Southampton to London Pipeline Project

Volume 6

Environmental Statement (Volume D) Appendix 11.1: Soils and Geology Supporting Information

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Contents

Appendix 11.1 Soils and Geology Supporting Information

1.1 Introduction

1.1.1 This appendix supports Chapter 11 Soils and Geology. It provides additional baseline information on soils, geology, minerals and land contamination within the study area, to support the Environmental Statement (ES) conclusions.

1.1.2 This appendix also includes a land contamination risk assessment, which covers the potentially contaminated land sites that have been scoped into the ES.

1.1.3 For the purposes of this assessment, the route and Order Limits are broken down into eight separate sections, further details can be found in Chapter 3 Project Description:

- Section A – Boorley Green to Bramdean;
- Section B – Bramdean to South of Alton;
- Section C – South of Alton to Crondall (via Alton pumping station);
- Section D – Crondall to Farnborough (A327 crossing);
- Section E – Farnborough (A327 crossing) to Bisley and Pirbright Ranges;
- Section F – Bisley and Pirbright Ranges to M25;
- Section G – M25 to M3; and
- Section H – M3 to the West London Terminal storage facility.

Activities That Could Affect Soils and Geology

1.1.4 The principal activities associated with the project that could affect soils and geology are outlined below. A description of the project is contained within Chapter 3 Project Description.

Temporary Construction Compounds and Laydown Areas

1.1.5 Approximately 52 temporary compounds would be established along the route of the new pipeline for the storage of pipe, materials, plant and equipment. The fenced compounds would be accessed from the existing road network and would comprise single-storey staff welfare facilities, parking, waste storage, and wheel washing areas. The temporary compounds would also provide hardstanding areas, with apron and access areas comprising stone laid on a geotextile membrane.

Temporary Logistics Hubs

1.1.6 Six logistics hubs would be established. Each of the hubs would provide a pipe laydown area, secure plant storage area, bunded fuel storage, single-storey offices, staff welfare facilities and a vehicle parking area. Where applicable the topsoil would be stripped from the logistics area and stockpiled around the hub perimeter within the site fence. A stone road and apron would be laid on a geotextile membrane to

provide an all-weather surface access to the local highway.

Topsoil Removal and Storage

1.1.7 Where topsoil stripping is required, the normal working practice (where not otherwise specified within a methodology document) would be to strip full depth of topsoil (where present) from construction compounds and logistics hubs; access roads; across the working width; and any other areas to be trafficked. The topsoil would be reinstated above the subsoil (G154).

1.1.8 The depth of topsoil strip would not be expected to exceed 0.3m. Topsoils and subsoils intended for reinstatement would be temporarily stockpiled as close to where they were stripped from as practicable (G155) unless the working width is reduced to such an extent that the topsoil would need to be stored at an alternative location close by.

Haul Road Construction

1.1.9 Haul roads would be formed through most of the working area. Where soils are suitable, the haul roads would be formed from the exposed subsoil. Appropriate techniques would be used when necessary to provide protection for subsoils from compaction and smearing in areas subject to heavy trafficking. The specific protection measures and their required locations would be set out in the appointed contractor(s)' methodology document and agreed between the contractor(s) and overseeing Suitably Experienced Person (SEP) prior to construction commencing (G157). Appropriate techniques could be treating the subsoil with a soil binder, laying the track with inert material on a geotextile membrane or installing timber bog mats.

Trench Excavation and Pipe Installation

1.1.10 Open cut methods would be used for the majority of the route. The trench would be excavated, with temporary storage of subsoil on the opposite side of the working width to previously removed topsoil. Either selected backfill or imported granular pipe bedding material would then be placed into the excavation and, following pipe installation, suitable surround materials would be placed as required. The trench would then be backfilled with the subsoil arisings and compacted.

Open Cut Trench Excavation in the Road

1.1.11 Where trench excavation is required in the road, this would commence with the breaking out of hard surfaces prior to excavation of the trench. Arisings generated by these activities would typically be tested and where suitable sent to a recycling facility.

Trenchless Installation

1.1.12 At a number of locations trenchless installation techniques would be used to avoid certain obstructions or mitigate impacts on sensitive areas. The choice of technique at any location is dependent on a number of site-specific factors including ground conditions, the space available for pipe stringing either side of the obstruction, and the sensitivity of the obstruction to potential settlement. Where a certain type of

trenchless technique has been selected this is listed in Appendix 3.1 Table of Trenchless Crossings. Trenchless crossings that intersect potentially contaminated sites are presented in Annex A to this appendix.

- Auger bore is a trenchless method used over relatively short distances and usually at shallow depths. Shallow launch and reception shafts would be dug on either side of the obstacle. These may need supporting with concrete rings or sheet piles and dewatering may be required, depending on groundwater levels. An auger would bore horizontally to install a sleeve pipe beneath the obstacle and connect each pit.
- Horizontal directional drilling is a trenchless method of pipeline construction. A series of flexible rods would be driven through the earth from a 'launch pit' to form a small tunnel. A mud slurry would be used as a hydraulic fluid and coolant. As the rods progress through the earth, extra rods would be added until the drill head emerges at the 'reception pit'. At the reception pit, the drill head would be removed and a larger one attached. This would continue to enlarge the tunnel until it is a size greater than the pipe. A length of pipeline would be laid out and welded (pipe stringing) beyond the crossing. The welded pipe would then be pulled back through the tunnel completing the drilling operation.

Dewatering

1.1.13 In some locations groundwater levels may be high and dewatering would be required to aid pipeline construction. There would be no intentional discharge of site runoff to ditches, watercourses, drains or sewers without appropriate treatment and agreement of the appropriate authority (except in the case of emergency) (G12).

Information Sources

Publicly and Commercially Available Information

1.1.14 The sources of publicly or commercially available information that have been consulted in the preparation of this report are listed in Chapter 11 Soils and Geology.

Engagement with Statutory Organisations

1.1.15 Data were obtained from the Environment Agency and local authorities:

Environment Agency

- Data package received 19 June 2018 containing information on authorised landfills (including Home Farm, Queen Mary Quarry, Laleham Landfill) and historical landfills (Land South of Queen Mary Reservoir).
- Data package received 31 August 2018 containing information on historical landfills (Redlands/Wildland House Area 1 and Area 2, South of Frimley Station, Red Road Hill Depot, Hanworth Trading Estate, Abbey Moor Golf Club); also data on sites with past potentially contaminative land uses (Southwood Military area, Queen Elizabeth Barracks).
- Personal communication from the EA 31 August 2018 regarding permitting status of landfills north of the Thames.

- Data package received 9 October 2018 containing information on historical landfills (Upper Froyle at Manor Farm, Home Farm, South of Queen Mary Reservoir, Abbey Moor Golf Club, Four Marks Golf Club and South of Frimley Station) and environmental permits for Queen Mary Quarry.
- Data package received 9 October 2018 containing information on Homers Farm proposed mineral extraction site and Queen Mary Quarry authorised landfill.
- Data package received 20 November 2018 containing information on the River Thames Scheme.
- Data package received 18 December 2018 containing information on Johnson Wax, Frimley.

Local Authorities

- Email from Spelthorne Borough Council dated 22 May 2018 with information on West Bedfont (Short Lane Landfill).
- Email from Spelthorne Borough Council dated 22 May 2018 with information on White House Garage, 47 Woodthorpe Road, 21-35 Woodthorpe Road, Hitchcock & King, Former Bulldog Service Station, Former Lionvale Service Station.
- Email from Spelthorne Borough Council dated 3 July 2018 with information on Lavenders Landfill, Old Littleton Lane Landfill, Sheep Walk Landfill, Littleton Lane Landfill, Laleham Landfill, and St. David's School Landfill.
- Email from Spelthorne Borough Council dated 24 July 2018 with information on Land South of Queen Mary Reservoir, Queen Mary Quarry, Home Farm, St David's School Landfill.
- Email from Spelthorne Borough Council dated 5 September 2018 with information on Woodthorpe Road.
- Email from Spelthorne Borough Council dated 5 September 2018 with information on St David's School Landfill.
- Email from Spelthorne Borough Council dated 5 September 2018 with information on the River Thames Scheme.
- Email from Spelthorne Borough Council dated 7 September 2018 with information on Bulldog Service Station.
- Email from Surrey Heath Borough Council dated 13 April 2018 with information on Red Road Hill Depot, Chobham Car Spares and Johnson Wax Ltd.

<u>Other Information</u>

1.1.16 Information specific to scoped-in land contamination sites was also received:

- Environmental Reports from St James School (10 May 2018) with regard to Clockhouse Lane and St David's School Landfill.
- CD provided by the Brett Group (19 October 2018) with permit and monitoring information on Queen Mary Quarry, Lavenders Landfill, Laleham Landfill and Home Farm Landfill, and Manor Farm gravel extraction site.
- National Archives website. Accessed November 2018.

- Travers, R., 2016. Inquest Touching the death of Zane Ilorie Christopher Yusuf Gbangbola, Factual Findings and Conclusions. H.M. Senior Coroner for the County of Surrey.
- General internet searches including planning portals (East Hampshire District Council Public Register website, Eastleigh Borough Council Public Register website).

Previous Surveys and Investigations

Project-related Ground Investigation

1.1.17 A number of boreholes were commissioned by Esso to investigate the ground conditions and geology along the pipeline route. Borehole locations are identified on Figures 11.3 and 11.4. These commenced in May 2018. At the time of writing this report, most of these boreholes had been drilled and either a full factual report or draft borehole log issued. Data available up to February 2019 have been used to inform the geological baseline and to inform the assessment.

Other Surveys and Investigations

1.1.18 Historical borehole records are available from the British Geological Survey (BGS) Onshore GeoIndex viewer (BGS, 2018). Those located within 250m of the Order Limits have been used to inform the geological baseline and are identified on Figures 11.3 and 11.4. The BGS boreholes have also been used to inform the likely ground conditions of the scoped-in potentially contaminated sites, the details of which are included in the desk studies contained in Annex B of this appendix.

1.1.19 A number of surveys and investigation reports have been identified that are relevant to defining land contamination baseline including boreholes, installation of monitoring wells and groundwater and gas monitoring. Some of these reports were made available in their entirety and some were summarised by third parties. These are referenced within the report where applicable.

1.2 Soil Types and Quality

Introduction

1.2.1 Information on soil types and quality within the study area obtained from published sources is presented below.

1.2.2 Statutory and non-statutory designated wildlife sites and other priority habitats with sensitive vegetation/flora which might be impacted due to soil/substrate changes arising as a result of the project are detailed in Chapter 7 Biodiversity.

Study Area

1.2.3 The study area for soil comprises the area directly affected by the project, that is the area within the Order Limits as shown on Figures 11.1 and 11.2. The figures also show soil information for land within a 1km buffer of the Order Limits, to provide context within which to assess the information.

Soil Types

1.2.4 To establish the baseline soil conditions of the study area, NATMAP vector data were obtained from Cranfield University (2018). These data identify the geographical distribution of 297 soil associations across England and Wales at a 1:250,000 scale. Soil associations group commonly occurring soil series, the lowest soil taxonomic unit within the soil classification system for England and Wales.

1.2.5 The soil associations mapped within the study area are presented in Table 1.1 and shown on Figure 11.1.

1.2.6 These comprise a range of soil types from freely draining loamy soils to fen peat. Table 1.1 summarises the area of each soil unit mapped within the Order Limits, and the relative percentages of each simplified soil type present. These simplified soil types have been devised for use herein to group soils with similar characteristics based on the Soilscapes system (LandIS, 2018a). The table shows that the predominant soils are freely draining slightly acid to acid loamy and sandy soils, with more limited areas of freely draining lime-rich soils and seasonally waterlogged loamy and clayey soils; the area of soil mapped as peat is relatively small.

Table 1.1: Soil Types in the Study Area

Soil Unit Name*	Area Within Order Limits (ha)	Simplified Soil Type	% of Order Limits#
1024b - ADVENTURERS' 2	4.9	Fen peat soils	1.2
342a - UPTON 1	2.5	Freely draining lime-rich loamy soils, often shallow	21.6
343h - ANDOVER 1	36.4		
511d - Blewbury	7.4		
511f - COOMBE 1	46.0		
571i - HARWELL	16.7	Freely draining slightly acid loamy soils	31.1
571m - CHARITY 2	15.1		
571w - Hucklesbrook	44.9		
571z - HAMBLE 2	1.2		
581d - CARSTENS	54.7		
554a - FRILFORD	1.7	Freely draining to naturally wet acid sandy and loamy soils	21.4
634 - SOUTHAMPTON	22.0		
643a - Holidays Hill	67.5		
711g - WICKHAM 3	28.0	Seasonally waterlogged loamy and clayey soils	18.8
711h - WICKHAM 4	7.4		
712c - WINDSOR	7.0		
813d - FLADBURY 3	2.1		
814a - THAMES	6.6		
841c - SWANWICK	29.1		
572j - Bursledon	18.9	Slightly acid loamy and clayey soils with impeded drainage	4.4

Soil Unit Name*	Area Within Order Limits (ha)	Simplified Soil Type	% of Order Limits#
** Soil associations in capital letters are named after the soil series or groups that, with similar soils, form extensive, often dominant, components of most delineations. More variable associations are shown in lower case letters; they have a number of less extensive, dissimilar soils and are named after the series which characterise them best (LandIS, 2018b).*			
#The total coverage of all the soil associations as a percentage of the Order Limits does not equal 100% because there are several areas in which soil associations are not mapped, e.g. at Frimley Heath and around the River Thames, but also because NATMAP vector data were not obtained for the area in which the construction compound near Bagshot is located.			

1.2.7 The soil associations within Section A (Boorley Green to Bramdean) are mainly freely draining loamy soils such as ANDOVER 1 and CARSTENS, but seasonally waterlogged loamy and clayey soils such as WICKHAM 3 and WINDSOR are mapped around the south of the section. Section B (Bramdean to South of Alton) is characterised by freely draining loamy soils – mainly slightly acid over superficial deposits such as CARSTENS, interspersed with shallow lime-rich soils often directly over chalk. COOMBE 1 is the dominant soil association in Section C (South of Alton to Crondall), which contains freely draining lime-rich loamy soils over chalk, but freely draining slightly acid loamy soils are also common, particularly HARWELL.

1.2.8 The most frequently occurring soil association within Section D (Crondall to Farnborough) is Holidays Hill, indicating very acid sandy and loamy soils with variable soil-water regimes. Seasonally waterlogged loamy and clayey soils such as Wickham 4 are also common in Section D. Section E (Farnborough to Bisley and Pirbright Ranges) contains mostly acid sandy and loamy soils of variable soil-water regimes, namely SOUTHAMPTON and Holidays Hill. Holidays Hill is again widespread across Section F with a mix of other soils including WICKHAM 3. Section F (Bisley and Pirbright Ranges to M25) also contains all of the mapped ADVENTURERS' 2 fen peat soils to the east of Lightwater and southeast of Windlesham.

1.2.9 Section G (M25 to M3) includes mainly seasonally waterlogged loamy and clayey soils of the THAMES and SWANWICK associations, and Section H (M3 to West London Terminal storage facility) contains only HUCKLESBROOK soils, indicative of freely draining slightly acid loamy soils.

Soil Quality

1.2.10 The economic resource value of soil is primarily measured by its ability to support agricultural uses. This is quantified by its ALC grade (Table 1.2), which is determined through climatic, topographical and interactive soil limitations. Best and most versatile (BMV) agricultural land equates to Grades 1 and 2 and Subgrade 3a of the ALC system and is the most flexible land in terms of the range of crops that can be grown, the level and consistency of yield and the cost of obtaining yield.

Table 1.2: ALC Grades (MAFF, 1988)

ALC Grade	MAFF Definition
Grade 1	Excellent quality agricultural land
Grade 2	Very good quality agricultural land
Subgrade 3a	Good quality agricultural land

Subgrade 3b	Moderate quality agricultural land
Grade 4	Poor quality agricultural land
Grade 5	Very poor quality agricultural land

1.2.11 Only limited post-1988 ALC data were available for the study area, for small areas of land near Four Marks (Section B), South of Crondall (Section C), and near Laleham (Section H).

1.2.12 Provisional ALC data are available nationally based on 1:250,000 scale mapping but these only provide an indication of potential ALC grades and do not differentiate between Subgrades 3a and 3b. To inform a conservative assessment, it is assumed herein that Subgrade 3a is present where Grade 3 land is mapped.

1.2.13 The ALC for the study area is summarised in Table 1.3 and shown on Figure 11.2. There are no areas in the study area which are mapped as ALC Grade 5. The combined pre- and post-1988 ALC data columns have been calculated by preferentially using post-1988 data within the combined areas where available.

Table 1.3: ALC Grades for the study area

ALC Grade	Pre-1988 ALC Data Only (ha)	Post-1988 ALC Data Only (ha)	Combined Pre- and Post-1988 ALC Data (ha)	Area of Combined Data as % of Order Limits
Grade 1	11.8	-	10.3	2.4
Grade 2	42.5	3.3	43.5	10.2
Grade 3 (undifferentiated)	182.4	-	175.3	41.1
Subgrade 3a	n/a	2.1	2.1	0.5
Subgrade 3b	n/a	5.1	5.1	1.2
Grade 4	37.1	-	37.1	8.7
Non-agricultural	113.5	-	113.1	26.5
Urban	39.4	-	39.4	9.2
Post-1988 other	n/a	0.8	0.8	0.2

1.2.14 The post-1988 ALC data show small areas of Grade 2 land in Sections C and H to the southeast of Crondall and southwest of Queen Mary Reservoir respectively. Subgrades 3a and 3b are mapped in Sections B and H to the southeast of Four Marks and southwest of Queen Mary Reservoir. 'Other land' is also mapped southeast of Four Marks.

1.2.15 As mentioned above, the provisional ALC data only provide a broad indication of potential ALC grades. However, they show BMV land to be potentially present for over a third of the Order Limits, mostly Grade 3, in Sections A to C, southwest of Aldershot. For the remainder of the route, non-agricultural and urban land are most common with pockets of Grades 1, 2, 3 and 4.

1.3 Geology

Introduction

1.3.1 The need for assessment of the environmental impact of the project associated with geology (including land stability) was scoped out at the scoping stage. However, information on the existing geology of the route has been included in this appendix as understanding of the geology underpins the other aspects including soils, minerals and potential land contamination.

1.3.2 Subsequent to the completion of the Scoping Report (Esso, 2018), a site of geological importance, known as Water Lane Site of Importance for Nature Conservation (SINC) was identified within the study area. This individual site has been scoped in to the assessment and the baseline condition is detailed below.

Study Area

1.3.3 The study area for environmental impact assessment of geology is limited to the area of the Water Lane SINC as shown on Figure 11.3 and 11.5.

1.3.4 Geological mapping of the general area has been reviewed to inform our understanding of the geological context. Figure 11.3 is based on the 'BGS 1:50,000 bedrock geological mapping' and Figure 11.4 on the 'BGS 1:50,000 superficial geological mapping' (BGS, 2018).

Bedrock Geology

1.3.5 The bedrock geology (geological units as shown on the 1:50,000 geological map, group names and the geological period to which they belong) is summarised in Table 1.4.

Table 1.4: Bedrock Geology

Geological Unit (As Shown on 1:50,000 BGS Mapping)	Group Name	Geological Period
Earnley Sand Formation	Bracklesham Group	Palaeogene
Wittering Formation		
Bagshot Formation		
Windlesham Formation		
Camberley Sand		
Durley Sand Member	Thames Group	
London Clay Formation		
Whitecliff Sand		
Claygate Member		
Lambeth Group - Clay, Silt and Sand	Lambeth Group	
Lambeth Group - Sand		
Tarrant Chalk Member	Chalk Group	Cretaceous
Newhaven Chalk		
Seaford Chalk		
Lewes Nodular Chalk		
New Pit Chalk		

Geological Unit (As Shown on 1:50,000 BGS Mapping)	Group Name	Geological Period
Holywell Nodular Chalk		
Zig Zag Chalk		
West Melbury Marly Chalk		
Upper Greensand Formation	Selborne Group	
Gault Formation		
Folkestone Formation	Lower Greensand Group	
Bargate Sandstone		

1.3.6 The bedrock geology in the general area, from Boorley Green to Bishop's Waltham (within Section A), comprises Palaeogene aged strata of the Bracklesham Group (silt, sand and clay), Thames Group (sand, gravel and clay) and Lambeth Group (clay, silt and sand). The Wittering Formation is the only formation present in the Bracklesham Group at this location. From Upham to Crondall (Sections A, B and C), the Cretaceous Chalk Group is present for a large extent and there is a smaller section of the Upper Greensand Formation and Gault Formation of the Selborne Group between Chawton and Bentley (Section C), both of which represent the rim of the Weald Anticline. From Crondall to West Bedfont (Sections C to H), the Palaeogene aged strata are present again for a large extent with the Bracklesham Group outcrop comprising the Camberley Formation, Windlesham Formation and the Bagshot Formation (Wittering Formation is absent), observed between Church Crookham and Shepperton (Sections D to H). North of Shepperton (Section H) the bedrock geology comprises Thames Group including the Claygate Member and the London Clay.

Superficial Geology

1.3.7 The superficial geology of the general area (geological units as shown on the 1:50,000 geological map (Figure 11.4), and the age range from within which they formed) is summarised in Table 1.5. Note that Figure 11.4 shows the geological map for the wider area and therefore includes some geological units not described in Table 1.5.

Table 1.5: Superficial Geology

Geological Unit (As Shown on 1:50,000 BGS Mapping)	Age Range
Alluvium	Holocene
Peat	Quaternary
Langley Silt	Quaternary (Devensian)
Head	Quaternary
Clay with Flints	Palaeogene - Pleistocene
River Terrace Deposits (undifferentiated)	Quaternary
Kempton Park Gravel	Quaternary (Devensian)
Shepperton Gravel	Quaternary (Wolstonian)
Lynch Hill Gravel	Quaternary (Wolstonian)

1.3.8 The superficial geology mapping shows superficial deposits are absent over much of the route in Sections A to F. From Boorley Green to Crondall (Sections A to C),

undifferentiated River Terrace Deposits are present as small areas associated with the main rivers. From Bishop's Waltham (Section A) to Chawton (Section B) Clay with Flints are locally present, particularly between Lower Farringdon and West Tisted (Section A). Head deposits are also present associated with the Clay with Flints.

1.3.9 Superficial deposits are absent from much of the study area between Crondall and Farnborough (Section D), with only localised Head deposits and Alluvium. From Frimley to Lyne (Sections E and F) there are areas of undifferentiated River Terrace Gravels, Alluvium and Head. Peat is locally present in the Chobham area (Section F).

1.3.10 The character of the superficial deposits changes in Sections G and H, with superficial deposits present throughout most of this area. These comprise various terrace gravels, including the Lynch Hill Gravel, the Shepperton Gravel and the Kempton Park Gravel. These gravels have been identified from various BGS boreholes and SLP boreholes (BH139, 25, 10, 09, 08, 06, 04, 03, 01) and have an average thickness of 6m, with a greater thickness where infilling deep hollows has taken place. The gravels are locally overlain by Langley Silt (in the Laleham area, Section H), up to 5m in thickness (average thickness of 3m) and Alluvium (particularly in Section G) up to 6m in thickness.

British Geological Survey Boreholes

1.3.11 The availability of boreholes in the BGS database pertinent to the project has been reviewed. BGS borehole locations are shown in Figure 11.3 and 11.4.

Project Ground Investigation

1.3.12 Some ground investigation has been undertaken for the project, targeting areas of uncertainty for engineering design, in particular trenchless crossings. Some areas of potential land contamination, as identified at an early stage of the project, during development of the project, were also targeted. The ground investigation has included chemical analysis of soil and groundwater. The ground investigation was limited by land access and health and safety considerations and is not complete at the time of writing. SLP borehole locations are shown in Figure 11.3 and 11.4.

1.3.13 The findings of the project ground investigations are consistent with the published geology.

Sites of Geological Importance

1.3.14 Review of national databases did not identify any sites designated for their geology within the study area, including Sites of Special Scientific Interest or Geological Conservation Review sites. However, a review of designations for nature conservation in Chapter 7 Biodiversity, identified one site within the study area, Water Lane, designated as a SINC where the criteria for designation were listed as 'Ancient Woodland' and 'RIGS (Regionally Important Geological Site)'. The site has therefore been reviewed as part of the baseline for the environmental assessment.

Water Lane

1.3.15 The Water Lane site is a SINC, which is a non-statutory designation, and according to the Hampshire SINC database the designation is for Ancient Woodland and

RIGS. The site does not however appear on other geological designation databases (Natural England, 2017; Natural England 2018; Joint Nature Conservation Committee 2017). The site was reviewed by the Sussex Geodiversity Partnership and Hampshire Biodiversity Information Centre (HBIC) in 2015 (Sussex Geodiversity Partnership, 2015) and '*the consensus after the visit confirmed that the site clearly met the criteria for designation as a RIGS (or Local Geological Sites). Documentation is now in progress*.'

1.3.16 Water Lane is an historic hollow lane linking West Worldham and Alton cutting down into the Upper Greensand Formation and the overlying Grey Chalk. The SINC designation covers a 2km length of the lane perpendicular to the route.

1.3.17 The rocky hollow lanes of Hampshire provide excellent exposures of the lithology and processes of geography but most of them have been surfaced with tarmac and incorporated into the modern highway network. As the historic Water Lane hollow lane from Selborne to Alton was replaced by a new road (B3006) in the mid-19th Century, the historic track has not seen major development, and the geological exposures can be viewed without risk from road traffic. The lane still appears much as it was in earlier times, with both historical and aesthetic interests. This includes in places a natural bedrock pavement where hard layers of the Lower Greensand are exposed in lane floor, and ancient cart ruts can be seen worn into the natural pavement. The historic interest of the site is linked to its geological interest as mentioned by Gilbert White in his world-famous classic work 'The Natural History and Antiquities of Selborne' (White, 1789). It is a route that that he routinely travelled along on his way to Alton.

1.3.18 The geology of the site comprises interbedded soft malmstone and hard siltstone of the Upper Greensand Formation, overlain to the northwest by the West Melbury Marly Chalk Formation of the Grey Chalk. The hard siltstone layers of Upper Greensand are known as Blue Rag and were specifically referred to by Gilbert White (Chatfield, 2015). According to Chatfield (2015), the Upper Greensand Formation is nationally limited to the western Weald and Wessex, while the Blue Rag is even more local and is potentially of international importance due to the international standing of the Gilbert White references.

1.3.19 In 2015 Water Lane was impacted by countryside access work to upgrade the Byway Open to All Traffic (BOAT) as part of The Writers' Way, and Hampshire County Council had started to cover up the natural bedrock with imported material and put in drainage pipes. The geological account by Chatfield (2015) confirmed the importance to the integrity of the geological site of retaining the site in its current state, and the upgrade works were halted.

1.4 Minerals

Study Area

1.4.1 The study area for minerals comprises the Order Limits as shown in Figure 11.6 which also shows the available minerals data for the wider area to provide context.

Hampshire

1.4.2 Minerals data were available from Hampshire County Council (2015, 2018), from Section A until where the pipeline cross the A331, northeast of Farnborough within Section E.

1.4.3 No minerals safeguarded sites have been identified within the study area.

1.4.4 A number of Minerals Consultation Areas are present however, comprising:

- Soft sand, based on Palaeogene Lambeth Group (sand) and sands of the London Clay Formation north of Boorley Green (approximately 9% of Section A);
- Brick clay, based on the Palaeogene Lambeth Group (clay, silt and sand) northwest of Bishop's Waltham (approximately 5% of Section A) and east of Crondall (approximately 10% of Section D); and
- Superficial soft sand and gravel between Boorley Green and Durley Street (approximately 13% of Section A), northeast of Alton (approximately 24% of Section C) and southeast to northeast of Fleet (approximately 28% of Section D).

1.4.5 Hampshire County Council also provided GIS data for Mineral and Waste Consultation Areas. These data were reviewed and no sites of relevance to Soils and Geology were identified within the study area or within the wider area of the Order Limits 1km buffer, since the sites were either related to waste (e.g. waste processing sites) or were dormant mineral extraction sites at which it is considered that no economically viable resources remain.

Surrey

1.4.6 In part of Section E and Sections F to H, minerals data were available from Surrey County Council.

1.4.7 There are no minerals sites designated in Section E. Approximately 7% of Section F, 78% of Section G and 55% of Section H lie within designated Surrey Mineral Safeguarding Areas for concreting aggregate.

1.4.8 Within the Mineral Safeguarding Areas there are two sites that lie partly within the study area (Section H) designated as Preferred Areas for mineral development and allocated for mineral extraction. These are:

- Queen Mary Reservoir, Sunbury − including land to the west of Queen Mary Reservoir within Reservoir Aggregates authorised landfill site, termed 'Queen Mary Quarry'. It is understood that there are no economically viable mineral reserves within Queen Mary Quarry, but that gravels dredged from the reservoir are processed at the quarry.
- Homers Farm, Bedfont − a permitted mineral working, from which the extraction of sand and gravel commenced in summer 2018, adjacent to the Esso West London Terminal storage facility. Planning permission was granted in 2015 for the extraction and a new access road from Short Lane, followed by restoration to agriculture. However, it is understood that the pipeline route would not overlap with areas intended for mineral extraction or the associated infrastructure, and that quarrying operations would largely have ceased before installation of the

pipeline reaches the site.

1.4.9 In addition, a conveyor link is due to be established via a tunnel under Ashford Road between another Preferred Area – Manor Farm, Laleham – and Queen Mary Quarry to transport minerals for processing at existing plant. The route of the proposed conveyor will pass through the Order Limits and thus although Manor Farm lies 100m west of the study area, it is included in the baseline for minerals. Site works are expected to start in 2019 at this permitted mineral working for the extraction of sand and gravel.

1.4.10 Existing minerals sites are identified at Laleham Landfill in Section H, but Brett Aggregates has confirmed that there are no economically viable resources remaining in this area and it is being restored.

1.5 Land Contamination

Study Area

1.5.1 The study area for land contamination is the Order Limits with a 250m buffer zone as shown in Figure 11.7. The inclusion of a 250m buffer is based on the Guidance for the Safe Development of Housing on Land Affected by Contamination (National House-Building Council and Environment Agency, 2008). This buffer is a conservative but sensible approach in the context of the project, taking into account the distance over which contamination can migrate.

Potentially Contaminated Sites

1.5.2 Sites within the study area which may potentially be affected by contamination from historical and/or current uses have been identified from a variety of information sources, including historical mapping, national databases and local regulatory enquiries. Sites were screened at the scoping stage based on an initial assessment of their potential as a contaminant source. Sites with a low contamination source potential were scoped out, allowing the desk study to focus on site uses which might have resulted in land contamination, with the potential for significant effects resulting from the project.

1.5.3 The baseline of scoped-in potentially contaminated sites (Table 1.6) is based on the following:

- Authorised and historical landfills – all scoped in for further desk study.
- COMAH (Control of Major Accident Hazards) sites – all scoped in for further desk study.
- Pollution incidents – information reviewed and scoped out as no incidents to land recorded within the study area above Category 3, with the exception of a Category 2 incident to land of inert waste within an area of authorised landfill (Laleham Landfill), already scoped in.
- Waste transfer sites – none identified within the Order Limits, scoped out.
- Historical potentially contaminative land uses identified from Groundsure mapping (Groundsure 2018a) – professional judgement used to identify specific land uses assessed to be of potentially higher source potential to be scoped in

(Table 1.6), land uses identified as lower source potential scoped out.

- Sites identified by regulators (including both local authorities and the EA) as potentially affected by contamination – professional judgement used in similar approach to identify higher source potential sites to be scoped in.
- Sites identified by Esso as potentially affected by activities associated with the existing pipelines – scoped in.

Table 1.6: Scoped-In Potentially Contaminated Sites

No.	Site Name	Section	Rationale for Scoping In
1	Boorley Green Gas Valve Compound	A	Historical land use (gas valve compound) within the study area but outside Order Limits.
2	West Tisted	B	Reported site of illegal pipeline tapping. Within Order Limits.
3	Four Marks Golf Club (former landfill Southwood Farm)	B	Historical landfill site within the study area but outside Order Limits.
4	Farringdon Business Park	B	Current industrial estate within the study area but outside Order Limits.
5	Star Energy, Alton	C	COMAH site (oil terminal) located within the study area but outside Order Limits.
6	Alton Material Recovery Facility (former railway sidings)	C	Current material recovery facility with historical land use (railway sidings) within the Order Limits.
7	Upper Froyle Land at Manor Farm (former landfill)	C	Historical landfill within the Order Limits.
8	Oak Park Golf Club (former tileries)	D	Historical land use (former tileries) within the study area but outside Order Limits.
9	Redlands/Wildlands House Area 1 (former landfill)	D	Historical landfill site within the study area but outside Order Limits.
10	Redlands/Wildlands House Area 2 (former landfill)	D	Historical landfill within the study area but outside Order Limits.
11	Ewshot Hill (former brick yard)	D	Historical land use (brick yard) within the study area but outside Order Limits.
12	Ewshot (former brick & timber yard)	D	Historical land use (brick and timber yard) within the Order Limits.
13	Former Queen Elizabeth II Barracks	D	Historical land use (military barracks) within the Order Limits.
14	Pyestock Hill (former landfill)	D	Historical landfill within the study area but outside Order Limits.
15	Southwood (former military land)	D	Historical land use (military training ground) within the Order Limits.
16	Farnborough (Main) Station (former railway sidings)	E	Historical land use (railway sidings) within the study area but outside Order Limits.
17	Farnborough (Main) Station (former gas works)	E	Historical land use (gas works) within the study area but outside Order Limits.
18	Farnborough (Main) Station (former Powell Duffryn Fuels)	E	Former COMAH site within the study area but outside Order Limits.
19	Farnborough (North) Station (former gas works)	E	Historical land use (gas works) within the study area but outside Order Limits.

No.	Site Name	Section	Rationale for Scoping In
20	Farnborough (North) Station (former railway)	E	Historical land use (railway sidings) within the Order Limits.
21	South of Frimley Station (former landfill)	E	Historical landfill within the Order Limits.
22	Frimley Station (former railway sidings)	E	Historical land use (railway sidings) within the study area but outside Order Limits.
23	Johnson Wax Ltd., Frimley	E	Former COMAH site within the study area but outside Order Limits.
24	Princess Royal Barracks	E	Historical land use (military land) within the Order Limits.
25	Red Road Hill Depot	F	Historical and current land use (landfill, scrap yard, vehicle maintenance) within the study area but outside Order Limits.
26	Chobham Car Spares	F	Current land use (vehicle servicing yard/scrap yard) within the study area but outside Order Limits.
27	Hanworth Trading Estate	G	Current industrial estate within the study area but outside Order Limits.
28	Former Chertsey Gas Works	G	Former COMAH site within the study area but outside Order Limits.
29	Abbey Moor Golf Club (former landfill)	G	Historical landfill within the Order Limits.
30	Lavenders Landfill	G	Historical landfill within the Order Limits.
31	Old Littleton Lane Landfill	G	Historical landfill within the Order Limits.
32	Sheep Walk Landfill (Chertsey Road Tip)	G	Historical landfill within the study area but outside Order Limits.
33	Littleton Lane Landfill	H	Historical landfill within the Order Limits.
34	Laleham Landfill	H	Authorised landfill within the Order Limits.
35	*Home Farm Extension*	*H*	*Within 250m of proposed Order Limits at scoping stage. However, due to design development it is no longer within the study area, and is not reported further in this appendix.*
36	Home Farm Landfill	H	Authorised landfill within the Order Limits.
37	*Southwest of Queen Mary Reservoir*		*Within 250m of proposed Order Limits at scoping stage. However, due to design development it is no longer within the study area, and is not reported further in this appendix.*
38	South of Queen Mary Reservoir Landfill	H	Historical landfill within the Order Limits.
39	*Laleham Gas Valve Compound*		*Within 250m of proposed Order Limits at scoping stage. However, due to design development it is no longer within the study area, and is not reported further in this appendix.*
40	Queen Mary Quarry	H	Authorised landfill within the Order Limits.
41	White House Garage, Ashford	H	Historical land use (garage) and current land use (waste transport vehicle depot) within the study area but outside Order Limits.
42	Staines Bypass (former sewage works)	H	Historical land use (sewage works) within the study area but outside Order Limits.
43	47 Woodthorpe Road, Ashford	H	Historical land use (engineering site and other potentially contaminative uses) within the study area but outside Order Limits.
44	21-35 Woodthorpe Road, Ashford	H	Historical land use (electrical engineering works and printing works) within the study area but outside Order Limits.
45	Hitchcock & King (former	H	Historical land use (railway sidings and other contaminative

No.	Site Name	Section	Rationale for Scoping In
	railway sidings)		land uses) and current use (timber depot) within the study area but outside Order Limits.
46	Scott Freeman Gardens, Ashford	H	Historic land use (gravel pit possibly filled) within the study area but outside Order Limits.
47	St. David's School (former landfill)	H	Historical landfill within the Order Limits.
48	Clockhouse Lane (former landfill)	H	Historical landfill within the Order Limits.
49	Former Bulldog Service Station	H	Historical land use (service station) within the study area but outside Order Limits.
50	Former Lionvale Service Station	H	Historical land use (service station) and current land use (MOT garage) within the study area but outside Order Limits.
51	Homers Farm	H	Mineral extraction site within the Order Limits where historical contamination has been identified.
52	West Bedfont (former sewage works and landfill)	H	Historical land use (sewage works) and historical landfill within the Order Limits.
53	Esso West London Terminal	H	COMAH site and historical landfill within the Order Limits.

1.5.4 For each scoped-in site, a desk study was undertaken. This involved review of available information from environmental databases and national datasets including geology, hydrogeology and environmental setting, and review of pertinent information provided by regulators and site landowners or operators. Information from the SLP ground investigation and pertinent BGS boreholes was included. Aerial photography was also reviewed. Site reconnaissance with limited site walkover was undertaken for some, but not all sites. Access for site walkover was limited by factors including landowner access permission, safety of access, and perceived need for site walkover following initial desk study. The desk studies are summarised in Annex B of this appendix.

1.5.5 The desk studies have been used as the basis of preliminary risk assessment in general accordance with the principles in Contaminated Land Report 11 (CLR11; Environment Agency and DEFRA, 2004), allowing the development of an initial conceptual model for each site, and identification of potential pollutant linkages in the context of the project.

1.6 Land Contamination Risk Assessment

Introduction

1.6.1 This land contamination risk assessment has been prepared to support the application for development consent for the project. It covers the potentially contaminated land sites that have been scoped into the ES, as described in Chapter 6 Overview of Assessment Process. The assessment is based upon the desk-based review of available information, a site walkover (where this was possible) and the review of available site investigation and monitoring reports. A preliminary risk assessment has been undertaken to identify potential and/or plausible pollutant linkages which might impact or be impacted by the project.

1.6.2 The risk assessment is used to inform the determination of the receptor value/sensitivity, magnitude and impact significance for land contamination as

described in Chapter 11 Soils and Geology. The criteria for assessment of the magnitude of effects of contamination include criteria based on the outcome of qualitative risk assessment. For example, where the qualitative risk assessment identifies one or more high risk relevant pollutant linkage, the impact magnitude is assessed as large, and where qualitative risk assessment identifies only low risk relevant pollutant linkages, the impact magnitude is assessed as negligible.

Methodology

1.6.3 The process of contamination risk assessment is defined within CLR11. A summary of the approach, which has been adopted within this report, is outlined below.

- Hazard identification, which involves establishing contaminant sources and hazard assessment, by establishing pathways (a route or means by which a receptor can be exposed to, or affected by, a contaminant) and receptors, and identifying potential pollutant linkages (PPLs). Both hazard identification and assessment stages conclude in the development of a conceptual site model (CSM).
- Risk estimation, which predicts the likelihood of harm or pollution occurring (probability assessment) and the degree of harm or pollution occurring (consequence assessment). Risk estimation is only undertaken when a PPL exists. Risk estimation has two components:
  - probability assessment, which relates to the likelihood of whether pollution/harm could occur, including in the short and/or long term; and
  - consequence assessment, which relates to the magnitude of harm that could occur because of the PPL, that is, the degree of harm or pollution considering the sensitivity of the receptor.
- Risk evaluation, which is the process of deciding whether a risk is acceptable or not, entails the application of evaluation criteria, which may be absolute standards or recommended limit values, for example a health criterion for the intake of a substance.

1.6.4 To determine the risk to the identified receptor, both the likelihood and severity of the potential hazard is put into a risk assessment matrix (Table 1.7), using guidance within Tables A1.8 to A1.10. These matrices are based on standard industry guidance (Construction Industry Research and Information Association (CIRIA) C552, Rudland *et al.*, 2001) with some modification for additional clarification. Potential risk outcomes comprise very high, high, moderate, moderate/low, low and very low.

Table 1.7: Risk Ratings for Qualitative Risk Assessment (Based on CIRIA C552)

Risk Matrix		Consequence of Occurrence (Severity)			
		Severe	Medium	Mild	Minor
Probability (likelihood)	High likelihood	Very high	High	Moderate	Moderate/low
	Likely	High	Moderate	Moderate/low	Low
	Low likelihood	Moderate	Moderate/low	Low	Very low
	Unlikely	Moderate/low	Low	Very low	Very low

Note this risk matrix applies to qualitative risk assessment only

1.6.5 Under such a classification system the following categorisation of risk (Table 1.8), consequence (Table 1.9) and probability (Table 1.10) has been developed and the terminology adopted.

Table 1.8: Risk Rating Definitions for Qualitative Risk Assessment (Based on CIRIA C552)

Risk	Risk Description
Very high	There is a high likelihood of the event occurring and having severe consequences. If the risk is realised, it is likely to result in a substantial liability.
High	It is likely that an event with medium or even severe consequences could arise. If the risk is realised, it may result in a substantial liability.
Moderate	It is possible that an event could occur but it is either unlikely and consequences may be severe or, if it were to occur, it is likely that consequences would be relatively mild. Investigation would normally be required to clarify the risk and determine the potential liability.
Low risk	It is possible that an event could occur but it is likely that the consequences would be at worst mild.
Very low	It is unlikely that an event could occur, and if it happened the consequences are likely to be at worst mild.

Table 1.9: Classification of Consequence for Qualitative Risk Assessment (Based on CIRIA C552)

Classification	Human Health	Controlled Waters	Buildings/ Services	Grazing Animals
Severe	Short-term (acute) risk to human health. Concentrations present likely to result in 'significant harm' as defined by Part 2A.	Substantial pollution of water resources such that 'significant pollution' or 'significant possibility of pollution' of controlled waters as defined by Part 2A is being caused.	Catastrophic damage	Concentrations present likely to result in "significant harm" as defined by Part 2A.
Medium	Chronic damage to human health. Concentrations present that could result in significant harm.	Pollution of water resources such that there is a measurable (but not significant) reduction in water resources compared to the water quality standard.	Significant damage to buildings, structures or the environment making it unsafe to occupy, or damage that may impair a scheduled ancient monument.	Significant damage or harm to grazing animals that could endanger the long-term functioning of the asset.
Mild	Slight short-term health effects to humans. Exposure to human health unlikely to lead to significant harm.	Measurable reduction in water quality compared to baseline.	Minor damage to sensitive buildings, structures, services or the environment.	Minor or short-lived damage or harm to grazing animals.
Minor	Non-permanent health effects to humans (easily prevented by means such as personal protective clothing.)	Insubstantial pollution to water resources compared to baseline.	Easily repairable	Non-permanent health effects.

Classification	Human Health	Controlled Waters	Buildings/ Services	Grazing Animals
Note the use of the term 'significant' in this table is in accordance with CLR 11 and Part 2A statutory guidance on land contamination and does not relate to impact significance.				

Table 1.10: Classification of Probability

Classification	Definition
High likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a pollutant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain even over a longer period that such an event would take place and is even less likely in the shorter term.
Unlikely	There is a pollution linkage, but circumstances are such that it is improbable that an event would occur even in the very long term.
Note the terminology in this table is in accordance with CLR 11 and Part 2A statutory guidance on land contamination and does not relate to impact significance.	

Preliminary Conceptual Site Model

Potential Sources of Contamination

1.6.6 Details of the potential sources of contamination associated with each potentially contaminated site are included within the individual desk studies in Annex B of this appendix.

Potential Receptors of Contamination

1.6.7 Potential receptors have been identified for each potentially contaminated site and are included within the individual desk studies in Annex B of this appendix. The potential receptors identified are:

- construction workers;
- adjacent land users and buildings;
- adjacent grazing animals;
- principal aquifer;
- secondary aquifer (A, B or Undifferentiated); and
- surface water.

1.6.8 The pipeline itself has not been included as a potential receptor to aggressive contaminants that could be present within shallow soils and groundwater. The pipeline would be constructed of material to protect against aggressive contaminants, which is a measure embedded in the design.

Potential Pathways of Contamination

1.6.9 In accordance with the Updated Technical Background to the Contaminated Land Exposure Assessment (CLEA) model (Environment Agency, 2009a), the potential

pathways by which contaminants may affect the identified receptors are:

1.6.10 Human health and animal receptors:

- inhalation of contaminated dust, vapour phase contamination or ground gases;
- ingestion of contaminated soil, dust and groundwater; and
- dermal contact with contaminated soil, dust and groundwater.

1.6.11 Environmental receptors:

- leaching of contaminants through the unsaturated zone to underlying groundwater;
- migration of leachable contaminants via surface runoff to adjacent water courses/surface water bodies;
- migration of contaminants within groundwater to other water bodies (including other aquifer systems/surface water bodies); and
- migration of ground gases and vapours through permeable deposits followed by build-up within voids of buildings and services.

Preliminary Conceptual Site Model

1.6.12 Based on the potential sources, receptors and pathways identified above, preliminary CSMs showing the PPLs are presented for each potentially contaminated site in Annex B of this appendix.

1.6.13 In relation to adjacent site users and adjacent grazing animals, the potential pathway has been identified as inhalation of windblown contaminated dusts and vapours only. Dermal contact and ingestion of settled contaminated dusts has not been identified as a plausible pollutant linkage, due to the short length of time the excavation works would be undertaken within any potentially contaminated site, which would reduce the potential for contamination deposition (and subsequent uptake via ingestion or dermal contact pathways).

Qualitative Risk Assessment

1.6.14 The qualitative risk assessment carried out on each potentially contaminated site, in accordance with the CLR11 methodology described above, is presented within the individual desk studies in Annex B of this appendix. The risk assessment assumes no good practice measures are in place. A summary of the linkages which were found to be 'moderate/low risk' or greater are presented in Table 1.11. These are the linkages with a potential impact magnitude greater than negligible for the environmental impact assessment and are referred to as relevant pollutant linkages (RPLs). These RPLs are assigned ID numbers.

1.6.15 Refer to Annex B of this appendix for all PPLs for all sites, including those assessed as 'very low risk' and 'low risk', which require no specific action.

1.6.16 Where excavation work would be carried out at known landfill sites or sites where waste materials were known to be deposited, the potential also exists for the exposure to landfill gases (including methane and carbon dioxide). It should be noted that the risks associated with methane are acute and therefore the consequence is classified as very high (severe), meaning that however low the

likelihood that an event could occur, the overall risk cannot be considered any less than moderate/low. The consequence of the presence of carbon dioxide in isolation is classified as medium, as exposure at low concentrations would result initially in warning signs of its presence, such as headache and dizziness.

1.6.17 Where assessing the risk associated with asbestos in soil associated with scoped-in sites, where waste materials were known to be deposited, or previously demolished buildings were located, the consequence of exposure to asbestos has been classified as medium. This is because evidence gathered through the desk study suggests that for most sites, asbestos if present, is likely to be bonded (e.g. cement sheeting) or as very low concentrations of fibres in soil.

1.6.18 Where assessing the risk of all other organic and inorganic contaminants associated with the scoped-in sites, the consequence of exposure to humans from these contaminants has been classified as either medium or mild, dependent on the type and likely concentration of the contaminant.

1.6.19 The qualitative risk assessment has only been carried out for the construction phase, as land contamination is scoped out of the operational phase of the project.

Summary of Relevant Pollutant Linkages

1.6.20 As identified within Table 1.11, a number of RPLs have been identified which are moderate/low risk or above, and therefore would be assessed as greater than negligible if they were not modified by good practice measures.

1.6.21 Table 1.12 summarises how the good practice measures applicable to land contamination, address the identified RPLs, to break the linkage or modify them to an acceptable (low or very low) level of risk. Each commitment has its own reference number like this (G20). Good practice measures are set out in the Register of Environmental Actions and Commitments (Chapter 16 Environmental Management and Mitigation) and secured through Development Consent Order requirements such as the Code of Construction Practice (Appendix 16.1).

