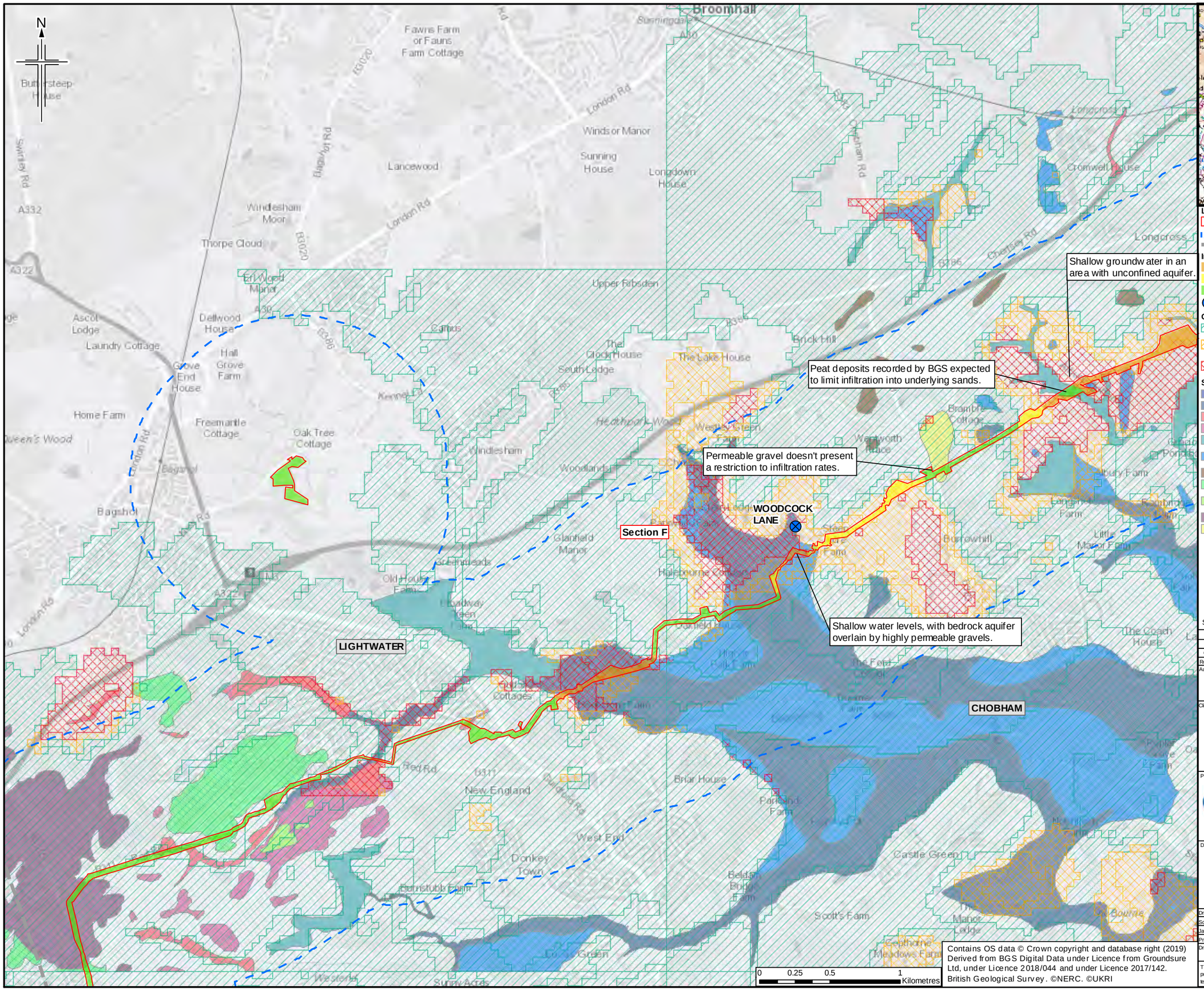
Esso
Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL INFILTRATION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue		
Scale	1:25,000	@ A3	DO NOT SCALE
Jacobs No.	B2325300		
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001120		

Drawing number: Figure A8.4.1 Sheet 10 of 14 — Rev 0



Legend

- Order Limits
- Order Limits 1km buffer
- Section break

Infiltration Potential within Order Limits

- High
- Moderate
- Low
- Other licenced groundwater abstraction

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

Superficial Geology

- Alluvium - Sand and Gravel
- Alluvium - Sand, Silt and Clay
- Head - Diamicton
- Head - Sand and Gravel
- Peat - Peat
- River Terrace Deposits (undifferentiated) - Sand and Gravel
- River Terrace Deposits, 6 - Sand and Gravel
- River Terrace Deposits, 8 - Sand and Gravel
- Sand and Gravel Of Uncertain Age and Origin - Sand and Gravel
- Surrey Hill Gravel Member - Sand and Gravel
- Taplow Gravel Formation - Sand and Gravel

Sheet displays part of Section F

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Check'd	Rev'd	Apprv'd
0	14/03/2019	For Issue	LM	NS	JW	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
POTENTIAL INFILTRATION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue
Scale	1:25,000 @ A3 — DO NOT SCALE
Jacobs No.	B232300
ProjectWise No.	B232300-JAC-000-ENV-DRG-001120
Drawing number	Figure A8.4.1 Sheet 11 of 14 — Rev 0

N

Langley Silt Member outcrops overlying the gravel deposits and semi-confines restricting infiltration, acting as an aquitard and reducing infiltration rates over some parts of the catchment.

PENTON HOOK

Section H

SHEPPERTON LANE - BOREHOLE B

Chertsey BH C

Chertsey BH E

SHEPPERTON LANE - WET PIT C

Chertsey BH B

POINT B, GRAVEL PIT AT LITTLETON LANE

Chertsey BH A

Chertsey BH D

Chertsey BH F

Chertsey BH H

Chertsey BH G

POINT A, GRAVEL PIT AT LITTLETON LANE

Chertsey BH I

Chertsey BH J

FG

Area with no superficial deposits recorded meaning no superficial aquifer is present to receive infiltration.

Section G

P3100005

P3100004

CHERTSEY

Water table expected to be deep and this creates a longer pathway for infiltration.

Section F

CHERTSEY SOUTH

Clay and silt-rich alluvium deposits overly the gravel, restricting potential infiltration rates. Thicker unsaturated zone.

Shallow groundwater in an area with unconfined aquifer.

FOXHILLS GOLF COURSE

ADDLESTONE

OTTERSHAW

0 0.25 0.5 1 Kilometres

Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Infiltration Potential within Order Limits

- Very high
- High
- Moderate
- Low
- Licenced public water supply groundwater abstraction
- Other licenced groundwater abstraction
- Unlicenced private water supply groundwater abstraction

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

Superficial Geology

- Alluvium - Sand, Silt and
- Alluvium - Silt
- Head - Diamicton
- Kempton Park Gravel Formation - Sand and Gravel
- Langley Silt Member - Silt
- Lynch Hill Gravel Member - Sand and Gravel
- Peat - Peat
- River Terrace Deposits (undifferentiated) - Sand and Gravel
- River Terrace Deposits, 6 - Sand and Gravel
- Shepperton Gravel Member - Sand and Gravel

Sheet displays parts of Section F, Section G and Section H

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
0	14/03/2019	For Issue	LM	NS	JW	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
POTENTIAL INFILTRATION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue		
Scale	1:25,000 @ A3	DO NOT SCALE	
Jacobs No.	B232300		
ProjectWise No.	B232300-JAC-000-ENV-DRG-001120		
Drawing number	Figure A8.4.1 Sheet 12 of 14	Rev	0

N

Langley Silt Member outcrops overlying the gravel deposits and semi-confines restricting infiltration, acting as an aquitard and reducing infiltration rates over some parts of the catchment.

PENTON HOOK

WELL 'A' AT LALEHAM ROAD

LITTLETON

SHEPPERTON LANE - BOREHOLE B

Section H

LITTLETON NURSERIES - BOREHOLE 'A'

Chertsey BH E

Chertsey BH C

Area with lower groundwater flooding risk shows that water levels are deeper with a thicker unsaturated zone.

SHEPPERTON LANE - WET PIT C

Chertsey BH B

POINT B, GRAVEL PIT AT LITTLETON LANE

Soils generally very permeable and don't prevent infiltration.

Chertsey BH A

Chertsey BH D

Chertsey BH F

Chertsey BH H

Chertsey BH G

POINT A, GRAVEL PIT AT LITTLETON LANE

High groundwater levels and highly permeable gravel aquifer allows very easy infiltration into the groundwater.

Chertsey BH I

F G

G H

Chertsey BH J

Area with no superficial deposits recorded meaning no superficial aquifer is present to receive infiltration.

Shepperton Gravel Member at surface allowing substances to very rapidly reach the shallow water table.

P3100005

P3100004

Deeper water table and thicker unsaturated zone reduces infiltration rates.

Section F

CHERTSEY

Section G

CHERTSEY SOUTH

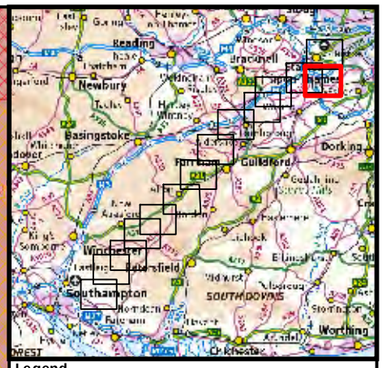
Clay and silt-rich alluvium deposits overly the gravel, restricting potential infiltration rates. Thicker unsaturated zone.

ADDLESTONE

OTTERSHAW

St George's

0 0.25 0.5 1 Kilometres



Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Infiltration Potential within Order Limits

- Very high
- High
- Moderate
- Low
- Licenced public water supply groundwater abstraction
- Other licenced groundwater abstraction
- Unlicenced private water supply groundwater abstraction

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

Superficial Geology

- Alluvium - Silt
- Boyn Hill Gravel Member - Sand and Gravel
- Head - Diamicton
- Kempton Park Gravel Formation - Sand and Gravel
- Langley Silt Member - Silt
- Lynch Hill Gravel Member - Sand and Gravel
- River Terrace Deposits (undifferentiated) - Sand and Gravel
- Sand and Gravel Of Unknown Age - Sand and Gravel
- Shepperton Gravel Member - Sand and Gravel
- Taplow Gravel Formation - Sand and Gravel

Sheet displays parts of Section F, Section G and Section H

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
0	14/03/2019	For Issue	LM	NS	JW	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
POTENTIAL INFILTRATION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:25,000 @ A3	DO NOT SCALE
Jacobs No.	B232300	
ProjectWise No.	B232300-JAC-000-ENV-DRG-001120	
Drawing number	Figure A8.4.1 Sheet 13 of 14	Rev 0

N

WEST BEDFONT

MAYFIELD FARM

Gravel aquifer at surface with permeable soils overlying. Very thin unsaturated zone allows rapid infiltration to occur.

Section H

ASHFORD

Alluvium overlies the gravel aquifer reducing infiltration rates.

GRAVELS AT ASHFORD ROAD

Gravel aquifer at surface with only permeable soils overlying. Very thin unsaturated zone allows rapid infiltration to occur.

Langley Silt Member outcrops overlying the gravel deposits and semi-confines restricting infiltration, acting as an aquitard and reducing infiltration rates over some parts of the catchment.

