Hampshire Water Transfer and Water Recycling Project

Environmental Statement – Appendix 19.3 Hydrogeological Impact Assessment

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1 Introduction

1.1 Introduction

1.1.1 This Hydrogeological Impact Assessment (HIA) has been prepared on behalf of the Applicant, for the Hampshire Water Transfer and Water Recycling Project (hereafter referred to as the 'Proposed Development').

1.1.2 The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (WER) are described in Environmental Statement (ES) Report Appendix 19.2 Water Environment Regulations compliance assessment, Volume II (Document reference 6.2, DCO Volume 6). The key objectives of the WER specifically in relation to groundwater, are to:

1. Protect, enhance and restore all groundwater bodies
2. Achieve good chemical and quantitative status of groundwater
3. Prevent pollution and deterioration of groundwater
4. Ensure a balance between groundwater abstraction and recharge.
5. Reverse any significant and sustained upward trend in the concentration of any pollutant resulting from the impact of human activity in order to progressively reduce pollution of groundwater.

1.1.3 This report is a technical appendix to ES Chapter 19 Water environment, Volume I (Document reference 6.1, DCO Volume 6), and provides a hydrogeological assessment of impacts from the Proposed Development on groundwater resources and groundwater dependent receptors only. The findings of this technical appendix inform the assessment of likely significant effects, which are reported in ES Chapter 19 Water environment, Volume I (Document reference 6.1, DCO Volume 6), together with proposed mitigation.

1.1.4 This assessment of hydrogeological impacts, based on desk study information and site-specific data:

1. Identifies groundwater or groundwater dependent receptors (including surface water interactions) within the study area (described in section 2.2) for the Proposed Development.
2. Assesses qualitatively whether identified receptors are susceptible to changes in groundwater conditions and, where required, quantitatively assesses the potential drawdown impacts (reduction in groundwater levels as a result of groundwater control) from the Proposed Development.

1.1.5 Groundwater related WER compliance and interactions with surface water and flooding topics are noted within this technical appendix but reported in further detail within ES Chapter 19 Water environment, Volume I (Document reference 6.1, DCO Volume 6), ES Appendix 19.1 Flood Risk Assessment, Volume II (Document reference 6.2, DCO Volume 6) and ES Appendix 19.2 Water Environment Regulations compliance assessment, Volume II (Document reference 6.2, DCO Volume 6).

1.1.6 The assessment should also be read in conjunction with ES Appendix 19.9 Outline Water Monitoring Plan, Volume II (Document reference 6.2, DCO Volume 6).

1.1.7 This technical appendix is based on a number of sources including public data sources, information provided by stakeholders, and site-specific investigation data. These sources of data are outlined within Table 2-1.

1.2 Description of the Proposed Development of relevance to the Hydrogeological Impact Assessment

1.2.1 ES Chapter 3 Description of the Proposed Development, Volume I, (Document reference 6.1, DCO Volume 6) describes the Proposed Development and parameters against which the assessment has been undertaken.

1.2.2 The Order Limits for the Proposed Development are shown in ES Figure 1.1 Location of the Proposed Development and Order Limits, Volume III (Document reference 6.3, DCO Volume 6). The study area used for this HIA is described in section 2.2.