Table: 1.11: Pollutant Linkages Assessed as Moderate / Low Risk and Greater (Relevant Pollutant Linkages)

RPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
13A	Former barracks (*Former Queen Elizabeth II Barracks*)	Organic and inorganic contaminants including polychlorinated biphenyls (PCBs), hydrocarbons including total petroleum hydrocarbons (TPH) and polyaromatic hydrocarbons (PAHs), solvents, asbestos and metals	Inhalation, ingestion and/or dermal contact with contaminants in shallow soils and groundwater and exposure to vapours.	Construction workers	Human health (medium)	Low. Contamination has been identified on site but is likely to be localised as previous site investigations did not encounter widespread contamination.	Moderate/low
13B			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of soils.	Adjacent land users	Human health (medium)	Low. Contamination has been identified on site but is likely to be localised as previous site investigations did not encounter widespread contamination. Commercial and residential use border the Order Limits.	Moderate/low
14B	Former landfill – household waste (*Pyestock Hill (former landfill*))	Landfill gas (methane and carbon dioxide)	Migration through permeable strata, ingress and accumulation within receiver pit and trench.	Construction workers	Health effect (severe)	Unlikely. There is the potential for landfill gas, if present, to migrate through the permeable Head deposits. However, the landfill is 90m distant and dilution and oxidation is likely.	Moderate/low
15A	Former military land (*Southwood (former military land*))	Organic and inorganic contaminants including PCBs, hydrocarbons including PAHs, solvents, asbestos and metals	Inhalation, ingestion and/or dermal contact with contaminants in shallow soils and groundwater and exposure to vapours.	Construction workers	Human health (medium)	Low. Long contaminative use. However, contamination, if present is likely to be localised.	Moderate/low

RPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
15B			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of soils.	Adjacent land users	Human health (medium)	Low. Long contaminative use. However, contamination, if present is likely to be localised. Residential land uses border the Order Limits.	Moderate/low
21E	Former landfill *(South of Frimley Station (former landfill)*	Landfill gas (carbon dioxide)	Ingress and accumulation within trench	Construction workers	Health effect (medium)	Low. Open cut trenching directly into waste materials. Potential for accumulation in trench, if present. However, trenches are open and dilution is likely.	Moderate/low
23A	Johnson Wax Ltd, Frimley	Diesel fuel, oils, hydrocarbons, hazardous chemicals solvents and asbestos.	Direct contact with shallow groundwater, or soil affected by contamination transported in groundwater.	Construction workers (contact with shallow groundwater, or soil affected by contamination transported in groundwater).	Health effect (medium)	Low. Long industrial history of manufacturing, which ceased six years ago. Previous investigations and groundwater sampling in 2001 and 2004 did not record elevated concentrations. Asbestos cement identified in shallow soils within Order Limits. Shallow groundwater likely to be present in receiver pit and trench. However, likelihood of contaminants being present is considered to be low.	Moderate/low
25B	Landfill, depot and scrap yard *(Red Road Hill Depot)*	Landfill gas (methane and carbon dioxide)	Migration through permeable strata, ingress and accumulation within trench.	Construction workers	Health effect (severe)	Unlikely. There is the potential for landfill gas, if present, to migrate through the permeable deposits. However, the landfill is 100m distant and dilution and oxidation is likely.	Moderate/low

RPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
26A	Vehicle servicing depot *(Chobham Car Spares)*	Metals, fuels and oils, degreasing agents, solvents.	Migration in shallow groundwater to trench followed by ingestion and/or dermal contact with contaminants in shallow groundwater.	Construction workers	Health effect (medium)	Low. Little is known of the site surfacing and drainage arrangements. Trench is 12m distant and underlying geology could act as a pathway, although groundwater levels are not known.	Moderate/low
29F	Former landfill waste *(Abbey Moor Golf Club (former landfill))*	Landfill gas (carbon dioxide)	Ingress and accumulation within trench and launch pit.	Construction workers	Health effect (medium)	Low. Potential for accumulation in trench and pit for trenchless crossings. However, trenches and pits are open and dilution is likely.	Moderate/low
30A	Landfill waste (*Lavenders Landfill*)	A range of organic and inorganic contaminants, including hydrocarbons, PAHs, heavy metals, asbestos	Inhalation, ingestion and/or dermal contact with contaminants in shallow soils and groundwater and exposure to vapours.	Construction workers	Health effect (medium)	Low. Due to low contaminant levels recorded in limited testing to date. Contaminants could be directly excavated during open cut trenching and asbestos known to be present. Contaminants could leach into the trench.	Moderate/low
30E		Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench.	Construction workers	Health effect (severe)	Low. Moderate in-waste methane and carbon dioxide gas concentrations were recorded.	Moderate
30F			Migration along preferential pathways created by trench and ingress and accumulation	Adjacent land users	Health effect (severe)	Unlikely. Although moderate in-waste methane and carbon dioxide gas concentrations were recorded, there appears little driving force for off-site migration.	Moderate/low

RPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
			within off-site confined spaces.				
34A	Landfill waste and mineral processing activities *Laleham Landfill*	A range of organic and inorganic contaminants, including hydrocarbons, PAHs, heavy metals.	Inhalation, ingestion and/or dermal contact with contaminants in shallow soils and groundwater and exposure to vapours.	Construction workers	Health effect (medium)	Low. Contaminants could be directly excavated during open cut trenching. However, limited GI confirms low contaminant levels recorded. Contaminants could leach into the trench from surrounding wastes.	Moderate/low
34E		Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench.	Construction workers	Health effect (severe)	Low. Elevated methane and carbon dioxide gas concentrations were recorded close to area where open cut is proposed. Dilution is likely in open trench.	Moderate
34F			Migration along preferential pathways created by trenchless crossing and ingress and accumulation within off-site confined spaces.	Adjacent land users	Health effect (severe)	Unlikely. Although elevated methane and carbon dioxide gas concentrations were recorded, there appears little driving force for off-site migration.	Moderate/low
36C	Landfill waste *(Home Farm Landfill)*	Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench.	Construction workers	Health effect (severe)	Likely. High in-waste methane and carbon dioxide gas concentrations were recorded.	High
36D			Migration along preferential pathways created by trench and ingress and accumulation	Adjacent land users	Health effect (severe)	Unlikely. Although high in-waste methane and carbon dioxide gas concentrations were recorded, there appears little driving force for off-site migration.	Moderate/low

RPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
			within off-site confined spaces.				
38C	Landfill waste *(South of Queen Mary Reservoir Landfill)*	Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench.	Construction workers	Health effect (severe)	Low. Elevated methane and carbon dioxide gas concentrations were recorded, although dilution is likely within open trench.	Moderate/low
40C	Former landfill *(Queen Mary Quarry)*	Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench.	Construction workers	Health effect (severe)	Unlikely. Fill material is inert and gas monitoring records show methane and carbon dioxide concentrations have remained low.	Moderate/low
41A	Former garage (with former oil sumps/pits)/ waste transport vehicle depot (with fuel storage tank). *(White House Garage, Ashford)*	Hydrocarbons, waste oils, solvents, metals, automotive wastes, diesel fuel and cutting oils.	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours via groundwater flow.	Construction workers	Health effect (medium)	Low. Much of the pipeline installation adjacent to the site would be in a trenchless crossing which would limit the exposure to receptors.	Moderate/low
47A	Former landfill and unauthorised fly tipping of waste.	Range of organic and inorganic contaminants	Direct contact, ingestion and inhalation of contaminants.	Construction workers	Health effect (medium)	Likely. The pipeline would be open cut centrally through the site possibly intercepting landfill waste. Little is known about the capping of the landfill.	Moderate
47B			Inhalation of windblown contaminated	Adjacent land users	Health effect (medium)	Likely. Adjacent land users (e.g. St James School) would	Moderate

RPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
	(St. David's School (former landfill))		dusts and vapours from excavation works and stockpiling of waste materials.			be close to the working area (within 20m).	
47C			Direct migration of shallow groundwater into surrounding Principal aquifer.	Principal aquifer	Deterioration of groundwater quality (mild)	Likely. The pipeline would be open cut centrally through the site possibly intercepting landfill waste leading to release of contaminants into the aquifer.	Moderate/low
47D		Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench.	Construction workers	Health effect (severe)	Unlikely. The recorded elevation in hydrogen sulphide concentration was not sustained, and concentrations of other gases (methane and carbon dioxide) were not elevated. Trenches are open which would allow gases to vent/disperse.	Moderate/low
48A	Former landfill/ made ground bunds *(Clockhouse Lane (former landfill))*	Asbestos (chrysotile fibres), TPHs, PAHs, PCBs and excavated materials from roads and building foundations.	Direct contact, ingestion and inhalation of contaminants.	Construction workers	Health effect (medium)	Likely. The pipeline would be open cut through the site possibly intercepting landfill waste. The landfill does not have a sufficient cap.	Moderate
48B			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (medium)	Likely. Adjacent land users (e.g. St James School) would be close to the working area (within 20m).	Moderate

RPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
48C		TPHs and PAHs.	Direct migration of shallow groundwater into surrounding Principal aquifer.	Principal aquifer	Deterioration of groundwater quality (medium)	Likely. The pipeline would be open cut centrally through the site possibly intercepting landfill waste leading to release of contaminants into the aquifer.	Moderate
48D		Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench.	Construction workers	Health effect (severe)	Low. Up to 11.1% carbon dioxide was detected within made ground. However, trenches are open allowing gases to vent/disperse.	Moderate
51A	Hydrocarbons in soil and groundwater *(Homers Farm)*	Hydrocarbons	Direct contact, ingestion and inhalation of contaminants.	Construction workers	Health effect (medium)	Likely. The pipeline would be open cut through the area of identified hydrocarbon contamination.	Moderate
51B			Direct migration of hydrocarbons into surrounding Principal aquifer	Principal aquifer	Deterioration of groundwater quality (medium)	As above.	Moderate
52C	Former sewage works *(West Bedfont (former sewage works and landfill))*	Chemicals, metals, organic compounds, inorganic compounds and fuel oils.	Direct migration of shallow groundwater/ leachate into surrounding Principal aquifer.	Principal aquifer	Deterioration of groundwater quality (medium)	Low. The pipeline could allow the release of contaminated groundwater from the former sewage works into surrounding Principal aquifer. However, given the time passed since the historical land use, dispersion and attenuation of contaminants is likely to have occurred.	Moderate/low
52D	Former landfill / oil terminal *(West Bedfont (former sewage*	Range of organic and inorganic contaminants	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours.	Construction workers	Health effect (medium)	Likely. The pipeline would be open cut along the southern margin of the site possibly intercepting waste materials.	Moderate

RPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
52E	*works and landfill))*		Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (medium)	Likely. Users of the mineral extraction site (Site 51) would be in close vicinity to the works. Recreational users would be 140m from the excavation works.	Moderate
52F			Direct migration of shallow groundwater / leachate into surrounding Principal aquifer.	Principal aquifer	Deterioration of groundwater quality (medium)	Likely. The pipeline entering the landfill could perforate the clay lining and allow the release of contaminated groundwater / leachate into the surrounding Principal aquifer.	Moderate
53C	Former sewage works *(Esso West London Terminal, West Bedfont)*	Chemicals, metals, organic compounds, inorganic compounds and fuel oils.	Direct migration of shallow groundwater / leachate into surrounding Principal aquifer.	Principal aquifer	Deterioration of groundwater quality (medium)	Low. The pipeline could allow the release of contaminated groundwater from the former sewage works into surrounding Principal aquifer. However, given the time passed since the historical land use, dispersion and attenuation of contaminants is likely to have occurred.	Moderate/low
53D	Former landfill/ oil terminal *(Esso West London Terminal, West Bedfont)*	Range of organic and inorganic contaminants	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours.	Construction workers	Health effect (medium)	Likely. The pipeline would be open cut along the southern margin of the site possibly intercepting waste materials.	Moderate
53E			Inhalation of windblown contaminated dusts and	Adjacent land users	Health effect (medium)	Likely. Users of the mineral extraction site (Site 51) would be in close vicinity to the works. Recreational users would be	Moderate

RPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
			vapours from excavation works and stockpiling of waste materials.			140m from the excavation works.	
53F			Direct migration of shallow groundwater/ leachate into surrounding Principal aquifer.	Principal aquifer	Derogation of groundwater quality (medium)	Likely. The pipeline entering the landfill could perforate the clay lining and allow the release of contaminated groundwater/leachate into the surrounding Principal aquifer.	Moderate

Table: 1.12: Good Practice Measures Relevant to Land Contamination and Modification of RPLs

Ref.	Commitment Description	Discussion
G71	For all areas, the following strategic approach would be taken for the management of both known and unknown land contamination: • a desk based qualitative risk assessment would be undertaken on the basis of available information to ascertain areas of known and unknown contamination; • working methodologies would be produced based on the assessment; • contingency plans would be developed for dealing with various forms of known or unknown contamination to allow work to progress with limited delay. These procedures would clearly define methods for dealing with any areas of unexpected contamination to manage immediate risks and prevent any contamination, ground gas, airborne contaminants or odour spreading from the affected area, and for appropriate disposal. Measures would contain protocols for dealing with areas of potential asbestos-containing materials, should they be encountered. For areas where potential contamination is known or strongly suspected to be present as a result of past activities, the following would also be undertaken: • ground investigation information would be shared and developed as appropriate; • risks to receptors would be assessed, and mitigation and working methods to control those risks would be developed. Risks would include: encountering contaminated dust, soils and groundwater; and where the presence of ground gas and/or vapours may lead to confined space risks, such as in excavations;	There are RPLs related to risks to construction workers from exposure to hazardous substances in the ground related to land contamination. Due to the need to undertake excavations to facilitate the installation of the pipeline, it is not possible to 'design out' potential risks to construction workers. These good practice measures would limit risks to construction workers from land contamination to low or very low. There are also RPLs that relate to the risk of exposure of contaminated windblown dusts and vapours to adjacent land users, from the excavation works and the stockpiling of soil arisings. These good practice measures limit risks to adjacent land users from land contamination to low or very low.

Ref.	Commitment Description	Discussion
	• a Suitably Experienced Person would ensure that risk areas are identified, working methods followed and mitigation carried out appropriately; • made ground and materials known or strongly suspected of being contaminated would be segregated from natural and inert materials; and • ground arisings deemed unsuitable for re-use within the project would be disposed of appropriately for example to a soil treatment centre or landfill.	
O7	Where required, water stops (or “stanks”) would be installed at intervals through the pipe bedding and side fill.	Where open cut and trenchless crossings are constructed through known landfill sites, there is the risk that these could act as preferential pathways for the migration of landfill gas off-site, with associated risks to users of adjacent land. Migrating landfill gas could enter and accumulate into nearby buildings. The likelihood of this occurring would be low with implementation of this good practice measure. Similarly, there is the risk that excavation works could mobilise contaminants into underlying sensitive aquifers (controlled waters). This could occur as a result of the trench and trenchless tunnels acting as a preferential pathway. The likelihood of this occurring would be low with implementation of this good practice measure.
G75	Where the route passes through areas where there are active Environmental Permits (for example authorised landfill sites), the contractor(s) would work with the permit holder to comply with the permit requirements. This could include: • seek agreement from permit holders and regulators to allow works to proceed; • reinstate surface restoration materials; • reinstate of artificial geological barriers (where present); and • if applicable to site, work in accordance with relevant quality assurance procedures.	Permitted landfill sites may include engineered containment measures and infrastructure which may be compromised by development, with consequent risks to adjacent land users and controlled waters. The likelihood of this occurring would be low with implementation of these good practice measures.

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Annex A Trenchless Crossings Through Potentially Contaminated Sites

Table A1: Trenchless Crossings Through Potentially Contaminated Sites

Potentially Contaminated Site No. / Name	Trenchless Crossing							Comment
	Name / Technique	Length Through Site	Depth Through Site	Launch Pit Location / Dimensions	Receiver Pit Location / Dimensions	Likely Ground Conditions	Likely Groundwater Level	
Site 6 Alton Material Recovery Facility (former railway sidings)	A31 and minor access Road – horizontal directional drilling (HDD) [TC009]	Trenchless under far western corner of the site	7.7m	None. Pits located outside Site 6 area	None. Pits located outside Site 6 area	Made Ground underlain by gravel to maximum depth of 6.8mbgl, underlain by 3-13.7m Green Clay	2.8mbgl	Pipeline would be installed well below the likely depth of any Made Ground and below the water table.
Site 21 South of Frimley Station (former landfill)	Railway, Blackwater Valley, auger bore or HDD or open cut [TC020]	215m east to west directly under or through site	6m to 8.12m	None. Pits located outside Site 21 area	None. Pits located outside Site 21 area	3.5m waste 3.5-3.9 Clay 3.9-8.4 Gravel	1.4 to 3.2mbgl	For trenchless crossings, pipeline would be installed below the waste (surplus material from road construction) within the underlying natural ground and below the water table.
Site 29 Abbey Moor Golf Club (former landfill)[1]	Chertsey branch railway - auger bore [TC031]	16m from northeast boundary	5m	Drive pit within landfill 4.9m deep, 11.2m long, 3.5m wide	None. Pit located outside Site 29 area	3.0m waste Underlain with Gravel. Silty Sand from 5.7mbgl	1.3mbgl	Pipeline would be installed in a trench within the waste (deposited soils and sub soils) through the majority of the site, then installed below the waste within the underlying natural ground and below the water table.
Site 30 Lavenders Landfill	River Thames and B375 Chertsey Bridge Road – HDD [TC034]	35m from south-eastern corner	9.2m	None. Pit located outside Site 30 area	35m from southeastern corner	Waste to 9.7m underlain by Gravel. Clayey Silt between 3 and 8mbgl.	1 to 3mbgl	Pipeline enters the landfill at depth and connects to pipe laid in trench close to the eastern site boundary.

Potentially Contaminated Site No. / Name	Trenchless Crossing							Comment
	Name / Technique	Length Through Site	Depth Through Site	Launch Pit Location / Dimensions	Receiver Pit Location / Dimensions	Likely Ground Conditions	Likely Groundwater Level	
Site 30 Lavenders Landfill	M3 - HDD [TC035]	20m from northern boundary	6.1m under M3 motorway	20m from northern boundary	None. Pit located outside Site 30 area	Waste to 9.7m Underlain by Gravel. Clayey Silt between 3 and 8mbgl.	1 to 3mbgl	Pipeline exits the landfill at depth (6.1m) from shallow trench.
Site 31 Old Littleton Lane Landfill	River Thames and B375 Chertsey Bridge Road - HDD [TC034]	Crosses under southern tip	9.2m	None. Pit located outside Site 31 area	None. Pit located outside Site 31 area	Unknown waste depth. Clayey Silt between 3 and 8mbgl.	3mbgl	Pipeline likely to be installed below the likely depth of any waste within the underlying natural ground and below the water table.
Site 34 Laleham Landfill	M3 - HDD [TC035]	20m from southern boundary	6.1m rising to trench connection	None. Pit located outside Site 34 area	20m from southern boundary within landfill area, connects to trench installed pipe at 1.2mbgl	Up to 9.1m waste underlain by Clayey Silt	3.4mbgl	Pipeline enters the landfill at 6.1m depth, close to base of waste (inert) and then is open cut through the majority of the landfill before being tunnelled at depth through the northern boundary.
Site 34 Laleham Landfill	B376 Shepperton Road - auger bore [TC036]	10m from northern boundary	6m	10m from northern boundary Length 11m, width 3m, depth 6m	None. Pit located outside Site 34 area			
Site 36 Home Farm Landfill	B376 Shepperton Road - auger bore	23m from southern boundary	6m	None. Pit located outside Site 36 area	23m from southern boundary. Length 3m,	4.0m waste underlain by Sand and	3.4mbgl	Pipeline enters the landfill at depth, close to the southern boundary and then is open cut

Potentially Contaminated Site No. / Name	Trenchless Crossing							Comment
	Name / Technique	Length Through Site	Depth Through Site	Launch Pit Location / Dimensions	Receiver Pit Location / Dimensions	Likely Ground Conditions	Likely Groundwater Level	
	[TC036]				width 3m, depth 6m	Gravel. Clay at 9.0mbgl.		through the remainder of the landfill waste (inert).
Site 47 St David's School (former landfill)	Waterloo to Reading railway line - auger bore [TC041]	Cuts through the far southwest part of site – 45m	6.1m	None. Pit located outside Site 47 area	None. Pit located outside Site 47 area	>5.45m waste materials, underlain by London clay	2.1mbgl	Pipeline could be installed within waste materials and below the water table.
Site 47 St David's School (former landfill)	Staines Road A30 – HDD or auger bore [TC042]	30m from northern boundary	5m to 6m	30m from northern boundary. If auger bore, pit would be 6m deep, 11m long, 3m wide	None. Pit located outside Site 47 area	>5.45m waste materials, underlain by London clay	2.1mbgl	Pipeline crosses the majority of the site in trench and exits the northern boundary, via tunnelling.

Annex B Scoped-in Potentially Contaminated Site Desk Studies

Table B1: Boorley Green Gas Valve Compound / ES Site No. 1

Site Name / Ref	Boorley Green Gas Valve Compound / ES Site No. 1
Basis for Scoping In	The site has been identified from historical mapping as a gas valve compound within 250m of the Order Limits.
Site Location and Description	The site is located ~50m north of Oakridge Farm off Maddoxford Lane along Section A of the route (E: 451272 N: 114247). The area of the site is ~0.35ha and the ground elevation is ~19m Above Ordnance Datum (AOD). It was not possible to view or access this site to undertake a walkover survey. However, aerial photos show that the majority of the site is occupied by grass (possibly being used as grazing land). The site is located outside the Order Limits, 80m to the south.
Site History	A review of the earliest historical maps indicates land was unoccupied in a rural setting in the late 1800s. The site remained undeveloped until 1987 when the gas valve compound first appear on maps (1:2,500 and 1:10,000), with two structures, presumably part of the infrastructure. From aerial photographs dated between 1999 and 2000, the two structures are no longer visible, but a gas installation is labelled as 'SGN IP/MP Gas Governor' on an existing services plan in a planning application dated 19/04/16 (O/16/78389), available to view on the Eastleigh Borough Council Public Register.
Other Pertinent Information	No other information has been identified.
Landfill Operations	n/a
Previous Ground Investigations	Previous ground investigation data are not available.
Geology	Superficial geology: River Terrace Deposits (Undifferentiated) – sand and gravel (Quaternary). Bedrock geology: Wittering Formation – clay, silt and sand (Lutetian – Ypresian).
Hydrogeology	There are no site-specific data for groundwater level. The River Terrace Deposits and the Wittering Formation are Secondary A aquifers.
Hydrology	There are no watercourses, recorded pollution incidents, groundwater abstractions and surface water abstractions on site. The site is not located within a Source Protection Zone (SPZ) or Flood Zone. There is limited potential for groundwater flooding to occur at the site. There is no risk of surface water flooding from rivers or reservoirs.
Environmental Setting	The site lies on Agricultural Land Classification (ALC) Grade 1 and Grade 3, which is classed as Best and Most Versatile (BMV) agricultural land and is within a Nitrate Vulnerable Zone (NVZ) (Hamble Estuary Eutrophic Water).
Soil, Groundwater or Gas Results	No information available.
Remediation	Not known, no information received.
Potential Sources of Contamination	No potential sources of contamination have been identified.

Site Name / Ref	Boorley Green Gas Valve Compound / ES Site No. 1
Potential Contaminants	n/a
Potential Receptors and Pathways	n/a
Ground Contamination Risk Assessment and Conceptual Site Model	n/a
References	References include those listed in Chapter 11 Soils and Geology. Eastleigh Borough Council (2018). Planning Register. Accessed November 2018. https://planning.eastleigh.gov.uk/s/public-register.

Table B2: West Tisted / ES Site No. 2

Site Name / Ref.	West Tisted / ES Site No. 2
Basis for Scoping In	Advised by Esso.
Site Location and Description	In rural land approximately 500m northwest of West Tisted Village, adjacent to a farm track/Public Right of Way. There is a small farm building adjacent to the site, which is located on the top of a hill. The site was the location of illegal tapping of the Esso Multiproducts line. The site is within the Order Limits. The pipeline would not be constructed within 3m of the Multiproducts line and the affected area.
Site History	The land appears to have been agricultural land throughout its history. The two existing pipelines comprising the Esso Multiproduct line and the existing Southampton to London pipeline were constructed through the site in the 1960s.
Other Pertinent Information	It was discovered in April 2015 that the Multiproducts line had been illegally tapped at the site. There was no evidence of any loss of product at the time of the tapping. A limited ground investigation was undertaken and monitoring conducted through a 'sniffer tube' In October 2017, it was noted that Volatile Organic Compounds (VOCs) were being detected in the sniffer tube, and the pipeline was inspected. There was an issue with the seal on the replacement clamp installed after the tapping. A maximum Total Petroleum Hydrocarbon (TPH) concentration of 6,895mg/kg was identified in the soil immediately beneath the tapping point. There was no visible effect at the surface and the groundwater (a Principal aquifer) beneath the site was very deep. A borehole was installed at the site to check for the presence of any hydrocarbons in the chalk, in particular in any fractures. The borehole was drilled in September 2018, and no evidence of hydrocarbons was observed at any stage in the borehole. Drilling was stopped at 20m and the borehole backfilled.
Landfill Operations	n/a
Previous Ground Investigations	See 'Other Pertinent Information'.
Geology	The site is underlain by superficial deposits of clay-with-flints, overlying Chalk of the Newhaven Chalk Formation.
Hydrogeology	The Chalk beneath the site is classified as a Principal aquifer. The site is not within a SPZ. The nearest SPZ (zone 2) is 350m to the south.

Site Name / Ref.	West Tisted / ES Site No. 2
	Based on a site elevation of 180mAOD, and the Environment Agency groundwater model for the Chalk and Upper Greensand (maximum contours February 2001) (Environment Agency, 2007), groundwater is anticipated to be at a depth of at least 75m below ground level (bgl) (105mAOD), with flow towards the west.
Hydrology	There are no surface water bodies within 250m of the site. The nearest surface water body is a small pond in West Tisted, 575m southeast of the site.
Environmental Setting	There are no environmental designations within 250m of the site.
Soil, Groundwater or Gas Results	See 'Other Pertinent Information'.
Remediation	See 'Other Pertinent Information'.
Potential Sources of Contamination	Multiproducts pipeline.
Potential Contaminants	Hydrocarbons
Potential Receptors and Pathways	Construction workers: direct contact, inhalation and ingestion of contaminants, and exposure to vapours, associated with shallow soil during open cut trenching. Adjacent land users: inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of soils. Underlying Principal aquifer: disturbance of contaminated soils could mobilise contamination into underlying aquifer.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the Potential Pollutant Linkage (PPL) has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 2 Table 1. The investigation demonstrates that the magnitude of impact of the loss of product to ground was very small and localised, with little impact beyond the immediate vicinity of the tapping point in the ground. The depth to groundwater (>75m) means that contamination would be attenuated by natural processes long before it reached the aquifer, with low impact. The small magnitude of the spill as reported and the distance (greater than 3m) to new pipeline indicates low risk to other receptors.
References	References include those listed in Chapter 11 Soils and Geology. Pers. Comm. Esso 15/11/18. Environment Agency (2007). Environment Agency Southern Region. East Hampshire and Chichester Chalk Numerical Modelling Project. Phase 2a – Model Construction and Refinement. Entec UK Limited.

Table B3: ES Site No. 2 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
2A	Multiproducts pipeline	Hydrocarbons	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours	Construction workers	Health effect (medium)	Unlikely. Contamination likely to be localised to Multiproducts pipeline, 3m from the open cut works.	Low
2B			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (medium)	Unlikely. Contamination likely to be localised to Multiproducts pipeline, 3m from the open cut works.	Low
2C			Direct migration into underlying Principal aquifer	Underlying Principal aquifer (Chalk)	Deterioration of groundwater quality (medium)	Unlikely. Contamination likely to be localised to Multiproducts pipeline, 3m from the open cut works. Overlying superficial deposits of clay-with-flints, likely to restrict downward migration into Chalk. No evidence of contamination in borehole drilled.	Low

Table B4: Four Marks Golf Club (Former Landfill Southwood Farm) / ES Site No. 3

Site Name / Ref.	Four Marks Golf Club (Former Landfill Southwood Farm) / ES Site No. 3
Basis for Scoping In	The site has been identified as a former landfill within 250m of the Order Limits.
Site Location and Description	The site is located at the west end of Four Marks Golf Club in Four Marks along Section B of the route (E: 468286 N: 134077) and covers an area of 0.21ha. The ground elevation of the site is ~200mAOD. A site walkover survey was carried out on 19/10/18. The purpose of this walkover was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was accessed with prior permission from the landowners. At the time of the walkover, the site was part of a golf course that also had a club house and car park. The topography across the golf course was undulating and gently rolling with mounds (some covered by vegetation) present across the site. Vegetation across the site consisted of grass, shrubs, semi-mature trees and mature trees. The site is located outside the Order Limits, 135m to the northwest.
Site History	The former land use of the site is labelled as 'old chalk pits' on maps dated from 1870 to 1936 (1:10,560). The pits were labelled as disused in the historical map dated 1972 (1:2,500). The Environment Agency (09/10/18) confirmed the pit was used as a landfill between 1989 and 1990. The former landfill has been overgrown with vegetation up to the present day.
Other Pertinent Information	A waste disposal licence was granted in May 1989 for land at Southwood Farm which was surrendered in April 1990 (Environment Agency, 09/10/18). The licence permitted the deposit of sand, chalk, gravel and other naturally occurring earth spoils plus '*waste produced in the course of constructing, improving, repairing or demolishing any building or structure; excluding all fibrous forms of*

Site Name / Ref.	Four Marks Golf Club (Former Landfill Southwood Farm) / ES Site No. 3
	asbestos'.
Landfill Operations	The landfill operated between 1989 and 1990 (Environment Agency, 09/10/18). The depth is unknown and there would not have been any lining or leachate/gas management systems. The licence did not require the licence holder to undertake any environmental monitoring, and the Environment Agency do not have any monitoring data for the site.
Previous Ground Investigations	No ground investigation data are available.
Geology	The British Geological Survey (BGS) geological mapping shows superficial geology comprising Clay-with-Flints Formation (Pliocene) overlying Seaford Chalk Formation – chalk (Santonian – Coniacian).
Hydrogeology	The Seaford Chalk Formation is classified as a Principal aquifer. Based on a site elevation of 200mAOD, and the Environment Agency groundwater model for the Chalk and Upper Greensand (maximum contours February 2001) (Environment Agency, 2007), groundwater is anticipated to be at a depth of at least 80mbgl (120mAOD), with flow towards the west.
Hydrology	There are no surface watercourses, groundwater abstractions, surface water abstractions or recorded pollution incidents on site. The site does not lie within a Flood Zone but it is located in two SPZs (Outer Zone 2 and Total Catchment Zone 3). There is limited potential for groundwater flooding to occur.
Environmental Setting	The site lies on ALC Grade 3 (BMV) agricultural land and is located within two NVZ (Hampshire Chalk Groundwater and North Wey Surface Water).
Soil, Groundwater or Gas Results	No information available.
Remediation	Not known, no information received.
Potential Sources of Contamination	Former landfill (1989 – 1990).
Potential Contaminants	Wastes and perched water/leachate: deposited wastes were natural soils and demolition materials. However, it is not uncommon for such wastes to contain organic and inorganic contaminants. Landfill gas: deposited wastes were natural soils and demolition materials. However, it is not uncommon for such wastes to contain elevated concentrations of carbon dioxide.
Potential Receptors and Pathways	Construction workers: exposure to landfill gas that, if present, could migrate through fissures in the Chalk and accumulate in the pipeline trench.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 3 Table 1. Materials present in the landfill are likely to be inert with low potential to generate landfill gas. Given the distance to the Order Limits (135m), any landfill gas is likely to oxidise during migration. Therefore, the likelihood of elevated carbon dioxide being encountered during open cut works is considered low.
References	References include those listed in Chapter 11 Soils and Geology.

Site Name / Ref.	Four Marks Golf Club (Former Landfill Southwood Farm) / ES Site No. 3
	Environment Agency. Email information from Environmental Planning and Engagement, dated 9/10/18. Environment Agency (2007). Environment Agency Southern Region. East Hampshire and Chichester Chalk Numerical Modelling Project. Phase 2a – Model Construction and Refinement. Entec UK Limited.

Table B5: ES Site No. 3 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
3A	Landfill materials	Landfill gas (carbon dioxide)	Migration through permeable strata, ingress and accumulation within trench	Construction workers	Health effect (medium)	Unlikely. The landfill is 135m distant, and if present, dilution and oxidation of carbon dioxide is likely during migration.	Low

Table B6: Farringdon Business Park / ES Site No. 4

Site Name / Ref.	Farringdon Business Park / ES Site No. 4
Basis for Scoping In	The site is identified as a current industrial estate with various other land uses within 250m of the Order Limits.
Site Location and Description	The site is located in Lower Farringdon west of the A32 main road along Section B of the route (E: 470373, N: 135239). The site covers an area of ~3.9ha and the ground elevation of the site is 120mAOD. The site was viewed at a distance from Public Rights of Way on Woodside Lane at the north end of the site, on 19/10/18. No access onto the site was possible, as no access had been granted from the landowner. The purpose of the visit was to observe the land use within and around the current site and to identify both potential contaminant sources and pathways through which contaminants could migrate to the pipeline. The site at the time of the visit consisted of an industrial estate known as Farringdon Business Park, residential housing, a public house, a motorbike dealership and agricultural fields. The industrial estate had various trades including in a vehicle servicing operation, a wine box supplier, metal fabricators, courier services, carpet warehouse, car parks and a vehicle storage depot. There was hardstanding around the trade units and very little vegetation (mostly grassy verges) was observed within the industrial estate itself. The topography across the site was generally flat but sloped westwards at the west edge of the site, and the industrial estate was at a lower level than the surrounding land in the north along Woodside Lane. There was a grassy bund to the left of the entrance to the industrial estate (south side of Aylward's Drive). Although surface drains were not immediately obvious from the location of viewing, the industrial estate appeared to be adequately drained. Major contamination was not immediately obvious within the industrial estate. However, there were a number of portable toilet facilities, portable buildings and unspecified Intermediate Bulk Containers (IBCs) at the north end of the site. Additionally, there was a large amount of manure on the adjacent field at the northwest corner of the site along the site boundary. The site is located outside the Order Limits, approximately 80m to the east. There is a trenchless crossing beneath the A32, 400m to the

Site Name / Ref.	Farringdon Business Park / ES Site No. 4
	north of the site. There is an access road 10m from the northeast corner of the site.
Site History	The earliest historical maps dated 1870 to 1910 (1:1,250) show that the land was largely unoccupied in a rural setting. There were several dwellings and a public house in 1888. By 1910, the Meon Valley Railway was present and running from the northwest end of the site. This intersects the Order Limits ~300m north of the site. By 1956 (1:10,560), there were unspecified buildings on site and railway siding. The buildings are labelled as poultry houses with several tanks and a water storage unit on the historical map dated 1966 (1:2,500). By 1991, the Meon Valley Railway was disused.
Other Pertinent Information	Advanced Scaffolding Ltd was granted permission in March 2007 for the siting of three additional portacabins for use as an office and storage (East Hampshire District Council, 2018). The proposal specified that the yard was to be used for storage of scaffolding materials in racks, bins and stillages. It was also mentioned that a coal yard operates from the business park.
Landfill Operations	n/a
Previous Ground Investigations	A BGS borehole (SU7NW1) drilled in 1966 was located on the east side of the site and a borehole log has been reviewed (see geology below).
Geology	Superficial geology: Head – dominantly sand and gravel with lenses of silt and clay (Quaternary). Bedrock geology: Zig Zag Chalk Formation – Grey Chalk Subgroup (Cretaceous). Data from BGS borehole SU73NW1 showed that made ground was encountered from 0 – 0.91mbgl underlain by silty clay with occasional peat from 0.91mbgl – 2.13mbgl. Dark brown peaty silt was encountered from 2.13mbgl – 3.35mbgl underlain by medium dense fine-grained grey sand from 3.35mbgl – 5.18mbgl. Firm grey sandy clay was encountered from 5.18mbgl – 11.58mbgl.
Hydrogeology	Head is a Secondary Undifferentiated aquifer. The Grey Chalk Subgroup is a Principal aquifer. BGS borehole SU7NW1 recorded groundwater at 1.5mbgl.
Hydrology	There are no watercourses, groundwater abstractions, surface water abstractions or recorded pollution incidents on site. The site does not lie within a SPZ or Flood Zone. There is potential for groundwater flooding to occur at the surface and at a property situated below ground level on this site. There is a 0.1% to 3% annual chance of surface water flooding to occur at this site.
Environmental Setting	The site lies on ALC Grade 3 (BMV) agricultural land and is located within South Downs National Park (SDNP) and two NVZs (Hampshire Chalk Groundwater and North Wey Surface Water).
Soil, Groundwater or Gas Results	None available.
Remediation	Not known, no information received.
Potential Sources of Contamination	Railway/siding (1910 – 1991). Industrial buildings including metal fabricators and vehicle servicing (1956 – present).

Site Name / Ref.	Farringdon Business Park / ES Site No. 4
Potential Contaminants	Fuels, oils, waste oils, solvents, metals.
Potential Receptors and Pathways	Construction workers: if shallow groundwater is present, construction workers could come into contact with contaminated groundwater during open cut trenching. Spills and leakages from site operations and storage may have caused contamination though either i) surface runoff to drains on the site, assuming drains discharge to soakaway, or ii) direct discharge to unsurfaced areas and vertical migration to shallow groundwater. Due to the topography of the western side of the site, any potential contaminants could flow west through the superficial aquifer towards the pipeline. Construction workers could also come into contact with contaminants in soil in the unsaturated zone, which have migrated during periods of higher groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 4 Table 1. The listed potential contaminants are likely to be present on site given the site's long industrial history, albeit the sources are likely to be small and localised. Leaks and spillages could enter shallow groundwater via vertical migration in areas without hard cover or via runoff from hardstanding areas if surface water drainage discharges to soakaway. If any contaminated shallow groundwater migrates westwards, it could be encountered within the pipeline installation trench where construction workers could be exposed. However, the depth to groundwater and flow direction has not been confirmed, and given the Order Limits are 85m distant, attenuation of any contaminants (if present) is likely, as well as smear in the unsaturated zone. The likelihood of substantial contamination from the site being encountered by the project is considered very low.
References	References include those listed in Chapter 11 Soils and Geology. East Hampshire District Council (2018). Planning – Simple Search. Accessed October 2018. https://planningpublicaccess.easthants.gov.uk/online-applications/.

Table B7: ES Site No. 4 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
4A	Metal fabricators and vehicle services.	Fuels, oils, waste oils, solvents, metals.	Surface runoff and/or transportation via drainage soakaway and groundwater flow	Construction workers	Health effect (mild)	Unlikely. Due to localised and limited source potential, and likelihood of attenuation due to distance from receptor.	Very low

Table B8: Star Energy, Alton / ES Site No. 5

Site Name / Ref.	Star Energy, Alton / ES Site No. 5
Basis for Scoping In	The site is identified as a Control of Major Accident Hazards (COMAH) site located within 250m of the Order Limits.

Site Name / Ref.	Star Energy, Alton / ES Site No. 5
Site Location and Description	Star Energy is located in a rural area on the south side of the A31, Cuckoo's Corner in Alton along Section C of the route (E: 474494 N: 141479). The estimated area of the site is 5.4ha and ground elevation at the site is ~100mAOD. The site was viewed from Public Rights of Way on 19/10/18. No access onto the site was possible, as no access had been granted from the landowner. The purpose of this visit was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. At the time of the visit, the site was an oil terminal consisting of small office buildings, loading and offloading bays, crude oil storage tanks and an electricity pylon near the site entrance with overhead power cables. The topography across the site was generally flat hardstanding tarmac and concrete. The site is at a lower elevation relative to the adjacent Alton Bypass. There were no obvious signs of subsidence. The site appeared to be adequately drained. Vegetation across the site consisted of grass, shrubs and semi-mature trees. The 2015 COMAH Safety Report for the site (Haztech Consultants Ltd. 2016), available from the East Hampshire District Council website, specifies that the oil terminal was constructed in 1985. The storage tanks are made of corrosion resistant material and have a capacity of 1,590m^3. They are positioned in a concrete bund with a grouted macadam floor and water tank. From the road tanker off-loading bays, the oil is transferred to the storage tanks via an eight-inch pipe. There is an oily water interceptor pump which has two submersible pumps, with one pumping out water to the River Wey. Crude oil is transferred to the terminal via a six-inch pipeline from Humbly Grove Energy Ltd Weston Common Gathering Centre. The site borders the western boundary of the Order Limits. The majority of the pipeline would be constructed in a trenchless crossing, (directional drilling) where it passes the site. The trenchless crossing would be approximately 7.5m deep.
Site History	From a review of the earliest historical maps suggests that the land was unoccupied in a rural setting in the late 1800s with a road running across the site, a railway line running parallel along the southern margin and a pond located at the northern margin of the site. There is the first appearance of a building adjacent to the railway line in 1939 (1:2,500) which is identified as a transformer station on the historical map dated 1974 (1:2,500). There is also the first appearance of the A31 road and embankment in the same year. The Safety Report specifies that the terminal was constructed in 1985. By 1994 (1:2,500), the crude oil storage tanks, depot and an electrical substation had developed. There has been no change to the land use since 1994.
Other Pertinent Information	No other information has been identified.
Landfill Operations	n/a
Previous Ground Investigations	Southampton to London Pipeline (SLP) ground investigation (GI) was undertaken, comprising the drilling of BH69 (November 2018) just beyond the eastern site boundary within the location of a construction compound and BH98 (October 2018) approximately 100m to the southeast of the site in the location of the trenchless crossing.
Geology	BGS information: Superficial geology: River Terrace Deposits – sand and gravel (Quaternary). Bedrock geology: West Melbury Marly Chalk Formation – chalk (Cretaceous), underlain by Upper Greensand Formation

Site Name / Ref.	Star Energy, Alton / ES Site No. 5
	(Cretaceous). SLP 2018 GI information from BH69: Sandy clay was encountered from ground level to 0.6mbgl underlain by clayey sandy gravel to 1.9mbgl (interpreted as Alluvium over River Terrace Deposits). This was in turn underlain by stiff very sandy clay to 6.1mbgl followed by siltstone and sandstone to 17.2mbgl (interpreted as weathered Upper Greensand Formation over Upper Greensand Formation). This is inconsistent with the BGS geological map which indicated that West Melbury Marly Chalk was expected to be present in this area. SLP 2018 GI information from BH98: • 0.05mbgl to 1.85mbgl: soft to firm sandy gravelly clay, interpreted as Alluvium. • 1.85mbgl to 4.55mbgl: soft gravelly clay becoming very gravelly with depth. This layer is assumed to be fully weathered bedrock of Upper Greensand Formation. • 4.55mbgl to 6.80mbgl: medium dense to dense clayey gravel. This layer is assumed to be fully weathered bedrock of Upper Greensand Formation. • 6.80mbgl to 20.15mbgl: Bedrock of Upper Greensand Formation comprising siltstone and sandstone. The upper part of the formation is generally weak to medium strong becoming medium strong to strong from a depth of 14.30m.bgl.
Hydrogeology	The River Terrace Deposits unit is a Secondary A aquifer. The West Melbury Marly Chalk Formation is part of the Grey Chalk Subgroup which is a Principal aquifer. The Upper Greensand is also a Principal aquifer. Within BH69, groundwater was encountered at 1.6mbgl during drilling. Three separate groundwater sampling events were undertaken at BH69 on 2/12/18, 12/12/18 and 3/1/19. Groundwater was detected at 2.56mbgl, 2.59mbgl and 2.67mbgl respectively. Within BH98, groundwater was encountered at 2.8mbgl during drilling. Three separate groundwater sampling events were undertaken at BH98 on 30/08/18, 06/09/18 and 12/09/18. Groundwater was detected at 2.89mbgl, 2.90mbgl and 2.91mbgl respectively.
Hydrology	There are no groundwater abstractions, surface water abstractions, recorded pollution incidents or surface watercourses on site. The site is not located within a SPZ or Flood Zone. There is a potential for groundwater flooding to occur at the surface at this site, and there is a 0.1% annual chance of surface water flooding on site. The River Wey is located 80m southeast of the site and flows northeastwards towards and intercepts the pipeline centreline.
Environmental Setting	The site lies on ALC Grade 2 (BMV) agricultural land and is located within two NVZs (Kingsclere and Greywell Groundwater, and North Wey Surface Water) and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	No notable elevated concentrations were detected in the soil or groundwater samples collected from BH69 and BH98. Results for PAHs, SVOCs, and TPHs are all shown to be below the analytical detection limit in these boreholes.
Remediation	Not known, no information received.
Potential Sources of Contamination	Railway land (1800s to present).

Site Name / Ref.	Star Energy, Alton / ES Site No. 5
	Transformer station (1939 to 1985). Oil Terminal (1985 to present). The Safety Report indicates that the only hazardous substances currently on site are the petroleum crude oil and diesel fuel, located in safe areas away from the main oil storage tanks. These are outside the Order Limits.
Potential Contaminants	Crude oil and diesel fuel. Toxic and phytotoxic metals, sulphate, fuels and oils, Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs), solvents, herbicides, de-icing fluids.
Potential Receptors and Pathways	Construction workers: if shallow groundwater is present, construction workers could come into contact with contaminated groundwater, during open cut trenching and excavation of launch and receiver pits (trenchless crossings). Spills and leakages from site operations and storage may have caused contamination though either i) surface runoff to drains on the site, assuming drains discharge to soakaway, or ii) direct discharge to unsurfaced areas and vertical migration to shallow groundwater. In addition, historical contaminants within shallow soils could leach and migrate via shallow groundwater. Construction workers could also come into contact with contaminants in soil in the unsaturated zone, which have migrated during periods of higher groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 5 Table 1. The listed potential contaminants are likely to be present on site given the site's long industrial history, albeit the sources are likely to be localised to the southern boundary. Leaks and spillages from current site use could enter shallow groundwater via vertical migration in areas without hard cover or via runoff from hardstanding areas if surface water drainage discharges to soakaway. However, these are likely to be negligible, given the strict COMAH regulations in place. Shallow groundwater was encountered during the drilling of BH69 at 1.6mbgl. Contaminated shallow groundwater that migrates westwards could be encountered within the pipeline installation trench where construction workers could be exposed. However, flow direction has not been confirmed and most likely is southwards towards the River Wey. The trench section and pits associated with the trenchless crossings are 100m from the site, at its nearest point, and attenuation of any contaminants (if present) is likely, as well as smear in the unsaturated zone. The likelihood of substantial contamination from the site being encountered by the project is considered low.
References	References include those listed in Chapter 11 Soils and Geology. Haztech Consultants Ltd. (2016). 2015 COMAH Safety Report. East Hampshire District Council (2018). Planning – Simple Search Accessed October 2018. https://planningpublicaccess.easthants.gov.uk/online-applications/. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project - BH98. Report ref. 10021961-AUK-XX-XX-RP-GE-0014-01-BH98 Factual.

Table B9: ES Site No. 5 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
5A	Current and historical site uses	Hydrocarbons, toxic and phytotoxic metals, sulphate, PAHs, PCBs, solvents, herbicides, de-icing fluids.	Surface runoff and/or transportation via drainage soakaway and groundwater flow	Construction workers	Health effect (medium)	Unlikely. Long history of contaminative uses. However, groundwater flow, although not confirmed, is likely to flow south towards River Wey. Attenuation likely during migration. No notable elevated concentrations were detected in groundwater samples.	Low

Table B10: Alton Material Recovery Facility (Former Railway Sidings) / ES Site No. 6

Site Name / Ref.	Alton Material Recovery Facility (Former Railway Sidings) / ES Site No. 6
Basis for Scoping In	This site is within the Order Limits and identified as a material recovery facility with potentially contaminative former land use (railway sidings).
Site Location and Description	The site is located 420m north of Hawkbridge Farm in Alton along Section C of the route (E: 474832 N: 141672). The estimated area of the site is 3ha and the ground elevation is ~100mAOD. Alton Materials Recovery Facility (MRF) processes and separates household recyclable waste. The materials are separated by type and baled up, prior to being sent off-site for recycling. It was not possible to view or access this site to undertake a walkover survey. The Order Limits border the western boundary of the site, with the exception of a small area of the Order Limits that are within the northwest corner of the site. The majority of the pipeline would be constructed in a trenchless crossing (directional drilling) where it passes the site. A section of trenchless crossing would pass 7.5m beneath the northwest corner of the site.
Site History	A review of the earliest historical maps shows that the land was unoccupied in a rural setting in the late 1800s (1:2,500). An unspecified depot (likely to be associated with the railway) is first indicated on the historical map dated 1937 (1:25,000) with railway sidings at either side of it within the site boundary, extending from the main line along the southern boundary. The sidings are outside the Order Limits of the pipeline. In 1974 (1:2,500), the A34 road at the northern margin of the site is first indicated and at this time the railway sidings no longer appear. Historical maps and aerial imagery indicate few discernible changes to the land use on site from between 1994 and 2000. Aerial imagery dated 2005 shows that the unspecified depot on the site has been redeveloped into a household waste collection facility outside the Order Limits of the pipeline.
Other Pertinent Information	From the information available on the East Hampshire District Council website, there was an application submitted by Veolia in 2011 (Ref. 33619/005) for the construction and operation of a food waste compactor unit and pit with access ramps in the north part of the site. It was specified that the unit would be fully enclosed and daily cleaning of the hopper and its area would be undertaken to ensure that spillages or residues are removed. The annual operational throughput was estimated to be 3,000 tonnes.
Landfill Operations	n/a
Previous Ground Investigations	SLP GI was undertaken ~110m southwest of the site in October 2018 comprising a single borehole located on grazing land at Hawkbridge Farm, Alton (BH98), within the location of the trenchless crossing.