PENTON HOOK

0 0.25 0.5 1 Kilometres

Legend

- Order Limits
- Order Limits 1km buffer

Infiltration Potential within Order Limits

- Very high
- High
- Moderate
- Other licenced groundwater abstraction

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

Superficial Geology

- Alluvium - Silt
- Head - Sand and Clay
- Kempton Park Gravel Formation - Sand and Gravel
- Langley Silt Member - Silt
- Shepperton Gravel Member - Sand and Gravel
- Taplow Gravel Formation - Sand and Gravel

Sheet displays part of Section H

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
0	14/03/2019	For Issue	LM	NS	JW	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
POTENTIAL INFILTRATION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue
Scale	1:25,000 @ A3 — DO NOT SCALE
Jacobs No.	B2325300
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001120
Drawing number	Figure A8.4.1 Sheet 14 of 14
Rev	0

N

Regional groundwater flow direction unclear. Combined abstraction drawdown may place the Order Limits within the Netherhills capture zone.

Groundwater restricted to the superficial gravel deposits. Underlying London Clay Formation is an unproductive strata.

Groundwater may flow towards the larger surface water feature of the River Hamble, placing the Order Limits within the Greywood capture zone.

Groundwater restricted to the superficial gravel deposits. Underlying London Clay Formation is an unproductive strata.

PW000033
PW000034
PW000035
PW000036
PW000037

0 0.15 0.3 0.6 Kilometres

Legend

- Order Limits
- Order Limits 1km buffer

Flow pathway potential within Order Limits

- Moderate
- Low
- Unlicenced private water supply groundwater abstraction
- 5m elevation contours
- Surface water line
- Surface water area

Superficial Geology

- Alluvium - Clay, Silt, Sand And Gravel
- Alluvium - Silt
- Head - Clay, Silt, Sand And Gravel
- River Terrace Deposits (undifferentiated) - Gravel, Sand And Silt
- River Terrace Deposits (undifferentiated) - Sand And Gravel
- River Terrace Deposits, 2 - Sand And Gravel
- River Terrace Deposits, 3 - Gravel, Sand And Silt
- River Terrace Deposits, 3 - Sand And Gravel
- River Terrace Deposits, 5 - Gravel, Sand And Silt
- River Terrace Deposits, 5 - Sand And Gravel

Sheet displays part of Section A

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Check	Rev'd	Apprv'd
0	25/03/2019	For Issue	LM	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
POTENTIAL FLOW PATHWAY
NETHERHILL AND GREYWOOD
ABSTRACTIONS
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:15,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 1 of 21	Rev 0

N

Outside the FlowSource Total Catchment, but within SPZ3. Potentially part of overall Northbrook capture zone, although modelled contours indicate flow to the north.

Outside SPZ, and the FlowSource Total Catchment. Regional groundwater flow is away from the Northbrook abstraction.

Outside SPZ, but within the Flow Source Total Catchment. Close to the modelled groundwater divide.

Outside SPZ, but within the FlowSource 70% Catchment. Groundwater flow towards the abstraction.

Potential for a rapid flow path along the heavily karstified Hamble dry valley.

SPZ2 but more limited karstification gives potential for some rapid flow.

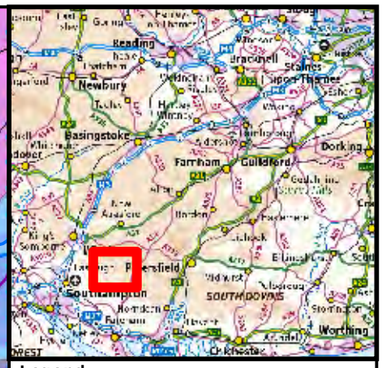
SPZ2, FlowSource 70% Catchment and heavy karstification gives potential for very rapid flow.

High karstification gives a rapid flow path, but outside defined SPZ.

Confined Chalk restricts the flow path, but still falls within the FlowSource Total Catchment.

Lower Upham

Northbrook



Legend

- Order Limits
- Order Limits 1km buffer

Potential flow pathway direction

- Very high
- High
- Moderate

Flow pathway potential within Order Limits

- Very high
- High
- Moderate
- Low
- Licenced public water supply groundwater abstraction
- EHCC Chalk and UGS maximum contours (February 2001)
- Test and Itchen chalk maximum contours (April 2001)

Flow source catchment

- Northbrook 50 day
- Northbrook 70% Catchment
- Northbrook Total Catchment Zone

Source Protection Zone

- 1
- 2
- 3

Soluble Rocks Class

- A
- B
- C
- D
- E

Sheet displays part of Section A

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Check'd	Rev'd	Appr'd
0	20/03/2019	For Issue	LM	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
POTENTIAL FLOW PATHWAY
NORTHBROOK
ABSTRACTION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:30,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 2 of 21	Rev 0

0 0.3 0.6 1.2 Kilometres

N

Soluble rocks providing a preferential flow path towards the north and away from the abstraction.

SPZ indicates that the abstraction may be drawing across from this area. This requires cross cutting the modelled groundwater contours.

Groundwater contours suggest the flow is towards the north.

Potential preferential flow path through the more soluble rocks found in the base of the dry valleys.

Rapid flow pathway in the base of dry valleys directed away from the abstraction.

FlowSource Total Catchment intersects the Order Limits.

Abstraction is located on the semi-confined Chalk, with a lower transmissivity and storage.

Lower Upham

Northbrook

30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135

0 0.35 0.7 1.4 Kilometres

Legend

- Order Limits
- Order Limits 1km buffer

Potential flow pathway direction

- Moderate
- Low

Flow pathway potential within Order Limits

- Moderate
- Low
- Licenced public water supply groundwater abstraction
- EHCC Chalk and UGS maximum contours (February 2001)
- Test and Itchen chalk maximum contours (April 2001)

Flow source catchment

- Lower Upham 50 day
- Lower Upham 70% Catchment
- Lower Upham Total Catchment

Source Protection Zone

- 1
- 2
- 3

Soluble Rocks Class

- A
- B
- C
- D
- E

Sheet displays part of Section A

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
0	20/03/2019	For Issue	LM	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

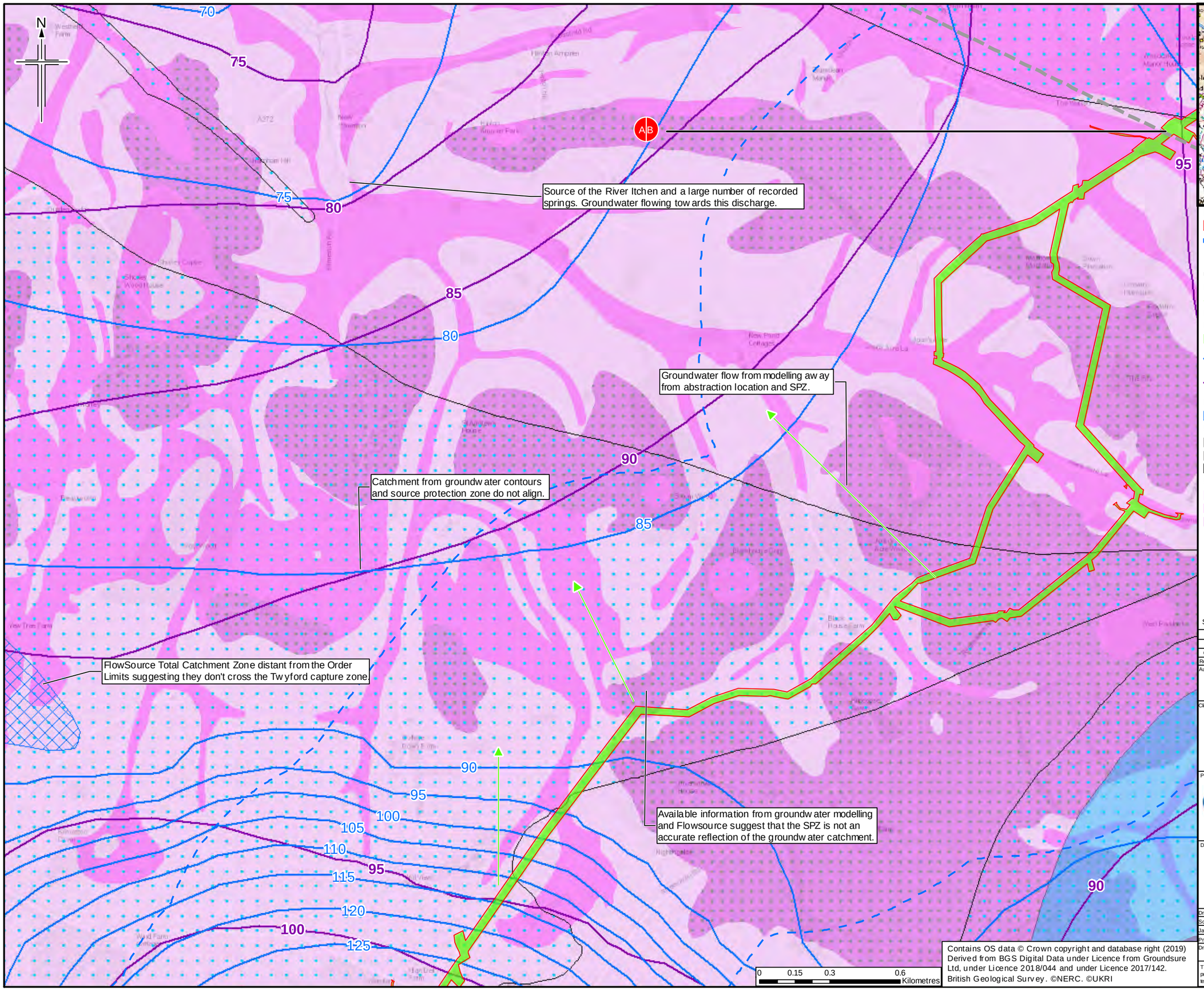
Project

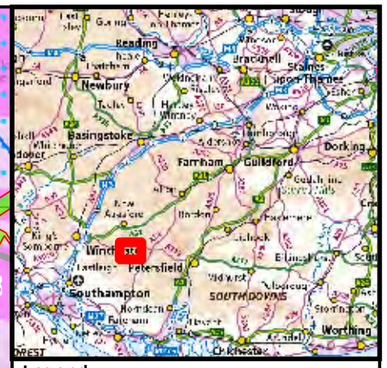
Esso Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL FLOW PATHWAY
LOWER UPHAM
ABSTRACTION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:35,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 3 of 21	Rev 0





Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Potential flow pathway direction

- Low

Flow pathway potential within Order Limits

- Low
- EHCC Chalk and UGS maximum contours (February 2001)
- Test and Itchen chalk maximum contours (April 2001)

Flow source catchment

- Twyford Total Catchment Zone

Source Protection Zone

- 1
- 2
- 3

Soluble Rocks Class

- B
- C
- D

Sheet displays parts of Section A and Section B

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Checkd	Rev'd	Apprv'd
0	1/04/2019	For Issue	LM	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