1.2.3 Key elements of the Proposed Development of particular relevance to the HIA are summarised as:

1. The Water Recycling Plant (WRP) site includes piled foundations which would be socketed into the underlying chalk bedrock; with Continuous Flight Auger (CFA) piles. Three launch shafts would also be constructed on the WRP site, anticipated to be approximately 32.5m bgl (see 2.7.6 regarding assumed depth of shafts and excavations). All shafts are anticipated to reach their full depth within the chalk, and be constructed using non-displacement methods. The WRP site shafts are anticipated to be built using diaphragm walls.
2. The Pipelines between Budds Farm Wastewater Treatment Works (WTW) and the WRP site would be installed by a trenchless methodology from the launch shaft in the WRP site. The crown of the pipelines would be a minimum of 2.5m below the lowest point of the Hermitage Stream. The reception shaft at Budds Farm are anticipated to be approximately 19m bgl.
3. The Pipelines between the WRP site and Havant Thicket Reservoir are split into two sections; the WRP site to Bedhampton Springs constructed by the Proposed Development and another section between Bedhampton Springs to Havant Thicket Reservoir utilising Portsmouth Water's pipelines which are subject to a separate planning consent. The pipeline would be trenchless from the WRP to Mill Lane, and then east of Mill Lane would be above-ground to avoid interaction with the Source Protection Zone (SPZ) around the Bedhampton Springs. The minimum depth to the pipeline crown would be 0.9m bgl (2.5m below watercourses). The maximum diameter of the casing containing the pipeline would be 2.5m. The shaft west of Mill Lane is anticipated to be approximately 8m bgl, with the shaft east of Mill Lane anticipated to approximately 7m bgl.
4. The Pipeline between the WRP and Otterbourne Water Supply Works (WSW) would be a minimum depth of 0.9m bgl to top of crown (1.5m for roads and 2.5m for watercourses) and 1.2m diameter (i.e. general depth to pipe invert at least 2.1m bgl). Due to the length of the pipeline, the route has been split into

sections (Section D to M) informed, where appropriate, by local planning authority boundaries and roads.

5. A number of trenchless crossings are located across the route of the Proposed Development (primarily along the Pipeline between the WRP and Otterbourne WSW), at the site of significant infrastructure (such as main roads and railways) and sensitive environmental receptors (such as Main Rivers and designated sites). Of particular relevance are the Wallington River and Poles Lane stream trenchless crossings which would be located within the chalk bedrock.
6. Section D (between the WRP site and ridge of Portsdown Hill) would be constructed by a tunnel boring machine (TBM). The reception shaft at construction compound E-1 (as shown on ES Figure 1.1 Location of the Proposed Development and Oder Limits, Volume III (Document reference 6.3, DCO Volume 6) is anticipated to be approximately 11m bgl, with an access cover retained at the location of the shaft to provide access for maintenance and repair during the operational phase. A temporary intermediate tunnel shaft would be located south of Portsdown Hill Road and west of Gilman Road, and is anticipated to be approximately 65m bgl. The intermediate shaft would be reinstated following construction.
7. Pipelines within open-cut trenches would be laid with associated engineered bedding material (typically granular material such as sand) and backfilled with selected material; site-won material if suitable for reuse from an engineering and quality perspective would be utilised.
8. A number of temporary (such as compounds) and permanent (such as pumping stations) above-ground sites are located across the route which would change the land use (potentially increasing the proportion of impermeable surfaces and altering infiltration and runoff characteristics).

1.2.4 Key assumptions and limitations for this HIA are highlighted in section 2.7.

2 Approach to assessment

2.1 Introduction

2.1.1 The National Policy Statement for Water Resources Infrastructure (NPSWRI) requires infrastructure projects to undertake an assessment of the impacts of the Proposed Development on water resources and physical characteristics. There is no specific guidance in relation to assessing the impact of water infrastructure on the hydrogeological regime, therefore the HIA of the Proposed Development is carried out in accordance with the Environment Agency (EA) technical guidance on 'Hydrogeological impact assessment for dewatering abstraction' [1], together with regards to the Design Manual for Road and Bridges (DMRB) LA 113 standard [2] and relevant legislation and policy in ES Chapter 19 Water environment, Volume I (Document reference 6.1, DCO Volume 6).

2.1.2 The methodology for determining whether the impacts would result in likely significant effects is outlined and reported in ES Chapter 19 Water environment, Volume I (Document reference 6.1, DCO Volume 6). Scoping and engagement with the stakeholders is also reported in ES Chapter 19 Water environment, Volume I (Document reference 6.1, DCO Volume 6).