Site Name / Ref.	Alton Material Recovery Facility (Former Railway Sidings) / ES Site No. 6
Geology	BGS information: Superficial geology: River Terrace Deposits – sand and gravel (Quaternary). Bedrock geology: West Melbury Marly Chalk Formation (Grey Chalk Subgroup) – chalk (Cretaceous), underlain by Upper Greensand Formation (Cretaceous). SLP 2018 GI information from BH98: • 0.05mbgl to 1.85mbgl: soft to firm sandy gravelly clay interpreted as Alluvium. • 1.85mbgl to 4.55mbgl: soft gravelly clay becoming very gravelly with depth. This layer is assumed to be fully weathered bedrock of Upper Greensand Formation. • 4.55mbgl to 6.80mbgl: medium dense to dense clayey gravel. This layer is assumed to be fully weathered bedrock of Upper Greensand Formation. • 6.80mbgl to 20.15mbgl: Bedrock of Upper Greensand Formation comprising siltstone and sandstone. The upper part of the formation is generally weak to medium strong becoming medium strong to strong from a depth of 14.30m.bgl.
Hydrogeology	The River Terrace Deposits are a Secondary A aquifer. The Grey Chalk Subgroup is a Principal aquifer. Three separate groundwater sampling events were undertaken in BH98 on 30/08/18, 06/09/18 and 12/09/18. Groundwater was detected at 2.89mbgl, 2.90mbgl and 2.91mbgl.
Hydrology	There are no groundwater abstractions, surface water abstractions, recorded pollution incidents or surface watercourses on site. The site is not located within a Source Protection Zone or Flood Zone. There is a potential for groundwater flooding to occur at the surface at this site, and there is a 0.1% annual chance of surface water flooding on site.
Environmental Setting	The site lies on ALC Grade 2 (BMV) agricultural land and is located two Nitrate Vulnerable Zones (Kingsclere and Greywell Groundwater, and North Wey Surface Water) and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	No notable elevated concentrations were detected in the soil or groundwater samples collected from BH98, 110m to the south (and likely down gradient). Results for PAHs, SVOCs, and TPHs are all shown to be below the analytical detection limit in this borehole.
Remediation	Not known, no information received.
Potential Sources of Contamination	Railway land (1937 to 1974) Unspecified depot (1937 to 2005) Household recyclable waste facility (2005 to present)
Potential Contaminants	Toxic and phytotoxic metals, sulphate, fuels and oils, PAHs, solvents, herbicides, de-icing fluids.
Potential Receptors and Pathways	Construction workers: if shallow groundwater is present, construction workers could come into contact with contaminated groundwater, during open cut trenching and excavation of launch and receiver pits for the trenchless crossing. Leachate runoff from site operations may have caused contamination though either i) surface runoff to drains on the site, assuming drains discharge to soakaway, or ii) direct discharge to unsurfaced areas and vertical migration to shallow groundwater. In addition, historic contaminants within shallow soils could

Site Name / Ref.	Alton Material Recovery Facility (Former Railway Sidings) / ES Site No. 6
	leach and migrate via shallow groundwater. Construction workers could also come into contact with contaminants in soil in the unsaturated zone, which have migrated during periods of higher groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 6 Table 1. The listed potential contaminants are likely to be present on site given the site's long industrial history. Leachates from current site use could enter shallow groundwater via vertical migration in areas without hard cover or via runoff from hardstanding areas if surface water drainage discharges to soakaway. Limited monitoring of the SLP BH98 recorded groundwater at ~2.90mbgl. Contaminated shallow groundwater is likely to migrate southwards towards the River Wey and could be encountered within the section of pipeline trench, some 20m distant, where construction workers could be exposed. However, attenuation of any contaminants (if present) is likely, as well as smear in the unsaturated zone. The likelihood of substantial contamination from the site being encountered by the project is considered low.
References	References include those listed in Chapter 11 Soils and Geology. East Hampshire District Council (2018). Planning – Simple Search. Accessed October 2018. https://planningpublicaccess.easthants.gov.uk/online-applications/. Veolia (2018). Alton Material Recovery Facility. Accessed October 2018. https://www.veolia.co.uk/hampshire/materials-recovery/alton-mrf. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project - BH98. Report ref. 10021961-AUK-XX-XX-RP-GE-0014-01-BH98 Factual. Arcadis (2019). Factual site investigation report, Southampton to London Pipeline Project – BH69. Report ref. 10021961-AUK-XX-XX-RP-GE-0035-01-BH69 Factual.

Table B11: ES Site No. 6 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
6A	Current and historical site uses	Hydrocarbons, toxic and phytotoxic metals, sulphate, PAHs, solvents, herbicides, de-icing fluids.	Direct contact with shallow groundwater, or soil affected by contamination transported in groundwater. Surface runoff and/or transportation via drainage soakaway and groundwater flow.	Construction workers	Health effect (medium)	Unlikely. Long history of contaminative uses, but substantial contamination (if present) likely to have been remediated during Alton MRF development. Open trench and trenchless crossing pits would be 20m away and downgradient of likely groundwater flow. Attenuation likely during migration.	Low

Table B12: Upper Froyle at Manor Farm (Former Landfill) / ES Site No. 7

Site Name / Ref.	Upper Froyle at Manor Farm (Former Landfill) / ES Site No. 7
Basis for Scoping In	The site is identified as a former landfill within the Order Limits.
Site Location and Description	The site is located in a field 360m east of West End Farm along Section C of the route (E: 475683 N: 142531). It has an estimated area of 0.04ha and the ground elevation at the site is ~110mAOD. A site visit was carried out on 19/10/18 to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was viewed from Public Rights of Way. At the time of the visit, the land was used for sheep farming. The topography across the site was generally undulating grassland and the land slopes down towards the southeast. Vegetation across this area consisted of grass, shrubs and semi-mature trees. There was a slight depression in the ground where the site boundary is. The site appeared to be adequately drained. The site is located within the Order Limits.
Site History	A review of the earliest historical map from 1871 indicates the site was an unspecified pit. The pit appeared to be infilled by 1894 (1:10,560). From 1911 to 1994 it is labelled as a pond. Agricultural land use, likely associated with Home Farm, is indicated by aerial imagery.
Other Pertinent Information	No other information identified.
Landfill Operations	A waste disposal licence was granted in March 1991 to the Treloar Trust for land at Manor Farm, Upper Froyle, Alton (Environment Agency, 09/10/18). As far as the Environment Agency is aware, the licence has been surrendered. It permitted the deposit of sand, chalk, gravel and other naturally occurring earth spoils, and it appears to have only involved the infilling of a small pit south of Fiennes Lane. Filling was completed in the same year the licence was granted. Depth is unknown, and it is assumed that there would not have been any lining or leachate/gas management systems. The licence did not require the licence holder to undertake any environmental monitoring and the Environment Agency do not have any monitoring data for the site.
Previous Ground Investigations	Previous ground investigation data are not available.
Geology	Superficial geology: none recorded. Bedrock geology: West Melbury Marly Chalk Formation – chalk (Cretaceous).
Hydrogeology	There are no site-specific data for groundwater level. The West Melbury Marly Chalk Formation is part of the Grey Chalk Subgroup which is a Principal aquifer.
Hydrology	There are no groundwater abstractions, surface water abstractions, recorded pollution incidents or surface watercourses on site. The site is not located within a Source Protection Zone or Flood Zone. There is a potential for groundwater flooding to occur at the surface at this site, and there is no risk of surface water flooding on site.
Environmental Setting	The site lies on ALC Grade 2 (BMV) agricultural land and is located within two Nitrate Vulnerable Zones (Kingsclere and Greywell Groundwater, and North Wey Surface Water) and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	No information available.

Site Name / Ref.	Upper Froyle at Manor Farm (Former Landfill) / ES Site No. 7
Remediation	Not known, no information received
Potential Sources of Contamination	Landfill material (1991).
Potential Contaminants	Wastes and perched water/leachate: deposited wastes were previously excavated natural soils. However, it was not uncommon for such wastes to contain unauthorised inert wastes potentially containing organic and inorganic contaminants. Landfill gas: deposited wastes were previously excavated natural soils. However, it is not uncommon for such deposited materials to generate low concentrations of carbon dioxide.
Potential Receptors and Pathways	Construction workers: direct contact and ingestion of contaminants and perched groundwater during open cut trenching. Exposure to landfill gas (carbon dioxide) that could accumulate in the trench. Adjacent land users: inhalation of windblown contaminated dusts from excavation works and stockpiling of landfill materials. Adjacent grazing animals: inhalation and uptake from dusts deposited on grass from windblown contaminated dusts from excavation works and stockpiling of landfill materials. Underlying Principal aquifer: disturbance of perched groundwater could mobilise any contaminants into the underlying Chalk aquifer.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 7 Table 1. Excavation work would be carried out within inert landfill materials, and exposure to contaminated wastes, shallow groundwater/leachate and landfill gas, if present, is likely. However, materials present in the landfill are likely to be inert with low potential to leach contaminants and generate landfill gas. The risks to construction workers are assessed as low. Adjacent land users and grazing animals could be affected by windblown contaminated dusts generated during excavation works and from the stockpiling of excavated materials in windy conditions. However, given the distance from the work area and low potential for contamination, risks are assessed as very low. Open cut could mobilise contaminants into the underlying aquifer. However, groundwater is likely to be deep and pollution of the aquifer has been assessed as low.
References	References include those listed in Chapter 11 Soils and Geology. Environment Agency. Email information from Environmental Planning and Engagement, dated 9/10/18.

Table B13: ES Site No. 7 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
7A	Landfill waste	Organic and inorganic contaminants	Direct contact, ingestion and inhalation of contaminants	Construction workers	Health effect (mild)	Low. Open cut would be directly into inert waste materials which are not anticipated to be substantially contaminated.	Low
7B			Inhalation of windblown contaminated dusts from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (mild)	Unlikely. The closest land use is residential properties located 90m from the excavation works. Exposure of landfill material would be of short duration, and settlement of contaminants resulting from windblown transit is unlikely.	Very low
7C			Inhalation and uptake from dusts deposited on grass from windblown contaminated dusts from excavation works and stockpiling of waste materials.	Adjacent grazing animals	Health effect (mild)	Unlikely. Grazing outside of Order Limits, which is 30m from the excavation works. Exposure of landfill material would be of short duration, and settlement of contaminants resulting from windblown transit is unlikely.	Very low
7D			Direct migration of shallow groundwater/leachate into surrounding aquifer.	Underlying Principal aquifer (Chalk)	Deterioration of groundwater quality (medium)	Unlikely. Open cut could mobilise perched water into deeper aquifer. However, contaminants are unlikely to be present in substantial quantities and groundwater in Chalk likely to be deep and attenuation of contaminants (if present) is likely.	Low
7E	Landfill waste	Landfill gas (carbon dioxide)	Ingress and accumulation within trench	Construction workers	Health effect (medium)	Unlikely. Open cut would be directly into waste materials, although the potential for carbon dioxide generation is considered to be low. There is a potential for accumulation in trench. However, trenches would be open and some dilution is likely.	Low

Table B14: Oak Park Golf Club (Former Tileries) / ES Site No. 8

Site Name / Ref.	Oak Park Golf Club (Former Tileries) / ES Site No. 8
Basis for Scoping In	The site is identified as a former tileries within 250m of the Order Limits.
Site Location and Description	The site is located at the north end of Oak Park Golf Club, off Heath Lane, along Section C of the route (E: 480744 N: 148805). The estimated area of site is 3.6ha and the ground elevation is 105mAOD. A site walkover survey was carried out on 19/10/18. The purpose of this walkover was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was accessed with prior permission from the landowner. At the time of the walkover, the land consisted of a house with a large garden surrounded by woodland, streams and a pond. The topography across the land was undulating and gently rolling with mounds. The site was heavily vegetated with many depressions and ponds. Vegetation across the site consisted of grass, shrubs, semi-mature trees and mature trees. To the northwest of the site in the woodland area there was hollow brick structure (possibly an old kiln) and the ground was formed of many tiles. The site appeared to be adequately drained and the streams were dry. The landowner commented that the lake at the southwest end of the site was formerly clay pit. It was also mentioned that there are holding tanks at the front of the house and this area was '*formerly an industrial waste pit as deep as a double decker bus*'. The site is located outside of the Order Limits, approximately 50m to the east.
Site History	From 1871 to 1930 (1:10,560), the site was known as Crondall Pottery with clay pits in the southern part of the site. On the historical map dated 1930 (1:10,560), the site is labelled as Crondall Tileries. A tramway first appears at the northeast part of the site by 1940 (1:2,500) which connected to a pit at the northeast end of the site (outside the Order Limits). An unspecified works and the pond which is present today is first shown on the historical map dated 1961 (1:10,560). By 1973 (1:2,500), the clay pits appear to have been infilled and the site was unoccupied comprising just woodland trees and the pond. The tramway is no longer shown. By 1979, a residential building labelled as 'The Tileries' was built adjacent to the pond which is still present today.
Other Pertinent Information	No other information identified.
Landfill Operations	No further information on this site is held by the Environment Agency or Hart District Council.
Previous Ground Investigations	There are no previous ground investigation data available. A BGS borehole was drilled approximately 100m southeast (SU84NW24) (see geology section below).
Geology	Superficial geology: none recorded. Bedrock geology: Lambeth Group – clay, silt and gravel (Thanetian - Ypresian Age). London Clay Formation – clay, silt and sand (Palaeogene). Data from BGS borehole SU84NW24 shows that yellow clay was encountered from 0mbgl – 6.1mbgl. Dark yellow clay was encountered from 6.1mbgl – 9.1mbgl and blue clay was encountered from 9.1mbgl – 18.2mbgl.
Hydrogeology	There are no site-specific data for groundwater levels. The Lambeth Group is classified as Unproductive Strata.

Site Name / Ref.	Oak Park Golf Club (Former Tileries) / ES Site No. 8
Hydrology	There are no groundwater abstractions, surface water abstractions, recorded pollution incidents or surface watercourses on site. The site is not located within a Source Protection Zone or Flood Zone. There is no risk of groundwater flooding on site but there is a 0.1% to 3.3% annual chance of surface water flooding.
Environmental Setting	The site is located within two Nitrate Vulnerable Zones (Kingsclere and Greywell Groundwater, and Hart Surface Water) and a Drinking Water Safeguard Zone (Surface Water). The majority of the site lies on ALC Grade 3 (BMV) agricultural land and a small portion of the site in the east lies on non-agricultural land.
Soil, Groundwater, or Gas Results	No information available.
Remediation	Not known.
Potential Sources of Contamination	Historical land uses including clay pits, industrial waste pit, tramway, tileries and kiln.
Potential Contaminants	Shallow soils, material used to infill pits, perched water/leachate: range of organic and inorganic contaminants. Landfill gas: deposited infill materials are unknown and may have the potential to generate landfill gas (methane and carbon dioxide).
Potential Receptors and Pathways	No potential pathways have been identified. Given the clayey nature of the shallow geology and distance of the closest infilled pond to the Order Limits (>100m), groundwater is unlikely to reach the trench, and if it did, any leachable contaminants would likely have been substantially attenuated and/or diluted. Similarly, the low permeability shallow geology would restrict the migration of any landfill gases present in the infilled pits.
Ground Contamination Risk Assessment and Conceptual Site Model	n/a
References	References include those listed in Chapter 11 Soils and Geology.

Table B15: Redlands/Wildland House Area 1 (Former Landfill) / ES Site No. 9

Site Name / Ref.	Redlands/Wildland House Area 1 (Former Landfill) / ES Site No. 9
Basis for Scoping In	This site is identified as a former landfill site within 250m of the Order Limits.
Site Location and Description	This site is located in Ewshot, mostly to the south of Ewshot Hill – the A287 (E: 480995 N: 149484). It has an approximate area of 6ha and the ground elevation rises from approximately 110mAOD in the west to 150mAOD in the eastern extent. It was not possible to view or access this site to undertake a walkover survey. The site is outside of the Order Limits, 130m to the east.
Site History	A review of historical maps indicates that the site mostly consisted of woodland called Ewshot Wood from 1871 to present day. Bushylease Farm House is mapped from 1973 (1:2,500) at the west end of the site. There has been very little change to the land use since the early 1970s. Aerial imagery from 1999 to 2017 shows open field and woodlands. There is no evidence of landfilling from historical maps or aerial imagery.

Site Name / Ref.	Redlands/Wildland House Area 1 (Former Landfill) / ES Site No. 9
Other Pertinent Information	No other pertinent information identified.
Landfill Operations	Subsoil may have been deposited under a planning permission dated 01/06/87 (Environment Agency, 31/08/18). However, no further information is available and no response to information requests have been received from Hart District Council.
Previous Ground Investigations	Previous ground investigation data are not available for the site.
Geology	Superficial geology: none recorded. Bedrock geology: London Clay Formation – clay, silt and sand (Palaeogene).
Hydrogeology	There are no site-specific data for groundwater levels. The London Clay Formation is classified as Unproductive Strata.
Hydrology	There are no groundwater abstractions, surface water abstractions, recorded pollution incidents or surface watercourses on site. The site is not located within a Source Protection Zone or Flood Zone. There is no risk of groundwater flooding on site but there is a 0.1% to 1% annual chance of surface water flooding.
Environmental Setting	The woodland area of the site (Ewshot Wood) is designated as a Site of Importance for Nature Conservation (SINC) by Hart District Council. The site is also located within a Nitrate Vulnerable Zone (Hart Surface Water) and a Drinking Water Safeguard Zone (Surface Water). The majority of the site lies on non-agricultural land with a small portion on ALC Grade 3 (BMV) agricultural land.
Soil, Groundwater or Gas Results	No data available.
Remediation	Not known, no information received.
Potential Sources of Contamination	Unknown landfill waste outside Order Limits.
Potential Contaminants	It is thought that inert materials were deposited at the landfill, but this is uncertain and such wastes may still contain organic and inorganic contaminants and elevated concentrations of carbon dioxide.
Potential Receptors and Pathways	No potential pathways have been identified. Given the geology (London Clay Formation) and distance to the Order Limits (135m), groundwater is unlikely to reach the trench, and if it did, any leachable contaminants would likely have been substantially attenuated and/or diluted. Similarly, the low permeability London Clay would restrict the migration of any carbon dioxide present in the infilled pits.
Ground Contamination Risk Assessment and Conceptual Site Model	n/a
References	References include those listed in Chapter 11 Soils and Geology. Environment Agency. Email information from Environmental Planning and Engagement, dated 31/08/18.

Table B16: Redlands/Wildland House Area 2 (Former Landfill) / ES Site No. 10

Site Name / Ref.	Redlands/Wildland House Area 2 (Former Landfill) / ES Site No. 10
Basis for Scoping In	The site is identified as a former landfill within 250m of the Order Limits.
Site Location and Description	This site is located west of Ewshot, intersecting Ewshot Hill − the A287 (E: 480446 N: 149912). It has an area of approximately 3.4ha and the ground elevation rises from approximately 111mAOD to 128mAOD. It was not possible to view or access this site to undertake a walkover survey. The site is outside of the Order Limits, 10m to the west at its closest point, where a construction compound is proposed. A trenchless crossing, trending southwest to northeast relative to the site, would be constructed approximately 90m to the east of the site.
Site History	A review of historical maps indicates that the site consisted of woodland (later labelled as 'Ten Acre Copse Woodland') between 1871 and 1940 (1:10,560). There was a kiln and a pit at the south end of site in 1940 (1:10,560). The kiln is not indicated again in subsequent historical maps though the pit is marked in 1966 (1:10,560). From 1970s to present, the site is unoccupied and the pit is no longer indicated, suggesting it may have been filled. Aerial imagery dated 2018 shows the site is densely marked with tracks.
Other Pertinent Information	No other information identified.
Landfill Operations	Subsoil may have been deposited under a planning permission dated 01/06/87 (Environment Agency, 31/08/18). However, no further information is available and no response to information requests have been received from Hart District Council.
Previous Ground Investigations	Previous ground investigation data are not available.
Geology	Superficial geology: none recorded. Bedrock geology: London Clay Formation – clay, silt and sand (Palaeogene).
Hydrogeology	There are no site-specific data for groundwater level. The London Clay Formation is classified as Unproductive Strata.
Hydrology	There are no groundwater abstractions, surface water abstractions, recorded pollution incidents or surface watercourses on site. The site is not located within a Source Protection Zone or Flood Zone. There is no risk of groundwater flooding on site, but there is a 0.1% to 1% annual chance of surface water flooding.
Environmental Setting	The site is located within a Nitrate Vulnerable Zone (Hart Surface Water) and a Drinking Water Safeguard Zone (Surface Water). The site lies on non-agricultural land and ALC Grade 4 (non-BMV) agricultural land.
Soil, Groundwater or Gas Results	No data available.
Remediation	Not known, no information received.
Potential Sources of Contamination	Historical kiln and pits infilled with inert waste (subsoils).
Potential Contaminants	It is not uncommon for inert materials used to backfill pits to contain organic and inorganic contaminants and elevated concentrations of carbon dioxide.
Potential Receptors and Pathways	The site is downslope of the Order Limits such that it is likely down-hydraulic gradient of the pipeline. The site would be at least

Site Name / Ref.	Redlands/Wildland House Area 2 (Former Landfill) / ES Site No. 10
	~45m west of the pipeline trench, and unlikely to encounter groundwater. Given the geology (London Clay Formation), likely topography and distance to the Limits of Deviation (LoD), groundwater is unlikely to reach the trench, and if it did, any leachable contaminants would likely have been substantially attenuated and/or diluted. Similarly, the low permeability London Clay would restrict the migration of any carbon dioxide present in the infilled pits. As such, no pathways involving migration of contamination to the trench have been identified and nor have any other plausible pathways.
Ground Contamination Risk Assessment and Conceptual Site Model	n/a
References	References include those listed in Chapter 11 Soils and Geology. Environment Agency. Email information from Environmental Planning and Engagement, dated 31/08/18.

Table B17: Ewshot Hill (Former Brick Yard) / ES Site No. 11

Site Name / Ref.	Ewshot Hill (Former Brick Yard) / ES Site No. 11
Basis for Scoping In	This site is identified as a former brick yard within 250m of the Order Limits.
Site Location and Description	The site is located west of Ewshot, intersecting Ewshot Hill – the A287 (E: 480864 N: 149673). The area of the site is approximately 3.4ha and the ground elevation rises from west to east from ~111mAOD to ~128mAOD. It was not possible to view or access this site to undertake a walkover survey. The site is located outside of the Order Limits, 150m to the east.
Site History	The earliest historical map dated 1871 indicates the land was used as a brick yard and clay pit set in woodlands known as 'Ewshot Wood'. Another clay pit appeared at the southwest end of the site by 1896 (1:2,500). Historical maps indicate the use of the brick yard ceased sometime between 1910 and 1930. The pits are covered by vegetation on the historical maps dated 1930 (1:10,560) to 1940 (1:2,500). By 1973, Bushylease Farm House had been built at the south end of the site and the pits are no longer indicated suggesting they had been filled. A drain from Ewshot Wood intersected the eastern end of the site as shown from a historical map in 1993 (1:2,500).
Other Pertinent Information	No other information identified.
Landfill Operations	n/a
Previous Ground Investigations	Previous ground investigation data are not available.
Geology	Superficial geology: none recorded. Bedrock geology: London Clay Formation – clay, silt and sand (Palaeogene).
Hydrogeology	There are no site-specific data for groundwater level. The London Clay Formation is classified as Unproductive Strata.

Site Name / Ref.	Ewshot Hill (Former Brick Yard) / ES Site No. 11
Hydrology	There are no groundwater abstractions, surface water abstractions, recorded pollution incidents or surface watercourses on site. The site is not located within a Source Protection Zone or Flood Zone. There is no risk of groundwater flooding on site, but there is a 0.1% to 3.3% annual chance of surface water flooding.
Environmental Setting	The site lies on non-agricultural land and is located within a Nitrate Vulnerable Zone (Hart Surface Water) and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	No data available.
Remediation	Not known.
Potential Sources of Contamination	Historical brick yard and clay pit (outside the Order Limits).
Potential Contaminants	There is no information as to the materials used to infill pits. Backfilled materials may contain organic and inorganic contaminants and elevated concentrations of landfill gas (methane and carbon dioxide).
Potential Receptors and Pathways	Given the geology (London Clay Formation) and distance to the Order Limits (150m), groundwater is unlikely to reach the trench, and if it did, any leachable contaminants would likely have been substantially attenuated and/or diluted. Similarly, the low permeability London Clay would restrict the migration of any landfill gas present in the infilled pits. As such, no pathways involving groundwater or gas migration to the trench have been identified and nor have any other plausible pathways.
Ground Contamination Risk Assessment and Conceptual Site Model	n/a
References	References include those listed in Chapter 11 Soils and Geology.

Table B18: Ewshot (Former Brick & Timber Yard) / ES Site No. 12

Site Name / Ref.	Ewshot (Former Brick & Timber Yard) / ES Site No. 12
Basis for Scoping In	This site is identified as a former brick and timber yard within the Order Limits.
Site Location and Description	The site lies south of Ewshot Lane, west of Hampton's Farm (E: 481006 N: 150276). The approximate area of the site is 1.3ha and the ground elevation falls from ~117mAOD in the southern tip to ~107mAOD in the northern extent of the site. A site walkover survey was carried out on 19/10/18. The purpose of this walkover was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was accessed with prior permission from the landowners. At the time of the walkover, the land use of the site was residential with large areas of hardstanding of concrete and tarmac at the front of the property and a large garden to the rear. There was historically a well centrally located in the garden which the landowner advised is at least 4m to 5m deep. The topography across the land was undulating and gently rolling with mounds. The site was

Site Name / Ref.	Ewshot (Former Brick & Timber Yard) / ES Site No. 12
	moderately vegetated with uneven ground and a pond. The site appears to be adequately drained. Vegetation across the site consisted of grass, shrubs, semi-mature trees and mature trees. There was no contamination evident at the site from visual observations. The site is located within the Order Limits.
Site History	From historical maps, the brick and timber yard and clay pit on the southeast margin of the site (now shown as a pond) are only indicated on the 1871 historical map (1:2,500). By 1896 (1:10,560), the site had become part of Seymour Farm. A water storage tank is first indicated at the eastern part of the site in 1909, downstream of a watercourse (1:10,560). A residential building 'Sarafand' with a pond first appears at the northern part of the site from the 1973 historical map (1:2,500). There has been no change to the land use since the early 1970s.
Other Pertinent Information	No other information of relevance identified.
Landfill Operations	n/a
Previous Ground Investigations	Previous ground investigation data are not available.
Geology	Superficial geology: Head – clay, silt, sand and gravel (Quaternary). Bedrock geology: London Clay Formation – clay, silt and sand (Palaeogene).
Hydrogeology	There are no site-specific data for groundwater levels. The Head is mapped as Secondary Undifferentiated aquifer. The London Clay Formation is classified as Unproductive Strata.
Hydrology	There is a surface watercourse located east of the pond on site flowing southeast to northwest along the northwest side of the site. This watercourse crosses through Order Limits at the east side of the site. There is a 3.3% annual chance of surface water flooding on this site. There are no recorded groundwater abstractions, surface water abstractions or recorded pollution incidents on site. The site is not located within a Source Protection Zone or Flood Zone. There is potential for groundwater flooding to occur at the surface along the northern margin of the site.
Environmental Setting	The majority of the site lies on ALC Grade 3 (BMV) land and the northern part of the site lies on ALC Grade 4 (non-BMV) land. The site is located within a Nitrate Vulnerable Zone (Hart Surface Water) and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	No data available.
Remediation	Not known.
Potential Sources of Contamination	Historical brick and timber yard (1871 – unknown) within Order Limits.
Potential Contaminants	Given the age and nature of the brick and timber yard, inert materials are most likely to be present within the soils, but inorganic contaminants such as metals could be present.
Potential Receptors and Pathways	Construction workers: potential inhalation, ingestion and/or dermal contact with contaminants in site soils; and potential ingestion and/or dermal contact with contaminants in shallow or perched groundwater. Adjacent land users: inhalation of windblown contaminated dusts from excavation works and stockpiling of soils.

Site Name / Ref.	Ewshot (Former Brick & Timber Yard) / ES Site No. 12
	Adjacent grazing animals: inhalation and uptake from dusts deposited on grass from windblown contaminated dusts from excavation works and stockpiling of soils. Surface water: a pond and stream are present just beyond the Order Limits of the open cut section of the pipeline. The stream then flows across the Order Limits. Surface runoff from the stockpiled soils could enter the pond and stream, and contaminated groundwater could migrate to the ponds and stream if in continuity with shallow groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPLs has been developed. A risk assessment has been undertaken to assess the significance of each PPL, which is presented in Site 12 Table 1. Excavation works would expose construction workers to contaminated soils and shallow groundwater, if present. Due to the nature of the historical use and the low likelihood of exposure, the risks to construction workers are assessed as low. Adjacent land users and grazing animals could be affected by windblown contaminated dusts generated during excavation works and from the stockpiling of excavated soils in windy conditions. However, given the low likelihood of substantial contamination being present, risks are assessed as low to very low. Excavation works could mobilise any contamination into any groundwater/perched water, which may be in continuity with the pond and stream. However, given the low likelihood of substantial contamination being present, risks are assessed as very low.
References	References include those listed in Chapter 11 Soils and Geology.

Table B19: ES Site No. 12 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
12A	Former brick & timber yard.	Inorganic contaminants, e.g. metals	Inhalation, ingestion and/or dermal contact with contaminated site soils and water	Construction workers	Health effect (mild)	Low. Age and nature of historical activities suggest limited potential for contamination.	Low
12B			Inhalation of windblown contaminated dusts from excavation works and stockpiling of soils.	Adjacent land users	Health effect (mild)	Low. The closest land use is a residential property which borders the Order Limits. Exposure of soils would be of short duration and settlement of contaminants as a result of windblown transit is unlikely. The age and nature of historical activities suggest limited potential for contamination.	Low
12C			Inhalation of windblown contaminated dusts from excavation works and stockpiling of soils.	Adjacent grazing animals	Health effect (mild)	Unlikely. Potential for grazing outside of Order Limits. Exposure of soils would be of short duration and settlement of contaminants as a result of windblown transit is unlikely. The age and nature of historical activities suggest limited potential for contamination.	Very low
12D			Surface runoff from stockpiles, direct migration of shallow/perched groundwater to ponds and stream	Surface water ponds and stream	Deterioration of water quality (mild)	Unlikely. The age and nature of historical activities suggest limited potential for contamination.	Very low

Table B20: Former Queen Elizabeth II Barracks / ES Site No. 13

Site Name / Ref.	Former Queen Elizabeth II Barracks / ES Site No. 13
Basis for Scoping In	Former Queen Elizabeth II Barracks is former military land known to have had historical contaminative land uses on site.
Site Location and Description	The site is located mostly to the south of Aldershot Road and west of Beacon Hill Road (the B3013), extending beyond these in places, on the southern outskirts of Fleet (E: 481744 N: 151130). The approximate area of the site, within 250m of the Order Limits, covers an area of approximately 50ha (the former military training area covers a total area of approximately 75ha) and the ground elevation within

Site Name / Ref.	Former Queen Elizabeth II Barracks / ES Site No. 13
	250m of the Order Limits falls from approximately 125mAOD to 95mAOD from southeast to northwest. A site walkover survey was carried out on 18/10/18. The purpose of this walkover was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was accessed with prior permission from the landowners. At the time of the walkover, the site mostly consisted of modern and older residential housing, a grassy park area (Quetta Park), army welfare services on Jubilee Drive and allotments south of Channer Gardens. There were some earthworks in front of the army welfare facilities within the Order Limits. The topography across this area of the site was undulating and sloping towards the southwest. Vegetation across the site consisted of grass, shrubs, semi-mature trees and mature trees. Woodland areas surrounded the residential housing in the north of the site. The site appeared to be adequately drained with provision of drainage channels across the site. Towards the north of the site, there were two business developments comprising modern office blocks surrounded by hardstanding ('Fleet Business Park' and 'Vertu' adjacent to Beacon Hill Road). A rough grassland area with mounds and some litter was observed adjacent to the Vertu business development. From aerial photographs, the mounds were present from 2009 after development of an employee car park. There was no visual evidence of contamination across the site. The site is located within the Order Limits.
Site History	The earliest historical maps from 1871 to 1898 (1:10,560) show that the site was unoccupied rural land and woodland with Wood Cottage at the north end of the site. Naishes Farm was shown on maps (1:10,560) from 1898–1909 in the southwest corner of the site. This area is currently used as an allotment. By 1909 (1:10,560), Leipzig Barracks and a small hospital had been developed to the east of Jubilee Drive. By 1930 (1:10,560), a small fire station had developed adjacent to Jubilee Drive within the Order Limits and this is last shown on the 1961 (1:10,560) historical map. There were several unspecified tanks across the site between 1940 (1:2,500) and 1984 (1:1,250); one was located adjacent to Jubilee Drive within the Order Limits. Additionally, two large unspecified buildings had developed to the east of Beacon Hill Road within the Order Limits. This is labelled as a depot in the 1970 (1:1,250) historical map and a tank is first shown within the depot boundary in the Order Limits. Several electrical substations also appeared on map editions between 1969 and 1994; one was within the Order Limits off Naishes Lane. Fleet Business Park is first shown in the 1994 historical map (1:1,250). By 1961 (1:1,250), barracks no longer appear on historical maps east of Jubilee Drive and residential housing had developed. A previous contaminated land assessment undertaken for a proposed residential development by WSP Environmental (2007) identified a former Motor Transport Complex on the south side of Allamand Close within 250m of the Order Limits. It was used for scrap and waste storage and can be observed in aerial photographs from 1999 to 2009. There was an underground fuel tank associated with the complex. Aerial photographs dated to 2013 show that construction of a new housing development had begun in this part of the site, and by 2017, allotments were established. This suggests that any contamination in that area had been remediated prior to the allotment development and there is therefore unlikely to be an ongoing source from the former fuel tank site.
Other Pertinent Information	No other information of relevance identified.
Landfill Operations	n/a
Previous Ground Investigations	Ground investigations were undertaken in 2002 and 2005 to support the contaminated land assessment by WSP Environmental (2007).

Site Name / Ref.	Former Queen Elizabeth II Barracks / ES Site No. 13
	A total of four trial pits were located within the Order Limits. A summary of the ground conditions within these trial pits is provided below. Topsoil was encountered to a depth of between 0.15mbgl and 0.30mbgl. This was found to overlie loose silty, gravelly sand of the Bagshot Beds to ~0.65mbgl and sandy silt/sandy clay of the Bagshot Beds at TP16 and TP17. A very strong hydrocarbon odour was noted in TP16 below 0.6mbgl. Sand with variable clay and gravel contents of the Bracklesham Beds was encountered in TP22 between 0.3mbgl and 3.0mbgl. Made ground of sandy clay with brick, pipe and concrete was recorded between 0.15mbgl and 0.75mbgl in TP20, underlain by firm sandy clay of the Bagshot Beds to 3.0mbgl.
Geology	Superficial geology: Mostly absent. Head deposits of sand and gravel (Quaternary) mapped on-site from ~150m from the Order Limits. Bedrock geology: Windlesham Formation (north end of site) – sand, silt and clay (Palaeogene). Bagshot Formation – sand (Palaeogene). London Clay Formation (south end of site) – clay, silt and sand (Palaeogene). From previous ground investigations, it was determined that the Bracklesham Beds and Bagshot Beds overlay the London Clay (WSP, 2007). The Bracklesham Beds and Bagshot Beds comprise a soft to firm brown sandy clay, or a very silty fine to coarse sand with some gravel (WSP, 2007). The London Clay was recorded as a firm to stiff, blue grey, slightly laminated clay.
Hydrogeology	The Head deposits are mostly classified as a Secondary A aquifer, although are mapped as a Secondary Undifferentiated aquifer in the southwestern tip of the site adjacent to the Order Limits. The Windlesham Formation and Bagshot Formation are Secondary A aquifers. The London Clay Formation is classified as Unproductive Strata. Groundwater levels measured across the site ranged between 0.8mbgl and 4.5mbgl (WSP, 2007).
Hydrology	There is a small ephemeral water body between Naishes Lane and Channer Gardens ~50m northwest of the Order Limits according to WSP (2007). Additionally, there are two surface watercourses, one flowing southeast to northwest along the northwest side of site starting north of Wakeford Park Road. The second watercourse is located at the south end of the site and flows southeast to northwest through the Order Limits (perpendicular to Naishes Lane). There is a 3.3% annual chance of surface water flooding and the area east of Church Crookham Junior School lies in Flood Zone 2 and Flood Zone 3. There are no groundwater abstractions or surface water abstractions on site. The site does not lie in a Source Protection Zone. The contaminated land assessment by WSP Environmental (2007) indicated two pollution incidents on site to surface watercourses in July 1989 (E: 480800, N: 151200) and April 1994 (E: 481200, N:151400). The July 1989 incident involved sewage pollution from a storm overflow sewer and was ranked as a 'Category 2 – Significant Incident'. In the April 1994 incident, the pollutant was waste oil and it was ranked as a 'Category 3 – Minor Incident'. There are no other recorded pollution incidents on site.
Environmental Setting	The site lies on non-agricultural and urban land. There are five areas partially intersecting the site designated as a SINC by Hart District Council. The site is also located within a Nitrate Vulnerable Zone (Hart Surface Water) and a Drinking Water Safeguard Zone (Surface Water).

Site Name / Ref.	Former Queen Elizabeth II Barracks / ES Site No. 13
Soil, Groundwater or Gas Results	No elevated concentrations of contaminants exceeding relevant threshold values were identified in shallow groundwater from previous ground investigations. Localised elevated concentrations of PAHs, metals and asbestos (from demolished buildings) were recorded within shallow soils (WSP Environmental, 2007). These levels were concentrated immediately north of the former Motor Transport Complex, 210m west of the Order Limits. Hydrocarbon hotspot contamination, indicated by elevated concentrations of benzo(a)anthracene and benzo(a)pyrene (both PAHs), was identified in five trial pits within 250m of the Order Limits.
Remediation	Not known, no information received.
Potential Sources of Contamination	Within Order Limits: Former barracks (1909 – 2009). Former fire station (1930 – 1938). Unspecified tanks (1940 – 1970). Electrical substation (1969 – 1994). Mounds east of Beacon Hill Road (2009 – present). As all of these land uses lie within the areas of the former barracks, they are captured within the 'former barracks' source hereafter. Within 250m of the Order Limits: Former Motor Transport Complex and underground fuel tank (Unknown date – 2009).
Potential Contaminants	Former barracks: organic and inorganic contaminants including PCBs, hydrocarbons including PAHs, solvents, asbestos and metals. Former Motor Transport Complex: hydrocarbons, metals.
Potential Receptors and Pathways	Construction workers: potential inhalation, ingestion and/or dermal contact with contaminants in site soils; and potential ingestion and/or dermal contact with contaminants in shallow groundwater. Adjacent land users: windblown migration of soil-borne contaminants followed by inhalation. Underlying Secondary A aquifers: excavation works could mobilise shallow contaminants deeper into the underlying aquifers. Surface water: streams are present both within and just beyond the Order Limits of the open cut section of the pipeline. Surface runoff from the stockpiled soils could enter watercourses and contaminated groundwater could migrate to the watercourses if in continuity with shallow groundwater.
Ground contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPLs has been developed. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 13 Table 1. Excavation works would expose construction workers to potentially contaminated soils and shallow groundwater, if present. Due to the long contaminative history and localised areas of contamination, the risks to construction workers are assessed as moderate/low. Adjacent land users could be affected by windblown contaminated dusts generated during excavation works and from the stockpiling of excavated soils in windy conditions. Given that residential and commercial uses border the Order Limits, risks are assessed as

Site Name / Ref.	Former Queen Elizabeth II Barracks / ES Site No. 13
	moderate/low. Excavation works could mobilise any contamination into the underlying groundwater, which may be in continuity with nearby streams. Contaminants could also leach from stockpiled soils and runoff could enter streams. However, given the likely localised nature of contamination, risks are assessed as low.
References	References include those listed in Chapter 11 Soils and Geology. WSP Environmental (2007). Environmental Statement Chapter 9 - Solid Waste and Contamination, Queen Elizabeth Barracks Church Crookham (LS/FSB02 Revised 03/10).

Table B21: Former Queen Elizabeth II Barracks / ES Site No. 13 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
Within Order Limits							
13A	Former barracks	Organic and inorganic contaminants including PCBs, hydrocarbons including PAHs, solvents, explosives asbestos and metals	Inhalation, ingestion and/or dermal contact with contaminants in shallow soils and groundwater and exposure to vapours	Construction workers	Human health (medium)	Low. Contamination has been identified on site but is likely to be localised as previous site investigations did not encounter widespread contamination.	Moderate/low
13B			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of soils.	Adjacent land users	Human health (medium)	Low. Contamination has been identified on site but is likely to be localised as previous site investigations did not encounter widespread contamination. Commercial and residential use border the Order Limits.	Moderate/low
13C			Direct migration of shallow groundwater into surrounding aquifer.	Underlying Secondary A aquifers (Head deposits, Windlesham Formation and Bagshot Formation)	Deterioration of groundwater quality (medium)	Unlikely. Excavation works could mobilise contaminants into the underlying aquifers. However, previous site investigations did not encounter widespread contamination.	Low
13D			Surface runoff from stockpiles, direct migration of shallow groundwater to streams.	Surface water streams	Deterioration of water quality (medium)	Unlikely. A stream is present within the Order Limits, close to the trench excavations. However, previous site investigations did not encounter widespread contamination.	Low

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
Outside Order Limits							
13E	Former Motor Transport Complex.	Hydrocarbons, metals	Ingestion and/or dermal contact with contaminants in shallow groundwater.	Construction workers	Human health (mild)	Unlikely. Attenuation and dispersion likely due to distance to route (some 210m).	Very low

Table B22: Pyestock Hill (Former Landfill) / ES Site No. 14

Site Name / Ref.	Pyestock Hill (Former Landfill) / ES Site No. 14
Basis for Scoping In	The site is identified as a former landfill within 250m of the Order Limits.
Site Location and Description	The site is located at Norris Bridge east of Fleet (E: 483215 N: 153645). The estimated area of site is approximately 1.1ha and the ground elevation ranges from ~82mAOD in the southwestern tip to ~87mAOD in the north. A site walkover survey was carried out on 19/10/18. The purpose of this walkover was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was accessed with prior permission from the landowners. The land at the time of the walkover was woodland and rough grassland. The topography across the land was undulating and sloping to the west. The site was heavily vegetated with uneven ground. Vegetation across the site consisted of grass, shrubs, semi-mature trees and mature trees. There was no contamination evident at the site from visual observation. The eastern boundary of the site borders the Order Limits, where a construction compound is proposed. The pipeline would be constructed in a trenchless crossing (directional drilling) for a length of 240m where it passes the site. Launch and receiver pits for the trenchless crossing would be located 90m and 135m from the site.
Site History	Historical maps indicate that the area was rough grassland and woodland from 1861 to 1994 (1:2,500). Paths were present in the woodland by 1975 (1:2,500). There has been no change to the land use since 1994. There are no indications of infilled land on the maps.
Other Pertinent Information	No other relevant information identified.
Landfill Operations	Records obtained in November 2017 from the Environment Agency's 'What's In Your Backyard?' website (now closed) indicate the site received household waste at an unspecified date. However, upon a recent data request submitted to the Environment Agency, no further information is held regarding the details of landfilling. Hart District Council has identified the site as a landfill but have no further information.
Geology	Superficial geology: Head – sand and gravel (Quaternary).

Site Name / Ref.	Pyestock Hill (Former Landfill) / ES Site No. 14
	Bedrock geology: Camberley Sand Formation – sand (Palaeogene).
Hydrogeology	There are no site-specific data for groundwater levels. The Head deposits and Camberley Sand Formation are Secondary A aquifers.
Hydrology	There are no watercourses, groundwater abstractions, surface water abstractions or pollution incidents on the site. The site does not lie within a Source Protection Zone or Flood Zone. There is limited potential for groundwater flooding to occur at the site. There is a 0.1% to 3.3% annual chance of surface water flooding at the south and east ends of site.
Environmental Setting	The site lies on non-agricultural land which is designated as a SINC by Hart District Council. The site is also located within a Nitrate Vulnerable Zone and a Drinking Water Safeguard Zone (Surface Water).
Previous Ground Investigations	No previous ground investigation data are available.
Remediation	Unknown, no information received.
Potential Sources of Contamination	Former household waste landfill outside Order Limits (unspecified date).
Potential Contaminants	Wastes and perched water/leachate: evidence suggests deposited wastes were household refuse and likely to contain a range of organic and inorganic contaminants. Landfill gas: methane and carbon dioxide.
Potential Receptors and Pathways	Construction workers: construction workers may encounter shallow groundwater contaminated with leachate derived from household waste (if present), within the receiver pit and trench located 35m distant. Exposure to landfill gas that, if present, could migrate through permeable Head deposits and accumulate in receiver pit and the pipeline trench.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model identifying the PPLs has been developed. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 14 Table 1. There is very limited information available about the former landfill regarding its contents and whether it is lined. The depth to the groundwater and flow direction has not been confirmed, and migration to the LoD is possible based on the topography. However, the site has a low susceptibility to groundwater flooding and any contaminants (if present) are likely to undergo some attenuation. If landfill materials present in the landfill are household refuse, the generation of methane and carbon dioxide is likely. Given the distance to the receiver pit and trench (90m), any landfill gas is likely to oxidise and dilute during migration. Therefore, the risk associated with landfill gas being encountered is considered moderate/low.
References	References include those listed in Soils and Geology.

Table B23: Pyestock Hill (Former Landfill) / ES Site No. 14 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
14A	Former landfill – household waste.	Organic and inorganic contaminants	Migration in shallow groundwater to reception pit/trench followed by ingestion and/or dermal contact with contaminants in shallow groundwater.	Construction workers	Health effect (mild)	Low. The landfill is 35m distant and there is the potential for leachate, if present, to migrate via groundwater flow. Some attenuation is likely.	Low
14B		Landfill gas (methane and carbon dioxide)	Migration through permeable strata, ingress and accumulation within receiver pit and trench.	Construction workers	Health effect (severe)	Unlikely. There is the potential for landfill gas, if present, to migrate through the permeable Head deposits. However, the landfill is 90m distant and dilution and oxidation is likely.	Moderate/low

Table B24: Southwood (Former Military Land) / ES Site No. 15

Site Name / Ref.	Southwood (Former Military Land) / ES Site No. 15
Basis for Scoping In	The site is within the Order Limits and was identified by the Environment Agency as being a former military training area with potentially contaminative activities.
Site Location and Description	The site is located west of Farnborough between Southwood and Cody Technology Park within Section D (E: 484800 N:154746). The site, within 250m of the Order Limits, covers an area of approximately 30ha (the entire former military training area covers a total area of approximately 70ha) and the ground elevation varies between ~70mAOD in the south to ~63mAOD in the north. A site visit or walkover survey was not undertaken at this site. The site is located within the Order Limits. A trenchless crossing (36m in length by auger bore method) would be used to pass beneath Ively Road,10m beyond the northeastern boundary of the site.
Site History	Information received from the Environment Agency (09/10/18) included a desk study factual report (Atkins, 2005) which identified the site to be a former military training area owned by the Ministry of Defence from 1940, which was vacated in 1980. Subsurface structures such as concrete slabs and rubble were encountered on site visits in 2004/2005 within the western portion of the site (within 250m of the Order Limits). These were thought to be remnants of the Ministry of Defence land and their use by the military is not known. However, it was suggested that they may have been remnants of guard houses, explosives and ammunition stores, gas training compounds, garages (‘depots’), rifle ranges, incinerators and landscaped areas to simulate battlefield conditions. In addition, fly tipping is known to have occurred at an unspecified date near the southern boundary of the western portion of the site. The majority of the site within 250m of the Order Limits was developed into a golf course in the 1970s. The golf course permanently closed in December 2017 and it is proposed to convert the land into new natural open parkland known as a Suitable Alternative Natural

Site Name / Ref.	Southwood (Former Military Land) / ES Site No. 15
	Greenspace (SANG) (Rushmoor Borough Council, 2018). The only parts of the site within 250m of the Order Limits which were not developed into a golf course were wooded areas.
Other Pertinent Information	No other relevant information has been identified.
Landfill Operations	n/a
Previous Ground Investigations	SLP GI was undertaken ~50m northeast of the site in January 2019 comprising a single borehole (BH59) in the location of the trenchless crossing.
Geology	Superficial geology: Head deposits and alluvium comprising clay, silt sand and gravel have been mapped across northwestern and northeastern parts of the site. No superficial deposits have been recorded across the remaining site area. Bedrock geology: Windlesham Formation – sand, silt and clay (Palaeogene) mapped across majority of the site. Camberley Sand Formation – sand (Palaeogene) is present in western and southern fringes of the site. SLP GI information from BH59: 0 to 1.40m Made Ground (clayey gravelly sand with concrete, brick), underlain by silty sand to 15.45mbgl.
Hydrogeology	There are no site-specific data for groundwater levels. The alluvium is a Secondary A aquifer and the Head deposits are a Secondary Undifferentiated aquifer. The Windlesham Formation and Camberley Sand Formation are also classified as Secondary A aquifers. Within BH59, a groundwater strike was encountered at 1.65mbgl or 61.03mAOD during drilling. Groundwater levels have been measured manually on two separate occasions, which indicate an average groundwater level of 0.95mbgl, or 61.73mAOD.
Hydrology	Cove Brook which is a minor watercourse flowing west to east along the northeastern margin of the site, intersecting the Order Limits at Ively Road. There is also a small watercourse mapped on site within the golf course. This watercourse is ~500m distant from the Order Limits and flows southeast to northwest. There are no recorded groundwater abstractions or surface water abstractions on the site. There were three pollution incidents to controlled waters on site between 1989 and 1996 in the wooded area adjacent to Kennels Lane (~520m northwest of the Order Limits) according to the factual report by Atkins (2005). All incidents were ranked as 'Category 3 – Minor Incidents' involving sewage, oils and chemicals. The site does not lie within a Source Protection Zone. There are no known pollution incidents from the site since 2005. There is limited potential for groundwater flooding to occur on the site, except for the land to the southwest of the site (Old Kennels Lane and Ively Road junction), which has the potential for groundwater flooding of property situated below ground level and at the surface. There is a 0.1% to 3.3% annual chance of surface water flooding to occur at this site and the area of land along Cove Brook is marked as Flood Zone 2 and Flood Zone 3.
Environmental Setting	The eastern half of the site lies on ALC Grade 4 (non-BMV) soils and the western half lies on non-agricultural land. The site is located within a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	With the exception of the presence of slightly elevated concentrations of PAHs in soil samples (benzo(a)pyrene 24.7mg/kg, benzo(b)fluoranthene 25.9mg/kg), no other determinands were present in concentrations exceeding the C4SL Public Open Space

Site Name / Ref.	Southwood (Former Military Land) / ES Site No. 15
	(Park) assessment criteria. The groundwater quality results from BH59 showed elevated ammoniacal nitrogen concentrations at up to 3.65mg/l and elevated COD concentrations up to 749mg/l in all three sampling occasions. Boron concentrations were also elevated (up to 1.42mg/l) with slightly elevated sulphate and chloride concentrations (up to 85mg/l and 75mg/l respectively). Low concentrations of PAHs were detected on all three sampling occasions with TPH also being detected. For TPH, the concentrations fell from 8.14mg/l in the first sampling round to 0.40mg/l in the third.
Remediation	Not known, no information received.
Potential Sources of Contamination	Former military training area within Order Limits (1940 – 1980).
Potential Contaminants	Organic and inorganic contaminants including PCBs, hydrocarbons including PAHs, solvents, asbestos and metals.
Potential Receptors and Pathways	Construction workers: potential inhalation, ingestion and/or dermal contact with contaminants in site soils; and potential ingestion and/or dermal contact with contaminants in shallow groundwater. Adjacent land users: windblown migration of soil-borne contaminants followed by inhalation. Surface water: migration of contaminants to surface water (Cove Brook) via surface runoff or through groundwater via open cut trenching works. Groundwater: mobilisation of contaminants to superficial aquifers (Secondary A and Secondary Undifferentiated).
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model identifying the PPLs has been developed. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 15 Table 1. Knowledge of the site's history is limited such that there a high degree of uncertainty in the conceptual site model. However, the historical land use could have led to the presence of contamination in the soils and groundwater. Moderate/low risks have been identified for construction workers due to potential exposure to this contamination during open cut trenching, and to adjacent land users from contaminants within site soils that may migrate off-site via aerial dispersion. Excavation works could mobilise any contamination into the underlying groundwater to affect underlying aquifers, which may be in continuity with nearby streams. Contaminants could also leach from stockpiled soils and runoff could enter streams. Given the likely localised nature of contamination, risks are assessed as low.
References	References include those listed in Chapter 11 Soils and Geology. Atkins (2005). Southwood Golf Course Geo-Environmental Assessment Desk Study Factual Report. Document Ref: 5029534/GTG.2004233/Southwood Golf Course/R.04/Rev.01. Rushmoor Borough Council (2018). Southwood Golf Course Consultation. Accessed November 2018. https://www.rushmoor.gov.uk/article/2999/Southwood-Golf-Course. Environment Agency. Email information from Environmental Planning and Engagement, dated 9/10/18. Arcadis (2019). Factual site investigation report, Southampton to London Pipeline Project – BH59. Report ref. 10021961-AUK-XX-XX-

Site Name / Ref.	Southwood (Former Military Land) / ES Site No. 15
	RP-GE-0038-01-BH59 Factual.