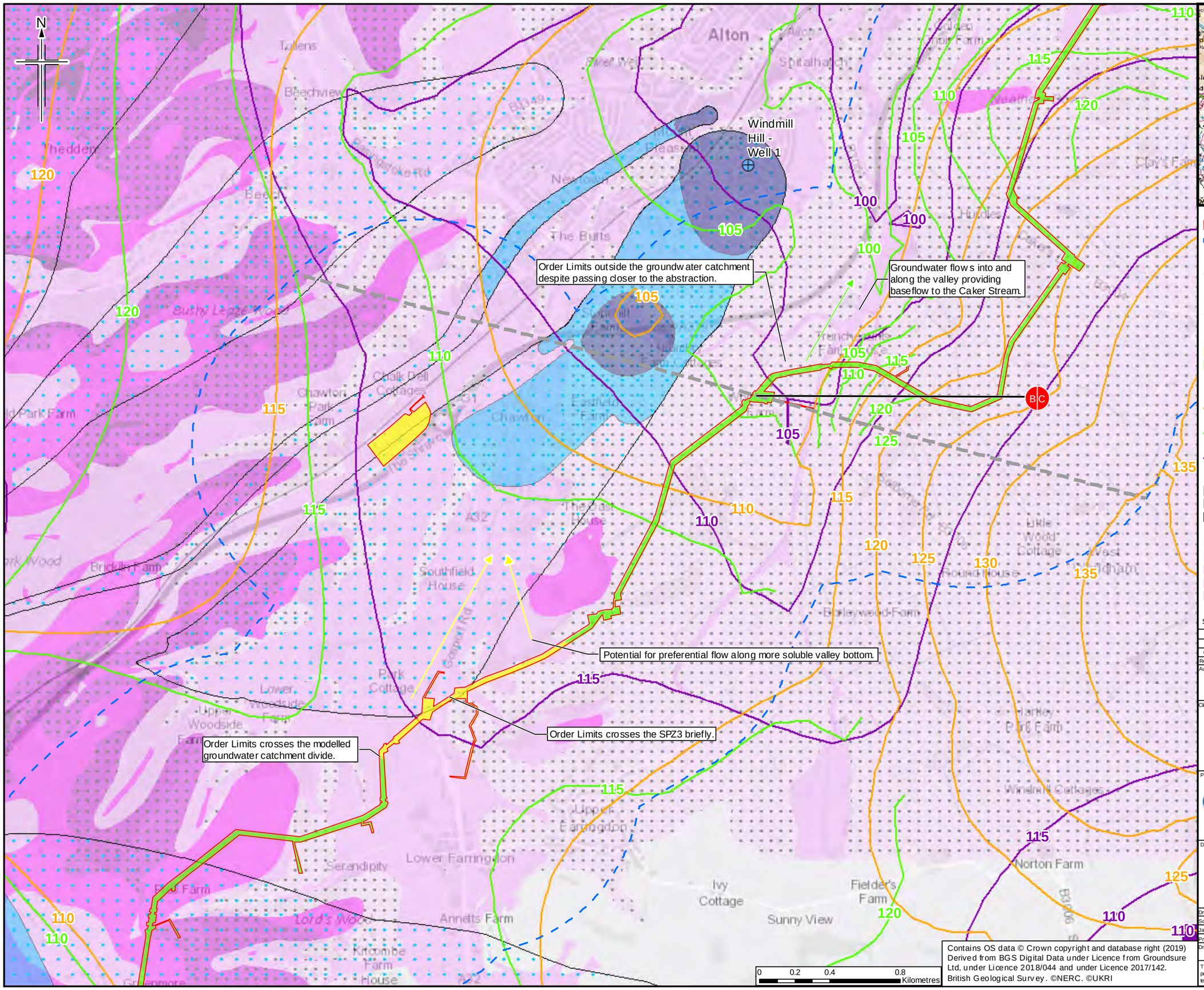
Project

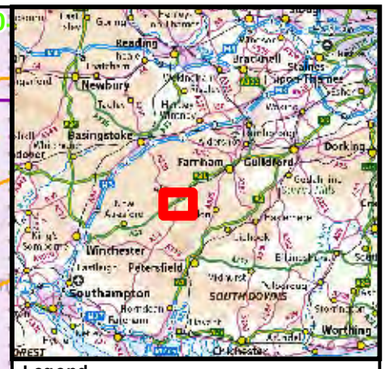
Esso
Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL FLOW PATHWAY
TWYFORD
ABSTRACTION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:15,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 4 of 21	Rev 0





Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Potential flow pathway direction

- Moderate
- Low

Flow pathway potential within Order Limits

- Moderate
- Low
- Licenced public water supply groundwater abstraction
- Mole UGS maximum contours (April 2001)
- Mole chalk maximum contours (April 2001)
- Test and Itchen chalk maximum contours (April 2001)

Source Protection Zone

- 1
- 2
- 3

Soluble Rocks Class

- A
- B
- C
- D
- E

Sheet displays parts of Section B and Section C

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Checkd	Rev'd	Apprv'd
0	20/03/2019	For Issue	LM	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

Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL FLOW PATHWAY
WINDMILL HILL
ABSTRACTION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:20,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 5 of 21	Rev 0

N

Itchel - Borehole 1

Itchel - Borehole 2

Itchel - Borehole Well

Confined Chalk is less permeable and so flow rates are slower.

Highly soluble and heavily fractured area of rock along the edge of the outcrop provides a potential rapid flow pathway. Relatively remote from the pipeline route.

Northward hydraulic gradient directs groundwater flow away from potential capture zone.

Groundwater flow along the edge of the outcrop could potentially provide a slower flow route up to the more rapid pathways in the north.

Isolated area of more soluble rock, not connected into wider area, so doesn't create a rapid flow path.

Hogs Back monocline creates a strip of highly soluble and transmissive Chalk along the edge of the outcrop.

Boxalls Lane - CHALK - BHC - 14

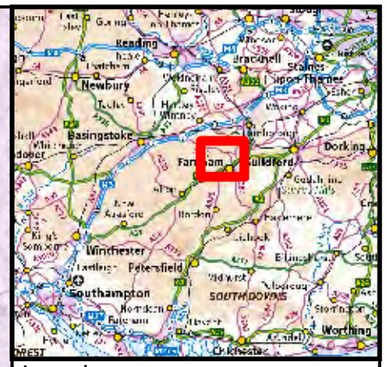
Boxalls Lane - CHALK - BHA - 12

Boxalls Lane - CHALK - BHE - 22

Boxalls Lane - CHALK - BHD - 21

Boxalls Lane - CHALK - BHB - 13

Boxalls Lane - CHALK - BHF - 23



Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Potential flow pathway direction

- Moderate
- Low

Flow pathway potential within Order Limits

- Moderate
- Low
- Licenced public water supply groundwater abstraction
- Mole chalk maximum contours (April 2001)
- Test and Itchen chalk maximum contours (April 2001)

Source Protection Zone

- 1
- 2
- 3

Soluble Rocks Class

- A
- B
- C
- D
- E

Sheet displays parts of Section C and Section D

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Checkd	Rev'd	Apprv'd
0	1/04/2019	For Issue	LM	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

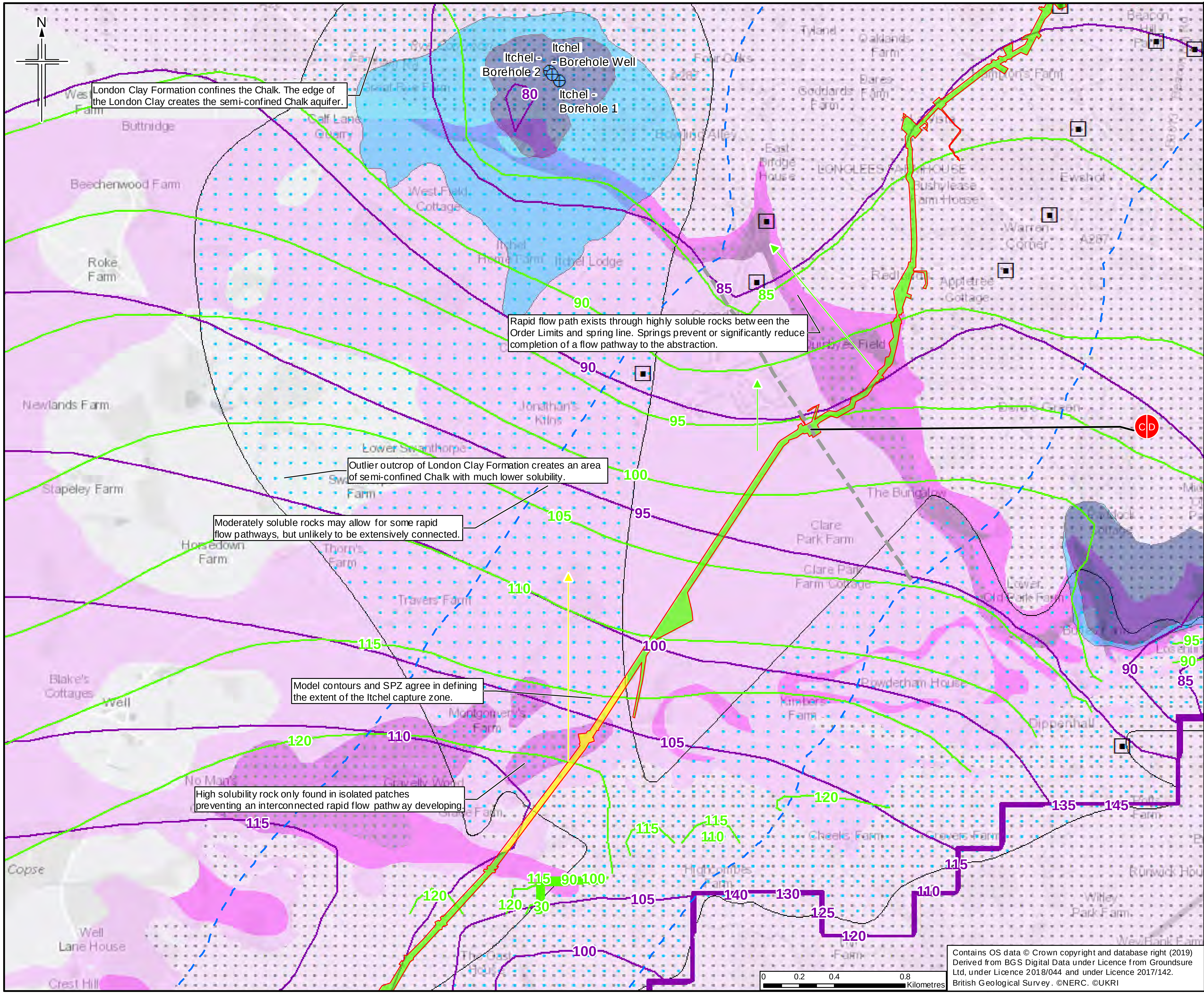
Southampton to London Pipeline Project

Drawing title

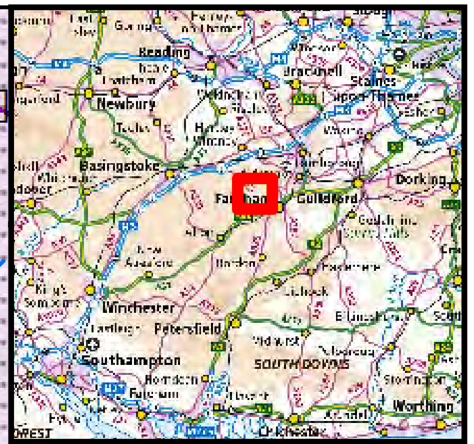
ENVIRONMENTAL STATEMENT
POTENTIAL FLOW PATHWAY
BOXALLS LANE
ABSTRACTION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue
Scale	1:30,000 @ A3 DO NOT SCALE
Jacobs No.	B2325300
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121
Drawing number	A8.4.2 Sheet 6 of 21
Rev	0