2.1.3 This section outlines the approach to the HIA, including the study area, scoped in impacts to be considered (both construction and operation), HIA methodology, data utilised to inform the assessment and assumptions and limitations of the assessment.

2.1.4 Effects from decommissioning of the Proposed Development are considered to be no greater than those identified during the construction phase and are therefore assessed as construction effects as a worst case scenario. Please refer to ES Chapter 3 Description of the Proposed Development, Volume I, (Document reference 6.1, DCO Volume 6) section 3.7 for further information on decommissioning.

2.2 Study area

2.2.1 The study area for this assessment includes groundwater features within a 1km buffer of the Order Limits where construction works are proposed and is based on the 'source-pathway-receptor' pollutant linkage principle, informed by conceptualisation and professional judgement. Based on the assessment undertaken, and secured mitigation measures, the study area is considered sufficient to identify impacts that could result in a likely significant effect. Stakeholders have agreed, through the technical working group, to the source-pathway-receptor approach and buffer applied at this stage (see paragraph 2.4.1). When referring to the study area for a specific project element (such as the WRP or a specific section of the Pipeline), this is referring to the Order Limits of that project element plus a 1km buffer.

2.2.2 The stream sinks that feed the karstic springs (such as Bedhampton and Havant Springs) are to the north of the Proposed Development, outside the 1km study area. It is considered that there is no reasonable pathway for impacts to the sinks as a result of the Proposed Development, and as such the study area has not been

extended to include them. This is due to the sinks being upgradient at significant distance.

2.2.3 The study area does not include groundwater features within 1km of Havant Thicket Reservoir as construction of the reservoir is not part of the Proposed Development, and the impacts of the Havant Thicket Reservoir construction has been considered under its separate consent. As presented in ES Chapter 20 Cumulative and in-combination effects, Volume I (Document reference 6.1, DCO Volume 6), Havant Thicket Reservoir is treated as both future baseline and part of the cumulative environmental effects.

2.2.4 Similarly, the study area does not include groundwater features within 1km of the Eastney Transfer Tunnel and Long Sea Outfall (LSO) as it is existing infrastructure, and no construction or operational activities would be undertaken that could impact groundwater features.

2.2.5 All anticipated construction works undertaken as part of the Proposed Development are considered. The operational impacts of Havant Thicket Reservoir are considered in ES Chapter 19 Water environment, Volume I (Document reference 6.1, DCO Volume 6) with groundwater topics scoped out.

2.3 Scoped in impacts

Construction impacts

2.3.1 The scope (see ES Appendix 5.2 EIA Scoping Opinion, Volume II (Document reference 6.2, DCO Volume 6)) for the groundwater assessments is detailed in ES Chapter 19 Water environment, Volume I (Document reference 6.1, DCO Volume 6) and summarised in paragraphs 2.3.3 to 2.3.10. The potential construction impacts to be assessed are as follows:

1. Impact 1: Direct disturbance of groundwater
2. Impact 2: Release of pollutants to groundwater
3. Impact 3: Changes to groundwater flows

2.3.2 Construction impacts considers both temporary construction impacts (such as from groundwater control) together with permanent impacts as a result of construction activities (such as the installation of below-ground infrastructure).

Impact 1: Direct disturbance of groundwater

2.3.3 Construction activities have the potential to directly impact upon the water quantity and quality of the groundwater bodies identified, together with other hydraulically linked receptors. Direct effects on the quantitative and chemical WER parameters for the underlying groundwater bodies are possible.

2.3.4 Disturbance could occur from the Proposed Development construction activities, including but not limited to the installation of the buried pipelines and associated infrastructure as part of the Proposed Development. Any temporary groundwater control, if required, for tunnel or pipeline construction would cause drawdown of the local water table resulting in reduced groundwater levels, which could impact groundwater dependent receptors (e.g. streams, abstractions, springs or

groundwater dependent terrestrial ecosystems (GWDTE)) within the extent of the drawdown (i.e. Zone of Influence (ZoI)).