Table B25: Southwood (Former Military Land) / ES Site No. 15 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
15A	Former military land	Organic and inorganic contaminants including PCBs, hydrocarbons including PAHs, solvents, asbestos and metals	Inhalation, ingestion and/or dermal contact with contaminants in shallow soils and groundwater and exposure to vapours	Construction workers	Human health (medium)	Low. Long contaminative use. However, contamination, if present in soils, is likely to be localised. Elevated concentrations recorded in groundwater within an off-site borehole.	Moderate/low
15B			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of soils.	Adjacent land users	Human health (medium)	Low. Long contaminative use. However, contamination, if present, is likely to be localised. Residential land uses border the Order Limits.	Moderate/low
15C			Surface runoff from stockpiles, direct migration of shallow groundwater to streams	Surface waters including Cove Brook	Deterioration of surface water quality (medium)	Unlikely. A stream is present within the Order Limits, close to the trench excavations. However, contamination, if present in soils, is likely to be localised. Elevated concentrations already present in groundwater 180m from Cove Brook.	Low
15D			Direct migration of shallow groundwater into surrounding aquifer.	Secondary A and Secondary Undifferentiated aquifers	Deterioration of groundwater quality (medium)	Unlikely. Excavation works along 700m of trench could mobilise contaminants into the underlying aquifers, although contamination, if present in soils, likely to be localised. Elevated concentrations already present in groundwater 180m from Cove Brook.	Low

Table B26: Farnborough (Main) Station / ES Site No. 16 (Former Railway Sidings), No 17 (Former Gasworks), and No 18 (Powell Duffryn Fuels)

Site Name / Ref.	Farnborough (Main) Station / ES Site No. 16 (Former Railway Sidings), No 17 (Former Gasworks), and No 18 (Powell Duffryn Fuels)
Basis for Scoping In	Identified as having a former potentially contaminative uses (railway sidings and gasworks) and a former COMAH site within 250m of the

Site Name / Ref.	Farnborough (Main) Station / ES Site No. 16 (Former Railway Sidings), No 17 (Former Gasworks), and No 18 (Powell Duffryn Fuels)
	Order Limits.
Site Location and Description	The sites are located south of Farnborough (Main) Railway Station in Section E (E: 486753 N: 155989). The approximate area of all sites is 4.7ha and the ground elevation varies between ~65mAOD and ~75mAOD. A site visit was carried out on 18/10/18. The purpose of this visit was to observe the land use within and around the current sites and to assess potential contaminant sources and receptors. The sites were viewed from the public pavement to the south of the site as it was not possible to access the sites to undertake a walkover survey due to landowners not granting access. The current land uses at the time of the visit was railway station and a car park, with office buildings at the eastern end of the sites. The topography across the sites was flat with hardstanding of tarmac and concrete. The sites were sparsely vegetated with vegetation consisting of grass, shrubs semi-mature trees. There was no contamination visually evident at the sites. Sites 17 (former gasworks) and 18 (former COMAH site) overlap with Site 16. The sites are outside of the Order Limits, approximately 30m to the south. A trenchless crossing (directional drilling) is proposed for a length of 450m and a depth of 6.1m, where it passes the sites. Another trenchless crossing (auger bore) is proposed some 100m northeast of the site beneath the A325.
Site History	The earliest historical map dated 1874 (1:10,560) indicates the sites were a railway station with sidings, with a gas works in the south of the site, and a post office in the east. The gasworks are not shown on the 1898 map, but two wells are shown at that location. The 1909 map showed the sidings to have expanded to cover much of the sites, but the two buildings formerly associated with the gasworks are still present up until 1974. Some embankments are shown on the sites. By 1969, the sidings were of more limited extent and a coal yard was indicated in 1969. A railway station car park, which is still present today, replaces much of the sidings by 1995. Although Powell Duffryn Fuels is not specifically indicated on historical maps, the national archives indicate that it distributed coal and fuel between 1909 and 1984. Historical maps indicate there were office buildings on site by 1993 (1:1,250). The site is currently being used as an office space by Qualcomm UK and HRG.
Other Pertinent Information	No other relevant information identified.
Landfill Operations	n/a
Previous Ground Investigations	The closest borehole drilled as part of the SLP 2018 GI is BH55, approximately 150m northeast of the sites, within the location of a proposed trenchless crossing. WDE Consulting undertook a ground investigation in 2014 (WDE Consulting, 2014) at a site which lies just beyond the south eastern boundary of these sites, ~180m south of the Order Limits. This was to assess ground conditions prior to redevelopment of the site into a seven-storey residential unit. Seven window sample boreholes were drilled, two with gas and groundwater monitoring wells installed.
Geology	Superficial geology: none recorded. Bedrock geology: Camberley Sand Formation – sand (Palaeogene). Ground conditions identified during the WDE Consulting (2014) investigation were made ground over clayey sand to a depth of 9.4mbgl. Ground conditions within the SLP GI BH55 recorded bands of silty, clayey and gravelly sand to a depth of 10.45mbgl.

Site Name / Ref.	Farnborough (Main) Station / ES Site No. 16 (Former Railway Sidings), No 17 (Former Gasworks), and No 18 (Powell Duffryn Fuels)
Hydrogeology	The Camberley Sand Formation is a Secondary A aquifer. Three separate groundwater monitoring events were undertaken as part of the 2018 SLP ground investigation on 30/08/18, 05/09/18 and 12/09/18 at BH55, during which groundwater was encountered at between 8.81mbgl and 9.00mbgl. Groundwater was encountered at depths of 6.10mbgl and 7.30mbgl during the WDE Consulting investigation.
Hydrology	There are no watercourses, recorded pollution incidents, groundwater abstractions or surface water abstractions on site. The site does not lie within a Source Protection Zone or Flood Zone. There is limited potential for groundwater flooding to occur, and there is a 3.3% annual chance of surface water flooding occurring at the sites.
Environmental Setting	The sites are located on urban land within a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	None of the soil samples collected from BH55 exceeded the C4SL Public Open Space (Park) assessment criteria. Groundwater samples collected from BH55 showed no notable results with the exception of a very low concentration of TPH on one occasion (0.030mg/l).
Remediation	Not known.
Potential Sources of Contamination	Railway sidings, goods shed, station (1874 – 1969). Gasworks (1874 – 1898). Powell Duffryn Fuels, coal and fuel (1909 – 1984).
Potential Contaminants	Heavy metals, sulphate, fuels and oils, coal, PAHs, solvents, ammoniacal liquor, coal tar, spent oxide, foul lime, heavy metals, hydrocarbons.
Potential Receptors and Pathways	Construction workers: potential ingestion and/or dermal contact with contaminants in shallow groundwater. If shallow groundwater is present, construction workers could come into contact with contaminated groundwater during open cut trenching and excavation of launch and receiver pits for trenchless crossing installation. Contamination derived from shallow soils could leach and migrate via shallow groundwater. Construction workers could also come into contact with contaminants in soil in the unsaturated zone, which have migrated during periods of higher groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model identifying the PPLs has been developed. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 16 Table 1. Depth to groundwater and flow direction has not been confirmed on site. However, contaminated shallow groundwater that migrates northwards is likely to be encountered within the launch and reception pits, where construction workers could be exposed. Although some attenuation of contaminants is likely to occur. Launch and receiver pits would be located >100m distant where no notable elevated concentrations were detected in groundwater samples, and risks have been assessed as low.
References	References include those listed in Chapter 11 Soils and Geology. WDE Consulting (2014). Geoenvironmental Assessment: Ham & Blackbird Public House, 281 Farnborough Road, Farnborough. The National Archives (2018). NRA 37255 Powell. Accessed November 2018. http://discovery.nationalarchives.gov.uk/details/r/N13868367.

Site Name / Ref.	Farnborough (Main) Station / ES Site No. 16 (Former Railway Sidings), No 17 (Former Gasworks), and No 18 (Powell Duffryn Fuels)
	Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project - BH55. Report ref. 10021961-AUK-XX-XX-RP-GE-0016-01-BH55 Factual.

Table B27: Sites 16, 17 and 18 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
16A	Railway station, goods shed and sidings	Toxic and phytotoxic metals, sulphate, fuels and oils, PAHs, solvents, herbicides, de-icing fluids.	Direct contact with shallow groundwater, or soil affected by contamination transported in groundwater.	Construction workers	Health effect (medium)	Unlikely. Localised and limited source potential. Attenuation and dispersion due to the distance to trench and pits (>100m).	Low
17A	Former gas works and coal yard	Ammoniacal liquor, coal tar, spent oxide, foul lime, heavy metals, hydrocarbons.	Direct contact with shallow groundwater, or soil affected by contamination transported in groundwater.	Construction workers	Health effect (medium)	Unlikely. Hardstanding would restrict rainwater infiltration and leaching of contaminants into groundwater. Attenuation and dispersion due to the age of the site (late 1800s) and distance to trench and pits (>100m).	Low
18A	Former Powell Duffryn Fuels	Toxic and phytotoxic metals, sulphate, fuels and oils, PAHs, solvents, herbicides, de-icing fluids.	Direct contact with shallow groundwater, or soil affected by contamination transported in groundwater.	Construction workers	Health effect (medium)	Unlikely. Localised source potential. Hardstanding would restrict rainwater infiltration and leaching of contaminants into groundwater. Attenuation due to the distance to trench and pits (>100m).	Low

Table B28: Farnborough (North) (Former Gas Works) / ES Site No. 19

Site Name / Ref.	Farnborough (North) (Former Gas Works) / ES Site No. 19
Basis for Scoping In	This site has been identified as a former gas works within 250m of the Order Limits.
Site Location and Description	The site is located south of Henry Tyndale School on Ship Lane, along Section E of the route (E: 487634 N: 156561). The estimated area of site is 0.4ha and the ground elevation is 65mAOD. A site visit was carried out on 17/10/18. The purpose of this visit was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was viewed via Henry Tyndale School with prior permission to access from the landowners. It was not possible to undertake a walkover on the area of the site outside the school boundary. The current land use at the time of the visit was mostly residential with the northern side of the site occupied by the Henry Tyndale

Site Name / Ref.	Farnborough (North) (Former Gas Works) / ES Site No. 19
	School. The topography across the site was flat with hardstanding including tarmac and concrete. Vegetation across the site consisted of grass and shrubs. There were no signs of subsidence and the site appeared to be adequately drained. The site is located outside of the Order Limits, 65m to the east.
Site History	A review of historical maps indicates that the site was predominantly agricultural land and open fields before 1872 (1:10,560). Between 1872 and 1895 (1:10,560), a gas works with unspecified buildings were present. The buildings remain from 1895 to at least 1964; they are labelled on some maps as 'Home Farm'. The 1971 map shows the site has been redeveloped as residential housing 'Home Farm Close' with Green Croft School present at north end of site from 1974 until present day (currently named Henry Tyndale School).
Other Pertinent Information	No other information identified.
Landfill Operations	n/a
Previous Ground Investigations	The closest borehole drilled as part of the SLP 2018 GI is BH155, approximately 100m northwest of the site, within the Order Limits.
Geology	Superficial geology: Head – sand and gravel (Quaternary). Bedrock geology: Camberley Sand Formation – sand (Palaeogene). SLP GI information from BH155: Bands of gravely sand, clayey sand, sand and gravel to 5mbgl. Underlain by silty sand to 15mbgl.
Hydrogeology	There are no site-specific data for groundwater levels available. The Head and Camberley Sand Formation are Secondary A aquifers. The site is an area mapped as having potential for groundwater flooding to occur to property situated below ground level. A groundwater strike was encountered during drilling of BH155 at 3.1mbgl. Monitoring on three occasions during September 2018, recorded groundwater levels between 2.68 and 2.72mbgl.
Hydrology	There are no watercourses, groundwater abstractions, surface water abstractions or recorded pollution incidents on site. The site does not lie within a Source Protection Zone or Flood Zone. There is a 3.3% annual change of surface water flooding at northwest end of site.
Environmental Setting	The site lies on non-agricultural land within an area designated as a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	None of the soil samples collected from BH155 exceeded the C4SL Public Open Space (Park) assessment criteria. Groundwater samples collected from BH155 showed no notable results with the exception of a slightly higher TPH concentration on one occasion (0.091mg/l). A very low concentration of PAHs was also detected on one occasion at 0.000105mg/l. The SVOC n-dibutyl phthalate was detected within the SVOC analysis on two occasions in BH155 (at 0.000124mg/l and 0.000171mg/l).
Remediation	Not known.
Potential Sources of Contamination	Gas works (late 1872 – 1895).

Site Name / Ref.	Farnborough (North) (Former Gas Works) / ES Site No. 19
Potential Contaminants	Ammoniacal liquor, coal tar, spent oxide, foul lime, heavy metals, hydrocarbons.
Potential Receptors and Pathways	Construction workers: potential ingestion and/or dermal contact with contaminants in shallow groundwater. If shallow groundwater is present, construction workers could come into contact with contaminated groundwater during open cut trenching. Contamination derived from shallow soils could leach and migrate via shallow groundwater. Construction workers could also come into contact with contaminants in soil in the unsaturated zone, which have migrated during periods of higher groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 19 Table 1. Contaminated shallow groundwater that migrates westwards could be encountered within the pipeline installation trench where construction workers could be exposed. However, the depth to groundwater and flow direction has not been confirmed on site. The likelihood of substantial contamination from the site being encountered by the project is considered low given the distance from the route (65m) and likely attenuation.
References	References include those listed in Chapter 11 Soils and Geology. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project – BH155. Report ref. 10021961-AUK-XX-XX-RP-GE-0013-02-BH155 Factual.

Table B29: Site 19 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
19A	Former gas works	Ammoniacal liquor, coal tar, spent oxide, foul lime, heavy metals, hydrocarbons.	Direct contact with shallow groundwater, or soil affected by contamination transported in groundwater.	Construction workers	Health effect (medium)	Unlikely. Attenuation due to the historic age of the site (late 1800s) and distance to trench (65m), as indicated by limited groundwater results.	Low

Table B30: Farnborough (North) Station (Former Railway) / ES Site No. 20

Site Name / Ref.	Farnborough (North) Station (Former Railway) / ES Site No. 20
Basis for Scoping In	The site is identified as former railway both within the Order Limits and within 250m of the Order Limits.
Site Location and Description	The site is located in Farnborough along Section E of the route (E: 487724 N: 156749) and extends over 1.3km southeast from Bradfords Roundabout through Ship Lane Cemetery, Farnborough North Station and eastwards across the River Blackwater leading to the current main railway line. The approximate area of the site is 5.7ha and the ground elevation varies between 63mAOD and 65mAOD. A site walkover survey was carried out on 17/10/18. The purpose of this walkover was to observe the land use within and around

Site Name / Ref.	Farnborough (North) Station (Former Railway) / ES Site No. 20
	the current site and to assess potential contaminant sources and receptors. The site was viewed from Public Rights of Way. It was not possible to access the platform of Farnborough North Station. The current land use at the time of the walkover was comprised of industrial and residential uses. The topography across the land was slightly uneven comprising hardstanding tarmac, concrete and grass slopes (sloping east towards Blackwater Valley). The site was poorly vegetated at the north but well vegetated in the south. There were no signs of subsidence, and the site appeared to be adequately drained in the north but poorly drained in the south between Chapel Street and the A331. Vegetation across the site consisted of grass and shrubs. The site is located within the Order Limits. A trenchless crossing is proposed just beyond the eastern site boundary. A launch pit for the trenchless crossing would be located some 10m from the site boundary and the likely depth of the trenchless crossing would be 6.1m.
Site History	A review of historical maps indicates that the site was agricultural land/open fields in 1872 (1:10,560). A single-track railway line is shown on the1874 (1:10,560) map but is absent on the next map from 1895. The land is shown as vacant until the 1960s when a sports ground is shown on the land within the Order Limits, with Ship Lane Cemetery immediately south of the sports field.
Other Pertinent Information	No other information identified.
Landfill Operations	n/a
Previous Ground Investigations	The closest borehole drilled as part of the SLP 2018 GI is BH152, approximately 15m east of the site, within the location of a proposed trenchless crossing.
Geology	Superficial geology: Alluvium – clay, silt and sand (Quaternary) Bedrock geology: Camberley Sand Formation – sand (Palaeogene). SLP 2008 GI BH152 recorded 1.48m Made Ground (gravelly clayey sand with brick), overlying 0.5m silty clay, followed by sand to 17.2mbgl.
Hydrogeology	Alluvium and the Camberley Sand Formation are Secondary A aquifers. No groundwater level data is available for BH152.
Hydrology	There are no groundwater abstractions, surface water abstractions or recorded pollution incidents on site. The River Blackwater, which flows southeast to northwest, runs adjacent to the site and intersects it in the south where the main railway line runs. The site lies within an area designated as Flood Zone 2 and there is a 3.3% annual change of surface water flooding at northwest end of site. The site does not lie within a Source Protection Zone. Just south of Farnborough (North) Station, there is a potential for groundwater flooding to occur to property situated below ground level and at the surface.
Environmental Setting	The site is located on non-agricultural land and ALC Grade 4 (non-BMV) land. It also lies within a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	None relating to site. None of the soil samples collected from BH152 exceeded the C4SL Public Open Space (Park) assessment criteria. No groundwater quality data is available for BH152.

Site Name / Ref.	Farnborough (North) Station (Former Railway) / ES Site No. 20
Remediation	Not known.
Potential Sources of Contamination	The railway track dating from the 1870s is not considered a substantial potential contaminant source.
Potential Contaminants	n/a
Potential Receptors and Pathways	n/a
Ground Contamination Risk Assessment and Conceptual Site Model	n/a
References	References include those listed in Chapter 11 Soils and Geology. ALS (2019). Certificate of analysis for BH152.

Table B31: South of Frimley Station (former landfill) / ES Site No. 21

Site Name / Ref.	South of Frimley Station (former landfill) / ES Site No. 21
Basis for Scoping In	The site is identified as a former landfill within the Order limits.
Site Location and Description	The site is located within the Blackwater Valley northeast of Ship Lane Cemetery, along Section E of the route (E: 487809 N: 157192). The approximate area of the site is 9.5ha and the ground elevation is ~62mAOD. A site visit was carried out on 17/10/18. The purpose of this visit was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was viewed at a distance from a public footpath to the west of the site. It was not possible to access the site to undertake a walkover survey. The current land use comprises fishing ponds. The topography across the land was uneven with mounds of silt in the centre of the ponds. The site was heavily vegetated and consisted of shrubs, semi-mature and mature trees in a boggy environment. There were signs of subsidence and the site appeared to be waterlogged and poorly drained. There was no apparent evidence of major contamination around the site, though the view of the site was obscured by dense woodland surrounding the site perimeter. The site is located within the Order Limits. The method of pipeline installation across this site is still to be decided but could consist of trenchless crossing or open cut methods for a length 450m, of which 200m would be beneath the site. Trenchless methods would be at a depth of 6.1m. A receiver pit for the trenchless crossing would be constructed some 40m from the site, where the pipeline would then be installed in an open cut. For the purpose of the risk assessment, a worst case scenario of open cut is assumed.
Site History	The site was agricultural land and open floodplain fields between 1871 and 1898 (1:2500). In 1938, within the Order Limits, the River Blackwater channel flows north-south along the western boundary of the site (1:10,560). By 1966, the area north of the Order Limits is marked as ‘gravel pit’. The River Blackwater is shown to be realigned more or less in its current channel. No detail is shown of the area within the Order Limits between the River and the (Frimley) Railway (1:1250). By 1974, a further gravel pit is shown across much of the area and the gravel pits to the north are shown to be water filled (1:10,560).

Site Name / Ref.	South of Frimley Station (former landfill) / ES Site No. 21
	The 1981 map showed the area between the river and the railway to be similar to the current mapping, with water filled pits (with islands) in the southern end of the site and marshland in the northern part (1:10,000). Evidence of landfilling is shown on the historical map dated 1989, after which no further evidence of infilling is shown (from 1:1250 and aerial imagery). Marshland/floodplain and several ponds are present at the site from aerial imagery.
Other Pertinent Information	No other information identified.
Landfill Operations	The site is an infilled gravel pit, filled with surplus material from construction of the Blackwater Valley Relief Road (Environment Agency, 31/08/18). It comprised an area of 2.78 hectares with capacity of about 60,000m^3. The mineral workings were described as being 3.5m deep, so likely to be the maximum thickness of waste deposits. Most of the waste deposited is believed to be waste silts from original gravel workings. The silts had to be moved from under the footprint of the Blackwater Valley Relief Road (A331) as they were unsuitable for road building. There is no evidence to suggest that any engineering of the site was undertaken before infilling. The Waste Disposal Authority (Surrey County Council) was of the opinion that no waste disposal licence was required, and no licence appears to have been issued for the site. The site was restored to a reed bed habitat.
Previous Ground Investigations	The closest borehole drilled as part of the SLP 2018 GI is BH151, approximately 165m northeast of the site at SC Johnson Ltd, Frimley Green Road (E: 487990, N: 157433) within the Order Limits. The borehole was advanced to 20.28mbgl.
Geology	Superficial geology: Alluvium – clay, silt and sand (Quaternary). River Terrace Deposits – sand and gravel (Quaternary). Bedrock geology: Camberley Sand Formation – sand (Palaeogene). BH151 encountered made ground underlain by layers of clay and gravelly sand and gravel.
Hydrogeology	The River Terrace Deposits and Camberley Sand Formation are Secondary A aquifers. Three separate groundwater monitoring events were undertaken in September and October 2018 at BH151, during which groundwater was encountered at between 1.52mbgl and 1.59mbgl.
Hydrology	The River Blackwater is located 6m southwest of the site and flows southeast to northwest. There are no groundwater abstractions, surface water abstractions or recorded pollution incidents on site. The site does not lie within a Source Protection Zone. The site lies in an area designated as Flood Zone 2 and there is a 1% annual chance of surface water flooding at northwest end of site. There is limited potential for groundwater flooding to occur at the site.
Environmental Setting	The site lies on non-agricultural land within an area designated as a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	One sample of made ground from BH151 was analysed for a range of contaminants. All recorded very low concentrations or concentrations below detection limits for the analysis. Asbestos cement was identified within all three samples of Made Ground, identified as chrysotile (white). One sample of asbestos sheet was subject to quantification, which recorded 2.32%. Groundwater samples collected from BH151 showed no notable results with the exception of a very low concentration of TPH on two occasions at 0.103mg/l and 0.181mg/l. A very low concentration of PAHs was also detected on one occasion at 0.000121mg/l in

Site Name / Ref.	South of Frimley Station (former landfill) / ES Site No. 21
	BH151.
Remediation	Not known.
Potential Sources of Contamination	Former landfill (1974 – 1981).
Potential Contaminants	Soils/wastes and perched water: deposited wastes were previously excavated natural soils (silts). However, it was not uncommon for such wastes to contain unauthorised inert wastes potentially containing organic and inorganic contaminants. Landfill gas: deposited wastes were previously excavated natural soils. However, it is not uncommon for such deposited materials to generate low concentrations of carbon dioxide.
Potential Receptors and Pathways	Construction workers: direct contact and ingestion of contaminants and perched groundwater during open cut trenching. Exposure to landfill gas (carbon dioxide) that could accumulate in the trench. Adjacent land users: inhalation of windblown contaminated dusts from excavation works and stockpiling of landfill materials. Underlying Secondary aquifer: disturbance of perched groundwater could mobilise any contaminants into the underlying gravel aquifer. Surface water: River Blackwater is situated 40m from the trench. Surface runoff from the stockpiled soils could flow towards the river and contaminated groundwater could migrate to the river through the underlying gravels.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 21 Table 1. The site has been used for the deposit of excavated natural soils (sits), and as such, the presence of gross contamination is unlikely. Groundwater levels are known to be high (1.5mbgl) in the local area, and the majority of the site is occupied by large ponds. However, materials present in the landfill are likely to be inert with low potential to leach contaminants. Furthermore, the migration of carbon dioxide, if present, would be restricted by the high groundwater levels. As such it is unlikely that contaminants transported in groundwater would affect construction workers and the risks have been assessed as low to very low. Excavation work would be carried out within inert landfill materials, and exposure to contaminated wastes, shallow groundwater/leachate and landfill gas, if present, is likely. However, materials present in the landfill are likely to be inert with low potential to leach contaminants and generate landfill gas. The risks to construction workers are assessed as low. Adjacent land users could be affected by windblown contaminated dusts generated during excavation works and from the stockpiling of excavated materials in windy conditions. However, given the distance from the work area and low potential for contamination, risks are assessed as low. Open cut could mobilise contaminants into the underlying aquifer and subsequently to the River Blackwater. However, materials present in the landfill are likely to be inert with low potential to leach contaminants, and risks are assessed as low.
References	References include those listed in Chapter 11 Soils and Geology. Environment Agency. Email information from Environmental Planning and Engagement, dated 31/08/18. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project – BH151. Report ref. 10021961-AUK-XX-XX-

Site Name / Ref.	South of Frimley Station (former landfill) / ES Site No. 21
	RP-GE-0018-02-BH151 Factual.

Table B32: Site 21 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
21A	Former landfill	Organic and inorganic contaminants	Direct contact, ingestion and inhalation of contaminants	Construction workers	Health effect (mild)	Low. Open cut would be directly into inert waste materials. However, contamination (if present) is likely to be limited.	Low
21B			Inhalation of windblown contaminated dusts from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (mild)	Low. The closest land use is 200m from the excavation works. However, public footpaths runs close to the trench. Exposure of landfill materials would be of short duration and dispersion of contaminated dust is unlikely.	Low
21C			Direct migration of shallow groundwater/leachate into surrounding aquifer.	Underlying Secondary A aquifer (River Terrace Deposits)	Deterioration of groundwater quality (medium)	Unlikely. Open cut could mobilise contaminants in perched water into aquifer. However, attenuation likely.	Low
21D			Surface runoff from soil stockpiles, direct migration of shallow groundwater river.	Surface water (River Blackwater)	Deterioration of water quality (medium)	Unlikely. Given the distance to the River (some 40m at its closest point to the trench), dispersion and attenuation likely.	Low
21E	Former landfill	Landfill gas (carbon dioxide)	Ingress and accumulation within trench	Construction workers	Health effect (medium)	Low. Open cut would be directly into waste materials. Potential for accumulation in trench, if present. However, trenches would be open and some dilution is likely.	Moderate/low

Table B33: Frimley Station (Former Railway Sidings) / ES Site No. 22

Site Name / Ref.	Frimley Station (Former Railway Sidings) / ES Site No. 22
Basis for Scoping In	The site is identified as former railway sidings within 250m of the Order Limits.

Site Name / Ref.	Frimley Station (Former Railway Sidings) / ES Site No. 22
Site Location and Description	The site is located at Frimley railway station along Section E of the route (E: 487635 N: 157519). The approximate area of the site is 2ha and the ground elevation is 63mAOD. The site boundary was based on Groundsure historical map polygons. Review of the historical maps themselves, and current land use, indicate that the majority of the site within 250m of the Order Limits is under continued use as railway. A site visit was carried out on 16/10/18. The purpose of this visit was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was viewed from Public Right of Way areas off Station Approach and Bridgemead. The current land use at the time of the visit was railway tracks with residential houses in the northwest end of the site (more than 250m from the Order Limits). Aerial photographs show that there are allotments adjacent to the railway within 250m of the Order Limits. The site is located outside of the Order Limits, 15m to the northwest. The pipeline would be installed as a trenchless crossing southwest to northeast as it passes the site. A receiver pit for the trenchless crossing would be located some 50m from the site boundary and the likely depth of the trenchless crossing would be 6.1m.
Site History	According to historical maps, the land was agricultural land and open fields in 1872 (from 1:10,560). Railway tracks were present on site from 1895 (1:1,250) which are still present today. The land to the east of the current tracks in the area now occupied by allotments is shown as marshy land from 1895 until 1938 when railway sidings are shown on part of the land. The railway sidings are no longer indicated in 1965, and an embankment is shown. The 1979 map shows some houses have been constructed adjacent to the former railway sidings; the remaining land (now allotments) is shown as vacant on the 1993 map. Allotments are visible in this land on the 1999 aerial photograph.
Other Pertinent Information	No other information identified.
Landfill Operations	n/a
Previous Ground Investigations	The closest borehole drilled as part of the SLP 2018 GI is BH151, approximately 80m east of the southern tip of the site at SC Johnson Ltd, Frimley Green Road (E: 487990, N: 157433), within the Order Limits. The borehole was advanced to 20.28mbgl.
Geology	Superficial geology: Alluvium – clay, silt and sand (Quaternary). River Terrace Deposits (Undifferentiated) – sand and gravel (Quaternary). Bedrock geology: Camberley Sand Formation – sand (Palaeogene). BH151 encountered made ground underlain by layers of clay and gravelly sand and gravel.
Hydrogeology	The River Terrace Deposits and Camberley Sand Formation are Secondary A aquifers. Three separate groundwater monitoring events were undertaken in September and October 2018 at BH151 (see 'Previous Ground Investigations' section), during which groundwater was encountered at between 1.52mbgl and 1.59mbgl.
Hydrology	There are no watercourses, groundwater abstractions, surface water abstractions or recorded pollution incidents on site. The site does not lie within a Source Protection Zone. There is limited potential for groundwater flooding to occur at this site. The site lies within areas designated as Flood Zone 2 and Flood Zone 3. There is a 1% annual chance of surface water flooding at northwest

Site Name / Ref.	Frimley Station (Former Railway Sidings) / ES Site No. 22
	end of site.
Environmental Setting	The site lies on urban and non-agricultural land within areas designated as a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	None relating to site. One sample of made ground from BH151 was analysed for a range of contaminants. All recorded very low concentrations or concentrations below detection limits for the analysis. Asbestos cement was identified within all three samples of Made Ground, identified as chrysotile (white). One sample of asbestos sheet was subject to quantification, which recorded 2.32%. Groundwater samples collected from BH151 showed no notable results with the exception of a very low concentration of TPH on two occasions at 0.103mg/l and 0.181mg/l. A very low concentration of PAHs was also detected on one occasion at 0.000121mg/l in BH151.
Remediation	Not known.
Potential Sources of Contamination	Railway tracks (1895 – present); railway sidings (1938 – 1965)
Potential Contaminants	Heavy metals, sulphate, fuels and oils, PAHs, solvents.
Potential Receptors and Pathways	Potential contaminants would be particularly mobile in shallow groundwater through local superficial deposits of Alluvium or River Terrace Deposits. Migration of groundwater in the Camberley Sand Formation may also be likely. Lateral groundwater flow through alluvium may be inhibited by potential clay content. Construction workers: if shallow groundwater is present, construction workers could come into contact with contaminated groundwater during open cut and excavation of receiver pits for trenchless crossing installation. Contamination derived from shallow soils could leach and migrate via shallow groundwater. Construction workers could also come into contact with contaminants in soil in the unsaturated zone, which have migrated during periods of higher groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 22 Table 1. Contaminated shallow groundwater that migrates southwards is likely to be encountered within the reception pits and trench, where construction workers could be exposed. The depth to groundwater and flow direction has not been confirmed on site and some attenuation of contaminants is likely to occur. The risks have been assessed as low.
References	References include those listed in Chapter 11 Soils and Geology. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project – BH151. Report ref. 10021961-AUK-XX-XX-RP-GE-0018-02-BH151 Factual.

Table B34: ES Site No. 22 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
22A	Former railway	Heavy metals, sulphate, fuels and	Direct contact with shallow groundwater, or soil	Construction workers	Health effect (medium)	Unlikely. Groundwater is likely to be encountered during excavation of receiver pit	Low

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
	sidings	oils, PAHs, solvents.	affected by contamination transported in groundwater.			that borders the site. However, localised and limited source potential.	

Table B35: Johnson Wax Ltd, Frimley / ES Site No. 23

Site Name / Ref.	Johnson Wax Ltd, Frimley / ES Site No. 23
Basis for Scoping In	This site is identified as a former COMAH site within 250m of the Order Limits.
Site Location and Description	The site is located 225m southeast of Central Frimley, off Frimley Green Road along Section E of the route (E: 488024 N: 157544). The approximate area of the site is 6.2ha and the ground elevation is 65mAOD. SC Johnson Wax Ltd manufactured home cleaning products before manufacturing ceased in 2012. A site walkover survey was carried out on 25/10/18. The purpose of this walkover was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. There were no visible signs of any contamination across the site. There were some tank bases and concrete footings which remained in place, but no signs of contamination were visible. Approximately 70–80% of the site is occupied by buildings and surfaced with hardstanding, including access roads and storage compounds. Grassy areas are located along each of the site boundaries and larger landscaped grassy areas are located on the northeastern and southwestern areas of the site. The site borders the Order Limits to the north. A receiver pit for a trenchless crossing would be constructed 70m to the southwest of the site. A construction compound would also be constructed some 20m to the north of the site. The access point and construction compound would be located adjacent to the site entrance.
Site History	A review of historical maps indicates that the site was agricultural land/open fields from 1872 to 1970 (1:10,560). The site was labelled as Polish Factory from 1970 to 1988 (1:1,250). SC Johnson was first labelled on the historical map dated 1988 (1:1,250). The site was developed in 1960 and additions and modifications to the site occurred over the years (Environment Agency, 07/08/12). These included the installation of the Gel Plant in two phases (1995 and 1997) and the hazardous waste storage area (late 1990s).
Other Pertinent Information	The site has the potential for storage of petrol, and diesel for generators, maintenance and process chemicals and waste (Surrey Heath Borough Council, 13/04/18). Former demolitions may have been carried out without removal of asbestos. The site previously held a permit to operate an A1 installation under Regulation 10 of the Pollution Prevention and Control (England and Wales) Regulations 2000, in relation to the manufacturing operations carried out at the Gel Plant. During the sites' operation, there were no direct process releases to groundwater or sewer. Surface water runoff ultimately drained to a stream which discharged to the River Blackwater. A penstock valve was installed to prevent discharge in the event of a spillage or incident. In addition, surface drainage from the lower yard passed through an interceptor prior to discharge. The lower yard also had a sealed kerb to contain firewater or contaminated water. Water from rinsing and flushing of process equipment was collected in drums

Site Name / Ref.	Johnson Wax Ltd, Frimley / ES Site No. 23
	or IBCs and sent off-site for disposal as hazardous waste. Drainage from the process buildings went to the on-site effluent treatment plant. The hazardous waste storage area drained via a drainage channel to a sump, which was pumped out and sent for off-site disposal. The permit was surrendered in 2012 as low risk for the following reasons Environment Agency, 07/08/12): • Due to the highly viscous nature of Hypol (the main chemical used in the process), there was a negligible risk of water or land pollution from the process. Hypol was always handled indoors on an impermeable floor where there were no drains or sub-surface features that could provide a pathway to ground or surface waters. • The other products that were part of the process like the fragrances and aqueous waste were handled and stored in areas with adequate measures in place to prevent pollution. • Inspection and maintenance of the floor, infrastructure and procedures in place to prevent pollution appears to have taken place. • There are very few records of incidents or spillages having taken place. When they occurred, they were adequately dealt with and corrective actions taken. • An audit was carried out on the site on 9/7/12 to verify maintenance records, incident records and other measures the operator had put in place to prevent pollution. The results of the audit were sufficient to satisfy the EA that measures taken on site during the life of the permit were satisfactory, and that intrusive investigations were not necessary.
Landfill Operations	n/a
Previous Ground Investigations	The closest borehole to the site drilled as part of the SLP 2018 GI is BH151, located at the south end of the site, within the Order Limits (E: 487990, N: 157433). The borehole was advanced to 20.28mbgl and encountered made ground to 1.00mbgl comprising mainly gravelly sand with anthropogenic inclusions of brick and concrete; a suspected asbestos sheet was noted between 0.70mbgl and 1.00mbgl. The made ground was underlain by layers of clay and gravelly sand and gravel. According to the Site Application Report, previous site investigations have been carried out in 2001 and 2004. A desk study carried out in 1997 identified that there were potential contamination issues in certain areas due to the former uses of the site. These areas were not within the installation boundary covered by the Permit. Subsequent intrusive investigations involved samples being taken from surface waters and locations around but outside the installation.
Geology	Superficial geology: River Terrace Deposits – sand and gravel (Quaternary). Bedrock geology: Camberley Sand Formation – sand (Palaeogene).
Hydrogeology	The River Terrace Deposits and Camberley Sand Formation are Secondary A aquifers. Three separate groundwater monitoring events were undertaken in September and October 2018 at BH151 (see 'Previous Ground Investigations' section), during which groundwater was encountered at between 1.52mbgl and 1.59mbgl.
Hydrology	Two surface water ditches/streams are located within the site. One of the streams borders the northeast corner and the other runs along the northeastern and southern boundary of the site. The streams flow from east to west towards a series of small lakes (created in former gravel pits during the 1970s) and the River Blackwater, which comprise the Blackwater Valley Nature Reserve, located approximately 200m southwest of the site. An open channel is located in the southeastern area, adjacent to the rear asphalt parking

Site Name / Ref.	Johnson Wax Ltd, Frimley / ES Site No. 23
	area. There are no surface water abstractions, groundwater abstractions or recorded pollution incidents on site. The site is not located within a Source Protection Zone. There is limited potential for groundwater flooding to occur, but there is a 3.3% annual chance of surface water flooding on the site and within the Order Limits south of the site. These areas are designated as Flood Zone 2 and Flood Zone 3.
Environmental Setting	The site lies on urban and non-agricultural land and is located within a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	One sample of made ground was analysed for a range of contaminants. All recorded very low concentrations or concentrations below detection limits for the analysis. Asbestos cement was identified within all three samples of Made Ground, identified as chrysotile (white). One sample of asbestos sheet was subject to quantification, which recorded 2.32%. Groundwater samples collected from BH151 showed no notable results with the exception of a very low concentration of TPH on two occasions at 0.103mg/l and 0.181mg/l. A very low concentration of PAHs was also detected on one occasion at 0.000121mg/l in BH151. **2001 Investigation** • Undertaken to assess any potential impacts generated from the site, on the surrounding environment. • Six groundwater monitoring wells installed up to 7mbgl, one upgradient and five downgradient of potential sources of contamination identified from the 1997 desk study. • Concentrations of potential contaminants were generally below laboratory detection limits for all borehole and surface water samples. **2004 Investigation** • Undertaken to assess levels of surfactants, chlorides and sulphates in the soil, in the vicinity of a spill from a scrubber unit. Samples collected by hand auger to depths of 1mbgl. • Concentrations were generally below laboratory detection limits or at trace concentrations.
Remediation	Not known.
Potential Sources of Contamination	Manufacture of cleaning products and air fresheners (1960s to 2012)
Potential Contaminants	Diesel fuel, oils, hydrocarbons, hazardous chemicals and solvents.
Potential Receptors and Pathways	Construction workers: shallow groundwater is present. Construction workers could come into contact with contaminated groundwater during open cut and excavation of the receiver pit. Contamination derived from shallow soils across the site could migrate via shallow groundwater. Construction workers could also come into contact with contaminants in soil in the unsaturated zone, which have

Site Name / Ref.	Johnson Wax Ltd, Frimley / ES Site No. 23
	migrated during periods of higher groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 23 Table 1. Contaminated shallow groundwater that migrates southwards could be encountered within the pipeline installation trench and receiver pit for the trenchless crossing, where construction workers could be exposed. The likelihood of substantial contamination from the site being encountered by the project is considered low, given that the facility ceased operations six years ago and the Environment Agency allowed the surrender of the Environmental Permit on the basis that there was limited potential for contamination.
References	References include those listed in Chapter 11 Soils and Geology. Application Site Report for IPPC Application, Frimley Green. Prepared for SCJ EurAFNE Wax. Conestoga-Rovers & Associates (Europe) Limited. March 2006. Environment Agency. Email information from PPC Regulatory Officer, dated 7/08/12. Environment Agency. Decision Document for the Permit Application relating to SCJ EurAFNE Ltd. Frimley Green Gel Plant. 2006. Surrey Heath Borough Council. Email information from Planning Officer, dated 13/04/18. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project – BH151. Report ref. 10021961-AUK-XX-XX-RP-GE-0018-02-BH151 Factual.

Table B36: ES Site No. 23 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
23A	Johnson Wax facility	Diesel fuel, oils, hydrocarbons, hazardous chemicals solvents and asbestos.	Direct contact with shallow groundwater, or soil affected by contamination transported in groundwater.	Construction workers (contact with shallow groundwater, or soil affected by contamination transported in groundwater).	Health effect (medium)	Low. Long industrial history of manufacturing, which ceased six years ago. Previous investigations and groundwater sampling in 2001 and 2004 did not record elevated concentrations. Asbestos cement identified in shallow soils within Order Limits. Shallow groundwater likely to be present in receiver pit and trench. However, likelihood of contaminants being present is considered to be low.	Moderate/low

Table B37: Princess Royal Barracks / ES Site No. 24

Site Name / Ref.	Princess Royal Barracks / ES Site No. 24
Basis for Scoping In	The site is identified as former military land within the Order Limits.
Site Location and Description	The site is located east of Pine Ridge Golf Course in Frimley, along Section E of the route (E: 491036 N: 157980). The approximate area of site is 138ha and the ground elevation is ~114mAOD. A site walkover survey was carried out on 17/10/18. The purpose of this walkover was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. Permission was sought and granted from the landowner to undertake the site walkover. Permission was not granted to conduct a walkover survey on the land west of Deepcut Bridge Road (B3015) due to current tree felling operations and risk of encountering Unexploded Ordnance. At the time of the walkover, the site consisted of residential housing (estimated age 1970s to post 2000) with a recreational sports ground and public open spaces. Army services were present across the site with a military zone located at the northern end of the site whose access is strictly controlled with gates, barbed wire fencing and check points. The topography across the site was generally flat and even, with no obvious signs of subsidence. There was a small area in the northern end of the site comprising several mounds (possibly former bunkers), and an area of excavated land surrounded by fencing. The site appeared to be adequately drained with provision for drainage. Vegetation across the site was generally sparse and consisted of grass and semi-mature trees. Surrounding the site were mature trees and woodland. There was no evidence of plinths, remnants of bunds around the site and no evidence to indicate underground or above ground storage tanks. The site borders the Order Limits to the south. A construction compound would be located within the western part of the site. A haul road would lead from the compound to the pipeline trench, approximately 450m to the west of the site.
Site History	The area has been used as a training ground for the army from the late 1800s until 1900 when the Royal Engineers commenced the build of a number of camps. These camps were subsequently demolished over the years and redeveloped into barracks. The barracks were closed in 2013 and parts of the site redeveloped to housing. A review of historical maps indicates the following: Open fields/woodland (1871 – 1915) from 1:2,500. Alma and Dettingen Barracks (1915 – 1994) from 1:2,500. Frith Barracks extending west (1918 – 1994) from 1:10,560. Gravel pit north side of Frith Barracks (1918 –1935) from 1:10,560. Residential estate (unspecified date – present day) from aerial imagery.
Other Pertinent Information	No other information identified.
Landfill Operations	n/a
Previous Ground Investigations	There are no previous ground investigation data available. A BGS borehole was drilled in the north end of the site in 1982 (SU95NW17) (see geology section below).
Geology	Superficial geology: River Terrace Deposits – sand and gravel (Quaternary).

Site Name / Ref.	Princess Royal Barracks / ES Site No. 24
	Bedrock geology: Camberley Sand Formation – sand (Palaeogene). According to the BGS borehole (SU95NW17) drilled in the north end of the site, topsoil was encountered from 0mbgl – 0.2mbgl. The River Terrace deposits were encountered from 0.2mbgl – 2.5mbgl. The terrace deposits comprised of fine to coarse gravel with angular flint and fine to medium sand. Reddish-yellow sand was encountered from 2.7mbgl – 3.7mbgl.
Hydrogeology	There are no site-specific data for groundwater level. The River Terrace Deposits and Camberley Sand Formation are Secondary A aquifers.
Hydrology	There are no watercourses, groundwater abstractions, surface water abstractions or recorded pollution incidents on site. The site does not lie within a Source Protection Zone or Flood Zone. There is limited potential for groundwater flooding to occur for the majority of the site. However, there are localised areas along the southern and western margin of the site where there is a potential for groundwater flooding to occur to property situated below ground level.
Environmental Setting	The site is located on non-agricultural land within a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	No data available.
Remediation	Remediation activities undertaken on this site are not known.
Potential Sources of Contamination	Former military training area and military barracks (late 19th century to 2013)
Potential Contaminants	Organic and inorganic contaminants including PCBs, hydrocarbons including PAHs, solvents and metals.
Potential Receptors and Pathways	Potential contaminants would be highly mobile in shallow groundwater through local superficial deposits of the River Terrace Deposits. Construction workers: if shallow groundwater is present, construction workers could come into contact with contaminated groundwater during open cut trenching. Contamination derived from shallow soils across the site could leach and migrate via shallow groundwater. Construction workers could also come into contact with contaminants in soil in the unsaturated zone, which have migrated during periods of higher groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 24 Table 1. Contaminated shallow groundwater that migrates northwestwards could be encountered within the pipeline installation trench where construction workers could be exposed. However, the depth to groundwater and flow direction has not been confirmed. The likelihood of substantial contamination from the site being encountered by the project is considered low given that any contamination is likely to be localised.
References	References include those listed in Chapter 11 Soils and Geology.

Table B38: ES Site No. 24 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
24A	Former military barracks	Organic and inorganic contaminants including PCBs, hydrocarbons including PAHs, solvents and metals.	Direct contact with shallow groundwater, or soil affected by contamination transported in groundwater.	Construction workers	Health effect (medium)	Unlikely. Contamination, if present, across the site is likely to be localised. Only a small section of the trench is situated adjacent to the site with the remainder up to 260m distant.	Low

Table B39: Red Road Hill Depot / ES Site No. 25

Site Name / Ref.	Red Road Hill Depot / ES Site No. 25
Basis for Scoping In	The site is identified as a depot within 250m of the Order Limits. There is limited knowledge about the use of the depot.
Site Location and Description	The site is located on Heatherside Corner along Section F of the Order Limits, 190m northwest of the route (E: 490694 N: 160829). The approximate area of site is 1ha and the ground elevation is 121mAOD. It was not possible to view or access this site to undertake a walkover survey. The site is located outside of the Order Limits, 100m to the north.
Site History	From historical maps, the site was unoccupied consisting of a field (possibly used for agriculture) between 1868 and 1896 (1:2,500). A gravel pit was active from 1915 to 1961 (1:10,560). By 1982 (1:10,000), the site was an unspecified depot and there was an unspecified tank in the far southeast corner of the site. From recent aerial photographs, the site appears to be currently used for vehicle storage and service.
Other Pertinent Information	No other information identified.
Landfill Operations	According to the Environment Agency (31/08/18), the land was owned by the Ministry of Defence Property Services Agency and used by Surrey Heath Borough Council for storing aggregates and highways maintenance waste. However, there are complaints on file that other wastes were being deposited such as metal window frames, scrap iron, plastic, cloth, wood, and polythene and that these were being bulldozed and spread across the site. There is no information on file as to whether these deposits were removed. There is no information on the thickness of deposits. There is no record of a waste disposal licence being in force on this site. It is very unlikely there would have been any engineering of the site for the deposit of waste.
Previous Ground Investigations	No previous ground investigation data are available. A BGS borehole was drilled 40m west of the site (SU96SW100) (see geology section below). The date of drilling is not known.
Geology	Superficial geology: River Terrace Deposits (Undifferentiated) – sand and gravel (Quaternary). Bedrock geology: Camberley Sand Formation – sand (Palaeogene). According to the BGS borehole (SU96SW100), compact brown fine sand with medium flint gravel was encountered 0mbgl –

Site Name / Ref.	Red Road Hill Depot / ES Site No. 25
	1.5mbgl. Very dense reddish-brown clayey coarse sand with fine to medium angular gravel was encountered 1.5mbgl – 2.7mbgl. Medium dense brown fine sand was encountered 2.7mbgl – 9.1mbgl.
Hydrogeology	There are no site-specific data for groundwater level available. The River Terrace Deposits and Camberley Sand Formation are Secondary A aquifers.
Hydrology	There are no watercourses, groundwater abstractions, surface water abstractions or recorded pollution incidents on site. The site does not lie within a Source Protection Zone or Flood Zone. There is limited potential for groundwater flooding to occur at this site and a 0.1% annual change of surface water flooding.
Environmental Setting	The site is located on non-agricultural land within a Nitrate Vulnerable Zone (Chertsey Bourne) and a Drinking Water Safeguard Zone (Surface Water).
Remediation	It is unlikely the site has been remediated since it is currently used as a car repair depot.
Potential Sources of Contamination	Infilled pit (1960s – present) Highways maintenance depot (1960s – 1982) Scrap yard (1982 – present)
Potential Contaminants	Wastes/perched water/shallow groundwater: evidence suggests deposited wastes could have included biodegradable materials and likely to contain a range of organic and inorganic contaminants. In addition, contaminants associated with maintenance depot and scrap yard could include metals, fuels and oils, degreasing agents, solvents. Landfill gas: methane and carbon dioxide
Potential Receptors and Pathways	The River Terrace Deposits could provide a pathway for contaminants. Construction workers: it is possible that construction workers may encounter shallow groundwater contaminated with leachate derived from the site within the trench located 100m to the south. In addition, construction workers could be exposed to landfill gas that, if present, could migrate through permeable River Terrace Deposits and accumulate the pipeline trench.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 25 Table 1. There is very limited information available about the former infilled pit regarding its contents. The depth to the groundwater and flow direction has not been confirmed and migration to the pipeline is possible based on the topography. However, any contaminants (if present) are likely to undergo some attenuation. If waste materials present in the infilled pit are degradable, the generation of methane and carbon dioxide is likely. Given the distance to the trench (100m), any landfill gas is likely to oxidise and dilute during migration. Therefore, the risk of elevated landfill gas being encountered is considered moderate/low.
References	References include those listed in Chapter 11 Soils and Geology. Environment Agency. Email information from Environmental Planning and Engagement, dated 31/08/18.