0 0.3 0.6 1.2 Kilometres



N
Itchel - Borehole 2
Itchel - Borehole Well
Itchel - Borehole 1
London Clay Formation confines the Chalk. The edge of the London Clay creates the semi-confined Chalk aquifer.
Rapid flow path exists through highly soluble rocks between the Order Limits and spring line. Springs prevent or significantly reduce completion of a flow pathway to the abstraction.
Outlier outcrop of London Clay Formation creates an area of semi-confined Chalk with much lower solubility.
Moderately soluble rocks may allow for some rapid flow pathways, but unlikely to be extensively connected.
Model contours and SPZ agree in defining the extent of the Itchel capture zone.
High solubility rock only found in isolated patches preventing an interconnected rapid flow pathway developing.
C D
Contains OS data © Crown copyright and database right (2019)
Derived from BGS Digital Data under Licence from Groundsure Ltd, under Licence 2018/044 and under Licence 2017/142.
British Geological Survey. ©NERC. ©UKRI
0 0.2 0.4 0.8 Kilometres



Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Potential flow pathway direction

- Moderate
- Low

Flow pathway potential within Order Limits

- Moderate
- Low
- Licenced public water supply groundwater abstraction
- BGS Karst - Springs
- Mole chalk maximum contours (April 2001)
- Test and Itchen chalk maximum contours (April 2001)

Source Protection Zone

- 1
- 2
- 3

Soluble Rocks Class

- A
- B
- C
- D
- E

Sheet displays parts of Section C and Section D

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
0	20/03/2019	For Issue	LM	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 POTENTIAL FLOW PATHWAY ITCHEL ABSTRACTION APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:20,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 7 of 21	Rev 0

N

Outcrop of the Seaford Chalk is relatively soluble and coincides with SPZ3.

SPZ2 coincides with the Seaford Chalk Formation outcrop.

SPZ not laterally continuous, due to the presence of a springline. Lower risk of a flow pathway to the abstraction from this part of the Order Limits.

Logistics hub on the boundary of the SPZ1, and outcrop of the Seaford Chalk Formation, mapped as moderately soluble. Modelled groundwater contours indicate flow towards the centre of the SPZ1.

SPZ2 coincides with the Newhaven Chalk Formation outcrop, with potentially some hydraulic isolation.

Outcrop of Newhaven Chalk Formation which acts hydraulically independently; the connectivity to the abstractions is not certain.

Outcrop of Seaford Chalk Formation within SPZ2, the strata from with water is abstracted.

No contiguous rapid flow pathway observed through high solubility rock between the Order Limits and the abstraction. SPZ shows the best available Watercress Bed capture zone definition.

Legend

- Order Limits
- Order Limits 1km buffer
- Section break

Potential flow pathway direction

- Very high
- High

Flow pathway potential within Order Limits

- Very high
- High
- Moderate
- Low
- EHCC Chalk and UGS maximum contours (February 2001)
- Test and Itchen chalk maximum contours (April 2001)

Source Protection Zone

- 1
- 2
- 3

Soluble Rocks Class

- A
- B
- C
- D
- E

Sheet displays parts of Section A and Section B

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Check'd	Rev'd	Apprv'd
0	25/03/2019	For Issue	LM	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

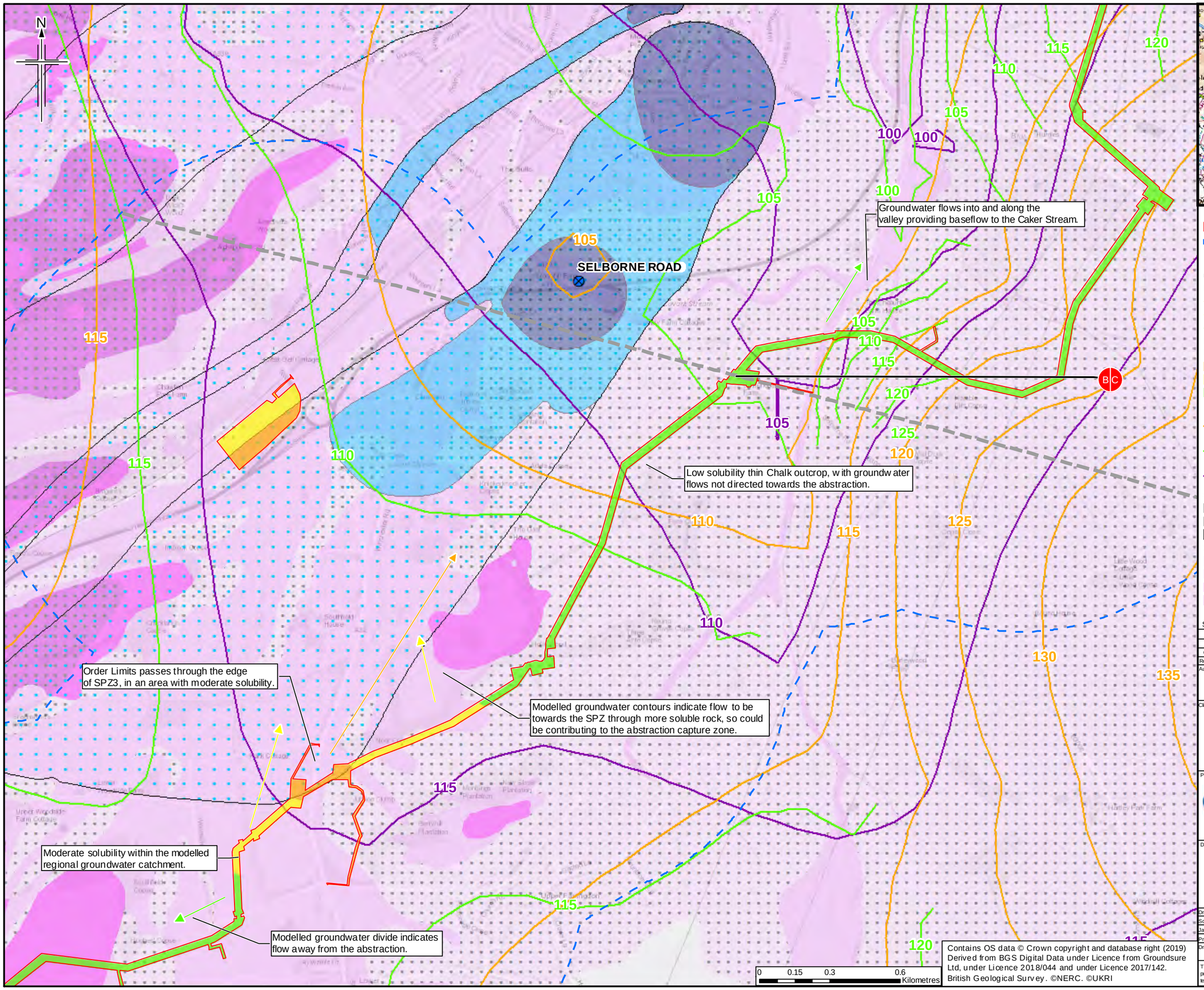
Esso — Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL FLOW PATHWAY
WATERCRESS BEDS
ABSTRACTIONS
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:30,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 8 of 21	Rev 0

0 0.3 0.6 1.2 Kilometres



Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Potential flow pathway direction

- High
- Moderate
- Low

Flow pathway potential within Order Limits

- High
- Moderate
- Low
- Other licenced groundwater abstraction
- Mole UGS maximum contours (April 2001)
- Mole chalk maximum contours (April 2001)
- Test and Itchen chalk maximum contours (April 2001)

Source Protection Zone

- 1
- 2
- 3

Soluble Rocks Class

- A
- B
- C
- D

Sheet displays parts of Section B and Section C

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Check'd	Rev'd	Apprv'd
0	25/03/2019	For Issue	LM	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
POTENTIAL FLOW PATHWAY
SELBORNE ROAD
ABSTRACTION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue		
Scale	1:15,000 @ A3	DO NOT SCALE	
Jacobs No.	B2325300		
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121		
Drawing number	A8.4.2 Sheet 9 of 21	Rev	0

N

More soluble rock doesn't link up to the abstraction to provide a complete preferential pathway.

Area immediately upgradient of the abstraction and relatively close likely to be a substantial source of the water abstracted.

Some flow may cross the modelled groundwater contours to contribute to the capture zone.

BELMORE HOUSE

Topographic high separating the dry valleys is less permeable, and restricts the flow of water across, limiting the capture zone for relatively small abstractions.

Order Limits relatively distant from the abstraction, but could potentially link into a preferential flow network and provide part of the capture zone.

Preferential flow pathway within the base of the dry valley may allow water to flow across hydraulic gradient and directly to the abstraction borehole.

BIGPATH FARM

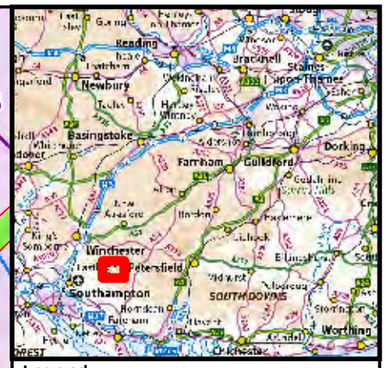
PW000202

Short distance from pipeline to potential preferential pathway.

Soluble valley base likely to be more permeable and offer a preferential pathway. Carries water away from the abstractions.

Hydraulic gradient too oblique to allow water to reach the potential preferential flow pathways, and so flows away from the abstractions.

105 130 100 125 120 95 115 105 110 90 100 85 90 95 80 85 70 75 75 80 65 70 60 65 55 60 50 55 50 45



Legend

- Order Limits
- Order Limits 1km buffer

Potential flow pathway direction

- High
- Moderate
- Low

Flow pathway potential within Order Limits

- High
- Moderate
- Low
- Other licenced groundwater abstraction
- Unlicenced private water supply groundwater abstraction
- EHCC Chalk and UGS maximum contours (February 2001)
- Test and Itchen chalk maximum contours (April 2001)

Soluble Rocks Class

- B
- C
- D
- E

Sheet displays part of Section A

Rev.	Rev. Date	Purpose of revision	Orig'/Dwn	Checkd	Rev'd	Apprv'd
0	15/03/2019	For Issue	LM	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
POTENTIAL FLOW PATHWAY
BELMORE HOUSE, BIGPATH FARM AND BETTY MUNDYS COTTAGE ABSTRACTIONS
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:15,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 10 of 21	Rev 0

0 0.15 0.3 0.6 Kilometres

N

Groundwater flows away from the abstractions, with groundwater divides separating them from the Order Limits.

Rapid flowpath through more soluble rock in the base of the valley directly downgradient towards the abstraction.

Modelled regional groundwater divide.

Groundwater divide separates Wheely Farm abstraction from the Order Limits.

Long pathway with a low abstraction rate limits the relative contribution of this part of the Stanmore Farm capture zone.

Potential for small amounts of oblique flow to contribute to the Lomer Farm capture zone.

Capture zone for Rooksgrove Farm doesnt include areas where the Order Limits pass through.

Order Limits close to and directly upgradient of the Lomer Farm abstraction.

Groundwater divide as defined by the modelled levels during a high-stand.

Groundwater divide may change seasonally, extending Lomer Farm abstraction catchment to the south.