Impact 2: Release of contaminants to groundwater

2.3.5 The operation of construction machinery has the potential to cause the accidental release of lubricants, fuels and oils on to the ground, which could migrate into the underlying groundwater. This could also be caused by spillage, leakage and in-wash from vehicle storage areas following rainfall, accidental release of foul waters (e.g. from welfare facilities) and construction materials, such as concrete, grout and inert drilling fluids from trenchless crossings or tunnelling.

2.3.6 Any activities that disturb the ground, such as excavation, tunnelling or piling, could release contaminants below-ground and potentially adversely affect groundwater quality or locally alter the hydraulic properties of the aquifer, which may in turn impact groundwater dependent features such as abstraction points or GWDTEs. The mobilisation of existing contaminants following disturbance of contaminated ground or groundwater, or through uncontrolled site runoff in areas impacted by contamination is not considered within this assessment, these are assessed within the ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6).

Impact 3: Changes to groundwater flows

2.3.7 Groundwater flows and levels may be impacted by temporary physical modifications (e.g. excavations, tunnelling or infilling followed by compaction), which could interrupt the natural groundwater flow pathways.

2.3.8 Below-ground infrastructure installed below the water table has the potential to permanently act as a barrier to groundwater flows, leading to mounding upstream of the feature, which could result in groundwater flooding upstream or drawdown impacts downstream. Conversely infrastructure installed below the groundwater table may act as a preferential pathway creating connections between currently hydraulically disconnected aquifers and/or receptors. This has the potential to impact upon the quality and quantity of groundwater at dependent receptors.

2.3.9 Permanent above-ground infrastructure, such as the Above Ground Plant (AGP) and the WRP site, is likely to increase the impermeable area across the catchments. This could decrease infiltration rates and permanently change surface runoff pathways impacting recharge of the underlying aquifers.

Construction impact causes

2.3.10 Based on the baseline data collated to date, the following key construction activities are identified, which have the potential to cause impacts to receptors within the study area:

1. The majority of Pipeline shafts/pits are assumed to require dewatering to enable construction. This has the potential to locally reduce the groundwater table; potentially impacting any receptors within the radius of influence. When constructed in the chalk, the risks of reducing the groundwater table could be significant due to the dependency of the receptors to the chalk groundwater (such as chalk streams, public water supply (PWS) abstractions and GWDTE).

2. The construction of any tunnels within the chalk has the potential to act as a barrier to flow; in particular if the tunnel cuts across a rapid flow pathway (such as a dissolution feature). Conversely, the tunnel has the potential to act as a preferential pathway, enabling continuity between sources and receptors. The permanent impacts from the tunnel installation are assessed within the construction impacts.
3. Shafts (associated with tunnelling or trenchless crossings) constructed into the chalk could provide a direct pathway for contamination from construction activities to the Principal aquifer. Where the shafts are located within a SPZ1, this risk is increased due to the potential of impacting the local PWS.
4. Tunnelling within the chalk also has the potential to impact the groundwater quality, as the Pipeline would be in direct continuity with the Principal aquifer. Any loss (e.g. slurry) from the tunnel face could migrate to receptors, whilst turbidity risks can be present from the creation of suspended sediments. Groundwater quantity impacts could occur if groundwater is not fully excluded from the Pipeline.
5. Crossings of surface watercourses are a risk to both water quality and quantity. Quantity impacts could occur from a reduction in the groundwater table (from dewatering of the drive and reception shafts), which in turn could lead to a reduction in baseflow to the watercourse(s). Quality impacts have the potential to occur from a polluting event (e.g. slurry breakout, spillage, uncontrolled surface run-off). This risk is increased when tunnelling through higher permeability deposits (Principal or Secondary A aquifers).
6. Construction of foundations of any buildings or structures such as the WRP site, particularly piled foundations that may provide a preferential pathway.
7. Introduction of buildings and impermeable surfacing associated with AGP resulting in decreased infiltration rates leading to reduced recharge of the underlying aquifers.