Table B40: ES Site No. 25 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
25A	Landfill, depot and scrap yard	Range of organic and inorganic contaminants including, metals, fuels and oils, degreasing agents, solvents.	Migration in shallow groundwater to trench followed by ingestion and/or dermal contact with contaminants in shallow groundwater.	Construction workers	Health effect (medium)	Unlikely. The landfill is 100m distant. There is the potential for leachate, if present, to migrate via groundwater flow, although dispersion and attenuation is likely.	Low
25B		Landfill gas (methane and carbon dioxide).	Migration through permeable strata, ingress and accumulation within trench.	Construction workers	Health effect (severe)	Unlikely. There is the potential for landfill gas, if present, to migrate through the permeable deposits. However, the landfill is 100m distant and dilution and oxidation is likely.	Moderate/low

Table B41: Chobham Car Spares / ES Site No. 26

Site Name / Ref.	Chobham Car Spares / ES Site No. 26
Basis for Scoping In	The site is identified as a current vehicle servicing yard/scrap yard within 250m of the Order Limits.
Site Location and Description	The site is located 400m east of Round Pound Nursery off Windsor Road along Section F of the route (E: 497291 N: 163823). The approximate area of the site is 1.6ha and the ground elevation is ~48mAOD. It was not possible to view or access this site to undertake a walkover survey. The site borders the Order Limits to the north.
Site History	From a review of historical maps, the site was unoccupied and labelled as Marlake from 1870 to 1912 (1:2,500). The area is then shown to be marshland from historical maps between 1912 and 1955 (1:10,560). An unspecified building was present on site between 1969 to 1976 (1:2,500 and 1:10,000). From 1990 to present day, a car scrap yard is indicated (from 1:2,500 historical maps and aerial photographs).
Other Pertinent Information	The site has been used as a vehicle dismantling and parts recycling yard, with workshops for repair, maintenance, spraying and servicing of vehicles for at least 30 years (Surrey Heath Borough Council, 13/04/18).
Landfill Operations	n/a
Previous Ground Investigations	There are no previous ground investigation data available.
Geology	Superficial geology: none recorded.

Site Name / Ref.	Chobham Car Spares / ES Site No. 26
	Bedrock geology: Windlesham Formation – sand, silt and clay (Eocene).
Hydrogeology	There are no site-specific data for groundwater level. The Windlesham Formation is a Secondary A aquifer.
Hydrology	There are no water courses, groundwater abstractions, surface water abstractions or recorded pollution incidents on site. The site does not lie within a Source Protection Zone. There is a potential for groundwater flooding to occur below ground level and a 3.3% annual chance of surface water flooding at the site.
Environmental Setting	The site is located on non-agricultural land within Chobham Common which is designated as a National Nature Reserve and an SSSI, a Nitrate Vulnerable Zone (Chertsey Bourne), a Drinking Water Safeguard Zone, London Area Greenbelt and a Special Conservation Area (Thames Basin Heaths).
Soil, Groundwater or Gas Results	No data available.
Remediation	Not known, no information received.
Potential Sources of Contamination	Vehicle workshop/scrap yard (1990 – present day)
Potential Contaminants	Metals, fuels and oils, degreasing agents, solvents.
Potential Receptors and Pathways	Construction workers: it is possible that construction workers may encounter contaminated shallow groundwater during open cut trenching. Spills and leakages from site operations and storage may have caused contamination though either i) surface runoff to drains on the site, assuming drains discharge to soakaway, or ii) direct discharge to unsurfaced areas and vertical migration to shallow groundwater. Construction workers could also come into contact with contaminants in soil in the unsaturated zone, which have migrated during periods of higher groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 26 Table 1. There is very little information regarding the storage and use of materials, site surfacing and drainage arrangements at the site. Contaminated shallow groundwater could be encountered within the pipeline installation trench where construction workers could be exposed. However, the depth to groundwater and flow direction has not been confirmed on site, and therefore risks to construction workers have been assessed as moderate/low.
References	References include those listed in Chapter 11 Soils and Geology. Surrey Heath Borough Council. Email information from Planning Officer, dated 13/04/18.

Table B42: ES Site No. 26 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
26A	Vehicle servicing depot.	Metals, fuels and oils, degreasing agents, solvents.	Migration in shallow groundwater to trench followed by ingestion and/or dermal contact with contaminants in shallow groundwater.	Construction workers	Health effect (medium)	Low. Little is known of the site surfacing and drainage arrangements. Trench is 12m distant and underlying geology could act as a pathway, although groundwater levels and flow direction are not known.	Moderate/low

Table B43: Hanworth Trading Estate / ES Site No. 27

Site Name / Ref.	Hanworth Trading Estate / ES Site No. 27
Basis for Scoping In	The site is identified as a business and industrial park within 250m of the Order Limits.
Site Location and Description	The site is located off Hanworth Lane, along Section G of the Order Limits (E: 503861 N: 166044). It occupies an area of approximately 4.5ha and is at a ground elevation of 14mAOD. A site visit was carried out on 16/10/18. The purpose of this visit was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was viewed from Public Right of Way areas off Hanworth Lane. Access to some of the business grounds was controlled with barriers or gates, and therefore it was not possible to undertake a walkover survey for these areas of the site. The site was predominantly commercial use consisting of private trades with car parks, offices, a vehicle servicing/MOT station, a welding supply shop, a vehicle parts supplier and a driving test centre. At the western end of the site, there are residential apartments with young trees in the courtyard. The topography across the paved areas was flat and even, with no obvious signs of subsidence or uneven ground. The site appeared to be adequately drained. Vegetation across the site is generally sparse and consists of grass and semi-mature trees. Surrounding the site along the southern margin was dense vegetation consisting of semi-mature trees and shrubs, and a drain or stream of static flow. There was no evidence to indicate underground storage tanks within the areas that were viewed. The site is outside of the Order Limits, 250m to the north. A trenchless crossing is proposed 320m to the southwest of the site (direction drilling). The road at the southwest end of the site would be an access point to a construction compound, located 60m to the southwest.
Site History	The earliest historical maps from 1870 (1:2,500) indicate that the land use of the site was rural open space with vegetation marking the field boundaries. Development on the land is first indicated by the 1955 (1:10,560) historical map with unspecified buildings on the western half of the site. From historical maps dated 1969 (1:2,500), unspecified works and two small chimneys had been developed across the site. Tanks and four electricity substations are first indicated on the maps dated from 1980 to 1981 (1:1,250). At present, the site compromises several industrial and trade units.
Other Pertinent Information	No other information identified.
Landfill Operations	n/a

Site Name / Ref.	Hanworth Trading Estate / ES Site No. 27
Previous Ground Investigations	Three historical BGS boreholes were drilled in 1947, approximately 30m north of the site (TQ06NW153,154,155) (see geology section below).
Geology	Superficial geology: Kempton Park Gravel Formation – sand and gravel (Devensian). Bedrock geology: Bagshot Formation – sand (Eocene). According to the historical BGS boreholes, made ground containing brown clay and ashes was recorded from 0mbgl – 1.8mbgl. Coarse sand and gravel was recorded from 1.8mbgl – 5.2mbgl. Fine grey-brown sand was recorded from 5.2mbgl – 6.7mbgl. Soft grey clay was recorded from 6.7mbgl – 15.24mbgl.
Hydrogeology	The Kempton Park Gravel Formation is a Principal aquifer. The Bagshot Formation is a Secondary A aquifer.
Hydrology	There are no watercourses through the site, but there are minor watercourses or drains around south and east sides of the site. There are no surface water abstractions and ground water abstractions on site. The site is located within two Source Protection Zones (Zone 2 and Total Catchment Zone 3). There is limited potential for groundwater flooding to occur at this site, but there is a 0.1% to 1% annual chance of surface water flooding. There was a 'Category 3 (Minor)' pollution incident on the site in 2006 in which engine oil was leaked from a 45-gallon ruptured drum at the end of Hanworth Trading Estate onto the road and into the adjacent drainage ditches that lead to River Bourne (Environment Agency, 31/08/18). Booms and absorbent were deployed as well as a cleanup contractor to contain and remove oil from ditches.
Environmental Setting	The site is located on urban land within the London Area Greenbelt, a Nitrate Vulnerable Zone and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	No data available.
Remediation	Remediation activities undertaken on this site are not known.
Potential Sources of Contamination	Various industrial uses including vehicle servicing/MOT station (1955 to present). Electricity substations (1980 – 1981)
Potential Contaminants	Fuels, oils, waste oils, PCBs, solvents, metals.
Potential Receptors and Pathways	Construction workers: if shallow groundwater is present, construction workers could come into contact with contaminated groundwater during open cut trenching. Spills and leakages from site operations and storage may have caused contamination though either i) surface runoff to drains on the site, assuming drains discharge to soakaway, or ii) direct discharge to unsurfaced areas and vertical migration to shallow groundwater. Construction workers could also come into contact with contaminants in soil in the unsaturated zone, which have migrated during periods of higher groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 27 Table 1. The listed potential contaminants are likely to be present on site given the site's long industrial history, albeit the sources are likely to be localised. Leaks and spillages could enter shallow groundwater via vertical migration in areas without hard cover or via runoff from

Site Name / Ref.	Hanworth Trading Estate / ES Site No. 27
	hardstanding areas if surface water drainage discharges to soakaway. Contaminated shallow groundwater that migrates southwards could be encountered within the pipeline installation trench where construction workers could be exposed. However, the depth to groundwater and flow direction has not been confirmed. Given the Order Limits are 250m distant, dispersion of contaminants (if present) is likely, as well as attenuation and smear in the unsaturated zone. The likelihood of substantial contamination from the site being encountered by the project is considered low.
References	References include those listed in Chapter 11 Soils and Geology. Environment Agency. Email information from Environmental Planning and Engagement, dated 31/08/18.

Table B44: ES Site No. 27 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
27A	Vehicle serving / MOT station	Fuels, oils, waste oils, PCBs, solvents, metals.	Surface runoff and/or transportation via drainage soakaway and groundwater flow	Construction workers	Health effect (medium)	Unlikely. Long industrial history. However, groundwater flow is unknown and high likelihood of attenuation and dispersion due to distance from receptor (250m).	Low

Table B45: Chertsey Gas Works / ES Site No. 28

Site Name / Ref.	Chertsey Gas Works / ES Site No. 28
Basis for Scoping In	This site is identified as a former COMAH site within 250m of the Order Limits.
Site Location and Description	The site is located north of Hanworth Lane Business Park in Chertsey north of Section G of the Order Limits (E: 503935 N: 166106). The area of the site is ~2ha and the ground elevation is ~15mAOD. A site visit was carried out on 16/10/18. The purpose of the visit was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was viewed from Public Rights of Way off Pretoria Road. It was not possible to access all areas of the site to undertake a walkover survey due to the large number of private residential properties. At the time of the visit, the land use was residential consisting of modern blocks of apartments and houses surrounded by green areas. The topography across the site was flat and there were no obvious signs of subsidence or uneven ground. The site appeared to be adequately drained. Vegetation across the site consisted of grass, shrubs, young trees and semi-mature trees. There are no watercourses on or nearby to the site. The site is located outside of the Order Limits, 420m to the north. An access road and a construction compound would be located 150m southwest of the site.
Site History	The earliest historical maps available show the gas works in 1870 (1:2,500). Two wells were present on site between 1865 and 1894 (1:10,560). An unspecified tank at the east end of the site is indicated on the 1934 historical map (1:2,500). There were unspecified

Site Name / Ref.	Chertsey Gas Works / ES Site No. 28
	works at the north and south end of site as indicated by historical maps dated from 1965 to 1995. A drain along the southern margin of the site was present. The gas works was closed down in 1934, and in 1954, a 1 million m^3 gas holder was erected and the site became a gas holder station (Edith's Streets Blog, 2018).
Other Pertinent Information	No other information identified.
Landfill Operations	n/a
Previous Ground Investigations	Three historical BGS boreholes were drilled in 1947 approximately 30m north of the site (TQ06NW153,154,155) (see geology section below).
Geology	Superficial geology: Kempton Park Gravel Formation – sand and gravel (Devensian). Bedrock geology: Bagshot Formation – sand (Eocene). According to the historical BGS boreholes, made ground containing brown clay and ashes was recorded from 0mbgl – 1.8mbgl. Coarse sand and gravel was recorded from 1.8mbgl – 5.2mbgl. Fine grey-brown sand was recorded from 5.2mbgl – 6.7mbgl. Soft grey clay was recorded from 6.7mbgl – 15.24mbgl.
Hydrogeology	There is no site-specific data for groundwater level available. The Kempton Park Gravel Formation is a Principal aquifer. The Bagshot Formation is a Secondary A aquifer.
Hydrology	There are no watercourses, recorded pollution incidents, surface water abstractions or ground water abstractions on site. The site is located within two Source Protection Zones (Zone 2 and Total Catchment Zone 3). There is limited potential for groundwater flooding to occur at this site, and there is a 0.1% to 1% annual chance of surface water flooding.
Environmental Setting	The site is located on urban land within the London Area Greenbelt, a Nitrate Vulnerable Zone and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	No data available.
Remediation	During the early 2000s, the site was remediated prior to the redevelopment as housing and commercial use. The works involved the targeted remediation of approximately 5,000 tonnes of soils contaminated with BTEX (Benzene, Toluene, Ethylbenzene and Xylene) compounds, petroleum hydrocarbons, phenols and coal tars, using enhanced bioremediation techniques.
Potential Sources of Contamination	Former gas works (1870 – 1934).
Potential Contaminants	Ammoniacal liquor, coal tar, spent oxide, foul lime, heavy metals.
Potential Receptors and Pathways	Construction workers: if shallow groundwater is present, construction workers could come into contact with contaminated groundwater during open cut trenching.
Ground Contamination Risk	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk

Site Name / Ref.	Chertsey Gas Works / ES Site No. 28
Assessment and Conceptual Site Model	assessment has been undertaken to assess the significance of each PPL and is presented in Site 28 Table 1. The source of contamination has been removed through remediation prior to redevelopment of the site to residential use. Residual contaminants within groundwater that migrates southwards could be encountered within the pipeline installation trench where construction workers could be exposed. However, the depth to groundwater and flow direction has not been confirmed. Given the Order Limits are 420m distant, the migration of any contaminants (if present) over that distance is unlikely. The likelihood of substantial contamination from the site being encountered by the project is considered low.
References	References include those listed in Chapter 11 Soils and Geology. Edith's Streets Blog (2018). M25 Chertsey Station. Accessed November 2018. http://edithsstreets.blogspot.com/2017/02/m25-chertsey-station.html

Table B46: ES Site No. 28 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
28A	Gas works	Ammoniacal liquor, coal tar, spent oxide, foul lime, heavy metals.	Migration in shallow groundwater to trench followed by ingestion, inhalation and/or dermal contact with contaminants in shallow groundwater.	Construction workers.	Health effect (medium)	Unlikely. Remediation of the site would have removed the source of contamination. Any residual contamination is unlikely to migrate to the trench some 420m distant.	Low

Table B47: Abbey Moor Golf Club (Former Landfill) / ES Site No. 29

Site Name / Ref.	Abbey Moor Golf Club (Former Landfill) / ES Site No. 29
Basis for Scoping In	The site is identified as a former landfill within the Order Limits.
Site Location and Description	The site is located off Green Lane in Addlestone/Chertsey along Section G of the pipeline section (E: 503935 N: 166106). The area of the site is ~21ha and the ground elevation varies between ~11m and 17mAOD. A site walkover survey was carried out on 16/10/18. The purpose of this walkover was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was accessed with prior permission from the landowners. The land use of the site was recreational consisting of a golf course and club house which are at a lower level relative to the adjacent road (A317). Electricity pylons cut across the site. A railway is present along the northeast boundary of site at a similar elevation to the subject site. The topography across the golf course was undulating and gently rolling with mounds (some covered by vegetation) present across the site. There were no obvious signs of subsidence or uneven ground. The site appeared to be adequately drained. Vegetation across the site consists of grass, shrubs, semi-mature trees and mature trees. There were several drains of static flow oriented north-south and east-west, and small ponds in the northern half of the site.

Site Name / Ref.	Abbey Moor Golf Club (Former Landfill) / ES Site No. 29
	The site is within the Order Limits. The pipeline would exit the site through a trenchless crossing (auger bore), which would continue for 77m beneath the railway running adjacent to the northern margin of the site. A launch pit, 4.9m deep, would be excavated within the site boundary. The Order Limits also include an access road that would be constructed along the southern boundary of the site, connecting to the area around the trenchless crossing.
Site History	The former land use of the site was agricultural or open space in the late 1800s (1:2,500) with vegetation marking the field boundaries. A small unspecified building is first indicated at the centre of the site by the 1896 historical map (1:2,500). Earthworks are first indicated by the 1912 historical map 150m south of the Order Limits (1:10,560). The main road which borders the southern margin of the site is first drawn on the 1979 historical map (1:1,250). The earthworks are not indicated again in following historical maps. The opening date of the golf club is unknown, although it is assumed to be during the 1990s (see Landfill Operations).
Other Pertinent Information	No other information identified.
Landfill Operations	A waste disposal licence was granted in August 1990 for the deposit of class A (1) dry and solid inert soils (soils and sub soils) to create a golf course (Environment Agency,31/08/18). Disposal was reported as complete by January 1991. There are some site inspection reports on file at the Environment Agency reporting that there was unauthorised waste consisting of reinforced concrete, brick and some wood and plastic present on site. The depth of the deposited waste is likely to be variable due to the function as a golf course, but planned raising at the time of the application was intended to be up to 3.0 metres above the pre-existing ground level. However, there is no final survey drawing to confirm actual depths of deposits. There would have been no liner or cap or any other type of landfill engineering. Runnymede Borough Council do not hold any information regarding the filling of this area. However, anecdotal information suggests infilling comprised overburden inert material derived from the construction of the M25.
Previous Ground Investigations	Three historical BGS boreholes were drilled within the boundaries of this site (TQ06NW157, 273, 132). They are not dated and do not record potential landfill material. The closest borehole drilled as part of the SLP 2018 GI is BH30, located along the eastern site boundary, at the location of the trenchless crossing.
Geology	Superficial geology: Kempton Park Gravel Formation – sand and gravel (Devensian). Alluvium – silt (Flandrian). Bedrock geology: Bagshot Formation – sand (Eocene). Ground conditions within the SLP BH30 comprised 1.24m of Made Ground (gravelly clayey sand and sandy gravelly clay with brick and concrete). This was underlain by layers of sandy clay, gravelly sand, sandy gravel, clayey sand to 15.1mbgl.
Hydrogeology	There are no site-specific data for groundwater level available. The Kempton Park Gravel Formation is a Principal aquifer. The Bagshot Formation is a Secondary A aquifer. During drilling of BH30, a groundwater strike was recorded at 1.4mbgl and 2mbgl. Groundwater levels as measured on three occasions between December and January, recorded 0.83 to 0.95mbgl.

Site Name / Ref.	Abbey Moor Golf Club (Former Landfill) / ES Site No. 29
Hydrology	There are several small ponds in the northern half of the site. There are no surface water abstractions, groundwater abstractions or recorded pollution incidents on the site. There is limited potential for groundwater flooding to occur at this site and a 0.1% to 3.3% annual chance of surface water flooding. The site is located within two Source Protection Zones (Zone 2 and Total Catchment Zone 3).
Environmental Setting	The site is located within the London Area Greenbelt. The northern half of the site lies on urban land and the southern half is lies on ALC Grade 3 (BMV) agricultural land.
Soil, Groundwater or Gas Results	No notable results were detected within BH30 with the exception of slightly elevated concentrations of ammoniacal nitrogen (up to 0.62mg/l) with a sample also showing elevated cyanide (0.34mg/l). Two samples of Made Ground and one sample of underlying natural material (3.5-5.2mbgl) were analysed for a range of organic and inorganic determinands. All recorded very low concentrations or concentrations below detection limits for the analysis. The three soil samples were screened for asbestos. None was identified.
Remediation	Not known.
Potential Sources of Contamination	Landfill material (1990s).
Potential Contaminants	Soils/wastes and perched water: deposited wastes are understood to be previously excavated natural soils. However, it was not uncommon for such wastes to contain unauthorised inert wastes potentially containing organic and inorganic contaminants, as was confirmed by inspection records. Landfill gas: deposited wastes were understood to be excavated natural soils. However, it is not uncommon for such deposited materials to generate low concentrations of carbon dioxide, especially where wood was deposited as per the inspection records.
Potential Receptors and Pathways	Construction workers: direct contact and ingestion of contaminants, and exposure to associated waste materials and shallow groundwater/leachate, during open cut and excavation of launch pit for trenchless crossing, as excavations are within areas of known landfilling. Exposure to landfill gas (carbon dioxide) that could accumulate in trenches and pits for trenchless crossings. Adjacent land users: inhalation of windblown contaminated dusts from excavation works and stockpiling of excavated soils. Adjacent grazing animals: inhalation and uptake from dusts deposited on grass from windblown contaminated dusts from excavation works and stockpiling of soils. Underlying Principal aquifer: disturbance during the excavation of the trench and launch pit could allow the release of any perched contaminated groundwater/leachate into the deeper Kempton Park Gravel Formation. Surface water ponds: ponds are present on site just to the south and north of the open cut section of the Order Limits. Surface runoff from the stockpiled soils could enter the ponds. As the pipeline exits the landfill beneath a surface water drainage ditch, contaminated groundwater/leachate could migrate to the ponds if in continuity with shallow groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 29 Table 1. Excavation work would be carried out within approximately 3m of deposited material, which may contain unauthorised materials and low concentrations of carbon dioxide. The risks to construction workers are assessed as moderate/low to low.

Site Name / Ref.	Abbey Moor Golf Club (Former Landfill) / ES Site No. 29
	Adjacent land users and grazing animals could be affected by windblown contaminated dusts generated during excavation works and from the stockpiling of excavated soils in windy conditions. However, due to the low likelihood of substantial contamination being present, risks are assessed as low to very low. Ponds are located close to the excavation works and the site is underlain by a Principal aquifer. There is the potential for mobilisation of any contamination present. However, the risk of leachable contamination to be present is considered to be low. Risks to groundwater and surface water are assessed as low to very low.
References	References include those listed in Chapter 11 Soils and Geology. Environment Agency. Email information from Environmental Planning and Engagement, dated 31/08/18. Arcadis (2019). Factual site investigation report, Southampton to London Pipeline Project – BH30. Report ref. 10021961-AUK-XX-XX-RP-GE-0036-01-BH30 Factual.

Table B48: ES Site No. 29 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
29A	Former landfill waste.	Organic and inorganic contaminants	Direct contact, ingestion, inhalation	Construction workers	Health effect (mild)	Low. Trench and pit excavation directly into landfill material. If contamination is present from unauthorised materials, likely to be low level and localised.	Low
29B			Inhalation of windblown contaminated dusts from excavation works and stockpiling of soils	Adjacent land users	Health effect (mild)	Low. The closest land use is a residential property located 15m from the excavation works. Also, users of the golf course border the Order Limits. Exposure of landfilled material would be of short duration and there is a low likelihood of contamination being present which could migrate off-site in windblown dust.	Low
29C			Inhalation of windblown contaminated dusts from excavation works and stockpiling of soils.	Adjacent grazing animals	Health effect (mild)	Unlikely. Grazing outside of Order Limits, which is 10m from the excavation works. Exposure of landfilled material would be of short duration and there is a low likelihood of contamination being present which could migrate off-site in windblown dust.	Very low
29D			Direct migration of shallow groundwater/leachate into underlying aquifer.	Underlying Principal aquifer (Kempton Park Gravel Formation)	Deterioration of groundwater quality (medium)	Unlikely. It is considered unlikely that leachable contamination resulting from deposition of unauthorised materials is present. Elevated concentrations already present in groundwater within eastern boundary.	Low
29E			Runoff from stockpiled soils and baseflow into surrounding ponds	Surface water ponds	Deterioration surface water quality (mild)	Unlikely. Surface runoff from the stockpiled soils could potentially enter the ponds, some 10m distant. Contaminated groundwater/leachate could migrate to the ponds if in continuity with shallow groundwater. However, it is considered unlikely that leachable contamination resulting from deposition of unauthorised materials is present. Elevated concentrations	Very low

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
						already present in groundwater	
29F		Landfill gas (carbon dioxide)	Ingress and accumulation within trench and launch pit	Construction workers	Health effect (medium)	Low. Potential for accumulation in trench and pit for trenchless crossings. However, trenches and pits are open, and dilution is likely.	Moderate/low

Table B49: Lavenders Landfill / ES Site No. 30 (also known as Laleham Landfill – South Lake)

Site Name / Ref.	Lavenders Landfill / ES Site No. 30 (also known as Laleham Landfill – South Lake)
Basis for Scoping In	This site is identified as historical landfill within the Order Limits on the Environment Agency national dataset.
Site Location and Description	The site is located immediately west of Old Littleton Road and south of the M3 (E: 505712 N: 166995) within Section G of the Order Limits. The area of the site is ~13ha and the ground elevation varies between ~10m and 12mAOD. The site comprises a central lake, surrounded by rough grassland used for horse grazing. The site is bounded to the north by the M3 motorway, to the east by Old Littleton Lane, and to the south and west by mainly residential areas. It was not possible to access the site during the walkovers in October 2018, due to the presence of livestock on the land. Prior to the construction of the M3 Motorway, the site was linked with Site 34 (Laleham Landfill) to the north. Site 31 (Old Littleton Lane Landfill) is located adjacent to the east. The site is located within the Order Limits. The pipeline would enter the site through a trenchless crossing (under the Thames and Chertsey Bridge Road) and then be open cut for 200m northeast along the east side of the site. The pipeline would exit the site via a trenchless crossing under the M3.
Site History	The site history has been deduced from multiple sources including historical maps, aerial photos and information received from regulators and the site operator. According to historical maps, the site was undeveloped land adjacent to Chertsey Lock from 1865 to 1934 (from 1:10,560). An arcuate water body labelled Bos Ait is shown on the land and appears to be a former channel of the River Thames. Chertsey Lock was constructed between 1811 and 1815 to improve river navigation through an area of shallows known as the Laleham Gulls, and it may be that Bos Ait was cut off from the Thames at this time. The site was then shown to be a sports ground in 1934 (from 1:10,560). The land appears to have been acquired for mineral extraction by a Mr Lavender in the 1950s, with the site boundary shown in a plan dated 1959, although this plan shows that mineral extraction only just extended onto the northern section of the subject site at that stage. Review of aerial photographs and Surrey County Council gravel pit maps by Spelthorne Borough Council (03/07/18) suggests gravel extraction progressed southwards across the site from 1955 to 1968. Consent for tipping of inert wastes was granted for the Laleham Quarry site (including the subject site) in 1957, and the records review by Spelthorne Borough Council suggests that waste disposal took place around the edges of the lake from 1961 to 1971.

Site Name / Ref.	Lavenders Landfill / ES Site No. 30 (also known as Laleham Landfill – South Lake)
	The M3 embankment was largely filled in 1970–71, and there seems to have been little landfilling on site after this period, with the current Abbeyfields Lake outline similar to the 1974 map. The site was included in the area covered by a 1977 Waste Management Licence for the wider Laleham Landfill site (Site 34), which has not been surrendered and is still in force as WML83099, but no landfilling appears to have taken place on the subject site under this licence. The site appears to have been used for grazing since the 1970s. The site is reported to have been subjected to flooding during early 2014 and was subject to investigation as part of the inquest into the death of a child in a neighbouring house in February 2014 (Travers, 2016). The inquest considered whether the death may have been caused by hydrogen cyanide entering the house from a source in the Lavenders Landfill site. The inquest found that none of the land/soil or water testing conducted at the house or the land behind it found any evidence of a source of hydrogen cyanide (or any other toxic gases). The inquest concluded that the death was accidental as the result of carbon monoxide poisoning resulting from the use of a petrol pump in the house. The inquest report also mentions that '*in an effort to divert the water away from their properties, some of the residents from Chertsey Bridge Road used mechanical diggers to dig a ditch and to create a bund running parallel to Chertsey Bridge Road and to the rear of their properties*.' It is understood that Brett Aggregates, as operator of the site, were responsible for removing this illegal waste from the site.
Landfill Operations	As detailed in the site history section above, landfilling appears to have taken place at the Lavenders Landfill between circa. 1957 and 1971. The earliest record of waste disposal is a 1957 consent for disposal of Class I inert wastes, specifically materials excavated from land in its natural state, including excavation from building sites; builders' rubbish, brick and hardcore, clinker and ashes. There were further restrictions on the proportions of lathe, plaster and ferrous metals permitted to be deposited into water. (December 1957 Consent to WJ Lavender Ltd.) Further tipping consents were issued for the Laleham Quarry site (including both Site 27 and Site 31) in March 1973 and July 1973, as detailed in the Site 31 summary. There does not appear to have been any filling of the subject site under these consents. 1977 – 2005 1977 Surrey County Council Waste Management Licence, under the Control of Pollution Act (COPA) 1974, site references 2/62 and 83099. This licence covered the whole of the former gravel pit (i.e. both north and south of the M3 motorway, Site 31 and Site 27). It was partially replaced to the north of the M3 in 2006 by EPR/RP3233LJ, which has not been surrendered. Waste materials to be accepted under the 1977 licence were limited to Class 1 materials: materials excavated from land in its natural state, brick and concrete. However, it does not appear that any waste was disposed of in the subject site under this licence. Brett Aggregates are currently the operator of the closed site under WML83099.
Previous Ground Investigations	BGS Borehole TQ06NE75, drilled in October 1967 within the Order Limits under the M3, encountered a layer of brick, rubble, ash and concrete to 1.8mbgl, underlain by clay with some organic matter and occasional concrete. Five boreholes were drilled in the southeast corner of the site by the Transmission Division of the Central Electricity Generating Board in May 1972 on behalf of the South Eastern Electricity Board (BGS boreholes TQ06NE10,11,12,13,14) (Spelthorne Borough

Site Name / Ref.	Lavenders Landfill / ES Site No. 30 (also known as Laleham Landfill – South Lake)
	Council, 03/07/18). The boreholes encountered mixed landfill waste to between 2.9m and 9.7mbgl, including bricks, concrete, metal, clay, wood and tins. In borehole TQ06NE14 (within the Order Limits but outside the limit of deviation), the drilling appeared to strike a metal canister at 3.0mbgl which released a substance that effervesced with water in the borehole and gave rise to an 'obnoxious smell'. Borehole GGW51 drilled by Fugro in 2004 (Bretts, 25/10/18), also within the Order Limits around 40m south of the M3, found made ground to 7mbgl containing flint, brick and concrete gravel/cobbles, with rare decomposed plant remains, bones fragments and rootlets, and underlain by sandy clay. Gas and groundwater monitoring data are available for this borehole from 2005 – 2018. SLR Consulting Ltd undertook fieldwork in November 2014 including surface emissions survey using a flame ionisation detector, flux box survey and surface water sampling, mainly in the southwest of the site more than 100m from the Order Limits (Spelthorne Borough Council, 03/07/18). The work was associated with the inquest (Travers, 2016). The landfill was subject to site investigation in 2015/16 by Fugro Engineering Services on behalf of the Environment Agency as part of Thames Flood Alleviation Scheme. Three boreholes were excavated along the eastern boundary, either within or very close to the Order Limits, including Fugro borehole C3BH07 in the vicinity of the 1972 BGS boreholes described above. Made ground was present to 8.4mbgl and included: brick, concrete, flint, plastic, ceramics, glass, wood, chert and metallic fragments, with a locally strong hydrocarbon odour.
Geology	Superficial geology: Shepperton Gravel Member – sand and gravel (Devensian). Alluvium – silt (Flandrian). Bedrock geology: Bagshot Formation – sand (Eocene). Fugro (2016) undertook a ground investigation and found the following depth to the top of stratum range: Made ground – n/a Alluvium – 2.2mbgl Shepperton Gravel Member – 2.3mbgl – 2.5mbgl (2.4mbgl average) Bagshot Formation (including Swinley Clay Member) – 7mbgl – 8.4mbgl (7.66mbgl average). London Clay Formation 10.2mbgl – 11.5mbgl (10.72m average).
Hydrogeology	The Shepperton Gravel Member is a Principal aquifer. Alluvium and the Bagshot Formation are Secondary A aquifers.
Hydrology	There are no watercourses on site though there is extensive surface water across the site forming a lake. There are no surface water abstractions, groundwater and recorded pollution incidents on the site. There is potential for groundwater flooding to occur at this site to property situated below ground level. The site lies within areas designated as Flood Zone 2 and Flood Zone 3 and there is a 0.1% annual chance of surface water flooding. The site is located within two Source Protection Zones: Zone 2 along the west side of the site and Total Catchment Zone 3 in the east.
Environmental Setting	The site is located on non-agricultural land within the London Area Greenbelt, a Drinking Water Protected Area (Surface Water) and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	SLR Consulting Ltd investigations in 2014 found that no methane, carbon monoxide or hydrogen cyanide was detected using the

Site Name / Ref.	Lavenders Landfill / ES Site No. 30 (also known as Laleham Landfill – South Lake)
	infrared detector in the flux box testing (Spelthorne Borough Council, 03/07/18). Carbon dioxide levels were generally <0.5% by volume except location 1 where levels reached 2.9% by volume. During the flame ionisation detector walkover survey, no elevated hydrocarbon (methane) concentrations were detected in air from the surface of the site. Results from the Thames Flood Alleviation Scheme investigation (GBV, 2017) recorded slightly elevated concentrations of lead but no exceedances of C4SL Public Open Space (Park) assessment criteria. Leachate and groundwater testing indicated elevated concentrations of PAHs and ammoniacal nitrogen. Asbestos was identified in four out of six samples, from between 1.5m and 3.5m, in all boreholes. The types of asbestos included chrysotile and amosite and was identified as being found in clumps and bundles and as microscopic insulation fragments and cement fragments, quantified as between <0.001% to 0.059% mass%. Gas monitoring of two boreholes (GBV, 2017) showed the presence of methane in the ground at concentrations up to 26.1%, carbon dioxide at up to 6% and carbon monoxide up to 7 parts per million (ppm). The maximum flow rate was 3.7l/hr.
Remediation	None known.
Potential Sources of Contamination	Landfill waste 1957 – 1972, nominally inert waste from construction and demolition but known to contain a range of organic and inorganic wastes.
Potential Contaminants	Soils/wastes and perched water: a range of organic and inorganic contaminants, including hydrocarbons, PAHs, heavy metals, ammoniacal nitrogen, asbestos. Landfill gas: methane and carbon dioxide.
Potential Receptors and Pathways	Construction workers: direct contact and ingestion of contaminants, and exposure to associated waste materials and shallow groundwater/leachate, during open cut and excavation of pits for trenchless crossings, as excavations are within areas of known landfilling. Exposure to landfill gas that could accumulate in trenches and pits for trenchless crossings. Adjacent land users: inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials. Adjacent grazing animals: inhalation and uptake from dusts deposited on grass from windblown contaminated dusts from excavation works and stockpiling of waste materials. Surface water: a large lake is present on site just to the west of the open cut section of the Order Limits. Surface runoff from the stockpiled wastes could enter the lake. As the pipeline would be installed close to the lake, contaminated groundwater/leachate mobilised during installation could migrate to the lake if in continuity with shallow groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 30 Table 1. Likely contaminants present on site are heavy metals, PAHs and ammoniacal nitrogen. However, limited testing to date shows that these have not been found above generic human health assessment criteria. Asbestos fibres have been detected in soil above the laboratory limit of detection. Contaminated shallow groundwater could be encountered within the pipeline installation trench where construction workers could be exposed. Excavation work would be carried out within landfill materials and exposure to contaminated wastes and shallow groundwater/leachate is likely. Taking into account the test data available to date, the risks to

Site Name / Ref.	Lavenders Landfill / ES Site No. 30 (also known as Laleham Landfill – South Lake)
	construction workers are assessed as moderate/low. Adjacent land users could be affected by windblown contaminated dusts generated during excavation works and from the stockpiling of excavated materials in windy conditions. Given the test data available to date, the risks are assessed as low. The risk to grazing animals on site has been ranked as very low, due to low contaminant levels recorded in limited testing to date. The trench entering the landfill could create new pathways and linkages for landfill gas to migrate along and effect construction workers. In addition, landfill gas migrating off-site could enter and accumulate in nearby buildings. However, the perimeter monitoring wells show little landfill gas outside the waste, implying there is little driving force for gas migration outside the waste body itself. The risks associated with asphyxiation and explosion have been assessed as moderate to moderate/low.
References	References include those listed in Chapter 11 Soils and Geology. Fugro Geoservices Limited (2017). River Thames Scheme -Channel Section 3 Additional Investigation, Factual Report. GBV JV Ltd (2017). River Thames Scheme Capacity Improvements and Flood Channel Project, Geotechnical and Geoenvironmental Interpretative Report – Zone 26. GBV document number: 122368-BVL-Z0-C3-RP-G-00126 Travers, R. (2016). Inquest Touching the death of Zane Ilorie Christopher Yusuf Gbangbola, Factual Findings and Conclusions. H.M. Senior Coroner for the County of Surrey. Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 3/07/18. Brett 25/10/18. CD containing monitoring data, borehole logs, permits, completion reports.

Table B50: ES Site No. 30 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
30A	Landfill waste	A range of organic and inorganic contaminants, including hydrocarbons, PAHs, heavy metals, asbestos	Inhalation, ingestion and/or dermal contact with contaminants in shallow soils and groundwater and exposure to vapours	Construction workers	Health effect (medium)	Low. Due to low contaminant levels recorded in limited testing to date. Contaminants could be directly excavated during open cut, and asbestos known to be present. Contaminants could leach into the trench.	Moderate/low
30B			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (medium)	Unlikely. Due to low contaminant levels recorded in limited testing to date. The closest land use is a residential property located 10m from the excavation works. Exposure of landfill material would be of short duration.	Low

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
30C			Inhalation and uptake from dusts deposited on grass from windblown contaminated dusts from excavation works and stockpiling of waste materials.	Adjacent grazing animals	Health effect (mild)	Unlikely. Due to low contaminant levels recorded in limited testing to date. Exposed soils would be of short duration and settlement of contaminants resulting from windblown transit is unlikely.	Very low
30D			Runoff and direct migration of shallow groundwater/ leachate into lake.	Surface water	Deterioration of surface water quality (mild)	Low. Lake is adjacent to the excavation works. However, the lake is likely to have been in hydraulic continuity with waste for decades.	Low
30E	Landfill waste	Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench.	Construction workers	Health effect (severe)	Low. Moderate in-waste methane and carbon dioxide gas concentrations were recorded. Some dilution likely in open trench.	Moderate
30F			Migration along preferential pathways created by trench and ingress and accumulation within off-site confined spaces.	Adjacent land users	Health effect (severe)	Unlikely. Although moderate in-waste methane and carbon dioxide gas concentrations were recorded, there appears little driving force for off-site migration.	Moderate/low

Table B51: Old Littleton Lane Landfill / ES Site No. 31

Site Name / Ref.	Old Littleton Lane Landfill / ES Site No. 31
Basis for Scoping In	This site is identified by the local authority as an area of former landfill partially within the Order Limits.
Site Location and Description	The site is situated along Section G of the route between Old Littleton Road and Littleton Lane (E: 505915 N: 167013). The area of the site is ~1.1 ha and the ground elevation varies between 11-13mAOD. The site was viewed at a distance from the east on Littleton Lane on 15/10/18. The purpose of the visit was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. It was not possible to access this site to undertake a walkover survey. The current land use comprises a residential caravan park at the northern end, and a pond area covering the southern half of the site. The topography across the site was generally sloped towards the pond in the southern end and is flat in the northern residential area. Littleton Lane is raised on an embankment above the site to the east, and the site is also slightly below the level of

Site Name / Ref.	Old Littleton Lane Landfill / ES Site No. 31
	the M3 motorway to the north. There is a bund on the site between the pond and Old Littleton Lane to the west. Vegetation across this area consisted of grass, shrubs, semi-mature trees, with some evidence of Japanese Knotweed. The southern side of the side was heavily vegetated. There were signs of subsidence around the pond area. The site appeared to be poorly drained. There was evidence of fly-tipping in the pond area. Site 30 (Lavenders Landfill) is located west of the site, Site 32 (Sheep Walk Landfill) is located east of the site, and Site 34 (Laleham Landfill) is located north of the site. The site is within the Order Limits. A trenchless crossing (TC034, River Thames) would be constructed through the southern tip of the site.
Site History	According to historical maps, the area was agricultural land and open fields from 1865 to 1938 (1:10,560), with Old Littleton Lane (west of the site) present as a road. In 1938, a Ballast Pond is shown east of Old Littleton Lane, extending into the area now occupied by the caravan site, and is still present in 1960. The 1968 (1:10,560) map shows that the northern area formerly occupied by the Ballast Pond has been infilled, and the gravel workings have been extended into the southern part of the site. The 1973 map shows that the M3 motorway has been constructed north of the site, and current Littleton Lane has been constructed on a flyover east of the site, leaving the site in the same general configuration as seen currently, with the pond in the southern section. The 1970 aerial photograph excerpt provided by Spelthorne Borough Council (22/05/18) shows gravel extraction up to Old Littleton Lane with the exception of what appears to be a working area in the corner of the site which is crossed by the Order Limits. The residential area (caravan site) is currently present at the north end of the site (aerial imagery and site walkover).
Other Pertinent Information	No other information identified.
Landfill Operations	The land between Old Littleton Lane and Littleton Lane is recorded by them as historical landfill known as Old Littleton Lane Landfill (Spelthorne Borough Council, 03/07/18). Spelthorne's information includes reference to the 1970 aerial photograph, which indicates that this landfill site was also originally part of the larger Thames Ballast pit. It showed that the north of the landfill was being infilled into the flooded gravel workings in connection with the construction of the M3 motorway and the new road alignment of Littleton Lane to create a flyover over the motorway. There are no specific details available about the nature of materials used.
Previous Ground Investigations	In 2016, Fugro Exploratory Services carried out a ground investigation with trial pits in the bund adjacent to Old Littleton Lane, in association with the proposed Thames Flood Alleviation Scheme (Fugro Geoservices Limited, 2017). The trial pits were excavated to 1.2mbgl and identified made ground with brown clayey sand and gravel of flint, chert, brick and concrete, comprising demolition and construction waste. Rare possible cement tile asbestos was observed in two of the three trial pits. BH25 was drilled 50m to the south as part of the SLP GI, at the location of a proposed trenchless crossing.
Geology	Superficial geology: Shepperton Gravel Member – sand and gravel (Devensian). Bedrock geology: Bagshot Formation – sand (Eocene). There is one BGS borehole within the site boundary, reference TQ06NE 190, dating from 1962. This borehole was approximately 1m deep into natural strata. The 2016 Fugro investigation within the site was limited to shallow trial pits in a bunded area and found made ground only. Deeper

Site Name / Ref.	Old Littleton Lane Landfill / ES Site No. 31
	investigations in the adjacent Lavenders site (Site 30) confirm the deeper geology. BH25 encountered alluvial material comprising very soft sandy clay, from ground level to 1.80m.bgl, over medium dense Shepperton Gravels between 1.80m to 8.10m.bgl, over stiff and very stiff clay interlaminated with dense very dense sand of the Bagshot Formation between 8.10m to 14.60m.bgl, comprising of alternating stiff clay and dense to very dense sand layers, over very stiff London Clay Formation from 14.60m.bgl to the base of the borehole
Hydrogeology	The Shepperton Gravel Member is a Principal aquifer. The Bagshot Formation is a Secondary A aquifer. Groundwater levels have been measured manually on five separate occasions in BH25, which is located at an elevation of 11.43mAOD and was completed to a depth of 20.41mbgl. These measurements indicate an average groundwater level of 1.09mbgl, or 10.34mAOD.
Hydrology	There are no water courses on site, although there is a pond located at south end of site. The River Thames is located 100m south of the site. There are no groundwater abstractions, surface water abstractions or recorded pollution incidents on site. The site lies within an area designated as a Source Protection Zone (Total Catchment Zone 3). The area is also designated as Flood Zone 2 and Flood Zone 3 and there is 0.1% to 1% annual chance of surface water flooding occurring on the site. There is potential for groundwater flooding to occur at this site to property situated below ground level.
Environmental Setting	The site is located on non-agricultural land within the London Area Greenbelt, a Drinking Water Protected Area (Surface Water) and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	The presence of asbestos was confirmed in two of the Thames Flood Alleviation Scheme trial pits from the bund. Chrysotile was found in clumps, fibres and cement debris at 0.003% and 0.007% total mass%. Chemical testing of soil samples from the bund found slightly elevated lead and PAHs but no results in exceedance of C4SL Public Open Space (Park) assessment criteria. It should be noted that the investigation data from the bund are unlikely to be representative of the fill that may be present at depth in the area of the Order Limits No gas or groundwater monitoring data are available for the Old Littleton Lane site. For the groundwater sample collected in BH25, ammoniacal nitrogen concentrations were slightly elevated at up to 1.26mg/l. Low concentrations of organic determinands were also recorded, with TPH detected on the first two sampling occasions (at up to 0.303mg/l) and PAHs on the first sampling occasion (at 0.000199mg/l). Soil samples were collected at 0.7m and 2.0mbgl from BH25. Concentrations recorded were below of C4SL Public Open Space (Park) assessment criteria.
Remediation	Not known.
Potential Sources of Contamination	Possible former landfill waste. Extent and nature of waste within Order Limits not known.
Potential Contaminants	Range of organic and inorganic contaminants including heavy metals, PAHs, asbestos.
Potential Receptors and Pathways	No open cut is proposed within the site, so construction workers would only come into contact with site-derived contamination if it migrated from the site, or if it was present in drilling arisings associated with the trenchless crossing, if the crossing passes through

Site Name / Ref.	Old Littleton Lane Landfill / ES Site No. 31
	the waste. The adjacent land is also landfill (Lavenders Landfill, Site 30), and therefore risk associated with contamination which has migrated from the site is considered under Site 30.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 31 Table 1. The likelihood of substantial contamination from the site being encountered by the project is considered low. This is because there is only limited evidence for waste actually being present in the part of the site to be crossed, and even if waste is present, it may not be present at the depth at which the pipeline would pass through the site. The risks have been ranked as low.
References	References include those listed in Chapter 11 Soils and Geology. Fugro Geoservices Limited (2017). River Thames Scheme - Channel Section 3 Additional Investigation, Factual Report. GBV JV Ltd (2017). River Thames Scheme Capacity Improvements and Flood Channel Project, Geotechnical and Geoenvironmental Interpretative Report – Zone 26. GBV document number: 122368-BVL-Z0-C3-RP-G-00126 Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 22/05/18. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project – BH25. Report ref. 10021961-AUK-XX-XX-RP-GE-0009-01-BH25 Factual.