STANMORE FARM

WHEELY FARM

LOMER FARM

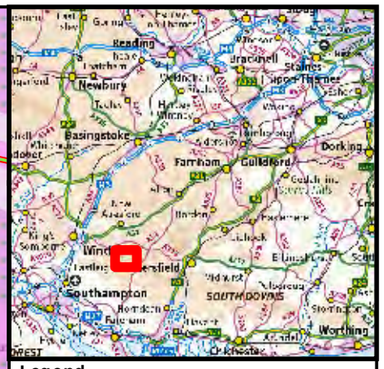
PW000021

PW000111

85 90 95 100 105 110 115 120 125 130 135

80 75 70 65

0 0.15 0.3 0.6 Kilometres



Legend

Order Limits

Order Limits 1km buffer

Potential flow pathway direction

Very high

High

Moderate

Low

Flow pathway potential within Order Limits

Very high

High

Moderate

Low

Other licenced groundwater abstraction

Unlicenced private water supply groundwater abstraction

EHCC Chalk and UGS maximum contours (February 2001)

Test and Itchen chalk maximum contours (April 2001)

Soluble Rocks Class

B

C

D

Sheet displays part of Section A

Rev.	Rev. Date	Purpose of revision	Orig'd	Chk'd	Rev'd	Appr'd
0	15/03/2019	For Issue	LM	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

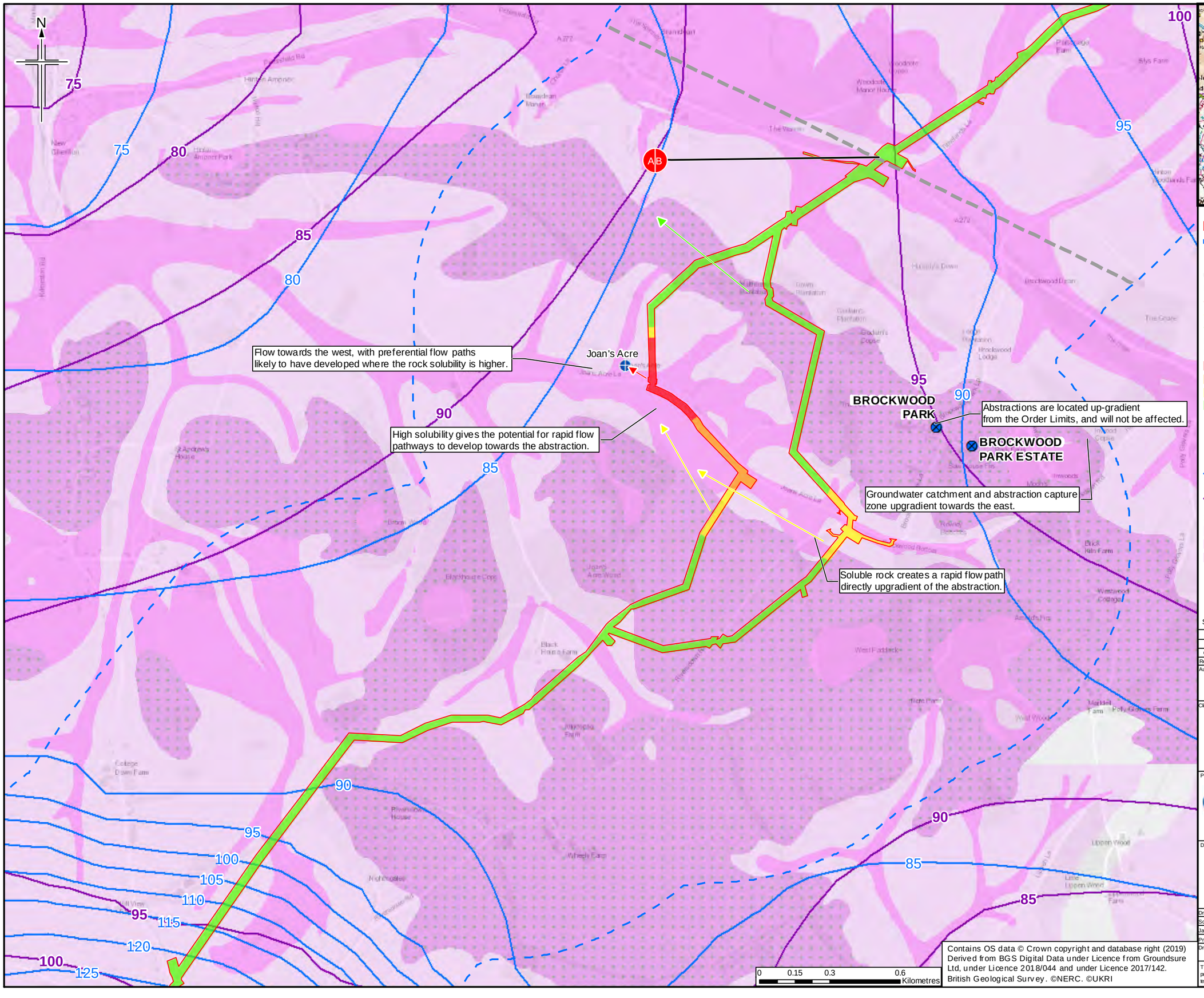
Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

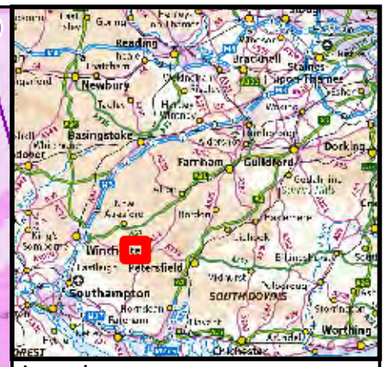
Project

Esso | Southampton to London Pipeline Project

Drawing title: ENVIRONMENTAL STATEMENT
POTENTIAL FLOW PATHWAY
BLACKHOUSE FARM, STANMORE FARM, WHEELY FARM, LOMER FARM AND ROOKSGROVE FARM ABSTRACTIONS
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:15,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 11 of 21	Rev 0





Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Potential flow pathway direction

- Very high
- Moderate
- Low

Flow pathway potential within Order Limits

- Very high
- High
- Moderate
- Low
- Other licenced groundwater abstraction
- Unlicenced private water supply groundwater abstraction
- EHCC Chalk and UGS maximum contours (February 2001)
- Test and Itchen chalk maximum contours (April 2001)

Soluble Rocks Class

- B
- C
- D

Sheet displays parts of Section A and Section B

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Checkd	Rev'd	Apprv'd
0	15/03/2019	For Issue	LM	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

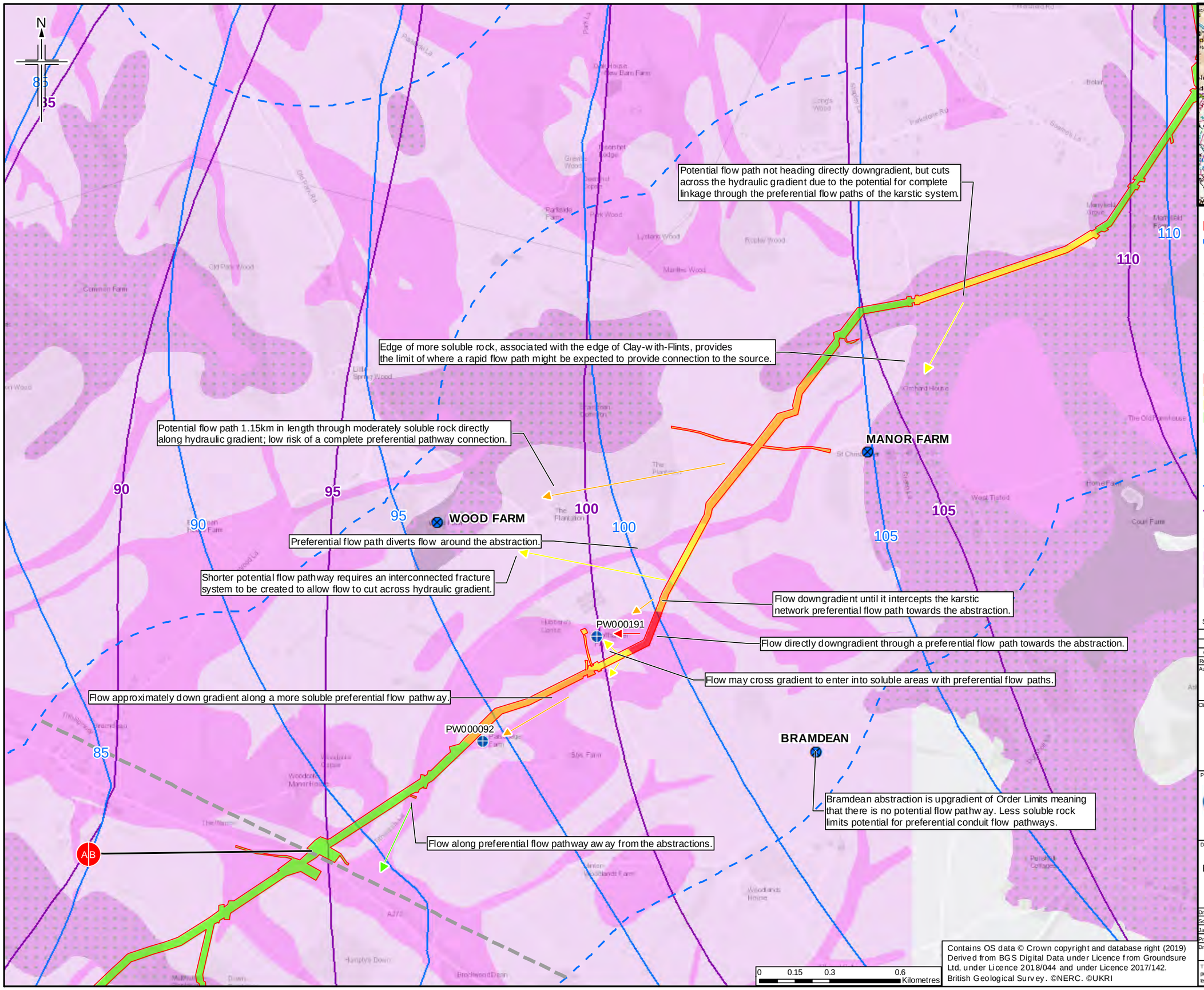
Project

Esso Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL FLOW PATHWAY
BROOKWOOD PARK, BROCKWOOD PARK ESTATE AND JOAN'S ACRE ABSTRACTIONS
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:15,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 12 of 21	Rev 0



Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Potential flow pathway direction

- Very high
- High
- Moderate
- Low

Flow pathway potential within Order Limits

- Very high
- High
- Moderate
- Low
- Other licenced groundwater abstraction
- Unlicenced private water supply groundwater abstraction
- EHCC Chalk and UGS maximum contours (February 2001)
- Test and Itchen chalk maximum contours (April 2001)

Soluble Rocks Class

- B
- C
- D
- E

Sheet displays parts of Section A and Section B

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Check'd	Rev'd	Appr'd
0	15/03/2019	For Issue	LM	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
POTENTIAL FLOW PATHWAY
BRAMDEAN, MANOR FARMS, WOOD FARM, PARSONAGE FARM AND WOLFHANGER ABSTRACTIONS
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue		
Scale	1:15,000 @ A3	DO NOT SCALE	
Jacobs No.	B2325300		
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121		
Drawing number	A8.4.2 Sheet 13 of 21	Rev	0

N

OAK PARK
GOLF CLUB
- BOREHOLE

Confined Chalk is less soluble, and located downgradient of the abstraction.