Table B52: ES Site No. 31 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
31A	Landfill waste	Range of organic and inorganic contaminants including heavy metals, PAHs, asbestos	Entrainment in drilling fluid and arisings	Construction workers (contact with arisings)	Health effect (medium)	Unlikely. Due to depth of drilling and low likelihood of presence of waste at depth.	Low

Table B53: Sheep Walk Landfill (Chertsey Road Tip) / ES Site No. 32

Site Name / Ref.	Sheep Walk Landfill (Chertsey Road Tip) / ES Site No. 32
Basis for Scoping In	The site is identified as a former landfill within 250m of the Order Limits.
Site Location and Description	The site is located north of Chertsey Road, at the west of Sheep Walk Road and bisected by the M3 along Section G of the route (E: 506450 N: 167057). The area of the entire site is ~50ha and the ground elevation varies between ~11mAOD and 13mAOD. The boundary of the scoped in site is defined by the location of the historical landfill polygon ‘Sheep Walk’ on the Environment

Site Name / Ref.	Sheep Walk Landfill (Chertsey Road Tip) / ES Site No. 32
	Agency historic landfills Open Data. However, it is noted that Spelthorne Borough Council hold different boundaries for the site. The area of the site within 250m of the Order Limits was viewed at a distance from the south from the Chertsey Road on 15/10/18 as it was not possible to access the site. At the time of viewing, the land use of the site was primarily open fields with lakes at the north end of the site. There was also a waste transport vehicle depot operated by SITA at the south end of the site (more than 250m from the Order Limits). The topography was generally undulating grassland and vegetation consisted of grassland, shrubs, semi-mature trees and mature trees. There were signs of isolated subsiding areas and uneven ground. The site appeared to be moderately drained. There was an unspecified container seen at the south end of the site in a horse field. There were several minor ponds on the western side of the site. The site is located outside of the Order Limits, 30m to the east. A trenchless crossing is proposed approximately 60m to the southeast of the site.
Site History	Historical maps indicate the site was predominantly agricultural land and open fields from 1865 to 1968 (1:10,560). Ponds in the southwest corner of site have also been present from 1973 to the present day (from 1:10,000 and aerial imagery). A refuse tip was present in the southwest corner of site in 1988 (1:10,000). Landfill sites were also shown in the southwest corner of the site in 1992 (from 1:2500). A household waste depot operated by SITA has been shown from 1990 to the present day (from 1:10,000 and aerial imagery).
Landfill Operations	Information received from Spelthorne Borough Council (03/07/18): The western part of the landfill is also known as Riverscroft, or Chertsey Road Tip. The Riverscroft site was originally part of the Thames Ballast Pit and gravel extraction commenced in 1920s. By 1981, the site was a flooded gravel pit and by 1992 had been infilled. Riverscroft was licensed by Surrey County Council under COPA, with reference 2/54. It is understood that an artificial clay liner was constructed to each cell from imported clay materials. The larger area of the site including land to the east of the 250m buffer was known as Sheep Walk. Landfilling of mixed industrial and commercial wastes took place between 1946 to 1975. Poor conditions and contraventions are noted on inspections throughout the 1950s. For example, an oil sump accepting waste from London Transport garages operated (without consent) on the south of the site through to the early 1960s. Further details are available, but as the area identified by Spelthorne Borough Council as Sheep Walk is more than 250m from the Order Limits, it has been excluded from further assessment here.
Previous Ground Investigations	The landfill was subject to site investigation in 2015/16 by Fugro Engineering Services on behalf of the Environment Agency as part of preparations for Environmental Statement for the Thames Flood Alleviation Scheme (Fugro Geoservices Limited, 2017). Six boreholes and five trial pits were excavated within the south west corner, within the 250m buffer. Made ground resulting from construction and demolition landfill was encountered in all exploratory locations. This was generally a brown to dark grey clayey sand and gravel with a low to medium cobble content. The sand was fine to coarse. The gravel was angular to subangular, fine to coarse comprising brick, chert, concrete and flint. The cobbles were typically angular brick and

Site Name / Ref.	Sheep Walk Landfill (Chertsey Road Tip) / ES Site No. 32
	concrete. Other materials such as wood, glass, wire and ash were identified. Trial pits C3TP09 and C3TP10 encountered black stained sand with frequent plastic bags, plastic strapping and burnt ash. A strong hydrocarbon/methane gas odour was noted. The made ground was underlain were underlain by soft to firm to stiff grey sandy clay, possible clay liner.
Geology	Superficial geology: Alluvium (locally absent) Shepperton Gravel Member – sand and gravel (Devensian). Bedrock geology: Bagshot Formation – sand (Eocene).
Hydrogeology	The Shepperton Gravel Member is a Principal aquifer. The Bagshot Formation is a Secondary A aquifer. No groundwater was encountered during drilling. However, standing water was recorded between 1mbgl and 2mbgl within monitoring boreholes.
Hydrology	There are several surface water ponds on the site. The River Thames is located around 40m south of the site. There are no groundwater abstractions, surface water abstractions or recorded pollution incidents on site. The west part of the site is within a Source Protection Zone (Total Catchment Zone 3). There is limited potential for groundwater flooding to occur over much of the site. The site is located within Flood Zone 2 and Flood Zone 3 and there is a 0.1% to 1% annual chance of surface water flooding occurring on the site.
Environmental Setting	The site is located on non-agricultural land within the London Area Greenbelt, a Drinking Water Protected Area (Surface Water) and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	Results from the Thames Flood Alleviation Scheme 2015/16 investigation recorded slightly elevated concentrations of lead and PAHs with rare slight exceedances of C4SL Public Open Space (Park) assessment criteria. Leachate testing indicated elevated concentrations of PAHs, ammoniacal nitrogen and cyanide. Three out of 35 soil samples analysed were found to contain asbestos. The types of asbestos revealed included chrysotile, amosite and crocidolite identified as being found in clumps and bundles within the soil, quantified as between 0.003% to 0.016% mass%. Ground gas monitoring recorded elevated levels of both methane (maximum 86.6%) and carbon dioxide (maximum 17.4%) and flow rates up to 13.4l/hr.
Remediation	None known.
Potential Sources of Contamination	Former landfill.
Potential Contaminants	Soils/wastes and perched water/leachate: heavy metals, asbestos containing materials, solvents, waste oils, hydrocarbons, clinker, ashes, varied municipal wastes. Landfill gas: methane and carbon dioxide
Potential Receptors and Pathways	Construction workers: might be a receptor if exposed to mobile contaminants which have migrated from the landfill into the surrounding shallow ground and groundwater, despite the presence of a clay liner. However, given that the area of the Order Limits closest to the site also comprises former landfill, the additional risk from this site is not considered substantial and is therefore

Site Name / Ref.	Sheep Walk Landfill (Chertsey Road Tip) / ES Site No. 32
	excluded from further risk assessment.
Ground Contamination Risk Assessment and Conceptual Site Model	n/a
References	References include those listed in Chapter 11 Soils and Geology. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project – BH25. Report ref. 10021961-AUK-XX-XX-RP-GE-0009-01-BH25 Factual. GBV JV Ltd (2017). River Thames Scheme Capacity Improvements and Flood Channel Project, Geotechnical and Geoenvironmental Interpretative Report – Zone 19. GBV document number: 122368-BVL-Z0-C3-RP-G-00119 Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 3/07/18. Fugro Geoservices Limited (2017). River Thames Scheme - Channel Section 3 Additional Investigation, Factual Report.

Table B54: Littleton Lane Landfill / ES Site No. 33

Site Name / Ref.	Littleton Lane Landfill / ES Site No. 33
Basis for Scoping In	This site is identified as historical landfill on the Environment Agency national dataset. The site boundary also includes former land uses identified from historical maps including railway sidings.
Site Location and Description	The site is located north of the M3 and southeast of Littleton Lane, along Section H of the route (E: 506395 N: 167588). The area of the site is ~42ha and the ground elevation is 11-19mAOD. The majority of the Littleton Lane Landfill is a flooded former sand and gravel working which has been restored to a formal recreational water feature, currently occupied by the Littleton Sailing Club. There are two areas of land adjacent to the water used for boat parking and clubhouses. It was not possible to access the site to undertake a walkover survey. The site boundary includes Littleton Lane (including part of the eastern verge), which is raised on a flyover across the M3 motorway in the southeast of the site. The southern site boundary is formed by the M3. Site 34 (Laleham Landfill) is located west of the site and Site 32 (Sheep Walk Landfill) is located south of the site. The site extends into the eastern extent of the Order Limits. However, the LoD for the pipeline are not located within the site boundary. The endpoint of a proposed trenchless crossing beneath the M3 would be located about 70m west of the site boundary.
Site History	According to historical maps, the site was previously agricultural land and open fields from 1865 – 1934. During that time, the alignment of Littleton Lane was along the site's western boundary, west of the current road alignment. The site was labelled as Ballast Pit from 1934 – 1960 (1:10,560). The Ballast Pit extended further south and west than the defined site boundary, forming parts of Site 32 (Sheep Walk Landfill) and Site 31 (Old Littleton Lane Landfill). A short length (approximately 140m) of mineral railway line is shown adjacent to a landing stage parallel to Littleton Lane (on the current road alignment). The area has been shown as Littleton Lake from 1960 – present day (aerial imagery and 1:10,560).

Site Name / Ref.	Littleton Lane Landfill / ES Site No. 33
	The M3 is shown to have been constructed across the site in the 1973 map. The 1990 map shows some infilling associated with the northern clubhouse.
Other Pertinent Information	No other information identified.
Landfill Operations	The gravel workings were excavated by Thames Ballast (Shepperton) Ltd between the late 1920s and the late 1950s (Spelthorne Borough Council, 03/07/18). A scheme of working agreed under planning permission SUN 3476 in 1951 indicates that it was originally intended to fill much of the worked out land with waste materials. In 1956, a further 2ha extension adjoining Littleton Lane on the northwest side of the Thames Ballast Pit was approved. There was temporary permission for use of the lake by a sailing club from 1959. In 1969, permission was granted for some filling in order to enlarge a peninsula to provide parking and access to Littleton Lane as a location for a new permanent sailing clubhouse. This remains the home of Littleton Sailing Club. Permanent use of the lake for sailing was also granted in 1969. Filling at the northern peninsula to create land for the new clubhouse occurred at an unknown date between 1970 and 1981. There may have been some limited further filling associated with landscaping of the sailing lake and or restoration of the banks around the lake, though there is currently no record of this. There is no record of waste types used in the filling activities.
Previous Ground Investigations	In 2015, Opus carried out a ground investigation for the Thames Scheme, with two boreholes within the site to the east of Littleton Lane. The boreholes found 3m to 5.4m of made ground (construction and demolition waste) underlain by clays, gravel and sand. The made ground included chalk, ceramic, brick, wood, concrete and flint.
Geology	Superficial geology: Shepperton Gravel Member – sand and gravel (Devensian). Bedrock geology: Bagshot Formation – sand (Eocene).
Hydrogeology	The Shepperton Gravel Member is a Principal aquifer. The Bagshot Formation is a Secondary A aquifer.
Hydrology	There is extensive surface water coverage across the whole site. There are no groundwater abstractions, surface water abstractions or recorded pollution incidents on site. The west part of the site is within a Source Protection Zone (Total Catchment Zone 3). The site lies within areas designated as Flood Zone 2 and Flood Zone 3.
Environmental Setting	The site is located on non-agricultural land within the London Area Greenbelt Drinking Water Protected Area (Surface Water) and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	Asbestos was identified in two samples from Fugro borehole C3BH17 at 1m and 3.2mbgl. Chrysotile was found in fibre bundles and cement at 0.001% and 0.707% total mass%. Chemical test data have not been reviewed in detail. Samples found slightly elevated heavy metals and PAHs but no results in exceedance of C4SL Public Open Space (Park) assessment criteria.
Remediation	Not known.
Potential Sources of Contamination	Former gravel extraction with limited landfilling (1934 – 1981).

Site Name / Ref.	Littleton Lane Landfill / ES Site No. 33
Potential Contaminants	Waste contaminated with heavy metals, PAHs, asbestos containing material.
Potential Receptors and Pathways	Construction does not include any excavation within the site boundary. Given that the land within the Order Limits adjacent to the site also comprises former landfill, the additional risk from this site is not considered substantial and is therefore excluded from further risk assessment. No pathways are identified for risk assessment.
Ground Contamination Risk Assessment and Conceptual Site Model	n/a
References	References include those listed in Chapter 11 Soils and Geology. Opus (2015). River Thames Scheme Capacity Improvement Channel 3 Ground Investigation – Environment Agency, Factual Report. Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 3/07/18.

Table B55: Laleham Landfill / ES Site No. 34

Site Name / Ref.	Laleham Landfill / ES Site No. 34
Basis for Scoping In	The site is listed as authorised landfill on the Environment Agency national dataset and is within the Order Limits.
Site Location and Description	The site is located between Shepperton and Laleham in Section H of the route, centred around E: 505806 N: 167791. The site covers a total area of approximately 85.5ha and the ground elevation varies between 12mAOD and 13mAOD. A site walkover survey was carried out on 24/10/18. The purpose of this walkover was to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was accessed with prior permission from the landowners. The site extends from Shepperton Road in the north to the M3 in the south, and is bounded to the east by Littleton Lane, and to the West by Laleham Park and the River Thames. The northern section of the site (~39ha) has been restored to agriculture and is farmed as a market garden. Part of the southern section of the site along Littleton Lane (~4ha) is now used as an industrial estate. The remainder of the southern section (~42.5ha) is operated by Brett Aggregates who are in the process of restoring the site to mixed environmental habitat, recreational and agricultural grazing use. The site currently includes water filled pits, vegetated areas, and former gravel and aggregate working areas. Prior to the construction of the M3 Motorway, the site was linked with Site 30 (Lavenders Landfill). The Environment Agency have plans to construct a flood channel for the Thames Flood Alleviation Scheme from east to west across the site. The site is located within the Order Limits. The pipeline would enter the site via a trenchless crossing beneath the M3, with associated laying out areas and access routes. The pipeline would be open cut through the site, except for the crossing of the Thames Flood

Site Name / Ref.	Laleham Landfill / ES Site No. 34
	Alleviation Scheme, which is yet to be confirmed. The pipeline would exit the site via a trenchless crossing under the Shepperton Road.
Site History	The site history has been deduced from multiple sources including historical maps, aerial photos and information received from regulators and the site operator. Historical maps and 1945 aerial photographs show the whole site was agricultural land. However, much of the southern (Brett Aggregates) area was worked for minerals prior to 1953. Review of aerial photographs and Surrey County Council gravel pit maps by Spelthorne Borough Council (03/07/18) suggests gravel working in this area was mainly completed by 1966. The land is currently occupied by the industrial estate, and parts of the southeastern corner of the site (adjacent to the Littleton Lane crossing of the M3) do not appear to have been worked for gravel. Consent for tipping of inert wastes was granted in 1957, and the records review by Spelthorne Borough Council suggests that waste disposal took place in areas of the southern site from 1957 until the early 1970s. The M3 embankment was filled in 1970–71. Waste disposal appears to have continued in the southern area under the Waste Management Licence until at least 2003. Gravel was extracted from the northern area (Laleham Farm) from about 1978 until about 2003, with a systematic plan of extraction followed by infilling with inert waste and restoration to agriculture. In 2005, an application was made for further permission to extract the remaining gravel reserves from the central part of the site, partially infill with inert waste, and restore for recreation/agriculture. Permission was granted, although the development did not proceed. However, the site was used for mineral processing, including aggregate processing and waste recovery, with parts of the site occupied by tenants including small haulage firms. The industrial estate has continued to have mixed use including vehicle maintenance and other small light industry businesses.
Other Pertinent Information	No other information identified.
Landfill Operations	Various permissions were granted for waste disposal: • December 1957 Consent to WJ Lavender Ltd. • March 1973 Staines UDC Consent to Greenham Sand and Ballast Company Ltd. • July 1973 Surrey CC Consent to Greenham Sand and Ballast Company Ltd. • 1977 Surrey County Council Waste Management Licence, under the COPA 1974, site references 2/62 and 83099. This licence covered the whole of the former gravel pit (i.e. both north and south of the M3 motorway, Site 31 and Site 27). It was partially replaced in 2006 by the new Environmental Permitting Regulations (EPR) but has not been surrendered. • Environmental Permit EPR/RP3233LJ was first issued in 2006 and covers an area of land within the southern part of the site. Areas which had already been filled were excluded from this permit, which includes the industrial estate, the lake, and the southern area close to the M3. The permit partially supersedes WML 83099. The permit has never been enacted. These permissions allowed the disposal of Class I inert wastes only, specifically materials excavated from land in its natural state, including excavation from building sites, builders' rubbish, brick and hardcore, clinker and ashes. There was a small lagoon used in the east of the site near Littleton Lane (north of current industrial estate) which was filled in circa 1966–67 as an experimental pit trialling tipping of household refuse directly into the lagoon.

Site Name / Ref.	Laleham Landfill / ES Site No. 34
Previous Ground Investigations	The summary below focuses on ground investigations within the Order Limits, from north to south. Ground investigations were undertaken on the site by Oakley Soils and Concrete Engineering Ltd (1995), Fugro (2004, 2005) and Opus (2015). All below data was supplied by Brett Aggregates in October 2018 (Bretts, 25/10/18). Borehole logs in the northern part of the site (restored to agriculture) include boreholes GWM42 (1995) which found clay to 1.4m overlying made ground comprising concrete and stone rubble to 9.1m, over sand. The log for GWM43 further north along the same track (1995) records only natural ground, with clay to 1.8m underlain by sand from 1.8m to 8.5m. In the central part of the site, GGW54 (2017) found made ground under block paving interbedded with two separate concrete layers to 2.4m.bgl, with brick, flint and concrete gravel in the made ground. This was overlying a 0.6m layer of sand with occasional pockets of peaty organic clay, overlying sand from 3m. In the southern central part of the site are six boreholes installed in 2017, all close to or within the Order Limits. Borehole M1, 10.4m deep, located to the east of the centre of the Brett Aggregates site centre point, found concrete over made ground to 1.8m.bgl with a concrete layer at 0.4–0.5m.bgl. Brick, concrete and flint gravel. Strong hydrocarbon odour. Clay and gravel underlying. Borehole M2, 10m deep, located centre in Brett site, found concrete over made ground to 1mbgl containing flint and brick gravel and wood. Slight hydrocarbon odour. Clay and gravel underlying. Borehole M3, 8m deep, located centre in Brett site. Concrete over made ground to 0.6mbgl contains flint, brick and concrete gravel. Slight hydrocarbon odour. Sand and gravel underlying. Borehole M4, 7.2m deep, located in the southwest part of the site just north of M3. Made ground to 5m.bgl. Contains gravel of flint, concrete, brick, ash, slag. Fragments of metal, plastic and wood after 1.6mbgl. Hydrocarbon odour between 0.8mbgl and 1.6mbgl. Sand gravel and clay from 5m. Borehole M5, 7.5m deep, located in southeast part of the site north of the M3. Asphalt to 0.1mbgl over concrete to 0.7mbgl. Clay over sand and gravel underlying. Organic inclusions in clay. Borehole M6, 6.5m deep, located in southeast corner of Brett site (north of borehole M5). Made ground over asphalt and concrete to 0.6mbgl. Clay sand and gravel underlying. Slight hydrocarbon noted in 0.6mbgl – 1.3mbgl clay (noted as probable natural ground). The landfill was subject to site investigation in 2015/16 by Fugro Engineering Services on behalf of the Environment Agency as part of the Thames Flood Alleviation Scheme. Three boreholes were excavated along the eastern boundary, either within or very close to the Order Limits. Made ground encountered in the boreholes included reworked Shepperton Gravel as well as localised construction and demolition waste and undifferentiated landfill. In 2015, Opus carried out a ground investigation in the central part of the site. This comprised one borehole, two window samples, two trial pits and one cone penetration test. A further two trial pits and a window sample investigation were undertaken in the southwest of the site outside the Order Limits. Made ground recovered in the investigation was interpreted to be related to Brett Aggregates and was comprised of reworked Shepperton Gravel. Hydrocarbon odours were recorded in many of the excavation locations.
Geology	Superficial geology: Shepperton Gravel Member – sand and gravel (Devensian).

Site Name / Ref.	Laleham Landfill / ES Site No. 34
	Alluvium – silt (Flandrian). Langley Silt Member – silt (Devensian) Kempton Park Gravel Formation – sand and gravel (Devensian). Bedrock geology: Bagshot Formation – sand (Eocene). Claygate Member – sand (Eocene). Opus (2015) undertook a ground investigation and found the following sequences and thicknesses of strata: Made ground – 0.3m – 5.4m thick Alluvium – 0mbgl – 5.3mbgl (1.28m average depth to top surface). Shepperton Gravel Member – 0.3mbgl – 5.4mbgl (2.07m average depth to top surface). Bagshot Formation (including Swinley Clay Member) – 6.9mbgl – 8.9mbgl (7.83m average depth to top surface). London Clay Formation (including Claygate Member 9mbgl – 12mbgl (10.3m average depth to top surface).
Hydrogeology	The Shepperton Gravel Member and Kempton Park Gravel Formation are Principal aquifers. Alluvium, Bagshot Formation and Claygate Member are Secondary A aquifers.
Hydrology	There is extensive surface water in the southwest of the site. There are five groundwater abstractions across site, but no surface water abstractions. The site is located within three Source Protection Zones (Zone 1, Zone 2 and Total Catchment Zone 3). The site lies within areas designated as Flood Zone 2 and Flood Zone 3, and there is a 0.1% to 1% annual chance of surface water flooding occurring on the site. There is potential for groundwater flooding to occur on the surface and below ground level at the site. Three 'Category 3 (Minor)' pollution incidents occurred on the site in 2003 and 2017 (Environment Agency, 31/08/18). The 2003 incident was a small release of diesel from a fuel tank as a result of theft and no watercourses were affected. The two incidents in 2017 involved tipping of waste materials which possibly breached planning control. The pollutant type was not identified.
Environmental Setting	The site is located on non-agricultural land within the London Area Greenbelt, a Drinking Water Protected Area (Surface Water) and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	Results from the Thames Flood Alleviation Scheme investigation (GBV, 2017) recorded concentrations of arsenic, PAHs and petroleum hydrocarbons but no exceedances of C4SL Public Open Space (Park) assessment criteria. Leachate testing indicated elevated concentrations of arsenic, zinc, PAHs and ammoniacal nitrogen. Groundwater testing indicated slightly elevated concentrations of PAHs and ammoniacal nitrogen. Asbestos was not identified in any of the samples screened. Soil test data are not available for other parts of the site. Available gas data over the last three years (2016 to 2018), confirm that gas concentrations within monitoring boreholes in the central part of the site, close to the Order Limits, recorded up to 18.3% methane and up to 2.8% carbon dioxide.

Site Name / Ref.	Laleham Landfill / ES Site No. 34
Remediation	The site is currently undergoing restoration.
Potential Sources of Contamination	Landfill waste (1957 – 2003). Nominally inert waste. However, it was not uncommon for such wastes to contain unauthorised inert wastes potentially containing organic and inorganic contaminants. Investigations have confirmed the presence of other wastes such as wood and plastic. Filling only took place in the northern parts of the site, and localised parts of the southern site. Hydrocarbons from gravel extraction and processing activities (at least 2003 – present).
Potential Contaminants	Soils/wastes and perched water: a range of organic and inorganic contaminants, including hydrocarbons, PAHs, heavy metals, ammoniacal nitrogen. Landfill gas: methane and carbon dioxide.
Potential Receptors and Pathways	Construction workers: direct contact and ingestion of contaminants, and exposure to associated waste materials and shallow groundwater/leachate during open cut and excavation of pits for trenchless crossings, as excavations are within areas of known landfilling. Exposure to landfill gas that could accumulate in trenches and pits for trenchless crossings. Adjacent land users: inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials. Adjacent grazing animals: inhalation and uptake from dusts deposited on grass from windblown contaminated dusts from excavation works and stockpiling of waste materials. Surface water: a large water filled pit is present on site just to the west of the open cut section of the Order Limits. Surface runoff from the stockpiled wastes could enter the pit. As the pipeline would be constructed close to the pit, contaminated groundwater/leachate mobilised during installation could migrate to the pit if in continuity with shallow groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 34 Table 1. Wastes other than inert have been identified through site investigations. However, limited testing to date shows that contaminants have not been found above generic human health assessment criteria. Contaminated shallow groundwater could be encountered within the pipeline installation trench where construction workers could be exposed. Excavation work would be carried out within landfill materials, and exposure to contaminated wastes and shallow groundwater/leachate is likely. Taking into account the test data available to date, the risks to construction workers are assessed as moderate/low. Adjacent land users and could be affected by windblown contaminated dusts generated during excavation works and from the stockpiling of excavated materials in windy conditions. Given the test data available to date, the risks are assessed as low. The risk to grazing animals on site has been ranked as very low, due to low contaminant levels recorded in limited testing to date. The trenchless crossing entering the landfill could create new pathways and linkages for landfill gas including construction workers and off-site migration. However, the limited gas data indicates little driving force for gas migration outside the waste body itself. The risks associated with asphyxiation and explosion have been assessed as moderate to moderate/low.
References	References include those listed in Chapter 11 Soils and Geology. Opus (2015). River Thames Scheme Capacity Improvement Channel 3 Ground Investigation – Environment Agency, Factual Report.

Site Name / Ref.	Laleham Landfill / ES Site No. 34
	Oakley Soils and Concrete Engineering Ltd (1995). Borehole Logs. Fugro (2005). Cable Percussion Borehole Logs (GGW26 to GGW29). Project: Shepperton L/F Site, Middlesex Robert Brett & Sons Ltd. Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 3/07/18. Environment Agency. Email information from Environmental Planning and Engagement, dated 31/08/18. Brett 25/10/18. CD containing monitoring data, borehole logs, permits, completion reports.

Table B56: ES Site No. 34 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
34A	Landfill waste and mineral processing activities	A range of organic and inorganic contaminants, including hydrocarbons, PAHs, heavy metals.	Inhalation, ingestion and/or dermal contact with contaminants in shallow soils and groundwater and exposure to vapours	Construction workers	Health effect (medium)	Low. Contaminants could be directly excavated during open cut. However, limited GI confirms low contaminant levels recorded. Contaminants could leach into the trench from surrounding wastes.	Moderate/low
34B			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (medium)	Unlikely. Due to low contaminant levels recorded in limited testing to date. The closest land use is the industrial estate adjacent to the Order Limits. Exposure of landfill material would be of short duration.	Low
34C			Inhalation and uptake from dusts deposited on grass from windblown contaminated dusts from excavation works and stockpiling of waste materials.	Adjacent grazing animals	Health effect (mild)	Unlikely. Due to low contaminant levels recorded in limited testing to date. Exposed soils would be of short duration and settlement of contaminants resulting from windblown transit is unlikely.	Very low
34D			Runoff and direct migration of shallow groundwater/leachate into lake	Surface water	Deterioration of surface water quality (mild)	Low. Large pit is adjacent to the excavation works. However, the pit is likely to have been in hydraulic continuity with waste for decades.	Low
34E	Landfill waste and mineral	Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench.	Construction workers	Health effect (severe)	Low. Elevated methane and carbon dioxide gas concentrations were recorded close to area where open cut is proposed.	Moderate

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
	processing activities					Some dilution likely in open trench.	
34F			Migration along preferential pathways created by trenchless crossing and ingress and accumulation within off-site confined spaces.	Adjacent land users	Health effect (severe)	Unlikely. Although elevated methane and carbon dioxide gas concentrations were recorded, there appears little driving force for off-site migration.	Moderate/low

Table B57: Home Farm Landfill / ES Site No. 36

Site Name / Ref.	Home Farm Landfill / ES Site No. 36
Basis for Scoping In	The site is identified as an authorised landfill within the Order Limits.
Site Location and Description	The site is located north of Shepperton Road and southwest of Queen Mary Reservoir along Section H of the route (E: 506464 N: 168334) and is split into two areas referred to as Home Farm North and Home Farm South (see 'Landfill Operations'). The site covers an area of approximately 70ha and the ground elevation varies between 12m and 14mAOD. It was not possible to view or access the site to conduct a walkover survey. It is understood that the land is currently being cultivated for arable agriculture. The site is located within the Order Limits. The pipeline would be open cut centrally through the site for about 900m, from a trenchless crossing (TC036) beneath Shepperton Road at the south end of the site. The trenchless crossing would intersect the site for a length of about 20m from the southern site boundary.
Site History	From historical maps, the site consisted of fields (possibly used for agriculture) lined with vegetation between 1865 and 1935 (1:10,560). By 1938 (1:10:560), nurseries and associated buildings developed at the southeast end of the site (known as 'Laleham Nurseries'). Between 1938 and the last available historical map (1992), there appears to have been no change to the land use and landfill/excavation was not indicated. However, aerial photographs show excavation and landfilling activities have taken place on the site more recently. By 2003, there were water filled pits in the northern and eastern areas of the site which had been filled and restored by 2004. At this time, the southern and western areas of the site had been excavated as indicated by water filled pits. By 2008, the western area had been filled and restored. Between 2008 and 2017, the water filled pit in the southern area was gradually filled, and by 2018, the majority of the land had been restored back to fields. See 'Landfill Operations' for more information.
Other Pertinent Information	See 'Landfill Operations'.
Landfill Operations	From the information received from the Environment Agency (pers. comm. 31/08/18), the Home Farm area originally had a COPA Licence (COPA 151/14429 issued 17/5/1991, modified 17/10/1994, 28/02/2000), superseded by a Waste Management Licence (WML83096) which was not completed when the Landfill Directive came in. The operator closed part of the site (Home Farm North) and applied for an environmental permit (JP3332SY) to continue working the rest of the site (Home Farm South). JP3332SY was issued 9/12/2005, and

Site Name / Ref.	Home Farm Landfill / ES Site No. 36
	varied 29/5/2008, 28/11/13 (when the new EPR number EPR/AB3902FM was allocated); and variation 24/9/18 which included modification of the site boundary; restored to agriculture 2017. The entire site is now in closure but neither WML83096 nor EPR/AB3902FM have been surrendered. In Home Farm North, the water filled pits created on site from the removal of sand and gravel were filled with inert waste from 1991 (primarily excavated soils disposed of directly into the water). The licence authorised the disposal of a range of inert wastes which includes dry and solid uncontaminated soils and overburden chemically unaltered from their naturally occurring state, together with concrete, stone, clay, brickwork, mortar, chalk and glass. There is no geological barrier in the Home Farm North area, and no requirement for an engineered cap. The site was restored to agricultural after use (arable). The environmental permit for Home Farm South requires artificial geological barrier constructed under Landfill Construction Quality Assurance (CQA). CQA reports (SLR, 2006, 2011a, 2011b, 2015, 2017) confirm that a 1m thick geological barrier comprising imported clay and indigenous subsoils was placed across the base and sidewalls of the Home Farm South landfilling area in advance of filling. The subsoils used for the geological barrier construction were derived from stockpiled materials which had already been inspected and screened. Therefore, the fill materials used would generally comply with the requirements for the geological barrier construction. The capping system was to comprise 1m of subsoil, comprising in part of recycled materials, and topsoil derived from stockpiled material which was stripped prior to mineral excavation. Filling was completed by 2012 and the site underwent restoration in 2017 (SLR, 2017). A trenchless crossing is proposed along the southern boundary of the site, which is to the south of the geological barrier. Therefore, the pipeline installation would not affect the integrity of the barrier. The permit was varied in 2018 as a retrospective correction of an oversight with regards to the boundary between Home Farm South and Home Farm North which led to the filling and restoration of an area (the former balancing pond) which was not in the environmental permit. The site is now in closure with the intention to surrender the licence.
Previous Ground Investigations	Ground investigation data available (provided by Brett Aggregates, October 2018) include borehole logs from the installation of perimeter monitoring in 1994 and 2004 – 2005. Data are also available from investigations within the area of waste disposal between 2017 and 2018 by Endeavour Drilling. Five perimeter boreholes BH20 to BH24 installed 1994 (Soiltec Soils and Gas, 1994). All found alternating layers of clay, sand and gravel overlying stiff clay (between 6.6mbgl and 10.5mbgl), with no evidence of Made Ground at most locations. Four boreholes GGW26 to GGW29 installed at the eastern perimeter of the site in 2004 – 2005 (Fugro, 2005). Typically topsoil over clay and sand overlying gravel overlying sand or clay; some localised made ground above the gravel in the east. Seven boreholes G13 to G19 were installed by Endeavour Drilling in 2017, in the part of Home Farm South north of Shepperton Lane in the vicinity of the Order Limits. They were all shallow rotary drilling boreholes within the waste, extended to between 3.5m and 4.5mbgl. All found topsoil over made ground comprising sandy gravelly clay, with brick, flint and concrete gravel. Rare glass and occasional fibrous organic material and wood were described in several locations. See 'Soil, Groundwater or Gas Results' for a summary of analytical results. A detailed groundwater assessment is beyond the scope of this report.
Geology	The BGS 1:10,000 artificial geology data indicate worked ground in the northwest of the site and three bands of made ground, approximately 50m in width, following the western and southern border of the site.

Site Name / Ref.	Home Farm Landfill / ES Site No. 36
	Superficial geology: Langley Silt Member (Devensian) is mapped across around two-thirds of the site. Kempton Park Gravel Formation (Devensian) in the northwest and south of the site Alluvium (of Flandrian origin) extends into the northeastern tip of the site. Bedrock geology: Claygate Member (Eocene)
Hydrogeology	The Kempton Gravel Formation is a Principal aquifer and the Alluvium is a Secondary A aquifer. The Langley Silt Member is classified as Unproductive Strata. The Claygate Member is classified as a Secondary A aquifer. Groundwater level is measured on a monthly basis by Bretts Aggregates. Most recent data from 20/08/18 records the groundwater level at around 11mAOD in the Home Farm North area and 11.3mAOD in the Home Farm South area.
Hydrology	There are no surface watercourses within the site. Except for the eastern extent of the site, the site lies within a Source Protection Zone (Total Catchment Zone 3), whilst Zone 2 extends approximately 400m into the west of the site. The northern, eastern and southern edges of the site lie within Flood Zone 3 and most of the site is within Flood Zone 2. There are no groundwater abstractions, surface water abstractions or recorded pollution incidents on site. There is potential for groundwater flooding to occur at surface at this site and there is a 0.1% to 3.3% annual chance of surface water flooding.
Environmental Setting	The site is located within the London Area Greenbelt, a Drinking Water Safeguard Zone (Surface Water). ALCs predate the landfilling and restoration of the site and are therefore no longer relevant.
Soil, Groundwater or Gas Results	Groundwater monitoring of perimeter wells has been undertaken from the 1990s and is ongoing. The most recent monitoring data provided by Brett Aggregates (October 2018) show monitoring was undertaken on a six-monthly basis at Home Farm North and quarterly at Home Farm South between February 2017 and August 2018 (Brett Group, 2018). Parameters were generally below Drinking Water Standards with the exception of manganese in Home Farm South, and potassium, manganese, ammoniacal nitrogen and sulphate in Home Farm North. Gas monitoring of perimeter wells has been undertaken from the 1990s and is ongoing. The 2017–2018 monitoring data showed no methane was detected above 0.3% in any monitoring locations. Carbon dioxide varied between 0.1% and 10.7% in Home Farm North, and between 0.2% and 11.4% in Home Farm South. Flow was not recorded. Gas data for the monitoring boreholes installed into the waste, have been reviewed for Home Farm North between 11/04 and 08/18, and for Home Farm South, between 11/17 and 12/18. From two sampling points in Home Farm North, the maximum concentration recorded for methane was 99.8% in 2005 (GL01). In 2018, methane concentrations were below 40% at both locations. Carbon dioxide reached a maximum concentration of 20.6% in 2007 (GL01) and had recorded concentrations of up to 2.2% in 2018. From seven in waste sampling points in Home Farm South monitored in 2018, the maximum concentration recorded for methane was 69.7% (G19), and for carbon dioxide it was 18.8% (G14 and G15), with a maximum gas flow of 4.1l/hr (G14).
Remediation	Restoration of the site was carried out in 2017 (Brett Group, 2018).
Potential Sources of Contamination	Landfill waste (filled 1991 – 2012)
Potential Contaminants	Soil/waste/shallow groundwater: inert waste, although borehole records indicate the presence of glass, fibrous organic material and wood.

Site Name / Ref.	Home Farm Landfill / ES Site No. 36
	The groundwater monitoring data suggest that this is not a substantial contaminant source for the purposes of this risk assessment. Landfill gas: methane and carbon dioxide.
Potential Receptors and Pathways	Construction workers: direct contact and ingestion of contaminants, and exposure to associated waste materials and shallow groundwater/leachate during open cut and excavation of pits for trenchless crossings, as excavations are within areas of known landfilling. Exposure to landfill gas that could accumulate in trenches and pits for trenchless crossings. Adjacent land users: the pipeline installation could create new preferential pathways for off-site landfill gas migration and accumulation in confined spaces (if present). Adjacent land users: inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 36 Table 1. The trench entering the landfill could create new pathways and linkages for landfill gas including construction workers and off-site migration. However, the perimeter monitoring wells show little landfill gas outside the waste, implying there is little driving force for gas migration outside the waste body itself. The risks associated with asphyxiation and explosion have been assessed as high to moderate/low. Wastes other than inert have been identified through site investigations. Excavation work would be carried out within landfill materials, and exposure to contaminated wastes and shallow groundwater/leachate is likely. However, analysis of groundwater samples suggest that this is not a substantial contaminant source, and therefore the risks to construction workers are assessed as low. Adjacent land users and could be affected by windblown contaminated dusts generated during excavation works and from the stockpiling of excavated materials in windy conditions. Given the test data available to date, the risks are assessed as very low.
References	References include those listed in Chapter 11 Soils and Geology. Brett Group (2018). Home Farm, Home Farm South & Home Farm Extension (WML83096, JP3332SY & KP3896EK) Annual Report January 2017 – December 2017. Fugro (2005). Cable Percussion Borehole Logs (GGW26 to GGW29). Project: Shepperton L/F Site, Middlesex Robert Brett & Sons Ltd. SLR (2017). Home Farm South Additional Area, Construction Quality Assurance Report. Prepared for: Shepperton Aggregates. SLR Ref: 401.01009.00090. SLR (2015). Home Farm South Landfill Site Geological Barrier Construction, Construction Quality Assurance Report No. 5, Shepperton Aggregates. SLR Ref: 401.01009.00009. SLR (2011b). Home Farm South Landfill Site Phase 16 Geological Barrier Construction. Construction Quality Assurance Report No. 5. Shepperton Aggregates. SLR Ref: 401-01009-00009. SLR (2011a). Home Farm South Landfill Site Geological Barrier Construction. Construction Quality Assurance Report No. 3. Shepperton Aggregates. SLR Ref: 401-01009-00009. SLR (2006). Home Farm South Landfill Shepperton, Middlesex, Phase 13 and 14 Geological Barrier Construction. Construction Quality Report. Shepperton Aggregates. SLR Ref: 401-01009-00009.

Site Name / Ref.	Home Farm Landfill / ES Site No. 36
	Soiltec Soils and Gas (1994). Borehole Logs.

Table B58: ES Site No. 36 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
36A	Landfill waste	A range of organic and inorganic contaminants	Inhalation, ingestion and/or dermal contact with contaminants in shallow soils and groundwater	Construction workers	Health effect (mild)	Low. Contaminants could be directly excavated during open cut. However, limited GI confirms low contaminant levels recorded. Contaminants could leach into the trench from surrounding wastes.	Low
36B			Inhalation of windblown contaminated dusts from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (mild)	Unlikely. Due to low contaminant levels recorded in limited testing to date. The closest land use is the industrial estate adjacent to the Order Limits. Exposure of landfill material would be of short duration.	Very low
36C		Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench.	Construction workers	Health effect (severe)	Likely. High in-waste methane and carbon dioxide gas concentrations were recorded.	High
36D			Migration along preferential pathways created by trench and ingress and accumulation within off-site confined spaces.	Adjacent land users	Health effect (severe)	Unlikely. Although high in-waste methane and carbon dioxide gas concentrations were recorded, there appears little driving force for off-site migration.	Moderate/low

Table B59: South of Queen Mary Reservoir Landfill / ES Site No. 38

Site Name / Ref.	South of Queen Mary Reservoir Landfill / ES Site No. 38
Basis for Scoping In	The site is identified as a former landfill within the Order Limits.
Site Location and Description	The site is located 130m southwest of Queen Mary Reservoir along Section H of the route (E: 505923 N: 169425). The approximate area of the site is 7ha and the ground elevation ranges between 13m and 15mAOD. The site is currently used as a solar farm. A site walkover survey was carried out on 16/10/18 to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was viewed from within land managed by Thames Water but observed from outside the solar farm fence. The area along the southern margin was not walked over due to dense vegetation. The site was predominantly made up of solar panels with electrical substations situated on undulating grassland. There was an electricity pylon at the northeast end of the site with

Site Name / Ref.	South of Queen Mary Reservoir Landfill / ES Site No. 38
	overheard cables trending northeast to southwest. The surrounding topography was generally flat with minor undulations. At the northeast end of the site, there was some loose rubble, metal piping, bricks and plastics on the surface. In the area around the former gravel pit to the west of the site, rubble/aggregate-like material was present in the soil and exposed at the surface. The site is within the Order Limits. Just outside the site to the north, a trenchless crossing (TC037) is proposed beneath the intake channel of Queen Mary Reservoir.
Site History	From historical maps, the site was predominantly agricultural land associated with Laleham Farm with a small pond from 1865 (1:2,500) to the early 1960s. By 1961 (1:2,500), there was a raised strip of land in the south of the site, and by 1990 (1:10,000), a gravel pit was present to the west of it. The last available historical map for the site, dated 1992 (1:1,250), shows the gravel pit had become larger in size and was filled with water. Additionally, the raised strip of land was still partially present. Aerial photographs indicate that excavation of the gravel pit had started by 1992, and that filling had taken place by 1998. The area of excavation and filling appears to extend 35m to 60m further south, down to the boundary with Home Farm landfill.
Other Pertinent Information	No other information identified.
Landfill Operations	From a site completion report produced by SLR (2008) on behalf of SITA UK Ltd, a waste management licence was issued to A&J Bull (Southern) Ltd in 1990 for disposal of Class A waste types which were as follows: clay, silt, sand, gravel, brick, concrete, silica, glass, and ceramics, mortar, calcium, sulphate, calcium hydroxide, steel and aluminium. Landfilling commenced in February 1993 and ceased in October 1994. The report indicates that no formal engineering containment measures were required or installed, because at the time the licence was issued, best practice did not require containment engineering for inert landfills. Additionally, no active landfill gas or leachate systems were required or installed, and it was concluded from a monitoring programme undertaken (see 'Soil, Groundwater or Gas Results') that the site did not represent a substantial source of landfill gas or groundwater pollution. The site was deemed to be suitable for agricultural after use.
Previous Ground Investigations	Borehole logs are included in the site completion report (SLR, 2008) including PG04 within the Order Limits. The date of the boreholes is not shown, and they appear to be perimeter boreholes. The logs show similar results in all boreholes with topsoil overlying varying thicknesses of brown soft sandy clay (Langley Silt) overlying brown stony and sandy gravel (River Terrace Deposits) over green grey coarse sand (Claygate Member) over blue grey stiff clay (London Clay). In PG04, the Langley Silt is present to 1.3mbgl and the River Terrace Deposits to 4mbgl. Several BGS boreholes were drilled within the site in 1911. BGS borehole TQ06NE542 records approximately 1.2m of topsoil overlying 4.5m of 'clean ballast' and 5.4m of sand. Strata recorded as 'London Clay' underlie this, although it is recorded as 'sandy'. Further boreholes across the site are listed in the BGS database but are classed as confidential and the borehole logs are unavailable.
Geology	Superficial geology: Langley Silt Member – silt (Devensian; River Terrace Deposits (Quaternary) Bedrock geology: Claygate Member – sand (Eocene).
Hydrogeology	The Langley Silt Member is classified as Unproductive Strata. The underlying River Terrace Deposits is a Principal aquifer. The Claygate Member is a Secondary A aquifer.
Hydrology	There are no watercourses, surface water abstractions, groundwater abstractions or recorded pollution incidents on site. The site lies within areas designated as Flood Zone 2 and Flood Zone 3, and there is a 0.1% annual chance of surface water flooding on the site. The

Site Name / Ref.	South of Queen Mary Reservoir Landfill / ES Site No. 38
	site is located within a Source Protection Zone (Total Catchment Zone 3). The site has a low susceptibility to groundwater flooding.
Environmental Setting	The site is located on non-agricultural land within the London Area Greenbelt, a Drinking Water Safeguard Zone (Surface Water and is 20m from the Queen Mary Reservoir which is designated as a SINC.
Soil, Groundwater or Gas Results	The site completion report (SLR, 2008) contained the following information: Gas monitoring was carried out between 2005 and 2007. Methane was detected at one borehole (located outside the Order Limits) on only one occasion, at a concentration of 3.9%; carbon dioxide was recorded in all boreholes at concentrations of up to 4.3%; gas flow rates were not recorded. Groundwater levels ranged between 9.65mAOD and 12.22mAOD. Occasional exceedances of the Drinking Water Standard (DWS) thresholds were recorded for ammoniacal nitrogen, nitrate, sulphate, nickel, phosphate, manganese, iron and calcium in groundwater. Occasional exceedances of the DWS for ammoniacal nitrogen, iron, manganese, nitrite, phosphorus were recorded in the three surface water monitoring locations (River Ash and lake associated with the landfill).
Remediation	Not known, no information received.
Potential Sources of Contamination	Raised artificial land (1961 – unknown). Former landfill/infilled gravel pit (1993 – 1994).
Potential Contaminants	Soil/waste/shallow groundwater: inert waste (silt, brick, rubble, demolition waste and metals). Evidence suggests deposited wastes could have included biodegradable materials and likely to contain a range of organic and inorganic contaminants. Landfill gas: methane and carbon dioxide.
Potential Receptors and Pathways	Construction workers: direct contact and ingestion of contaminants, and exposure to associated waste materials and shallow groundwater/leachate during open cut and excavation of trench as excavations are within areas of known landfilling. Exposure to landfill gas that could accumulate in the trench. Adjacent land users: inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 38 Table 1. Excavation work would be carried out within inert landfill materials, and exposure to contaminated wastes, shallow groundwater/leachate and landfill gas is likely. However, materials present in the landfill are likely to be inert, although slightly elevated concentrations of methane and carbon dioxide have been detected. The risks to construction workers are assessed as moderate/low to low. Adjacent land users could be affected by windblown contaminated dusts generated during excavation works and from the stockpiling of excavated materials in windy conditions. However, given the low potential for contamination, risks are assessed as very low.
References	References include those listed in Chapter 11 Soils and Geology. SLR (2008). Land South of Queen Mary Reservoir Landfill (PWS 14) Laleham, near Heathrow. Site Completion Report. SLR Ref: 412-0079-00234.

Table B60: ES Site No. 38 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
38A	Landfill waste	A range of organic and inorganic contaminants	Inhalation, ingestion and/or dermal contact with contaminants in shallow soils and groundwater	Construction workers	Health effect (mild)	Low. Contaminants could be directly excavated during open cut. GI confirms contaminant levels exceeding DWS in groundwater. Contaminants could leach into the trench from surrounding wastes.	Low
38B			Inhalation of windblown contaminated dusts from excavation works and stockpiling of waste materials	Adjacent land users	Health effect (mild)	Unlikely. Due to low contaminant levels recorded in limited testing to date. The closest land use is the solar farm adjacent to the Order Limits. Exposure of landfill material would be of short duration.	Very low
38C		Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench	Construction workers	Health effect (severe)	Low. Elevated methane and carbon dioxide gas concentrations were recorded, although some dilution within open trench.	Moderate/low

Table B61: Queen Mary Quarry / ES Site No. 40

Site Name / Ref.	Queen Mary Quarry / ES Site No. 40
Basis for Scoping In	This site is identified as an authorised landfill within the Order Limits on the Environment Agency national dataset.
Site Location and Description	The site is located on the west side of Queen Mary Reservoir in Ashford along Section H of the route (E: 506008 N: 170127). It covers an approximate area of 41ha and is in a low-lying area with surface water covering large parts of the site. Ground elevation across the site is ~14mAOD and up to 16mAOD in localised areas. An intake channel used to convey water from the River Thames to a pumping station at the foot of the reservoir embankment forms the southern boundary of the site. The River Ash is located east of the site, between the site boundary and the Queen Mary Reservoir (which is elevated above normal ground level). A site walkover survey was carried out on 24/10/18 to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was accessed with prior permission from the landowners and the following information was gathered. At the time of the walkover, the site consisted of an operational gravel processing works with infrastructure in place to receive material dredged from the adjacent Queen Mary Reservoir and sort the silt/sand. There was heavy traffic movement of trucks in the northern part of the site. A pathway along the eastern edge of the site led to the southern boundary. This pathway passed under the overhead conveyor bringing dredged silt from the Queen Mary Reservoir. Two above ground storage tanks were observed close to the conveyor, labelled as gas oil 21,000l and gas oil 40,000l. These were constructed on concrete stilts in a large concrete bund which extended below surface. This was

Site Name / Ref.	Queen Mary Quarry / ES Site No. 40
	full of water which had no sheen on its surface. An over-ground pipe ran from one tank to the conveyor. There was no evidence of spills and no hydrocarbon odour was present. A site worker mentioned that these tanks were used to supply fuel to the dredging equipment at the end of the conveyor and they are filled once or twice every year. There were no obvious signs of landfilling in the northern half of the site. The southern part of the site did not appear to be in active use. Two monitoring boreholes were observed east of the pathway. The operator of the site indicated that there is historical landfill of rubble underlying the southeast part of the site, which was placed at an unspecified date. Concrete rubble was observed embedded in the soil at this location. On the northern edge of the pathway running along the southern edge of the site, ground level could be seen to be raised about 0.3m above the general level. Red brick was observed embedded in the surface and shrubs and moss dominated the vegetation at this location suggesting lack of soil. All of this suggests potential infilling of construction and demolition waste. However, the lateral extent is not known. The central and western parts of the site could not be safely accessed during the site walkover. There were silt filled reedbeds and warning signs indicating the presence of soft ground and quicksand. The Order Limits include part of the southern margin of the site, which then abut the site's western boundary along Ashford Road. There is also a small incursion of the Order Limits into the site in the northwest. From a trenchless crossing in the south end of the site (TC037), the pipeline would be open cut along Ashford Road and then would be installed as a trenchless crossing beneath the Staines Reservoirs Aqueduct (TC038).
Site History	From historical maps between 1865 and 1913 (1:10,560), the site was unoccupied and consisted of fields (possibly use for agriculture). Slip woodland and the River Ash bounded the site to the east. By 1935 (1:10,560), the Queen Mary Reservoir was established with placement of drainage channels on and around the site, including the intake channel. A site closure report (Arup, 2010) suggests that the site was used during the Second World War as a vehicle depot with hardcore and concrete hardstanding. By 1955 (1:10,560), the first buildings (unspecified) had been developed on site. The site was originally developed as a gravel pit, and gravel excavation north of the reservoir intake channel is known to have started in 1969. It is believed that the excavated material from the original war depot was used to form a bund of the western side of the installation (Arup, 2010). Later historical maps indicate the gravel works was in operation at the northeast corner of the site by 1971 (1:1,250). Several water filled gravel pits were present on site by 1973 (1:10,000) and some have been filled today (i.e. southeast half of the site) as indicated by aerial imagery. The extraction of aggregates is known to have been completed by 2005.
Other Pertinent Information	The site was issued an Environmental Permit (NP3132LN) on the 22/06/06 permitting the disposal of inert waste at the site. However, Reservoir Aggregates Ltd decided not to proceed with landfilling of inert waste after the permit was issued, so no waste was placed at the site. The Environmental Permit was surrendered 17/01/11 (Surrender notice number EPR/SP3593VY/S003). The site currently holds Environmental Permits for Mining Waste (Permit No. 103959) and for Waste Treatment (Permit No. 103836) (telephone correspondence on 31/08/18). The Mining Waste Permit is concerned with silt discharge and managing the risk of uncontrolled silt discharge to surface waters. The permit shows the permitted area extending south to the intake channel, all the way to the Ashford Road, and to the toe of the embankment (Figure 11.8). The silt discharge from the site is via the stream on site to the delta in the western lake visible on aerial photography, with the expectation that the lagoon would fill with silt over time. The Waste Treatment Permit allows for the treatment of waste to produce soil for restoration.