Area with recorded karstic features, including stream sinks that provide a pathway to the abstraction, although slightly off the direct hydraulic gradient.

Highly soluble rocks upgradient of the abstraction provide a very fast potential pathway.

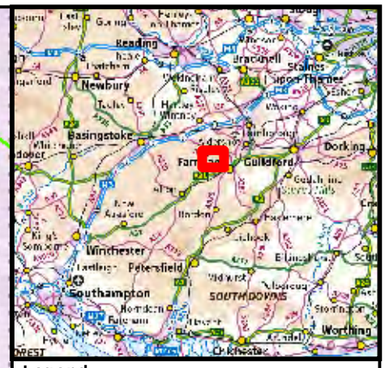
Rock is moderately soluble. Abstraction is immediately down hydraulic gradient.

0.75-1.5km from abstraction, unlikely to provide significant volumes of water to source. Rock is only moderately soluble.

>1.5km from abstraction, unlikely to provide water to source.

85 90 95 100 105 110 115 120 125 130 135 140 145

CD



Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Potential flow pathway direction

- Very high
- High
- Moderate

Flow pathway potential within Order Limits

- Very high
- High
- Moderate
- Low
- Other licenced groundwater abstraction
- BGS Karst - stream sinks
- BGS Karst - springs
- Mole chalk maximum contours (April 2001)
- Test and Itchen chalk maximum contours (April 2001)

Soluble Rocks Class

- A
- B
- C
- D
- E

Sheet displays parts of Section C and Section D

Rev.	Rev. Date	Purpose of revision	Orig'd/Dwn	Check'd	Rev'd	Apprv'd
0	1/04/2019	For Issue	LM	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

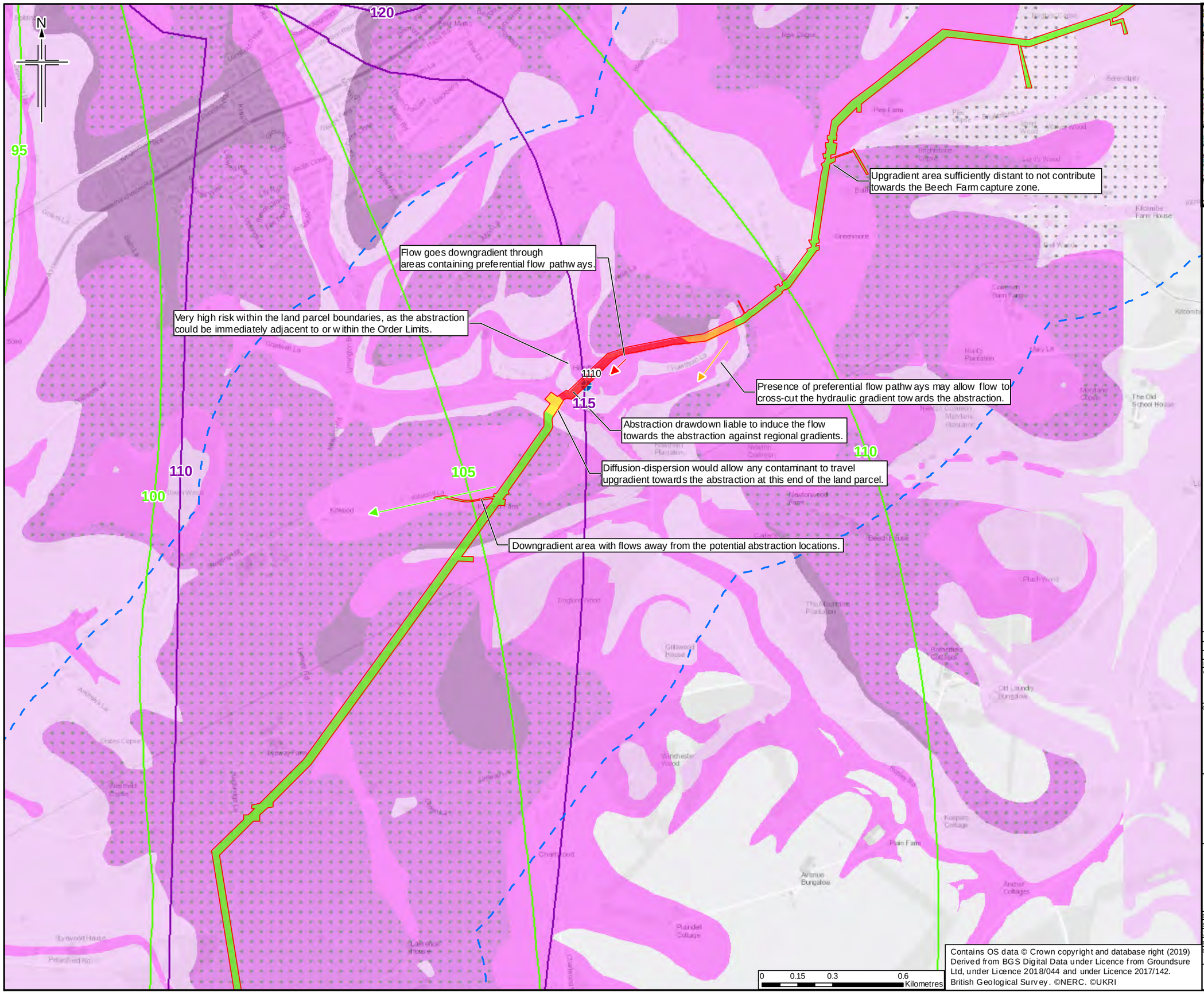
Esso — Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL FLOW PATHWAY
OAK PARK
ABSTRACTION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:15,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 14 of 21	Rev 0

0 0.15 0.3 0.6 Kilometres



Legend

- Order Limits
- Order Limits 1km buffer

Potential flow pathway direction

- Very high
- High
- Low

Flow pathway potential within Order Limits

- Very high
- High
- Moderate
- Low
- Unlicenced private water supply groundwater abstraction
- Mole chalk maximum contours (April 2001)
- Test and Itchen chalk maximum contours (April 2001)

Soluble Rocks Class

- A
- B
- C
- D
- E

Sheet displays part of Section B

Rev.	Rev. Date	Purpose of revision	Orig'd/Dwn	Check'd	Rev'd	Appr'v'd
0	15/03/2019	For Issue	LM	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

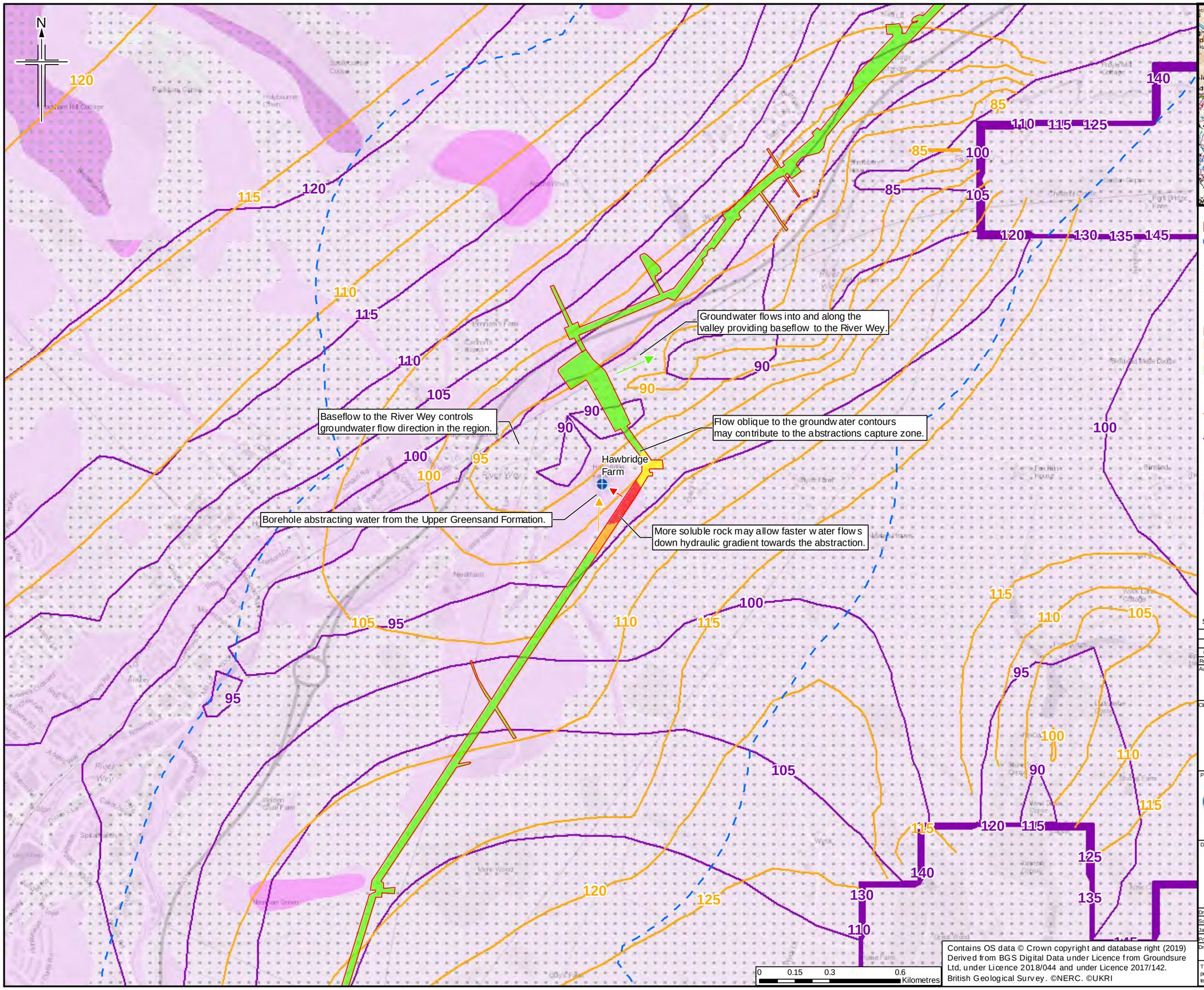
Project

Esso Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL FLOW PATHWAY
BEECH FARM
ABSTRACTION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:15,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 15 of 21	Rev 0



Legend

- Order Limits
- Order Limits 1km buffer

Potential flow pathway direction

- Very high
- High
- Low

Flow pathway potential within Order Limits

- Very high
- High
- Moderate
- Low
- Unlicenced private water supply groundwater abstraction
- Mole UGS maximum contours (April 2001)
- Test and Itchen chalk maximum contours (April 2001)

Soluble Rocks Class

- A
- B
- C
- D

Sheet displays part of Section C

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Check'd	Rev'd	Apprv'd
0	15/03/2019	For Issue	LM	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