Site Name / Ref.	Queen Mary Quarry / ES Site No. 40
Landfill Operations	Between 1965 and 1974, Surrey County Council Planning Department commissioned annual aerial photography of active mineral extraction and filling sites across the county (Spelthorne Borough Council, 24/07/18). From the aerial imagery, the Planning Department drafted Gravel Pit Maps depicting which areas of sites had been worked and/or filled since the previous image, and those areas filled previously (i.e. pre-1965). From aerial imagery, Spelthorne Borough Council have deduced that some limited filling occurred in the early 1970s. Aerial images from 1981 and 1992 suggest that one of the 'lakes' appears to have been filled within this time period, possibly with silt washings. The southern lake appears to have been filled in two phases, between 1992 and 1998, and between 1998 and 2002 (again possibly with silt washings).
Previous Ground Investigations	A previous ground investigation (no record of by whom or when) was undertaken at the site. This involved installation of six monitoring wells across the site. No borehole logs are currently available for these boreholes, but groundwater level monitoring records are available from 2017 to 2018 (see 'Hydrogeology' section). According to the site closure report (Arup, 2010), 16 gas monitoring boreholes within the site boundary were monitored from 1996 to 2010 in line with permit requirements. A total of 8 of these boreholes were installed along the Ashford Road, where the pipeline would be installed. The parameters included measurements of methane and carbon dioxide.
Geology	Artificial geology: Infilled ground and worked ground are mapped across the majority of the site. Superficial geology: Kempton Park Gravel Formation – sand and gravel (Devensian). Lies across the majority of the site. Langley Silt Member – silt (Devensian). Present in the southern extents of the site. Alluvium – silt (Flandrian). Extends into northern tip of site. Bedrock geology: London Clay Formation – clay (Eocene). Claygate Member – sand (Eocene). Present across southeast of site. Claygate Member – silt (Eocene). Extends into east of site.
Hydrogeology	The Kempton Park Gravel Formation is a Principal aquifer. The Alluvium is a Secondary A aquifer. The Claygate Member (both sand and silt) is a Secondary A aquifer. The Langley Silt Member and London Clay Formation are mapped as Unproductive Strata. Groundwater levels within the sand and gravel are very shallow. Groundwater level data from January to March 2010 recorded between 1.3 and 1.7mbgl, for the monitoring boreholes along Ashford Road.
Hydrology	The River Ash (a main river) flows along the eastern boundary of the site. There are artificial lakes across the site where silt disposal occurs. There are no surface water abstractions on the site but there is one groundwater abstraction on the site and there has been one EA supplied pollution incident from the southwest corner of the site (Category 3 minor impact to land). Almost the entire site lies within Flood Zone 2 and much of the site around the reservoirs is designated as Flood Zone 3. The southwestern half of the site lies within a Source Protection Zone (Total Catchment Zone 3). There is a potential for groundwater flooding to occur at surface on this site.
Environmental Setting	The site is located within the London Area Greenbelt, and an area designated as a Drinking Water Safeguard Zone (Surface Water). Provisional ALC data identify the land as non-agricultural and urban. A SINC named 'Land west of Queen Mary Reservoir, Ashford Road'

Site Name / Ref.	Queen Mary Quarry / ES Site No. 40
	is designated across most of the site. Queen Mary Reservoir is also classified as a SINC adjacent to the east.
Soil, Groundwater or Gas Results	The most recent data available collected between January 2009 and March 2010, recorded concentrations of methane within all the shallow boreholes along Ashford Road as <1%, with a maximum 0.4% recorded. Concentrations of carbon dioxide were low with a maximum of 2.9% recorded. Differential pressure was very low, often negative, suggesting insufficient gas pressures or flows to cause gas to migrate. Historically (between 1996 and 2008), concentrations of methane within the shallow boreholes along Ashford Road recorded <1% methane and a maximum of 4.7% carbon dioxide (Arup, 2010). The most recent available groundwater data was obtained from three boreholes along Ashford Road, on six occasions between January 2009 and February 2010. For many of the determinands, the results were below or just above detection limits of the analysis.
Remediation	None known.
Potential Sources of Contamination	Former vehicle depot (1939 – 1945). Former landfill – unknown content (1970s – 1980s). Quarry and fuel oil tanks (1971 – present)
Potential Contaminants	Soil/shallow groundwater/wastes: gas oil, silt, brick, rubble, demolition waste, asbestos, automotive wastes, waste oils and metals. Landfill gas: carbon dioxide and methane.
Potential Receptors and Pathways	Construction workers: if shallow groundwater is present, construction workers could come into contact with contaminated groundwater during open cut, derived from the former land uses. The Kempton Park Gravel Formation provides a pathway for contaminants. Construction workers could also come into contact with contaminants in soil in the unsaturated zone, which have migrated during periods of higher groundwater. Construction workers could also inhale windblown contaminated dusts during excavation works and from the stockpiling of excavated materials in windy conditions. Landfill gas (carbon dioxide and methane) may be present and could migrate through permeable strata, and ingress and accumulate within confined spaces such as the trench.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 40 Table 1. Given that the gas oil tanks in the quarry and former landfill material are distant from the Order Limits, there is a low likelihood of encountering contaminants associated with these land uses. Landfill gas is not considered a concern since the landfill material is inert and gas monitoring records show methane and carbon dioxide concentrations have remained low. Additionally, the former vehicle depot location on site is unknown, but given the time passed, contaminants are likely to have been diluted or attenuated. In consideration of the above, the risk to construction workers has been assessed as moderate/low to very low.
References	References include those listed in Chapter 11 Soils and Geology. Arup (2010). Reservoir Landfill Closure Report. Document Ref. REPSC01. Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 24/07/18.

Table B62: ES Site No. 40 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
40A	Quarry	Gas oil	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours.	Construction workers	Health effect (mild)	Unlikely. There have been no recorded spillages and the tanks are 375m from the Order Limits.	Very low
40B	Former landfill / former vehicle depot	Brick, rubble, concrete, automotive wastes, waste oils and metals	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours.	Construction workers	Health effect (mild)	Unlikely. Landfilled areas are believed to be only in the southeast corner of the site which are outside the Order Limits. The location of the former vehicle depot on site is not known. However, given the time passed, attenuation of contaminants (if any) is likely to have occurred.	Very low
40C	Former landfill	Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench.	Construction workers	Health effect (severe)	Unlikely. Fill material is inert and gas monitoring records show methane and carbon dioxide concentrations have remained low.	Moderate/low

Table B63: White House Garage, Ashford / ES Site No. 41

Site Name / Ref.	White House Garage, Ashford / ES Site No. 41
Basis for Scoping In	The site is identified as a former garage and current waste transport vehicle depot within the Order Limits.
Site Location and Description	The site is located on the east side of Ashford Road in Ashford along Section H of the route (E: 506211 N: 170748). The approximate area of the site is 0.8ha and the ground elevation is ~14mAOD. A site walkover survey was carried out on 15/10/18 to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was accessed with prior permission from the landowners. At the time of the walkover, the northern part of the site was a waste transport vehicle depot, and the southern part of the site was a vacant demolition site (not accessed). The topography across the site was generally flat hardstand tarmac and concrete with areas of undulating grassland at the eastern end of the site, and vegetation consisted of grass, shrubs, semi-mature trees. There were no obvious signs of subsidence or uneven ground. The site appeared to be adequately drained. There was a fuel storage tank (21,000 litre capacity) and a vehicle washing area in the centre of the site. There was some evidence of minor amounts of hydrocarbon spillage on the immediate concrete surfaces. An interceptor could not be observed, though the view of the ground surface was obscured by several parked disposal trucks. The site borders the Order Limits to the east. The pipeline would be installed via a trenchless crossing along Ashford Road

Site Name / Ref.	White House Garage, Ashford / ES Site No. 41
	(TC038), where it passes the site.
Site History	From historical maps, the site consisted of a building named 'White House' with greenhouses and trees to its rear between 1865 and 1964 (1:10,560). By 1967 (1:1,250), a garage had been developed at the rear of White House, and by 1981 (1:1,250), the garage premises had been extended to include a ramp and tank at the north end of the site. The last available historical map for the site dated 1992 suggests no change to the land use since 1981. Planning permission for use of the land to the rear of White House was granted for the repair and maintenance of vehicles in 1954 (Spelthorne Borough Council, 22/05/18). Prior to this time, there was light engineering (lathes) in outbuildings between 1946/47 and 1952 and vehicle repairs commenced in 1953. By 1981, a council depot was established on part of the site. White House Garage continued to be in existence through to the late 1990s.
Other Pertinent Information	No other information identified.
Landfill Operations	n/a.
Previous Ground Investigations	Three phases of site investigation were undertaken in 1999 (Spelthorne Borough Council, 22/05/18). See 'Soil, Groundwater or Gas Results' for more information. As part of the SLP 2018 GI, one borehole (BH10) was drilled approximately 30m east of the site and 150m east of the proposed trenchless crossing (outside of the Order Limits).
Geology	Superficial geology: Kempton Park Gravel Formation – sand and gravel (Devensian). Bedrock geology: London Clay Formation – clay (Eocene). BH10 encountered alluvial material comprising soft slightly gravelly clay below topsoil to 1.10m.bgl, over horizons of gravelly sand and sand and gravel-both part of the Kempton Park Gravels. These overly the bedrock geology of the London Clay Formation at a depth of 3.7mbgl.
Hydrogeology	The Kempton Park Gravel Formation is a Principal aquifer. The London Clay Formation is classified as Unproductive Strata. A groundwater strike was recorded at 0.83m within BH10 during drilling. Subsequent monitoring recorded groundwater levels of between 0.51 and 0.81mbgl.
Hydrology	There are no watercourses, surface water abstractions, groundwater abstractions or recorded pollution incidents on the site. The site is located within Flood Zone 2, and there is a potential for groundwater flooding to occur and a 0.1% to 1% annual chance of flooding to the east of the site within the Order Limits. The site is not located within a Source Protection Zone.
Environmental Setting	The site is located on urban land within the London Area Greenbelt and within a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	The ground investigations undertaken in 1999 determined that hydrocarbon contaminated ground with concentrations in excess of 5,000mg/kg were present locally in the south, central and southwest parts of the site and along the route of a former fuel pipeline on the northwest site boundary. The higher TPH concentrations were generally present in the shallow made ground. When the

Site Name / Ref.	White House Garage, Ashford / ES Site No. 41
	buildings were being demolished a number of oil sumps/pits were found. No evidence of gross contamination was detected during the 2018 SLP GI. All concentrations within soil samples were below C4SL Public Open Space (Park) assessment criteria. Groundwater samples collected from BH10, showed chloride concentrations were elevated at up to 197mg/l and ammoniacal nitrogen concentrations were also slightly elevated at up to 0.96mg/l. Chromium and benzo(a)pyrene were also slightly elevated.
Remediation	Remediation was undertaken to a target value of 5,000mg/kg TPH prior to redevelopment of the site to the current Council depot (Spelthorne Borough Council, 22/05/18).
Potential Sources of Contamination	Former garage with oil sumps/pits (1950s – 1990s) Waste transport vehicle depot with fuel storage tank (1981 – present)
Potential Contaminants	Soils/perched water/shallow groundwater: made ground, hydrocarbons, diesel fuel, waste oils, solvents, metals, automotive wastes and cutting oils.
Potential Receptors and Pathways	Construction workers: contamination from the site could have migrated in groundwater to the area of the proposed trenchless crossing beneath Ashford Road. Additionally, if shallow groundwater is present, construction workers could come into contact with contaminated groundwater during open cut. The Kempton Park Gravel Formation provides a pathway for contaminants. Construction workers could also come into contact with contaminants in soil in the unsaturated zone, which have migrated during periods of higher groundwater.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 41 Table 1. Residual contamination may be present at the site from historical activities, and contamination from the site might be encountered in soils and in shallow groundwater within the pipeline installation trench. On the other hand, much of the pipeline adjacent to the site would be installed via a trenchless crossing which would limit the exposure to the construction workers. The depth to groundwater and flow direction has not been confirmed on site and the site is susceptible to flooding. The risk to construction workers has been assessed as moderate/low.
References	References include those listed in Chapter 11 Soils and Geology. Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 22/05/18. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project – BH10. Report ref. 10021961-AUK-XX-XX-RP-GE-0024-02-BH10 Factual.

Table B64: ES Site No. 41 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
41A	Former garage (with former oil sumps / pits) / waste transport vehicle depot (with fuel storage tank).	Hydrocarbons, waste oils, solvents, metals, automotive wastes, diesel fuel and cutting oils.	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours groundwater flow.	Construction workers	Health effect (medium)	Low. Much of the pipeline installation adjacent to the site would be in a trenchless crossing which would limit the exposure to contaminants.	Moderate/low

Table B65: Staines By-pass (Former Sewage Works) / ES Site No. 42

Site Name / Ref.	Staines By-pass (Former Sewage Works) / ES Site No. 42
Basis for Scoping In	The site is identified from historical maps as a former sewage works within 250m of the Order Limits.
Site Location and Description	The area of the former sewage works is located in the area of the current dual carriageway named Staines By-Pass along Section H of the route (E: 505559 N: 171270). The area covered by the former sewage works is approximately 1.5ha and the ground elevation is ~14mAOD. It was not feasible to undertake a walkover survey of the site due to accessibility issues and dense vegetation covered much of the former sewage works site. The site is located outside of the Order Limits, 135m to the west. The pipeline would be installed via a trenchless crossing (TC039) beneath Staines By-pass and Woodthorpe Road, where it passes the site.
Site History	From historical maps, the land was unoccupied between 1865 and 1895 (1:10,560). By 1913 (1:10,560), sewage works with two circular structures and a tank had been developed and they last appear on the historical map dated 1938 (1:10,560). Aerial photographs from 1945 shows the land was unoccupied. By 1966 (1:10,560), Staines By-Pass had been constructed through the site. There has been little change to the land use since this time.
Other Pertinent Information	No other information identified.
Landfill Operations	n/a
Previous Ground Investigations	The closest SLP GI borehole (BH08) is located 160m to the east, within the location of a proposed trenchless crossing.

Site Name / Ref.	Staines By-pass (Former Sewage Works) / ES Site No. 42
Geology	Superficial geology: Alluvium – silt (Flandrian). Kempton Park Gravel Formation – sand and gravel (Devensian). Bedrock geology: London Clay Formation – clay (Eocene). Ground conditions within BH08 comprised 1.05m of made ground comprising gravelly slightly sandy clay with brick and concrete. This was underlain by 0.5m of Alluvium comprising firm to very stiff gravelly sandy clay. The Kempton Park Gravels comprising medium dense very gravelly sand were encountered between 1.50m to 4.20mbgl underlain by London Clay logged as firm to stiff silty clay.
Hydrogeology	The Kempton Park Gravel Formation is a Principal aquifer. The London Clay Formation is classified as Unproductive Strata. Groundwater was encountered during drilling of BH08 at 1.70mbgl in the sand layer. Subsequent monitoring recorded groundwater levels between 1.33 and 1.62mbgl.
Hydrology	There are no watercourses, surface water abstractions, groundwater abstractions or recorded pollution incidents on the site. The site is located within Flood Zone 2 and Flood Zone 3. There is potential for groundwater flooding to occur, and there is a 0.1% to 1% annual chance of surface water flooding. The site is located within a Source Protection Zone (Total Catchment Zone 3).
Environmental Setting	The site is located on urban land within the London Area Greenbelt and Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	No evidence of gross contamination was detected within BH08 during the 2018 SLP GI. All concentrations recorded were below C4SL. Groundwater samples from BH08 showed no notable results, although low concentrations of ammoniacal nitrogen (up to 0.66mg/l) was recorded and the SVOC bis(2-ethylhexyl) phthalate was detected on one occasion at 0.00262mg/l. A slight exceedance of chromium was also recorded.
Remediation	Not known, no information received.
Potential Sources of Contamination	Former sewage works (1913 – 1938).
Potential Contaminants	Soils/shallow groundwater: treatment chemicals, metals, organic compounds and fuel oils. Due to the time elapsed since the potentially contaminative use, the subsequent redevelopment as a major road, and the distance from the Order Limits, this source is not considered for further assessment.
Potential Receptors and Pathways	n/a
Ground Contamination Risk Assessment and Conceptual Site Model	n/a
References	References include those listed in Chapter 11 Soils and Geology. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project – BH08. Report ref. 10021961-AUK-XX-XX-RP-GE-0026-01-BH08 Factual.

Table B66: 47 Woodthorpe Road, Ashford / ES Site No. 43

Site Name / Ref.	47 Woodthorpe Road, Ashford / ES Site No. 43
Basis for Scoping In	A former engineering site and other potentially contaminative uses are known to have been on site which is within 250m of the Order Limits.
Site Location and Description	The site is located on Stanwell Road in Ashford along Section H of the route (E: 506393 N: 171857). The approximate area of the site is 0.27ha and the ground elevation is ~15mAOD. The site was viewed from a distance on 15/10/18 and at the time of viewing the site consisted of residential flats with a private car park. It was not possible to access this site to undertake a walkover survey. The site is located outside of the Order Limits, 50m to the north.
Site History	From historical maps, the land was unoccupied between 1865 and 1897 (1:10,560) and terrain markings indicate the site to be at a lower level than the adjacent Stanwell Road to the west. By 1913 (1:10,560), an unspecified building was present on the site. By 1980 (1,1:250) there were two larger unspecified buildings which were present in the last available historical map dated 1995 (1:1,250). Aerial photographs from 2000 to 2011 indicate that the older buildings were demolished, and newer buildings had been erected in their place. See 'Other Pertinent Information' for more information on historical land uses.
Other Pertinent Information	The site was a former engineering site with presence of hotspot hydrocarbon contamination (Spelthorne Borough Council, 22/05/18). Planning applications available on the Spelthorne Borough Council website suggest that there was a timber office building, warehouses, storage units and offices on site in the 1960s. In 2010, there was a planning application submitted by Shanley Homes Limited for the demolition of an existing office building to create a block of 28 flats.
Landfill Operations	n/a
Previous Ground Investigations	A previous ground investigation and geo-environmental assessment was undertaken by RSK Group plc in 2010. The data are currently not available to view.
Geology	Superficial geology: Kempton Park Gravel Formation – sand and gravel (Devensian). Bedrock geology: London Clay Formation – clay (Eocene).
Hydrogeology	The Kempton Park Gravel Formation is a Principal aquifer. The London Clay Formation is classified as Unproductive Strata.
Hydrology	There are no watercourses, surface water abstractions, groundwater abstractions and recorded pollution incidents on the site. There is a potential for groundwater flooding to occur, and there is a 0.1% to 1% annual chance of surface water flooding. The site is not located within a Source Protection Zone.
Environmental Setting	The site is located on urban land within the London Area Greenbelt, and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	No site-specific data are available.
Remediation	Remediation of the site was undertaken in 2012 (Aviron, 2012) including 500mm clean capping in garden/landscaping areas. Lead and benzo(a)pyrene (a PAH) encountered in soils at near surface levels within overlying made ground were removed from

Site Name / Ref.	47 Woodthorpe Road, Ashford / ES Site No. 43
	proposed garden areas across the site to levels below the remediation target and to a depth of at least 0.5mbgl.
Potential Sources of Contamination	Former engineering site (1960s – 2011).
Potential Contaminants	Soils/shallow groundwater: hydrocarbons, lead, PAHs and possibly asbestos may be encountered in deeper soils (> 0.5mbgl). However, the site has been remediated and redeveloped for residential end use and this source is not considered for further assessment.
Potential Receptors and Pathways	n/a
Ground Contamination Risk Assessment and Conceptual Site Model	n/a
References	References include those listed in Chapter 11 Soils and Geology. Aviron (2012). Remediation Validation Report at Land at Woodthorpe Road, Ashford, Middlesex, TW15 2RP on behalf of Shanly Homes (Beaconsfield) Limited. Aviron Project 11-162.05. Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 22/05/18.

Table B67: 21-35 Woodthorpe Road, Ashford / ES Site No. 44

Site Name / Ref.	21-35 Woodthorpe Road, Ashford / ES Site No. 44
Basis for Scoping In	The site is identified from historical maps as a former electrical engineering works and printing works within 250m of the Order Limits.
Site Location and Description	The site is located along Section H of the route and is currently occupied by residential housing under construction and a disused building named Imtech House located on the north side of Woodthorpe Road (E: 506504 N: 171878). The approximate area of the site is 0.62ha and the ground elevation is ~15mAOD. The site was viewed from a distance on 15/10/18, and at the time of viewing, the site included residential flats in the north of the site. It was not possible to access this site to undertake a walkover survey. The site borders the Order Limits to the north.
Site History	From historical maps, the site was largely unoccupied between 1865 and 1895 (1:10,560). By 1913 (1:10,560), buildings had been developed on the site which are labelled as works (unspecified) in the 1961 historical map (1:1,250). From the historical map dated 1980 (1:1,250), the works are identified as engineering works, electrical engineering works and printing works. There was also an electricity substation and a building labelled as 'Meadows House' on site at the time. The works and electricity substation are still shown on the last available historical map from 1995 (1:1,250), with the exception of the printing works which are last seen on the 1992 historical map (1:1,250). Aerial photographs show the works buildings from 2000 to 2017, after which, they were demolished to accommodate new residential development on the land to the rear of Imtech House (formerly Meadows House) in 2018.
Other Pertinent Information	Planning applications were submitted in 2016 for the residential development of the land to the rear of Imtech House (Spelthorne Borough Council, 22/05/18). There is no information available about the former works.

Site Name / Ref.	21-35 Woodthorpe Road, Ashford / ES Site No. 44
Landfill Operations	n/a
Previous Ground Investigations	A site investigation of eight windowless sampling boreholes was undertaken on the site in 2016 (Crossfield Consulting, 2016). See 'Soil, Groundwater or Gas Results' section for further information.
Geology	Superficial geology: Kempton Park Gravel Formation – sand and gravel (Devensian). Bedrock geology: London Clay Formation – clay (Eocene).
Hydrogeology	The Kempton Park Gravel Formation is a Principal aquifer. The London Clay Formation is classified as Unproductive Strata.
Hydrology	There are no watercourses, surface water abstractions, groundwater abstractions or recorded pollution incidents on the site. There is a potential for groundwater flooding to occur, and there is a 0.1% to 1% annual chance of surface water flooding. The site is not located within a Source Protection Zone or Flood Zone.
Environmental Setting	The site is located on urban land within the London Area Greenbelt and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	The 2016 site investigation (Crossfield Consulting, 2016) identified concentrations of lead, benz(a)anthracene, benzo(b)fluoranthene and benzo(a)pyrene which exceeded human health assessment criteria for residential development of the site. In addition, loose asbestos (chrysotile) fibres were recorded in shallow made ground although the quantity was stated to be too low to pose a risk to human health. Elevated carbon dioxide concentrations (8%) were also recorded (with negligible gas flow rates) in the central part of the site; concentrations were less than 5% in other monitored areas. Data from 2017 showed that carbon dioxide concentrations have decreased and are consistently recorded at about 4.5% (Crossfield Consulting, 2017a).
Remediation	The Spelthorne Borough Council case officer for the site has indicated that the site is currently undergoing redevelopment works. Recommendations within the remediation report (Crossfield Consulting, 2017b) were for the provision of imported clean topsoil/subsoil for landscaped areas, provision of ground gas protection measures suitable for CS2 and provision for multi-layer barrier pipe for potable water supply.
Potential Sources of Contamination	Engineering works, electrical engineering works and electrical substation (1961 – 1995); printing works (1961 – 1992).
Potential Contaminants	Soils/shallow groundwater: PAHs, VOCs, PCBs, asbestos, fuel, solvents, cyanides, photographic chemicals, dyes and inks. However, the site is being remediated and redeveloped for residential end use and the source is not considered for further assessment.
Potential Receptors and Pathways	n/a
Ground Contamination Risk Assessment and Conceptual Site Model	n/a
References	References include those listed in Chapter 11 Soils and Geology. Crossfield Consulting (2017b). Land to Rear of Imtech House, 33 to 35 Woodthorpe Road Ashford, TW15 2RP. Remediation Implementation Plan. Crossfield Consulting (2017a). Land to Rear of Imtech House, 33 to 35 Woodthorpe Road Ashford, TW15 2RP. Supplementary

Site Name / Ref.	21-35 Woodthorpe Road, Ashford / ES Site No. 44
	Assessment of Ground Gases. Crossfield Consulting (2016). Land to Rear of Imtech House, 33 to 35 Woodthorpe Road Ashford, TW15 2RP. Site Investigation Report. Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 22/05/18.

Table B68: Hitchcock & King (Former Railway Sidings) / ES Site No. 45

Site Name / Ref.	Hitchcock & King (Former Railway Sidings) / ES Site No. 45
Basis for Scoping In	Railway sidings and other contaminative land uses are known to be/have been on site within 250m of the Order Limits. At present, it is a timber depot named Hitchcock & King.
Site Location and Description	The site is located along Section H of the Order Limits on the north side of the railway tracks of Ashford Railway Station, between Church Road and Stanwell Road in Ashford, Surrey (E: 506496 N: 171971). The site boundary as defined from historical maps also includes the railway tracks at Ashford Station. The site was viewed from a distance on 15/10/18, and at the time of viewing, the site consisted of a builders merchants which was at a lower elevation than the surrounding land. It was not possible to access this site to undertake a walkover survey. The ground elevation on site is ~15mAOD and the approximate area of the site is 2.26ha. The site is immediately adjacent to Site 46 (Scott Freeman Gardens) and just north of Sites 43 and 44 (Woodthorpe Road). The southeast corner of the site just intercepts the Order Limits, where a trenchless crossing (TC040) is proposed. The pipeline would then be directed northwards to the east of the site and driven beneath the railway line as a trenchless crossing (TC041) (through Site 47).
Site History	From the historical maps, the whole area of site in 1865 (1:2,500) was a flooded gravel pit and there was a railway siding extending from the adjacent London and South West Railway Windsor Branchline. By 1895, the flooded gravel pit is no longer indicated suggesting it had been filled. By this time, the railway siding and an additional railway siding coming from the main line extended further west into the site and a goods yard is first shown. By 1913 (1:10,560), an additional railway siding extended from the main line to the northwest corner of the site. A coal yard was on site by 1961 (1:2,500) but does not appear on subsequent historical maps. The railway sidings and goods shed are last shown on the 1966 historical map (1:10,560). From 1971 to 1982 (1:1,250), there was a building contractor's yard. The planning history held by Spelthorne Borough Council indicates that the current retail warehouse of the timber depot/builders merchant was developed around 1986. Earlier planning index records indicate that the storage yard had an oil storage tank.
Other Pertinent Information	No other information identified.
Landfill Operations	n/a
Previous Ground Investigations	Whilst there are no previous ground investigation reports available, a BGS borehole was drilled on site (TQ07SE68).
Geology	Superficial geology:

Site Name / Ref.	Hitchcock & King (Former Railway Sidings) / ES Site No. 45
	Kempton Park Gravel Formation – sand and gravel (Devensian). Bedrock geology: London Clay Formation – clay (Eocene). A historical BGS borehole (TQ07SE68) drilled within the site identified made ground to a maximum thickness of 3.5mbgl. Gravel and clay were recorded underlying the made ground. These potentially correspond to the Kempton Park Gravels and the London Clay.
Hydrogeology	The Kempton Park Gravel Formation is a Principal aquifer. The London Clay Formation is classified as Unproductive Strata.
Hydrology	There are no watercourses, surface water abstractions, groundwater abstractions or recorded pollution incidents on the site. There is a potential for groundwater flooding to occur, and there is a 0.1% to 1% annual chance of surface water flooding. The site is not located within a Source Protection Zone or Flood Zone.
Environmental Setting	The site is located on urban land within the London Area Greenbelt, a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	No data.
Remediation	Not known, no information received.
Potential Sources of Contamination	Old gravel pit, possibly filled (1865 – 1895) Former railway sidings (1865 – 1966) Former coal yard (1961 – unknown) Former goods shed (1895 – 1966) Former building contractor's yard and oil tank (1971 – 1982) Timber yard (1986 – present) Main railway line (1865 – present)
Potential Contaminants	Soils/perched water/shallow groundwater: concrete, brick fragments, gravel, sand, timber, ash, clinker, tarmac, hardcore, organic traces, diesel fuel, chemicals (hazardous and non-hazardous), lubricating and waste oils, asbestos, heavy metals, herbicides, solvents, paints, coatings and adhesives, lead and PAHs
Potential Receptors and Pathways	Construction workers: could come into direct contact with contaminants in soil in the unsaturated zone, which have migrated during periods of higher groundwater. If shallow groundwater is present, construction workers could come into contact with contaminated groundwater during open cut trenching. The Kempton Park Gravel Formation provides a pathway for contaminants.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 45 Table 1. It is possible that construction workers would encounter contaminated soils or groundwater in the trench given the substantial contaminative land use history of the site and remediation of the site is not known. Contaminated shallow groundwater could migrate via the Principal aquifer and contaminants could be encountered within the trench where construction workers could be exposed. The site is marked as having the potential for groundwater flooding. The pipeline would be open cut at a short distance

Site Name / Ref.	Hitchcock & King (Former Railway Sidings) / ES Site No. 45
	from the site. However, given the time passed since historical land use activity and distance from the site, attenuation of contaminants is likely to have occurred. The risks to construction workers have been assessed as low to very low.
References	References include those listed in Chapter 11 Soils and Geology.

Table B69: ES Site No. 45 – Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
45A	Old gravel pit	Concrete, brick fragments, gravel, sand, timber, ash, clinker, tarmac, hardcore and organic traces.	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours groundwater flow.	Construction workers	Health effect (mild)	Unlikely. Given that the pipeline would not be open cut through the site and much time has passed since the historical land use, attenuation of contaminants is likely to have occurred.	Very low
45B	Former goods shed / former coal yard / former building contractor's yard / current timber yard	Heavy metals, asbestos, fuel oils, lubricating oils, waste oils, chemicals (hazardous and non-hazardous), solvents, paints, coatings and adhesives.	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours groundwater flow.	Construction workers	Health effect (medium)	Unlikely. Localised source and given that the pipeline would not be open cut through the site and much time has passed since the historical land use, attenuation of contaminants is likely to have occurred.	Low
45C	Railway sidings (former and current)	Heavy metals, herbicides, ashes and PAHs.	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours via groundwater flow.	Construction workers	Health effect (medium)	Unlikely. The pipeline would be open cut at a short distance from the former railway sidings and main line. However, the source (if present) is likely to be localised.	Low

Table B70: Scott Freeman Gardens, Ashford / ES Site No. 46

Site Name / Ref.	Scott Freeman Gardens, Ashford / ES Site No. 46
Basis for Scoping In	The site is identified as a former infilled gravel pit within 250m of the Order Limits.
Site Location and Description	The site is located south of Stanwell Road and opposite the St. James School along Section H of the route (E: 506470 N: 172047). The area of the site is approximately 0.76ha and the ground elevation is ~16mAOD. A site walkover survey was carried out on 15/10/18 to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was open access and viewed from Public Rights of Way. The land use of the site at the time of the walkover was parkland. The topography across the site was generally flat with slight undulation and vegetation consisted of grass, shrubs, semi-mature trees. There were no obvious signs of subsidence. The site appeared to be moderately drained. The site is located outside of the Order Limits, 13m to the west.
Site History	From historical maps, there were unspecified ground workings and an old gravel pit in northwest corner of site in 1865 (1:10,560). From 1895 to 1913 (1:10,560), the gravel pit was a pond and there were two other ponds adjacent to it within the site boundary. The ponds are no longer indicated after 1913 which suggests they may have been filled. Between 1934 and 1955 (1:10,560), there were two small unspecified buildings on the site. The land use between 1955 and 1961 is not indicated. From 1961 (1:1,250), the site was parkland with trees and there has been little change to the land use since.
Other Pertinent Information	No other information identified.
Landfill Operations	n/a
Previous Ground Investigations	Previous ground investigation data are not available. However, as part of the SLP 2018 GI, BH06 was drilled within the site, close to the eastern site boundary (outside of the Order Limits) to a depth of 15.45mbgl. Gas monitoring was not undertaken at this site.
Geology	Superficial geology: Kempton Park Gravel Formation – sand and gravel (Devensian). Bedrock geology: London Clay Formation – clay (Eocene). Ground conditions within BH06 encountered made ground between 0.30mbgl and 1.60mbgl, described as gravelly slightly clayey sand of ash, with glass and ceramic items and frequent fragments of brick and bones. Possible made ground was noted below to 2.48mbgl, recorded as gravelly clay, with sand beneath, underlain by clay.
Hydrogeology	The Kempton Park Gravel Formation is a Principal aquifer. The London Clay Formation is classified as Unproductive Strata. Groundwater levels have been measured manually on six separate occasions at location BH06. These measurements indicate an average groundwater level of 2.26mbgl, with the highest groundwater level recorded as 1.83mbgl.
Hydrology	There are no watercourses, surface water abstractions, groundwater abstractions or recorded pollution incidents on the site. There is a potential for groundwater flooding to occur, and there is a 0.1% to 1% annual chance of surface water flooding. The site is not located within a Source Protection Zone or Flood Zone.
Environmental Setting	The site is located on urban land within the London Area Greenbelt and Drinking Water Safeguard Zone (Surface Water).

Soil, Groundwater or Gas Results	Relatively high concentrations of lead (up to 1,150mg/kg), arsenic (109mg/kg) and elevated PAHs (e.g. benzo(a)pyrene at 13.1mg/kg, benzo(b)fluoranthene at 15mg/kg, dibenzo(a,h)anthracene at 1.95mg/kg) were recorded with soil samples from BH06, which exceeded the C4SL Public Open Space (Park) assessment criteria. No asbestos was identified. Groundwater samples from BH06 showed slightly elevated ammoniacal nitrogen concentrations at up to 1.31mg/l and slightly elevated pH at up to 8.13. TPH was detected in the first two sampling rounds at up to 0.906mg/l. Other organic compounds were largely absent in the samples, although bis(2-ethylhexyl) phthalate was detected on one occasion at 0.00364mg/l.
Remediation	Not known, no information received.
Potential Sources of Contamination	Old infilled gravel pit/ponds (1865 – 1913).
Potential Contaminants	Soil/filled ground: lead, PAHs, ash, glass, ceramic items, brick, bones, unknown hazardous wastes (possibly asbestos) and non-hazardous wastes. Landfill gas (carbon dioxide).
Potential receptors and pathways	Construction workers: if shallow groundwater is present, construction workers could come into contact with it during open cut trenching. The Kempton Park Gravel Formation provides a pathway for contaminants. Construction workers could also come into contact with contaminants in soil in the unsaturated zone, which have migrated during periods of higher groundwater. Materials used to infill the gravel pit are likely to be inert with low potential to generate landfill gas. Given the distance to the Order Limits any landfill gas is likely to oxidise during migration. Therefore, the likelihood of elevated carbon dioxide being encountered during open cut works is considered low.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 46 Table 1. It is considered unlikely that construction workers would encounter contaminated soils or groundwater in the trench, as this would require migration of mobile contaminants from the subject site to the working area. Given the distance from the site, attenuation of contaminants is likely. The risk to construction workers has been assessed as low.
References	References include those listed in Chapter 11 Soils and Geology. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project – BH06. Report ref. 10021961-AUK-XX-XX-RP-GE-0021-02-BH06 Factual.

Table B71: Site 46 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
46A	Old infilled gravel pit / ponds	Lead, PAHs, unknown hazardous wastes and non-hazardous wastes.	Direct contact, ingestion and inhalation of contaminants that have migrated from the subject site to the working area.	Construction workers	Health effect (medium)	Unlikely. Given the distance from the site, attenuation of contaminants is likely.	Low
46B		Landfill gas (carbon dioxide)	Ingress and accumulation within trench	Construction workers	Health effect (medium)	Unlikely. Potential for elevated carbon dioxide generation is considered to be low. There is a potential for accumulation in trench. However, trenches are open and some dilution is likely.	Low

Table B72: St. David's School (Former Landfill) / ES Site No. 47

Site Name / Ref.	St. David's School (Former Landfill) / ES Site No. 47
Basis for Scoping In	The site is identified as a historical landfill within the Order Limits.
Site Location and Description	The site is located in Ashford on the south side of Staines Road along Section H of the route (E: 507024 N: 172386). The entire site identified by Spelthorne Borough Council as St David's (Welsh Girls) School Landfill (03/07/18) is an irregular polygon and occupies about 53ha. The larger eastern part of the site comprises a lake used for recreation covering an area of approximately 38ha. The northwestern section of the site (around 7ha) is currently used as playing fields by Thomas Knyvett college. There is also a patch of land around 1.75ha east of the Thomas Knyvett playing fields currently used for rough grazing. The southwestern section of the site is an area of about 2.8ha, mainly occupied by a water filled pit, and adjacent to St James School south playing field. The Clockhouse Lane former landfill site (Site 48) is located between the northwestern section of Site 47 and the southwestern section of Site 47. The ground elevation of the majority of the site ranges between 14mAOD and 15mAOD, with the northwestern area around 16mAOD. It was not possible to access this site to undertake a walkover survey. The northwestern section was viewed from the public footpath on Staines Road. The pipeline would be installed in a trenchless crossing for a length of 45m (TC041) from the southern site boundary, through the southwestern part of the site. From the trenchless crossing, the pipeline would be open cut adjacent to the site (but outside it) for a length of approximately 150m in the field in front of St. James School (formerly St. David's (Welsh Girls) School). The Order Limits here intersect the site boundary. The pipeline would enter the northwestern part of the site from Site 48 (Clockhouse Lane (former landfill)) and would be open cut through

Site Name / Ref.	St. David's School (Former Landfill) / ES Site No. 47
	this area for approximately 410m and installed in a trenchless crossing at Staines Road (TC042), which would intersect the site for a length of 30m from the northern site boundary. Around 150m of this section would be within Thomas Knyvett School Playing fields, and around 260m and the trenchless crossing point would be within the rough grazing land.
Site History	From historical maps from 1865 to 1913 (1:10,560), the site was largely unoccupied and probably used for agriculture. St David's 'Welsh School' (now St. James School) was present from 1865. Aerial photography dated 1946 shows excavations to the east of the current Spelthorne Borough Council administrative area boundary, and also to the south of Harrow Road and between this and Desford Way. By 1961 (1:10,560), the lake was present and piggeries appeared at the south end of site by 1966 (1:10,560) in the area around the proposed trenchless crossing.
Landfill Operations	The site is a former landfill permitted to accept inert wastes (Spelthorne Borough Council, 24/07/18 and Environment Agency (pers. comm. 31/08/18). Filling of the landfill occurred from the 1940s to early 1970s, but mainly in the 1950s, and the last recorded input date of waste is 1971. There was some recontouring in the 1990s. An application was made (under reference STAINES P/317) in the late 1940s for continued excavation of sand and gravel at the existing gravel pits at Bedfont operated by Hall & Co Ltd. The application was called in by the Minister of Town & Country Planning. Condition 3 of the permission from the Minister stated that filling of the land was subject to the availability of suitable materials at reasonable prices with a surface layer to consist of at least 18 inches of material capable of readily promoting plant growth. Aerial photography dated 1953 held by Spelthorne Borough Council indicates that, in the late 1940s and early 1950s, the mineral processing plant for the gravel and sand extraction was located on the northern end of the land between Harrow Road and Desford Way (east of the Order Limits) and the land there was being filled. Historical records indicate the site was permitted to accept the following materials: material excavated from the land; excavated material from London Airport (Heathrow); overburden; brown London clay; blue London clay; ashes; concrete hardcore; brick hardcore; concrete rejects; rubble; tarmac; clinker; stone sets; and excavated materials from roads and building foundations. In December 1951, a further planning permission was granted (under reference P/317/2) to win gravel by surface working on land to the west of Edward Way (now rough grazing in the northwestern section). On this permission, there were no conditions about the minimum depth of capping to be provided to the subsequent landfilling. Condition 2 of the permission restricted excavations to not within 130ft of the highway. However, 1953 aerial photography shows earthworks and water filled pits within 10m (30ft) of the A30 Staines Road. Spelthorne Borough Council holds records of complaints of tipping of unauthorised materials leading to odour complaints and observations of floating tins and drums on the water filled pit in 1952, and of tipping of putrescible rubbish prior to mid-1955. Filling continued at areas of the gravel pit through to at least 1972, with new tipping consents issued in 1961 and 1962, including a planning permission in January 1962 for excavation of sand and gravel at the playing field of the then St. David's School. Correspondence held by the Council dated December 1963 details that the pit had another two years of life supplying gravel. An application was made in 1962 for retention of the processing plant. It is apparent that at this time the processing plant had been moved from adjacent to the A30 to the infilled spur southeast of the southern end of Desford Way. More aerial photography held by the Council shows the land west of Edward Way (including the Order Limits) and the land between Harrow Road and Desford Way to have both been filled and 'restored' to rough grassland by 1961. By 1992, more filling had taken place to recontour the edge of the lake and create one spur. This relates to planning permission SPW/FUL/88/396 for construction of a bund across the lake (Spelthorne Borough Council, 24/07/18). Between 1992 and 1998, earthworks

Site Name / Ref.	St. David's School (Former Landfill) / ES Site No. 47
	were undertaken to create subdivisions of the lake and further spurs. Planning permission, under reference 92/00669/FUL, was granted in June 1993 for re-allocation of overburden deposited when the pit was being worked to form a third area for water skiing, and again in August 1998, under reference 98/00122/FUL, for provision of a bund in the southwest corner of lake in a different position to that approved under the 1992 permission. A final planning permission was granted in March 2005, under reference 04/00185/FUL, for reconfiguration of parts of the shore line/bunds of the lake. The lake within the southwestern part of the site, adjacent to the Order Limits, appears to be separate from the main lake used for water sports.
Previous Ground Investigations	As part of the SLP 2018 GI, BH03 was drilled close to the southern boundary of the northwestern section, at the edge of Thomas Knyvett School playing fields, within the Order Limits. Ground gas monitoring was undertaken on six occasions between 14/06/18 and 01/08/18.
Geology	Superficial geology: Kempton Park Gravel Formation – sand and gravel (Devensian). Bedrock geology: London Clay Formation – clay (Eocene). Ground conditions within BH03 encountered made ground (re-worked natural ground) comprising sandy gravelly clay for the full depth of the borehole (5.45mbgl) and no anthropogenic inclusions were noted.
Hydrogeology	The Kempton Park Gravel Formation is a Principal aquifer. The London Clay Formation is classified as Unproductive Strata. Three groundwater monitoring rounds were undertaken in June 2018 at BH03 (see 'Previous Ground Investigations') during which groundwater was recorded between 2.46mbgl and 2.68mbgl.
Hydrology	There is extensive surface water across site and a 0.1% annual chance of surface water flooding within the Order Limits. There is also a potential for groundwater flooding to occur. There are no surface water or groundwater abstractions on the site. There are two EA supplied pollution incidents on the site, both listed as minor (Category 3).
Environmental Setting	The site is located within the London Area Greenbelt, and a Drinking Water Safeguard Zone (Surface Water). The majority of the site lies on urban land but parts of the northern margin overlie ALC Grade 1 (BMV) agricultural land.
Soil, Groundwater or Gas Results	With the exception of the presence of low concentrations of PCBs in soil samples, no other determinands were present in concentrations exceeding the C4SL Public Open Space (Park) assessment criteria. Groundwater samples from BH03 recorded elevated ammoniacal nitrogen (14.8mg/l), sulphate (638mg/l), boron (3.35mg/l), chromium (0.514 mg/l), PAHs (0.0212mg/l), TPH (2.2mg/l). pH recorded up to 10.30 (indicative of alkaline conditions).From the ground gas monitoring, methane and carbon dioxide concentrations were below the detection limit (0.1%) in most monitoring rounds. A maximum of 0.8% methane and 0.1% carbon dioxide were recorded on one occasion. Carbon monoxide concentrations ranged from <1ppm to 3ppm. Hydrogen sulphide concentrations were below detection limit of <1ppm except on one occasion (28/06/18) when 6ppm was recorded which exceeds the longterm exposure limit (8-hr time weighted average reference period).
Remediation	Not known, no information received.
Potential Sources of Contamination	Former landfill and unauthorised fly-tipping waste (1946 – 1961).
Potential Contaminants	Soils/wastes: Range of organic and inorganic contaminants including builders' rubble (possibly asbestos), PCBs, hydrocarbons, ashes and clinker and unpermitted waste types (from reported fly-tipping).

Site Name / Ref.	St. David's School (Former Landfill) / ES Site No. 47
	Landfill gas: methane and carbon dioxide.
Potential Receptors and Pathways	Construction workers: excavations would be within areas of known landfilling, and during open cut construction workers could be exposed via direct contact, ingestion and inhalation. Construction workers may become exposed to landfill gas that could accumulate in the trench. Adjacent land users: inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials. Underlying Principal aquifer: the pipeline entering the landfill could allow create new contaminant pathways to groundwater into the surrounding Kempton Park Gravel Formation.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 47 Table 1. Little is known about the landfill lining and remediation (if any) undertaken. Therefore, there is a possible risk of construction workers encountering landfill material during earthworks. Depth to groundwater is variable (2.46m – 4.36m), with the site being marked as having the potential for groundwater flooding. In which case, there is a likelihood that construction workers would encounter contaminated groundwater in the trench. Additionally, construction workers could inhale windblown contaminated dusts during excavation works and from the stockpiling of excavated materials in windy conditions. Therefore, the risk to construction workers has been assessed as moderate. The trench entering the landfill could cause the release of landfill gas which could migrate and accumulate in confined spaces or nearby buildings leading to an explosion or asphyxiation risk. However, given that the concentrations of methane and carbon dioxide were not elevated (from the limited investigation), the risk of asphyxiation and explosion has been assessed as moderate/low. Adjacent land users could be affected by windblown contaminated dusts generated during excavation works and from the stockpiling of excavated materials in windy conditions. The risk to adjacent land users has been assessed as moderate. The trench entering the landfill could cause the creation of new contaminant pathways into Principal aquifer. The pollution risk to the surrounding aquifer has been assessed as moderate/low.
References	References include those listed in Chapter 11 Soils and Geology. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project – BH03. Report ref. 10021961-AUK-XX-XX-RP-GE-0006-01-BH03 Factual. Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 3/07/18. Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 24/07/18. Environment Agency (pers. comm). Information from Thames Region Permitting Team, dated 31/08/18.

Table B73: ES Site No. 47 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
47A	Former landfill and unauthorised fly tipping waste.	Range of organic and inorganic contaminants	Direct contact, ingestion and inhalation of contaminants.	Construction workers	Health effect (medium)	Likely. The pipeline would be open cut centrally through the site, possibly intercepting landfill waste. Little is known about the capping of the landfill.	Moderate
47B			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (medium)	Likely. Adjacent land users (e.g. St James School) would be close to the working area (within 20m).	Moderate
47C			Direct migration of shallow groundwater into surrounding Principal aquifer.	Principal aquifer	Deterioration of groundwater quality (mild)	Likely. The pipeline would be open cut centrally through the site, possibly intercepting landfill waste leading to release of contaminants into the aquifer.	Moderate/low
47D	Former landfill and unauthorised fly tipping waste.	Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench.	Construction workers	Health effect (severe)	Unlikely. The recorded elevation in hydrogen sulphide concentration was not sustained, and concentrations of other gases (methane and carbon dioxide) were not elevated. Trenches would be open which would allow gases to vent/disperse.	Moderate/low

Table B74: Clockhouse Lane (Former Landfill) / ES Site No. 48

Site Name / Ref.	Clockhouse Lane (Former Landfill) / ES Site No. 48
Basis for Scoping In	The site is identified as a former landfill within the Order Limits.
Site Location and Description	The western part of the site is currently used as playing field belonging to St. James School located south of Staines Road along Section H of the route (E: 506628 N: 172377). It is referred to as the North Field site by Spelthorne Borough Council. The eastern part of the site appears to be a private property or boating clubhouse. The approximate area of the site is 4.22ha and the ground elevation ranges between 16m and 17mAOD. It was not possible to access any of the site to undertake a walkover survey. The site is within the Order Limits.
Site History	From historical maps, the site was unoccupied and probably used for agriculture between 1865 and until at least 1955 (1:10,560). From 1961 (1:2,500) to 1992 (1:1,250), the site was used as a playing field. Artificial L- and U-shaped mounds are visible on site from 2002, and 2008 aerial imagery which suggests presence of made ground. However, there are no indications of landfilling from historical maps

Site Name / Ref.	Clockhouse Lane (Former Landfill) / ES Site No. 48
	(see 'Landfill Operations'). A planning application was received in 2009 (09/00814/FUL) by Spelthorne Borough Council relating to the creation of school playing fields for St. James' School on the site.
Other Pertinent Information	No other information identified.
Landfill Operations	Information and ground investigation reports received from Spelthorne Borough Council (24/07/18) indicates the school leased the site to an aggregate company (Hall & Co Ltd) who extracted material from the site and in the 1950s was given a licence by Feltham UDC for the tipping of the following materials: material excavated from the land; excavated material from London Airport (Heathrow); overburden; brown London clay; blue London clay; ashes; concrete hardcore; brick hardcore; concrete rejects; rubble; tarmac; clinker; stone sets; and excavated materials from roads and building foundations. In 1961, Middlesex County Council withdrew the tipping consent and a newer consent was issued in accordance with new conditions. The consent permitted tipping of the following materials: material excavated from the land in its natural state including excavation from building sites; builders' rubbish; brick and hardcore; clinker; and ashes. Between 1961 and the late 1970s, the playing field extension north of St. David's School was excavated and filling continued. Hall Aggregates Thames Valley Limited applied for a permit to recommence filling obligations for the area worked. A further consent was given in 1971 to RMC Feltham from Surrey County Council to dispose of the following materials: material excavated from the land in its natural state including excavations from building, engineering and constructional sites; builders' rubbish; brick and hardcore, clinker and ashes (excluding pulverised fuel ash). The site had been completed and restored by 1981. Additional waste soil materials were deposited at the North Field site in the late 1990s from an unknown source, creating the U-shaped mound identified from aerial imagery. The creation of the playing field also involved moving this material to form a north-south bund on the eastern boundary of the North Field.
Previous Ground Investigations	There are a number of ground investigation reports associated with the 2009 planning application (Spelthorne Borough Council, 24/07/18): In 2003, laboratory analysis on 15 near surface soil samples collected from the bunds (not landfill) on site found that the imported soil material to create the bunds did not pose a substantial risk to current and future land use (REC Ltd, 2003). Asbestos screening was not undertaken on any samples. In 2010, laboratory analysis was undertaken on 11 surface samples (top 2mbgl), six from the bunds and five across the landfill capping layer (MWH, 2010a). Asbestos fibres (chrysotile) were reported in two bund samples and one landfill sample. Exceedances of screening levels for TPHs and PAHs were also recorded in some samples. An additional soil sampling exercise undertaken at the site in 2010 (MWH, 2010b) on near surface soils (top 0.5mbgl) concluded that the near surface soils on site are not contaminated. Near surface soil testing undertaken in 2013 across 20 locations (0.3mbgl to 0.8mbgl) suggests that the near surface soils are not significantly contaminated with asbestos (Leap Environmental, 2013). As part of the SLP 2018 GI, BH04 was drilled within the site adjacent to the southern boundary, within the Order Limits, to a depth of 5.45mbgl. Ground gas monitoring was undertaken on six occasions between 14/06/18 and 25/07/18.
Geology	Superficial geology: Kempton Park Gravel Formation – sand and gravel (Devensian).

Site Name / Ref.	Clockhouse Lane (Former Landfill) / ES Site No. 48
	Bedrock geology: London Clay Formation – clay (Eocene). The SLP 2018 GI indicates made ground to a depth of 5.45mbgl in BH04, described as sandy/gravelly clay, although from 4.00mbgl was a sandy very clayey gravel. Anthropogenic material included wood chippings, brick fragments, concrete and loose metal rebar. The Kempton Park Gravel Formation and London Clay Formation were not recorded in the borehole.
Hydrogeology	The Kempton Park Gravel Formation is a Principal aquifer. The London Clay Formation is classified as Unproductive Strata. Three groundwater monitoring rounds were undertaken in June 2018 at BH04 (see 'Previous Ground Investigations'), during which groundwater was recorded at between 4.33mbgl and 4.36mbgl.
Hydrology	There are no watercourses, surface water abstractions, groundwater abstractions or recorded pollution incidents on the site. There is a potential for groundwater flooding to occur at surface, and there is a 0.1% annual chance of surface water flooding. The site is not located within a Source Protection Zone.
Environmental Setting	The site is located on urban land within the London Area Greenbelt, and a Drinking Water Safeguard Zone (Surface Water).
Soil, Groundwater or Gas Results	With the exception of the presence of low concentrations of PCBs in soil samples taken from BH04, no other determinands were present in concentrations exceeding the C4SL Public Open Space (Park) assessment criteria. No asbestos was identified. Groundwater samples from BH04 recorded elevated ammoniacal nitrogen (17.0mg/l), sulphate (452mg/l), chloride (169mg/l), boron (19.2mg/l), chromium (0.395mg/l), nickel (0.0235mg/l), zinc (0.037mg/l), PAHs (0.164mg/l), TPH (8.95mg/l). From the ground gas monitoring undertaken, carbon dioxide concentrations were slightly elevated on all six occasions, with a maximum recorded concentration of 11.1% (16/07/18). Methane concentrations ranged between <0.1% to 0.5%. Carbon monoxide concentrations ranged from <1ppm to 2ppm. Hydrogen sulphide concentrations were below detection limit of <1ppm except on one occasion (28/06/18) when 2ppm was recorded.
Remediation	Not known, no information received.
Potential Sources of Contamination	Inside Order Limits: Former landfill (1950s – 1981) Outside Order Limits (within site boundary): Made ground bunds (1990s – 2008)
Potential Contaminants	Soils/wastes: asbestos (chrysotile fibres), TPHs, PAHs, PCBs and excavated materials from roads and building foundations. Landfill gas: carbon dioxide, methane, carbon monoxide and hydrogen sulphide.
Potential Receptors and Pathways	Construction workers: excavations would be within areas of known landfilling, and during open cut construction workers could be exposed via direct contact, ingestion and inhalation. Construction workers may become exposed to landfill gas that could accumulate in the trench. Adjacent land users: inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials. Adjacent land users/buildings: the pipeline entering the landfill could introduce a migration pathway for landfill gas through permeable strata, and ingress and accumulate within confined spaces.

Site Name / Ref.	Clockhouse Lane (Former Landfill) / ES Site No. 48
	Underlying Principal aquifer: the pipeline entering the landfill could allow the release of contaminated groundwater into the surrounding Kempton Park Gravel Formation.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 48 Table 1. Previous ground investigation reports indicate that there is no clay capping layer to the landfill. Therefore, there is a possible risk of construction workers encountering landfill material during earthworks. The site is marked as having the potential for groundwater flooding. In which case, there is a likelihood that construction workers would encounter contaminated groundwater in the trench. Additionally, remediation of the site is not known, and construction workers could inhale windblown dusts contaminated with asbestos fibres or other contaminants during excavation works and from the stockpiling of excavated materials in windy conditions. The risk to construction workers is assessed as moderate. Adjacent land users could be affected by windblown contaminated dusts generated during excavation works and from the stockpiling of excavated materials in windy conditions. The risk to adjacent land users has been assessed as moderate. The trench entering the landfill could cause the release of contaminated groundwater and landfill gas. Landfill gas migration and accumulation in confined spaces of nearby buildings could lead to an explosion or asphyxiation risk. The risk of asphyxiation and explosion has been assessed as moderate/low. The trench entering the landfill could create new contaminant pathways into the underlying Principal aquifer. The pollution risk to the surrounding aquifer has been assessed as moderate.
References	References include those listed in Chapter 11 Soils and Geology. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project – BH04. Report ref. 10021961-AUK-XX-XX-RP-GE-0007-01-BH04 Factual. Leap Environmental (2013). Near Surface Soil Testing at St James School, Ashford – Letter Report. MWH (2010b). Additional Soil Sampling at St James School, Ashford, Middlesex – Letter Report. MWH (2010a). Land Quality Interpretative Report: St James School, Ashford. Ref RT/EWICH10/0018/01.00. DRAFT. Soil sampling of bunds and five trial pits in north field. Resource & Environmental Consultants Ltd (REC) (2003). Letter report of Imported Soil Investigation: North field, St David's School. Report ref. 02c80133. Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 24/07/18.

Table B75: ES Site No. 48 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
48A	Former landfill / made ground bunds	Asbestos (chrysotile fibres), TPHs, PAHs, PCBs and excavated materials from roads and building foundations.	Direct contact, ingestion and inhalation of contaminants.	Construction workers	Health effect (medium)	Likely. The pipeline would be open cut through the site, possibly intercepting landfill waste. The landfill does not have a sufficient cap.	Moderate
48B			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (medium)	Likely. Adjacent land users (e.g. St James School) would be close to the working area (within 20m).	Moderate
48C		TPHs and PAHs.	Direct migration of shallow groundwater into surrounding Principal aquifer.	Principal aquifer	Deterioration of groundwater quality (medium)	Likely. The pipeline would be open cut centrally through the site, possibly intercepting landfill waste potentially creating new pathways into the aquifer.	Moderate
48D		Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench.	Construction workers	Health effect (severe)	Low. Up to 11.1% carbon dioxide was detected within made ground. However, trenches would be open allowing gases to vent/disperse.	Moderate

Table B76: Former Bulldog Service Station / ES Site No. 49

Site Name / Ref.	Former Bulldog Service Station / ES Site No. 49
Basis for Scoping In	The site is identified by Spelthorne Borough Council as a former service station within 250m of the Order Limits.
Site Location and Description	The site is located on the south side of Staines Road (west of Lodge Way) in West Bedfont along Section H of the route (E: 506452 N: 172743). The area of the site is approximately 0.13ha and ground elevation is ~16mAOD. A site visit was carried out on 15/10/18 to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was viewed from northern end of the site near Staines Road. At the time of the visit, a residential building named Ashcombe Court occupied the site with a small car park on the eastern side of the site. The topography across the site was generally flat with hardstand tarmac and concrete. Vegetation across this area consisted of narrow path of grass on the eastern edge of the site. There were no obvious signs of subsidence or uneven ground. The site appeared to be adequately drained.

Site Name / Ref.	Former Bulldog Service Station / ES Site No. 49
	The site is located outside of the Order Limits, 220m to the east.
Site History	From historical maps, the site was unoccupied between 1865 and 1934 (1:10,560). Small unspecified buildings were present on the eastern half of the site between 1935 and 1955 (1:10,560). From 1961 (1:2,500) to 1995 (1:1,250), one larger unspecified building occupied the site which was presumably Bulldog Service Station from planning application records on Spelthorne Borough Council's website. Google Earth aerial imagery shows the buildings on site had been demolished by 2002 and the construction of the residential development (Ashcombe Court) began by 2008.
Other Pertinent Information	Bulldog Service Station at closure, had interceptors and seven underground fuel storage tanks dating from 1981 (Spelthorne Borough Council, 22/05/18). The authorisation for the unloading of petrol into storage tanks at the service station was revoked in September 2001. The council stated that it does not appear to hold any plans or records about the previous underground fuel storage tanks, though earlier petroleum spirit tanks are likely to have been located close to the road frontage.
Landfill Operations	n/a
Previous Ground Investigations	As part of the remedial works undertaken on the site (detailed in 'Remediation'), various stages of ground investigation were undertaken to characterise the ground conditions. This was completed by QDS in 2001 and Delta Simons Environmental Consultants in 2004. Geology underlying the north and west of the site to a depth of approximately 3.5mbgl would have been removed and new material imported as part of the remediation. Across the site, records indicate <0.5m hardstanding overlying made ground containing sandy gravel with red brick and concrete fragments. In certain areas this extended to 3mbgl. Sandy gravel was recorded beneath the made ground.
Geology	Superficial geology: Kempton Park Gravel Formation – sand and gravel (Devensian). Bedrock geology: London Clay Formation – clay (Eocene). Exploratory holes across the site in areas not subject to remedial works recorded sandy gravel and occasional clay layers (potentially the Kempton Park Gravel) underlying made ground. The top of the London Clay may have been observed at depth greater than 6.5mbgl in some logs.
Hydrogeology	The Kempton Park Gravel Formation is a Principal aquifer. The London Clay Formation is classified as Unproductive Strata.
Hydrology	There are no watercourses, surface water abstractions, groundwater abstractions or recorded pollution incidents on the site. There is a potential for groundwater flooding to occur, and there is a 0.1% to 1% annual chance of surface water flooding on the roads surrounding the site. The site is not located within a Source Protection Zone or Flood Zone.
Environmental Setting	The site is located on urban land within the London Area Greenbelt, and a Drinking Water Safeguard Zone.
Soil, Groundwater or Gas Results	No data available.
Remediation	Delta Simons Environmental Ltd carried out remedial works on behalf of Esso in November 2004 (Spelthorne Borough Council, 22/05/18). This included excavation of hydrocarbon-contaminated soils identified within the Detailed Quantitative Risk Assessment – equating to approximately 992 tonnes of non-hazardous material disposed of to an off-site landfill. Some material at the northern boundary remained due to the proximity of the pavement and adjacent road. Groundwater monitoring during and after excavation revealed elevated concentrations of hydrocarbons thought to be associated with localised mobilisation of soil bound contaminants

Site Name / Ref.	Former Bulldog Service Station / ES Site No. 49
	during remediation. 1,000 litres of groundwater were purged and there was continued groundwater monitoring until January 2006. The residential development of Ashcombe Court, under planning permission 07/00358/FUL, incorporated a hydrocarbon vapour barrier and a clean cover of imported topsoils in amenity areas. Condition 2 of the planning permission related to investigation, assessment and remediation of land contamination, which was recommended for discharge in April 2009 following the Closure Report (WD Environmental, 2009).
Potential Sources of Contamination	Former service station (1961 – 1995), remediated.
Potential Contaminants	Soils: residual hydrocarbon contamination may still be present at the northern boundary of the site. However, the volume of residual contamination is likely to be small and the migration potential and impact on groundwater negligible as evidenced by the post remediation monitoring. This source is not considered for further assessment.
Potential Receptors and Pathways	n/a
Ground Contamination Risk Assessment and Conceptual Site Model	n/a
References	References include those listed in Chapter 11 Soils and Geology. WD Environmental (2009). Environmental Closure Report Former Bulldog Service Station Ashford, HAE 9BE. Report ref. 20142(R1). Spelthorne Borough Council website - http://my.spelthorne.gov.uk. Accessed November 2018. Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 22/05/18.

Table B77: Former Lionvale Service Station / ES Site No. 50

Site Name / Ref.	Former Lionvale Service Station / ES Site No. 50
Basis for Scoping In	The site is identified as a former service station and current MOT garage within 250m of the Order Limits.
Site Location and Description	The site is located at West Bedfont on the south side of Staines Road and west of Orchard Way Road, along Section H of the route (E: 506815 N: 172875). The area of the site is approximately 0.23ha and ground elevation is ~16mAOD. A site visit was carried out on 15/10/18 to observe the land use within and around the current site and to assess potential contaminant sources and receptors. The site was viewed from Public Rights of Way. It was not possible to access the site to undertake a walkover survey. At the time of the visit, the site was occupied by three different motor businesses (a car wash, a car sales company and a vehicle MOT garage). The topography across the site was generally flat with hardstand tarmac and concrete. There were no obvious signs of subsidence or uneven ground. The site appeared to be adequately drained. The site is located outside of the Order Limits, 30m to the south. A trenchless crossing is proposed 40m to the west where it passes the site.

Site Name / Ref.	Former Lionvale Service Station / ES Site No. 50
Site History	From historical maps, the site was unoccupied between 1865 and 1934 (1:10,560). Sheet metal works were present from 1935 (1:10,560) through to 1973 (1:1250) and a filling station was developed adjacent to the works by 1973. A review of the information received from Spelthorne Borough Council (22/05/18) and planning applications available on the Spelthorne Borough Council website identifies the filling station as Lionvale Service Station with the following history: Planning permissions were granted between 1960 and 1962 for use of the land for a motor service station and a petrol filling station. Records from the Petroleum Licensing Authority indicate that the site had a 40,000-litre underground storage tank (UST), a 20,000-litre UST and 5 x 15,000-litre USTs, all solid filled in 1999.
Other Pertinent Information	No other information identified.
Landfill Operations	n/a
Previous Ground Investigations	Previous ground investigation data are not available and Spelthorne Borough Council Environmental Health has confirmed it does not hold any site investigation reports relating to this site.
Geology	Superficial geology: Kempton Park Gravel Formation – sand and gravel (Devensian). Bedrock geology: London Clay Formation – clay (Eocene).
Hydrogeology	The Kempton Park Gravel Formation is a Principal aquifer. The London Clay Formation is classified as Unproductive Strata.
Hydrology	There are no watercourses, surface water abstractions, groundwater abstractions or recorded pollution incidents on the site. There is a potential for groundwater flooding to occur at the surface and below ground level at this site. There is a 0.1% annual chance of surface water flooding near to the site, especially along the route. The site is not located within a Source Protection Zone or Flood Zone.
Environmental Setting	The site is located within the London Area Greenbelt, and a Drinking Water Safeguard Zone (Surface Water). It overlies ALC Grade 1 (BMV) agricultural land.
Soil, Groundwater or Gas Results	No data available.
Remediation	Not known, no information received.
Potential Sources of Contamination	Former sheet metal works (1935 – 1973) Former service station and underground storage tanks (1973 – 1999) MOT garage (1995 – present)
Potential Contaminants	Soils/perched water/shallow groundwater: heavy metals, asbestos, petrol, chemical and petroleum products, VOCs, beryllium, degreasing agents, solvents, paint and paint sludges and waste oils.
Potential Receptors and Pathways	Construction workers: if shallow groundwater is present, construction workers could come into contact with contamination derived from the site during open cut trenching. The Kempton Park Gravel Formation provides a pathway for contaminants. Construction workers could also come into contact with contaminants in soil in the unsaturated zone, which have migrated during periods of higher groundwater.

Site Name / Ref.	Former Lionvale Service Station / ES Site No. 50
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 50 Table 1. Given that remediation of the site is not known, it is possible that construction workers would encounter contamination in the trench that has migrated via groundwater. The pipeline would be open cut at a short distance from the site. The risk to construction workers has been assessed as low.
References	References include those listed in Chapter 11 Soils and Geology. Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 22/05/18.

Table B78: ES Site No. 50 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
50A	Former sheet metal works / former service station / current MOT garage	Heavy metals, chemical and petroleum products, VOCs, beryllium, degreasing agents, solvents, paint and paint sludges and waste oils.	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours groundwater flow.	Construction workers	Health effect (medium)	Unlikely. The pipeline would be open cut at a short distance from the site. However, given distance, attenuation of contaminants is likely to have occurred.	Low
50C	Underground storage tanks	Hydrocarbons	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours groundwater flow.	Construction workers	Health effect (medium)	Unlikely. The pipeline would be open cut at a short distance from the site. However, given distance, attenuation of contaminants is likely to have occurred.	Low

Table B79: Homers Farm / ES Site No. 51

Site Name / Ref.	Homers Farm / ES Site No. 51
Basis for Scoping In	The site is identified as a proposed mineral extraction site within the Order Limits.
Site Location and Description	Homers Farm is located north of Staines Road in West Bedfont along Section H of the route (E: 507061 N: 173195). The area of the site is approximately 11ha and ground elevation across the site is ~16mAOD and up to 21mAOD in localised areas. The site is immediately adjacent to Site 52 (West Bedfont former sewage works and landfill) and Site 53 (West London Oil Terminal). The site was viewed at a distance from Public Rights of Way on 15/10/18 as it was not possible to access the site to undertake a

Site Name / Ref.	Homers Farm / ES Site No. 51
	walkover survey. At the time of viewing, ground excavations were taking place and there were two small industrial yards in the southwest corner of the site consisting of shipping containers and stacks of metallic fencing. Young and semi-mature trees lined the boundaries of the industrial yards and some apparent fly-tipping was observed. The Order Limits intersect the northern and northwest margin of the site. The pipeline would be connected to a PIG trap system at Esso West London Terminal (Site 53) through an above ground connection.
Site History	From historical maps, the site was largely unoccupied and likely used for agriculture from 1865 until 1913 (1:10,560). Homers Farm is first indicated at the southeast corner of the site on the 1913 historical map. Historical maps and aerial imagery indicate little change to the land use between 1913 and 2017. The two industrial yards viewed on 15/10/18 were established sometime between 1999 and 2000. By 2018, the site had been partially worked for gravel extraction (see 'Other Pertinent Information').
Other Pertinent Information	Planning permission was granted by Surrey County Council, as the waste and minerals Local Planning Authority, for the extraction of sand and gravel from land at Homers Farm (Spelthorne Borough Council, 22/05/18). The mineral is to be processed at Hengrove Farm, approximately 2km southwest on the A30. Following extraction, the site is proposed to be landfilled with inert material and restored to agricultural land. At the point of planning permission in early 2015, it was proposed that extraction would be completed by the end of November 2019 and restoration (including filling) to be complete by September 2020. Aerial photographs suggest that the stripping of topsoil started sometime between 2017 and 2018. There is a British Pipeline Authority fuel pipeline that crosses the north of the site.
Landfill Operations	It is understood (Environment Agency pers. comm.) that pre-application meetings have taken place with the operator for an Environmental Permit for future backfilling the gravel extraction voids with inert waste.
Previous Ground Investigations	A site investigation undertaken on Homers Farm (ESI Ltd., 2013) located immediately south of the oil terminal indicated the presence of hydrocarbon contamination (degraded kerosene and diesel) in the soil and groundwater along the site boundary with the oil terminal. Hydrocarbon staining was recorded from as shallow as 1.7mbgl in boreholes located adjacent to the fence line.
Geology	Superficial geology: Kempton Park Gravel Formation – sand and gravel (Devensian). Bedrock geology: London Clay Formation – clay (Eocene). Ground investigations reported by ESI Ltd. (2013) typically comprised between 0.5m and 1.1m of overburden material (topsoil, subsoil and gravelly clays) which were underlain by dense sands and gravels to approximately 8.5mbgl, underlain by London Clay.
Hydrogeology	The Kempton Park Gravel Formation is a Principal aquifer. The London Clay Formation is classified as Unproductive Strata.
Hydrology	There are no watercourses, surface water abstractions, groundwater abstractions or recorded pollution incidents on the site. There is a potential for groundwater flooding to occur, and there is a 0.1% annual chance of surface water flooding. The site is not located within a Source Protection Zone or Flood Zone.
Environmental Setting	The site is located within the London Area Greenbelt, and a Drinking Water Safeguard Zone (Surface Water). The site is classified as ALC Grade 1 (BMV) agricultural land (but is currently being worked for gravel).
Soil, Groundwater or Gas Results	Reports associated with the planning application for gravel extraction detail the hydrocarbon contamination. They show a maximum TPH C6-C40 concentration of 885µg/l in groundwater, and petroleum hydrocarbons also present at elevated concentrations in soil.

Site Name / Ref.	Homers Farm / ES Site No. 51
Remediation	A recent Operational Management Plan report for the gravel extraction (ESI Ltd., 2018) indicated that the extraction programme was amended to exclude the material affected by hydrocarbon contamination, and risks associated with the contamination would be managed by monitoring.
Potential Sources of Contamination	Inside Order Limits: Oil terminal (1966 – present, off-site/outside site boundary) Outside Order Limits (within site boundary): Industrial yards (1999 – present)
Potential Contaminants	Soils/perched water: hydrocarbons may be encountered in the trench.
Potential Receptors and Pathways	Construction workers: construction workers may come into contact with the hydrocarbon contaminant plume in the trench. Known hydrocarbon contamination in shallow groundwater could migrate through the aquifer and be encountered within the trench where construction workers could be exposed via direct contact or ingestion. Additionally, construction workers may come into contact with or inhale windblown contaminated dusts and vapours from excavation works and stockpiling of materials. Adjacent land users: inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 51 Table 1. Shallow hydrocarbon contamination could be encountered by construction workers during open cut trenching, given that contamination was encountered at depth at the site boundary in the Order Limits and remediation of the site is yet to be implemented. Available data demonstrates that the aquifer beneath the site is already affected by historical contamination. Construction workers could also be affected by smear in the unsaturated zone and windblown contaminated dusts generated during excavation works and from the stockpiling of excavated materials in windy conditions. The risks to construction workers have been assessed as moderate to very low. Adjacent land users could be affected by windblown contaminated dusts generated during excavation works and from the stockpiling of excavated materials in windy conditions. The risk to adjacent land users has been assessed as moderate/low to low given their distance from the Order Limits. The pipeline entering the northern margin of the site may create new pollutant linkages between contaminated groundwater associated with the made ground on site into the Principal aquifer, and contaminants could migrate through the sands and gravels of the Kempton Park Gravel Formation. The pollution risk to the surrounding aquifer has been assessed as moderate to very low.
References	References include those listed in Chapter 11 Soils and Geology. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project – BH01. Report ref. 10021961-AUK-XX-XX-RP-GE-0011-01-BH01 Factual. ESI Limited (2018). Homers Farm: Operational Management Plan for Hydrocarbon Contamination. Report ref. 60594R11Rev2. ESI Limited (2013). Factual Site Investigation Report, Homers Farm. Report ref. 60594R6.

Site Name / Ref.	Homers Farm / ES Site No. 51
	Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 22/05/18.

Table B80: ES Site No. 51- Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
51A	Hydrocarbons in soil and groundwater	Hydrocarbons	Direct contact, ingestion and inhalation of contaminants.	Construction workers	Health effect (medium)	Likely. The pipeline would be open cut through the area of identified hydrocarbon contamination.	Moderate
51B			Direct migration of hydrocarbons into surrounding Principal aquifer	Principal aquifer	Deterioration of groundwater quality (medium)	As above.	Moderate
51C	Industrial yards	Metals and oils.	Direct contact, ingestion and inhalation of contaminants.	Construction workers	Health effect (mild)	Unlikely. The pipeline would not be open cut through the industrial yards and some attenuation of contaminants is likely.	Very low
51D			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (mild)	Unlikely. As above.	Very low

Table B81: West Bedfont (Former Sewage Works and Landfill) / ES Site No. 52

Site Name / Ref.	West Bedfont (Former Sewage Works and Landfill) / ES Site No. 52
Basis for Scoping In	The site is a former sewage works and landfill located within the Order Limits.
Site Location and Description	The site is located in West Bedfont off Short Lane along Section H of the route (E: 507070 N: 173470). The area of the site is approximately 11ha and the ground elevation ranges between 18m and 20mAOD. It was not possible to view or access the site to undertake a walkover survey. Note that the site partially overlaps with the Esso West London Terminal (Site 53) which is constructed on the eastern part of the former sewage works and landfill. The Order Limits intersect the southwest margin of the site. The pipeline would be connected to a pig trap system at Esso West London Terminal (Site 53) through an above ground connection.
Site History	From historical maps, the site was unoccupied and possibly used for agriculture between 1865 and 1897 (1:10,560). The land was purchased by the Urban District of Staines in 1899 as a site for sewage works (Spelthorne Borough Council, 22/05/18). The sewage

Site Name / Ref.	West Bedfont (Former Sewage Works and Landfill) / ES Site No. 52
	works and filter beds first appear on the historical map dated 1913 (1:10,560). The disposal of sewage on the site ceased some time in 1934, after which the site consisted of machinery and a plant to compress air that was conveyed through a pipe system to feed 10 ejector stations in Staines. The 1961 (1:1,250) historical map labels the sewage as 'disused', and by this time the land in the southern part of the site had been filled with household waste (see 'Landfill Operations'). Esso West London Terminal and multiple circular tanks are first indicated in 1966 historical map (1:1,250). In the early 1970s, a sports ground was developed in the northwest corner of the site with the erection of a club house and pavilion. At an unspecified date prior to 2003, it is believed that several hundreds of tonnes of soil and demolition waste were deposited in a circular ring around the raised sports pitch area.
Other Pertinent Information	No other information identified (see Site 53 for information regarding the Esso West London Terminal).
Landfill Operations	This site is a former landfill which received household waste that was tipped into former sludge beds. The landfill depth is estimated to be up to 3.7mbgl (MWH, 2009). The Environment Agency hold data for this site in the form of an old Council reference which records the first input date of 31/12/46 and a last input date of 31/12/61 (pers. comm. 31/08/18). There is no other information in the record.
Previous Ground Investigations	The following site investigations were undertaken on the land south of the sports field off Short Lane. A site investigation undertaken in 2003 (Atkins, 2003) comprised a site walkover, trial pitting and analysis of five samples from the bund material. Four years later as part of a student project (Western, 2007), 30 shallow surface soil samples were collected on a grid across the raised area and there were eight targeted shallow surface soils. A site investigation undertaken in 2009 (MWH, 2009) identified an artificial clay lining present beneath the waste to the west of the site, overlying gravels. Made ground was also encountered and was described as sandy clayey fill material with frequent gravels of flint, chert, bricks, concrete and fragments of glass, ceramic, plastic, newspaper, rag, wood, metal as well as occasional tyre fragments and black pockets of ash/coal. Three ground gas monitoring visits were undertaken as part of the investigation. As part of the SLP 2018 GI, an inspection pit (BH01) was dug to 1.20mbgl at the southwest boundary of the site (within the Order Limits), but natural materials were encountered at 1.0mbgl. As such, further drilling was not deemed to be required. The pit location is believed to be within the former site entrance area and not representative of the site as a whole. Access restrictions prevented investigation within the main site. Above the natural materials, which were recorded as sand between 1.00mbgl and 1.20mbgl, were layers of made ground comprising asphalt, gravel of brick and concrete and slightly gravelly sand with gravel of brick, metal, concrete and flint.
Geology	Superficial geology: Kempton Park Gravel Formation – sand and gravel (Devensian). Taplow Gravel Formation – sand and gravel (Wolstonian). Bedrock geology: London Clay Formation – clay (Eocene) The SLP 2018 GI recorded made ground to 1mbgl and potential Kempton Park Gravel to 1.2mbgl (terminated at this depth) in BH01. There are no borehole logs available for other previous ground investigations. There is a description of ground conditions recorded in the MWH (2009) ground investigation. Topsoil over made ground was observed in all exploratory holes to a maximum depth of 3.7mbgl. Underlying the clay lining of the landfill were gravels up to 10mbgl (base of borehole). Underlying this is London Clay.
Hydrogeology	The sand and gravel deposits of the Kempton Park Gravel Formation and Taplow Gravel Formation are Principal aquifers. The London Clay Formation is classified as Unproductive Strata. Groundwater levels during the MWH (2009) ground investigation were recorded to be 5.11mbgl and 5.55mbgl. No record of which

Site Name / Ref.	West Bedfont (Former Sewage Works and Landfill) / ES Site No. 52
	borehole these readings are from or mAOD is available.
Hydrology	There are no watercourses, surface water abstractions, groundwater abstractions or recorded pollution incidents on the site. There is a potential for groundwater flooding to occur, and there is a 0.1% to 1% annual chance of surface water flooding. The site is not located within a Source Protection Zone or Flood Zone.
Environmental Setting	The site is located within the London Area Greenbelt, and a Drinking Water Safeguard Zone (Surface Water). It overlies ALC Grade 1 (BMV) agricultural land, but this classification does not reflect the current or historical use of the site or immediately adjacent land parcels.
Soil, Groundwater or Gas Results	The site investigation undertaken in 2003 (Atkins, 2003) determined that there are no elevated levels of contaminants in the samples from the bund materials. However, it concluded that the tipping to create the bund was more extensive than had been anticipated and so the frequency of sampling was insufficient to be conclusive. From the student project (Western, 2007), no elevated levels of heavy metals and inorganic contaminants were found in the surface soils, but there were hotspots of organic contamination. Elevated levels of arsenic, lead, zinc, and benzo(a)pyrene were recorded from the 2009 site investigation (MWH, 2009). Carbon dioxide concentrations were elevated with a maximum concentration of 14.6% by volume and no methane was detected in the three ground gas monitoring visits. Soil samples collected from BH01 did not record concentrations exceeding the C4SL Public Open Space (Park) assessment criteria. No asbestos was identified.
Remediation	None.
Potential Sources of Contamination	Former sewage works (1913 – 1961). Former landfill (1946 – 1961). Oil terminal (1966 – present).
Potential Contaminants	Made ground: it is possible that household waste and possibly asbestos would be encountered in the trench containing a range of organic and inorganic contaminants. Household waste may include glass, ceramic, plastic, newspaper, rags, wood, metal, tyre fragments and ash/coal. Hydrocarbons may be present in shallow ground in the south of the site (see Site 51). Additionally, soils may be contaminated with treatment chemicals, metals and organic compounds and fuel oils used for pumps from the former sewage works. Wastes/shallow groundwater/leachate: arsenic, lead, zinc and benzo(a)pyrene (see 'Previous Site Investigations'). Landfill gas: carbon dioxide.
Potential Receptors and Pathways	Construction workers: excavations would be within areas of known landfilling, and during open cut trenching it is possible that shallow groundwater could become contaminated from waste materials and leachate. The contaminated shallow groundwater could migrate through the aquifer and be encountered within the trench where construction workers could be exposed via direct contact or ingestion. Windblown contaminated dusts and vapours may be inhaled by construction workers. Construction workers may become exposed to landfill gas that could accumulate in the trench. Adjacent land users: inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials. Exposure to landfill gas that could accumulate in the two small buildings on site adjacent to the trench.

Site Name / Ref.	West Bedfont (Former Sewage Works and Landfill) / ES Site No. 52
	Adjacent land users/buildings: the pipeline entering the landfill could perforate the clay lining and allow the migration of landfill gas through permeable strata, and ingress and accumulation within confined spaces. Underlying Principal aquifers: the pipeline entering the landfill could perforate the clay lining and allow the release of contaminated groundwater/leachate into the surrounding Kempton Park Gravel Formation and Taplow Gravel Formation.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 52 Table 1. Shallow hydrocarbon contamination could be encountered by construction workers during open cut trenching, given that contamination was encountered at depth at the site boundary on the adjacent land (Site 51) in the Order Limits and remediation of the site is yet to be implemented. Available data demonstrates that the aquifer beneath the site is already affected by historical contamination. Additionally, excavation work would be carried out within landfill materials and exposure to contaminated wastes, shallow groundwater/leachate and landfill gas is likely. The risks to construction workers are assessed as moderate to low. Adjacent land users could be affected by windblown contaminated dusts generated during excavation works and from the stockpiling of excavated materials in windy conditions. The risk to adjacent land users has been assessed as moderate/low to low. The trench entering the landfill along its margin may penetrate the clay lining known to be present. This could cause the release of contaminated groundwater/leachate and landfill gas. The pollution risk to the surrounding aquifer has been assessed as moderate to low. Landfill gas migration and accumulation in confined spaces of nearby buildings leading to an asphyxiation risk has been assessed as moderate/low.
References	References include those listed in Chapter 11 Soils and Geology. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project – BH01. Report ref. 10021961-AUK-XX-XX-RP-GE-0011-01-BH01 Factual. Atkins (2003). Letter report of Land Investigation – Short Lane, Stanwell. Letter ref. 5022656/gtg2003361/c003.rpf. Prepared for Spelthorne Borough Council. ESI Limited (2018). Homers Farm: Operational Management Plan for Hydrocarbon Contamination. Report ref. 60594R11Rev2. MWH (2009). Site investigation of the former landfill and sewage works at Short Lane, Stanwell, Middlesex – Environmental Assessment Interpretative Report (final). Report ref. 41515911 RT-Hwy-258-01. Prepared for Spelthorne Borough Council. Western, R. (2007). Phase 1 and Preliminary Phase 2 investigation of a historic landfill site in Stanwell, Middlesex. MSc Thesis, prepared for University of Royal Holloway. Spelthorne Borough Council. Email information from Principal Pollution Control Officer, dated 22/05/18.

Table B82: ES Site No. 52 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
52A	Former sewage works	Chemicals, metals, organic compounds, inorganic compounds and fuel oils.	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours.	Construction workers	Health effect (mild)	Unlikely. The pipeline would be open cut along the southern margin of the site, possibly intercepting soils which may have been contaminated from the former sewage works (at depth beneath the landfill waste). However, given the time passed since the historical land use, attenuation of contaminants is likely to have occurred. The ground affected by the sewage works may be at depth below the trench.	Very Low
52B			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (mild)	Unlikely. As above, and adjacent land users would be at a reasonable distance from the trench, which may not encounter materials from the former sewage works.	Very Low
52C			Direct migration of shallow groundwater/leachate into surrounding Principal aquifer.	Principal aquifer	Deterioration of groundwater quality (medium)	Low. The pipeline could allow the release of contaminated groundwater from the former sewage works into surrounding Principal aquifer. However, given the time passed since the historical land use, attenuation of contaminants is likely to have occurred.	Moderate/low
52D	Former landfill / oil terminal	Range of organic and inorganic contaminants	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours.	Construction workers	Health effect (medium)	Likely. The pipeline would be open cut along the southern margin of the site, possibly intercepting waste materials.	Moderate
52E			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (medium)	Likely. Users of the mineral extraction site (Site 51) would be in close vicinity to the works. Recreational users would be 140m from the excavation works.	Moderate
52F			Direct migration of shallow	Principal aquifer	Deterioration of groundwater	Likely. The pipeline entering the landfill could perforate the clay lining and allow the	Moderate

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
			groundwater/leachate into surrounding Principal aquifer.		quality (medium)	release of contaminated groundwater/leachate into the surrounding Principal aquifer.	
52G	Former landfill	Landfill gas (methane and carbon dioxide)	Ingress and accumulation within trench.	Construction workers	Health effect (severe)	Unlikely. No methane was detected in previous gas monitoring undertaken. However, up to 14.6% carbon dioxide was detected within landfill materials. Trenches would be open allowing venting of gases.	Low
52H			Migration through permeable strata, ingress and accumulation within confined spaces.	Adjacent land users/buildings	Health effect (severe)	Unlikely. Given age of waste and low potential for gas generation.	Low

Table B83: Esso West London Terminal, West Bedfont / ES Site No. 53

Site Name / Ref.	Esso West London Terminal, West Bedfont / ES Site No. 53
Basis for Scoping In	This site is identified as a COMAH site within the Order Limits.
Site Location and Description	The terminal is located in West Bedfont off Crane Road along Section H of the route (E: 507142 N: 173612). The area of the site is approximately 12ha and ground elevation ranges between 17m and 18mAOD. It was not possible to view or access the site to undertake a walkover survey. The West London Terminal has 17 tanks in service with a combined overall capacity of approximately 100,000 cubic metres. It stores and supplies diesel, super unleaded petrol, mogas (gasoline), gasoil and jet fuel (Esso, 2018). The site partially overlaps with part of Site 52 West Bedfont (former sewage works and landfill). The site is immediately adjacent to Site 51 (Homers Farm). The Order Limits include part of the southwest corner of the site, and the pipeline would need to be connected into a PIG trap system near the southern boundary of the site through an above ground connection.
Site History	From historical maps, the site was unoccupied and possibly used for agriculture between 1865 and 1897 (1:10,560). Sewage works and filter beds first appear in the historical map dated 1913 (1:10,560). The 1961 (1:1,250) historical map labels the sewage works as ‘disused’, and by this time the land in the southern part of the site had been filled with household waste (see ‘Landfill Operations’). Esso West London Terminal and multiple circular tanks are first indicated in the 1966 historical map (1:1,250). By 1972 (1:1,250), electricity substations were present at the northern end of the site and these remain today according to aerial photographs.
Other Pertinent Information	As part of a site monitoring program, Esso reported the discovery of some hydrocarbons in monitoring wells at the site boundary to the Environment Agency in 2009. This was followed up with further investigation on a voluntary basis and an agreement that monitoring of

Site Name / Ref.	Esso West London Terminal, West Bedfont / ES Site No. 53
	wells would continue. This monitoring has continued and shows stable results with the continued presence of hydrocarbons in some wells (Esso pers comm). There was a previous investigation into the possible impact of the site on a private water supply (small scale groundwater abstraction for agricultural use) for a borehole located within the Homers Farm site (Site 51, now a gravel extraction site). Pump tests were undertaken and it was concluded there was no impact.
Landfill Operations	This site partially overlies part of a former landfill which received household waste that was tipped into former sludge beds (Site 53 West Bedfont). The landfill depth in the part of the landfill outside the Esso West London Terminal is estimated to be up to 3.7mbgl (MWH, 2009). The Environment Agency holds data for the landfill site in the form of an old council reference which records the first input date of 31/12/46 and a last input date of 31/12/61 (pers. comm. 31/08/18). There is no other information in the record.
Previous Ground Investigations	Previous GI data for the site are not currently available. Two GI's undertaken on the adjacent land to the west of the site (Western, 2007) and on the Homers Farm site (ESI Ltd., 2013) immediately south of the oil terminal determined hotspots of organic contamination and hydrocarbons (degraded kerosene and diesel) in the soil and groundwater along the site boundary with the oil terminal. The hydrocarbons are believed to originate from historical pollution events at the oil terminal. Hydrocarbon staining was recorded from as shallow as 1.7mbgl in boreholes located adjacent to the fence line (ESI Ltd., 2013). In addition, a GI in 2009 (MWH, 2009) on the adjacent Site 52 identified an artificial clay lining present beneath the waste to the west of the site, overlying gravels. Made ground was also encountered and was described as sandy clayey fill material with frequent gravels of flint, chert, bricks, concrete and fragments of glass, ceramic, plastic, newspaper, rag, wood, metal as well as occasional tyre fragments and black pockets of ash/coal. As part of the SLP 2018 GI, an inspection pit (BH01) was dug to 1.20mbgl approximately 145m to the west of the site (at the entrance to Site 52, within the Order Limits). Natural materials were encountered such that further drilling was not deemed to be required. Above the natural materials, which were recorded as sand between 1.00mbgl and 1.20mbgl, were layers of made ground comprising asphalt, gravel of brick and concrete and slightly gravelly sand with gravel of brick, metal, concrete and flint.
Geology	Superficial geology: Alluvium (Flandrian age). Kempton Park Gravel Formation – sand and gravel (Devensian). Taplow Gravel Formation – sand and gravel (Wolstonian). Bedrock geology: London Clay Formation – clay (Eocene). The project GI recorded made ground to 1mbgl and potential Kempton Park Gravel to 1.2mbgl (terminated at this depth) in BH01 west of the site. There are no borehole logs currently available from other previous ground investigations. There is a description of ground conditions recorded in the 2009 MWH ground investigation in the adjacent site. Topsoil over made ground was observed in all exploratory holes to a maximum depth of 3.7mbgl. Made ground was recorded as sandy/clayey fill with frequent flint, chert, brick, concrete gravel and fragments of glass, ceramic, plastic, newspaper, rags, wood, metal and occasional tyre fragments. Pockets of ash/coal were noted. Underlying the

Site Name / Ref.	Esso West London Terminal, West Bedfont / ES Site No. 53
	clay lining of the landfill were gravels up to 10mbgl (base of borehole). Underlying this is London Clay.
Hydrogeology	The sand and gravel deposits of the Kempton Park Gravel Formation and Taplow Gravel Formation are Principal aquifers. The London Clay Formation is classified as Unproductive Strata. Groundwater levels during the MWH 2009 GI on the adjacent site were recorded to be 5.11mbgl and 5.55mbgl. No record of which borehole these readings are for or mAOD is available.
Hydrology	There are no watercourses, surface water abstractions, groundwater abstractions or recorded pollution incidents on the site. There is a potential for groundwater flooding to occur, and there is a 1% to 3.3% annual chance of surface water flooding. The site is not located within a SPZ or Flood Zone.
Environmental Setting	The site is located within the London Area Greenbelt, an SSSI Impact Risk Zone and a Drinking Water Safeguard Zone (Surface Water). The ALC mapping shows the site to be designated Grade 1 (BMV) agricultural land, but this classification does not reflect the current or historical use of the site or immediately adjacent land parcels.
Soil, Groundwater or Gas Results	Elevated levels of arsenic, lead, zinc, and benzo(a)pyrene were recorded from the 2009 site investigation (MWH, 2009) on the adjacent land which may be similar to the ground beneath parts of Site 53. Carbon dioxide concentrations were elevated with a maximum concentration of 14.6% by volume and no methane was detected in the three ground gas monitoring visits. Soil samples collected from BH01 did not record concentrations exceeding the C4SL Public Open Space (Park) assessment criteria. No asbestos was identified.
Remediation	See ‘Other Pertinent Information’.
Potential Sources of Contamination	Former sewage works (1913 – 1961). Former landfill (1946 – 1961). Oil terminal (1966 – present).
Potential Contaminants	Made ground: it is possible that household waste would be encountered in the trench containing a range of organic and inorganic contaminants. Household waste may include glass, ceramic, plastic, newspaper, rags, wood, metal, tyre fragments and ash/coal. Hydrocarbons may be present in shallow ground in the south of the site (see Site 51). Additionally, soils may be contaminated with chemicals, metals and organic compounds and fuel oils used for pumps from the former sewage works. Wastes/leachate: arsenic, lead, zinc and benzo(a)pyrene. (see ‘Previous Site Investigations’). Landfill gas: carbon dioxide.
Potential Receptors and Pathways	Construction workers: direct contact and ingestion of contaminants, and exposure to associated waste materials and shallow groundwater/leachate during open cut trenching, as excavations are within areas of known landfilling. Exposure to landfill gas (carbon dioxide) that could accumulate in trench. Adjacent land users: inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials. Adjacent land users/buildings: the pipeline entering the landfill could perforate the clay lining and allow the migration of landfill gas (carbon dioxide) through permeable strata, and ingress and accumulation within confined spaces.

Site Name / Ref.	Esso West London Terminal, West Bedfont / ES Site No. 53
	Underlying Principal aquifers: installation of the pipeline through the historic landfill could perforate the clay lining (if present) and allow the release of contaminated groundwater/leachate into the surrounding Kempton Park Gravel Formation and Taplow Gravel Formation.
Ground Contamination Risk Assessment and Conceptual Site Model	Based on the sources, receptors and pathways identified above, a conceptual site model showing the PPL has been identified. A risk assessment has been undertaken to assess the significance of each PPL and is presented in Site 53 Table 1. Shallow hydrocarbon contamination could be encountered by construction workers during open cut trenching, given that contamination was encountered at depth at the site boundary on the adjacent land (Site 51) in the Order Limits and available data demonstrate that the aquifer beneath the site is already affected by historical contamination. Additionally, excavation work would be carried out within landfill materials and exposure to contaminated wastes, shallow groundwater/leachate and landfill gas is likely. The risks to construction workers have been assessed as moderate to low. Adjacent land users could be affected by windblown contaminated dusts generated during excavation works and from the stockpiling of excavated materials in windy conditions. The risks to adjacent land users have been assessed as moderate to low. The trench entering the landfill along its margin may penetrate the clay lining indicated to be present in the limited ground investigation on the adjacent site. This could cause the release of contaminated groundwater/leachate and landfill gas. The pollution risk to the surrounding aquifer has been assessed as moderate. The migration and accumulation of carbon dioxide in confined spaces of nearby buildings leading to an asphyxiation risk is assessed as low given that the site use would require protection from vapours associated with petroleum storage.
References	References include those listed in Chapter 11 Soils and Geology. Arcadis (2018). Factual site investigation report, Southampton to London Pipeline Project – BH01. Report ref. 10021961-AUK-XX-XX-RP-GE-0011-01-BH01 Factual. ESI Limited (2013). Factual Site Investigation Report, Homers Farm. Report ref. 60594R6. MWH (2009). Site investigation of the former landfill and sewage works at Short Lane, Stanwell, Middlesex – Environmental Assessment Interpretative Report (final). Report ref. 41515911 RT-Hwy-258-01. Prepared for Spelthorne Borough Council. Western, R. (2007). Phase 1 and Preliminary Phase 2 investigation of an historic landfill site in Stanwell, Middlesex. MSc Thesis, prepared for University of Royal Holloway. Esso (2018). West London Terminal. URL: https://cdn.exxonmobil.com/~/media/ unitedkingdom/files/operations/west_london.pdf Accessed 16/11/18.

Table B84: ES Site No. 53 - Potential Pollutant Linkages – Construction

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
53A	Former sewage	Chemicals, metals, organic	Direct contact, ingestion and inhalation of contaminants, and	Construction workers	Health effect (mild)	Low. The pipeline would be open cut along the southern margin of the site,	Low

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
	works	compounds, inorganic compounds and fuel oils.	exposure to vapours.			possibly intercepting soils which may have been contaminated from the former sewage works. However, given the time passed since the historical land use, attenuation of contaminants is likely to have occurred.	
53B			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (mild)	Low. Adjacent land users would be at a reasonable distance from the trench.	Low
53C			Direct migration of shallow groundwater/leachate into surrounding Principal aquifer.	Principal aquifer	Deterioration of groundwater quality (medium)	Low. The pipeline could allow the release of contaminated groundwater from the former sewage works into surrounding Principal aquifer. However, given the time passed since the historical land use, attenuation of contaminants is likely to have occurred.	Moderate/low
53D	Former landfill / oil terminal	Range of organic and inorganic contaminants	Direct contact, ingestion and inhalation of contaminants, and exposure to vapours.	Construction workers	Health effect (medium)	Likely. The pipeline would be open cut along the southern margin of the site, possibly intercepting waste materials and hydrocarbons.	Moderate
53E			Inhalation of windblown contaminated dusts and vapours from excavation works and stockpiling of waste materials.	Adjacent land users	Health effect (medium)	Likely. Users of the mineral extraction site (Site 51) would be in close vicinity to the works. Recreational users would be 140m from the excavation works.	Moderate
53F			Direct migration of shallow groundwater/leachate into surrounding Principal aquifer.	Principal aquifer	Deterioration of groundwater quality (medium)	Likely. The pipeline entering the landfill could perforate the clay lining and allow the release of contaminated groundwater/leachate into the surrounding Principal aquifer.	Moderate
53G	Former	Landfill gas (carbon	Ingress and accumulation within	Construction	Health effect	Unlikely. No methane was detected in previous gas monitoring undertaken.	Low

PPL No.	Potential Source	Potential Contaminants	Potential Pathway	Potential Receptor	Consequence of Occurrence	Likelihood of Occurrence	Potential Risk
	landfill	dioxide)	trench.	workers	(medium)	However, up to 14.6% carbon dioxide was detected within landfill materials. Trenches would be open allowing venting of gases.	
53H			Migration through permeable strata, ingress and accumulation within confined spaces.	Adjacent land users/buildings	Health effect (medium)	Unlikely. Facility is expected to be protected from vapour accumulation due to nature of activities.	Low

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