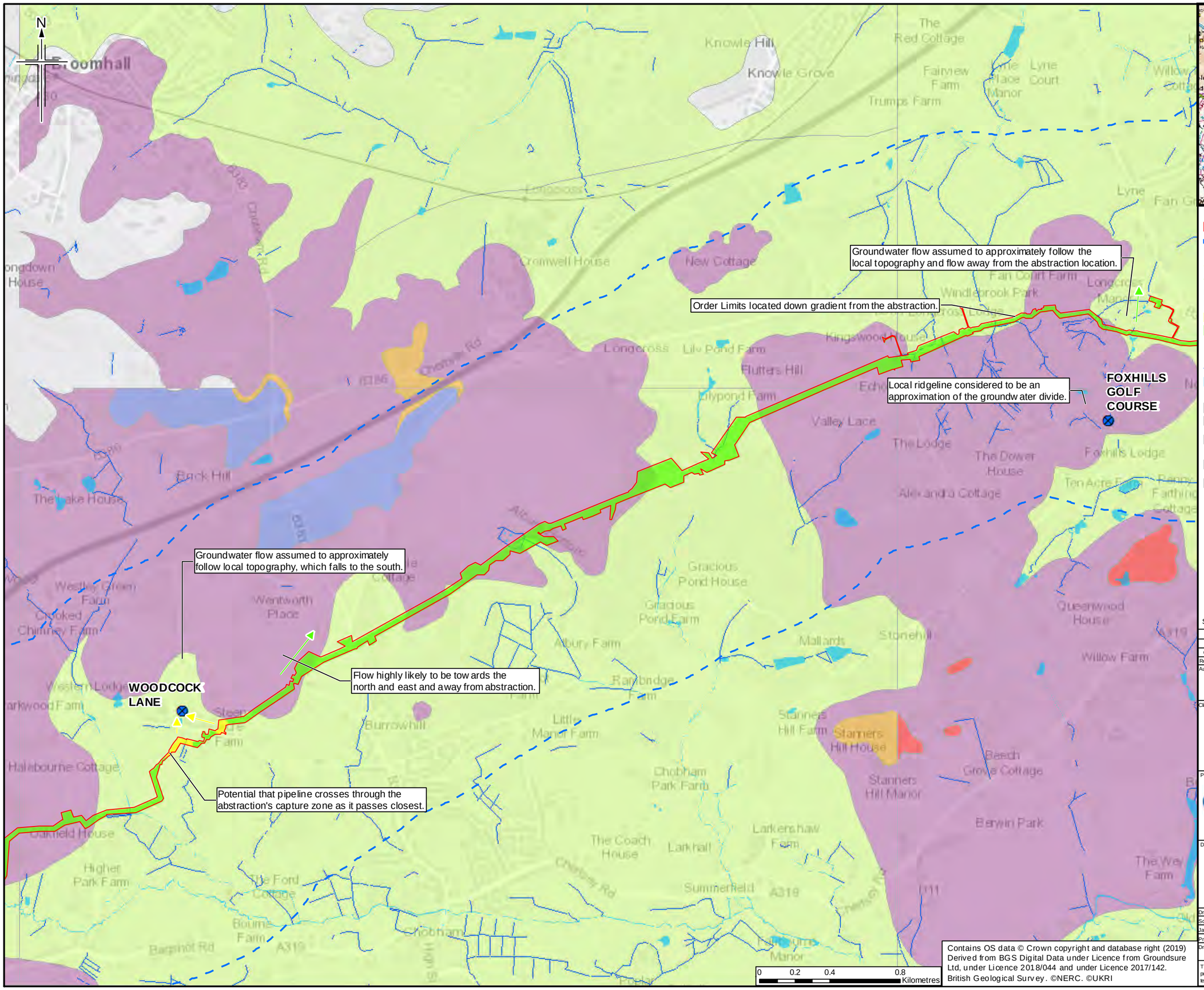
Esso | Southampton to London Pipeline Project

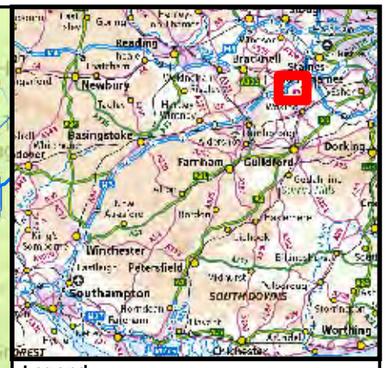
Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL FLOW PATHWAY
HAWBRIDGE FARM
ABSTRACTION
APFP Reg. (2009) 5(2)(I)

Drawing Status	For Issue	
Scale	1:15,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	

Drawing number: A8.4.2 Sheet 16 of 21 — Rev 0





Legend

- Order Limits
- Order Limits 1km buffer

Potential flow pathway direction

- Moderate
- Low

Flow pathway potential within Order Limits

- Moderate
- Low
- Other licenced groundwater abstraction
- Surface water line
- Surface water area

Bedrock Geology

- Bagshot Formation - Sand
- Camberley Sand Formation - Sand
- Stanners Hill Pebble Bed Member - Conglomerate
- Stanners Hill Pebble Bed Member - Gravel
- Windlesham Formation - Sand

Sheet displays part of Section F

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Check'd	Rev'd	Appr'd
0	15/03/2019	For Issue	LM	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

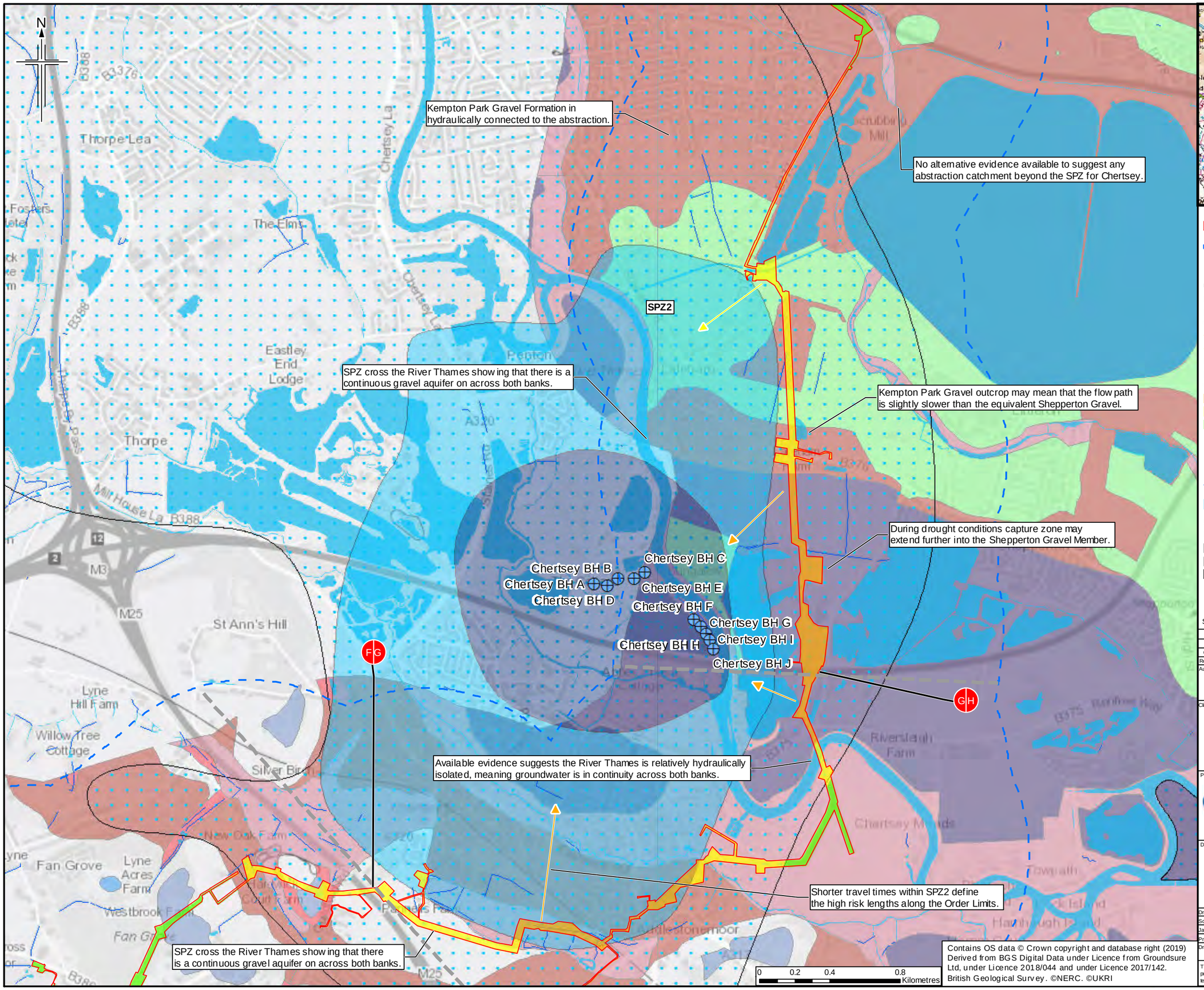
Project

Esso Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL FLOW PATHWAY
WOODCOCK LANE AND FOXHILLS ABSTRACTIONS
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:20,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
Project Wise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 17 of 21	Rev 0



Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Potential flow pathway direction

- High
- Moderate

Flow pathway potential within Order Limits

- High
- Moderate
- Low
- Licenced public water supply groundwater abstraction
- Surface water line
- Surface water area

Source Protection Zone

- 1
- 2
- 3

Superficial Geology

- Alluvium - Silt
- Head - Diamicton
- Kempton Park Gravel Formation - Sand And Gravel
- Langley Silt Member - Silt
- Lynch Hill Gravel Member - Sand And Gravel
- River Terrace Deposits (undifferentiated) - Sand And Gravel
- Shepperton Gravel Member - Sand And Gravel

Sheet displays parts of Section F, Section G and Section H

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Checkd	Rev'd	Apprv'd
0	25/03/2019	For Issue	LM	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

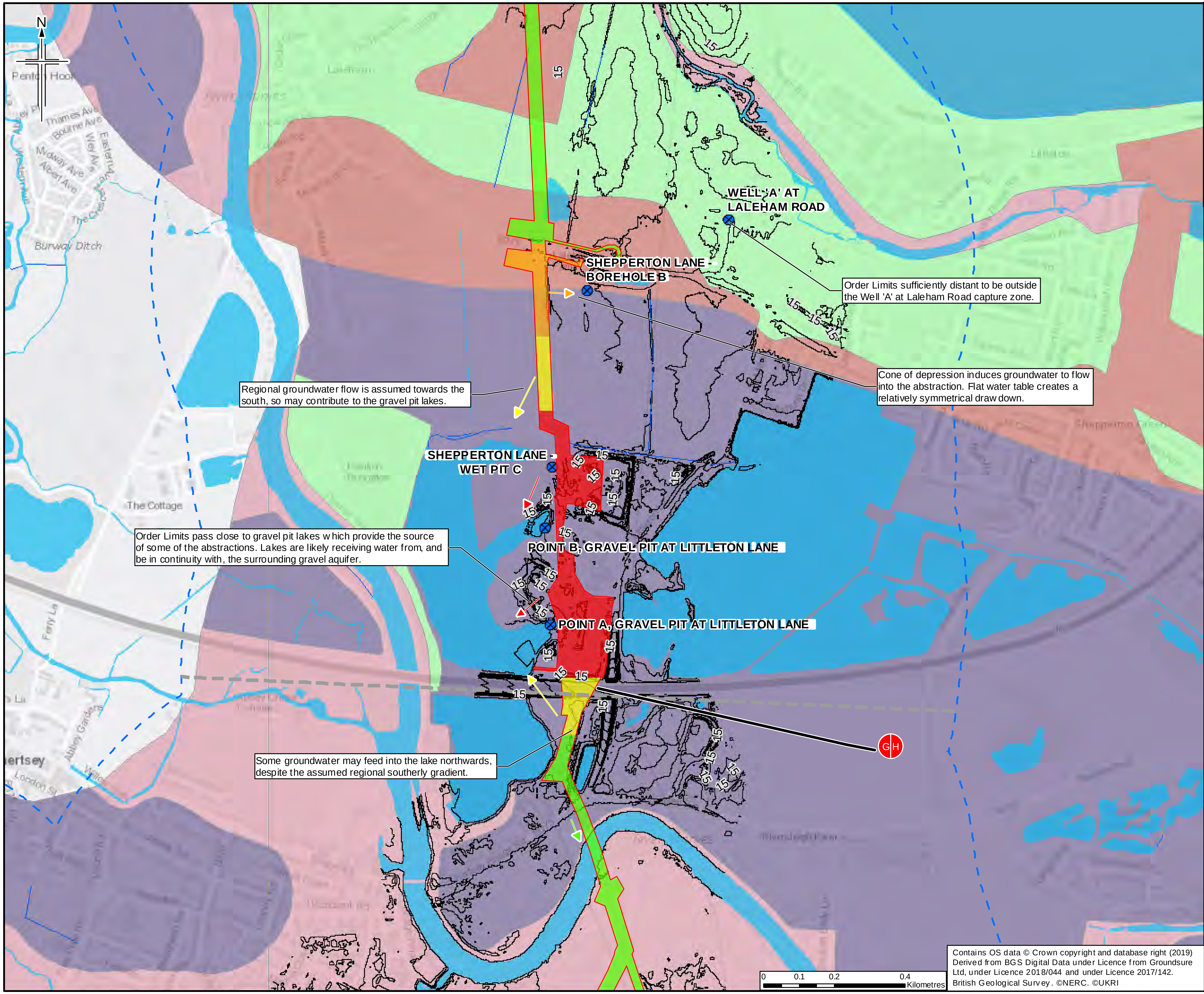
Project

Esso | Southampton to London Pipeline Project

Drawing title

ENVIRONMENTAL STATEMENT
POTENTIAL FLOW PATHWAY
CHERTSEY
ABSTRACTION
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue
Scale	1:20,000 @ A3 — DO NOT SCALE
Jacobs No.	B2325300
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121
Drawing number	A8.4.2 Sheet 18 of 21
Rev	0



Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Potential flow pathway direction

- Very high
- High
- Moderate
- Low

Flow pathway potential within Order Limits

- Very high
- High
- Moderate
- Low
- Other licenced groundwater abstraction
- 1m elevation contours
- Surface water line
- Surface water area

Superficial Geology

- Alluvium - Silt
- Kempton Park Gravel Formation - Sand And Gravel
- Langley Silt Member - Silt
- Shepperton Gravel Member - Sand And Gravel

Sheet displays parts of Section G and Section H

Rev.	Rev. Date	Purpose of revision	Orig/Dwn	Checkd	Rev'd	Apprv'd
0	1/04/2019	For Issue	LM	NS	VSM	SH

Author: JACOBS

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

Project: Esso — Southampton to London Pipeline Project

Drawing title: ENVIRONMENTAL STATEMENT POTENTIAL FLOW PATHWAY THAMES GRAVEL (LALEHAM) ABSTRACTIONS APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue
Scale	1:10,000 @ A3 — DO NOT SCALE
Jacobs No.	B2325300
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121
Drawing number	A8.4.2 Sheet 19 of 21
Rev	0

N

MAYFIELD FARM

Regional groundwater flow follows topography towards the south, away from the abstraction and towards the gravel pit lakes.

Order Limits routed along edge of the gravel pit lake, allowing rapid movement into the lake and river.

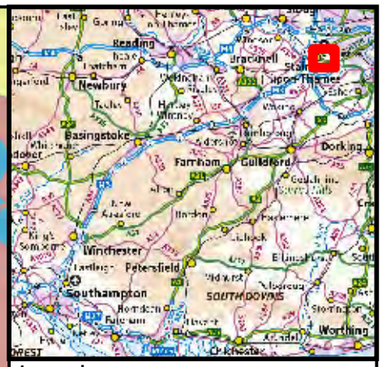
Reservoir assumed to be lined and not influencing groundwater in the area.

GRAVELS AT ASHFORD ROAD

Gravel pit lake in continuity with the gravel aquifer, and provides the source of abstraction. Surface water blends water fed in from different parts of the catchment.

Langley Silt Member may impede groundwater flow towards the gravel pit lake.

0 0.15 0.3 0.6 Kilometres



Legend

- Order Limits
- Order Limits 1km buffer

Potential flow pathway direction

- Very high
- Low

Flow pathway potential within Order Limits

- Very high
- High
- Moderate
- Low
- Other licenced groundwater abstraction
- 5m elevation contours
- Surface water line
- Surface water area

Superficial Geology

- Alluvium - Silt
- Kempton Park Gravel Formation - Sand And Gravel
- Langley Silt Member - Silt
- Shepperton Gravel Member - Sand And Gravel
- Taplow Gravel Formation - Sand And Gravel

Sheet displays part of Section H

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Check'd	Rev'd	Appr'd
0	15/03/2019	For Issue	LM	NS	VSM	SH

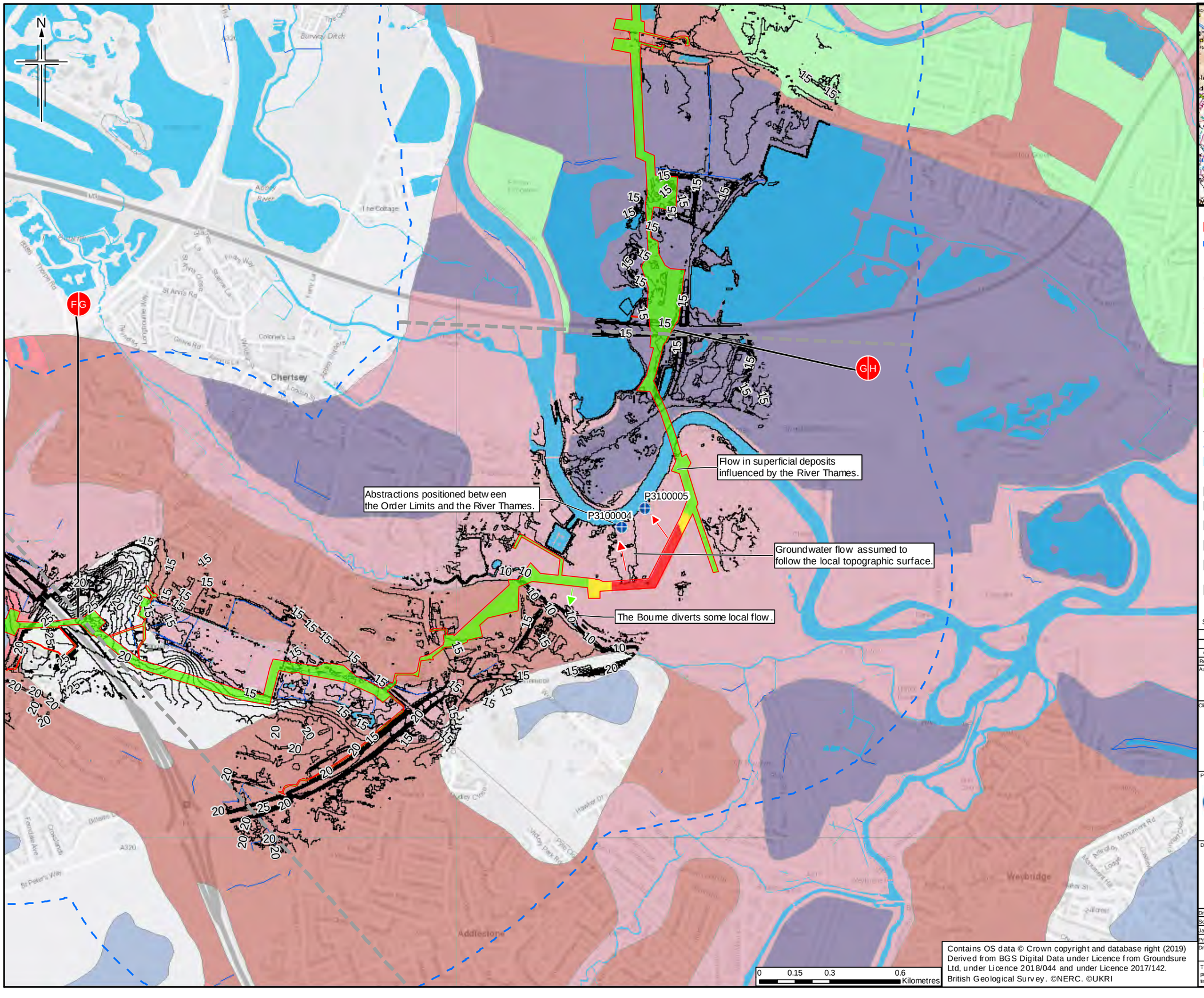
Author
JACOBS
1180 Eskdale Road, Winnersh, Wokingham, RG41 5TU, UK.
Tel: +44 (0)118 946 7000 Fax:+44(0)118 946 7001
www.jacobs.com

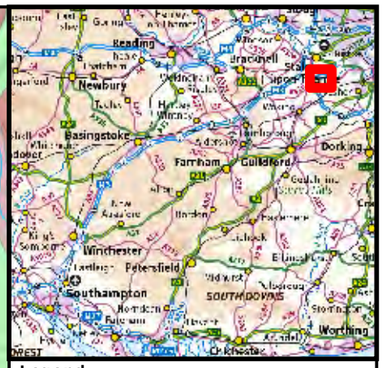
Client
Esso Petroleum Company, Limited
Ermyn House,
Ermyn Way,
Leatherhead,
Surrey,
KT22 8UX

Project
Esso Southampton to London Pipeline Project

Drawing title
ENVIRONMENTAL STATEMENT
POTENTIAL FLOW PATHWAY
THAMES GRAVEL (ASHFORD)
ABSTRACTIONS
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:15,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 20 of 21	Rev 0





Legend

- Order Limits
- Order Limits 1km buffer
- Section break
- Section break

Potential flow pathway direction

- Very high
- Low

Flow pathway potential within Order Limits

- Very high
- Moderate
- Low
- Unlicenced private water supply groundwater abstraction
- 1m elevation contours
- Surface water line
- Surface water area

Superficial Geology

- Alluvium - Silt
- Head - Diamicton
- Kempton Park Gravel Formation - Sand And Gravel
- Langley Silt Member - Silt
- Lynch Hill Gravel Member - Sand And Gravel
- Shepperton Gravel Member - Sand And Gravel

Sheet displays parts of Section F, Section G and Section H

Rev.	Rev. Date	Purpose of revision	Orig'Dwn	Checkd	Rev'd	Apprv'd
0	25/03/2019	For Issue	LM	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
POTENTIAL FLOW PATHWAY
HIGHLANDS AND DELICIA
ABSTRACTIONS
APFP Reg. (2009) 5(2)(l)

Drawing Status	For Issue	
Scale	1:15,000 @ A3	DO NOT SCALE
Jacobs No.	B2325300	
ProjectWise No.	B2325300-JAC-000-ENV-DRG-001121	
Drawing number	A8.4.2 Sheet 21 of 21	Rev 0

(This page is intentionally blank)