Operational impacts

2.3.11 The agreed scope (see ES Appendix 5.2 Scoping Opinion, Volume II (Document reference 6.2, DCO Volume 6)) for the groundwater assessments is detailed in ES Chapter 19 Water environment, Volume I (Document reference 6.1, DCO Volume 6), and summarised in paragraphs 2.3.12 to 2.3.15. The potential operational impacts to be assessed are as follows:

1. Impact 4: Continuous releases to groundwater
2. Impact 5: Intermittent releases to groundwater

Impacts 4 and 5: Continuous and intermittent releases to groundwater

2.3.12 There is the potential for accidental release of contaminants to groundwater during planned and unplanned operational maintenance. Activities could lead to accidental release of fine sediment, treatment chemicals, oils, fuels and lubricants to groundwater bodies and associated receptors.

2.3.13 Leakage of water from/into the pipeline(s) or associated infrastructure could also impact the groundwater quality, particularly if the leakages are large or long-term. It is assumed that drainage from within the tunnelled sections of the pipe would be

directed to the reject water pumping station and released via the Eastney LSO. This has been accounted for in the information provided for the dispersion modelling (see ES Appendix 19.5 Eastney Long Sea Outfall Solent dispersion modelling, Volume II (Document reference 6.2, DCO Volume 6)).

2.3.14 Washout valves are to be installed along the route of the Pipeline. Any source water released during commissioning and routine testing would be collected directly in a tanker and taken to a treatment works for treatment and disposal, with no source water discharged to the environment. In an emergency scenario, such as in the event of damage to the Pipeline, sections of the Pipeline may need to be drained. These events are considered operationally exceptional and are not expected during the life of the Proposed Development. Note that the potential impacts associated with emergency scenarios (e.g. pipe bursts or full flow run to waste in an emergency) are considered separately in ES Chapter 14 Major accidents and disasters, Volume I (Document reference 6.1, DCO Volume 6).

Operational impact causes

2.3.15 Based on the baseline data collated to date, the following key operational activities are identified, which have the potential to cause likely impacts to receptors within the study area:

1. Accidental release of contaminants to groundwater during planned and unplanned activities.
2. Leakage from/into the installed pipeline has the potential to alter the groundwater chemistry or lead to dissolution when within the chalk.

2.4 Hydrogeological Impact Assessment methodology

Engagement

2.4.1 The EA, Portsmouth Water and the Applicant's operational team have been engaged on the approach to the Hydrogeological Impact Assessment throughout the process, with consultation and engagement summarised in ES Chapter 19 Water environment, Volume I (Document reference 6.1, DCO Volume 6). This engagement has included review of the HIA document by the EA and Portsmouth Water prior to both Preliminary Environmental Information Report (PEI Report) and ES submission.

Guidance

2.4.2 As noted in section 2.1, there is no specific planning guidance in relation to assessing the impact of water infrastructure on the hydrogeological regime. As such, the HIA of the Proposed Development is carried out in accordance with the following key technical guidance:

1. DMRB standard LA 113 Appendix A [2]
2. EA 'Hydrogeological impact appraisal for dewatering abstractions' [1]

2.4.3 DMRB LA 113 sets out the requirements for the assessment and management of potential impacts on the water environment for highway projects. Although developed for highway projects, this methodology is a standard utilised for

assessing risks to the water environment for all construction projects and in particular linear infrastructure projects. DMRB LA 113 Appendix A outlines a three-stage process for assessing hydrogeological impacts:

1. Step 1: Establish regional groundwater body status.
2. Step 2: Develop a conceptual model for the surrounding area.
3. Step 3: Based on the conceptual model, identify all potential features which are susceptible to groundwater level and flow impacts.

2.4.4 The EA guidance outlines a similar but more detailed 14 step process:

1. Step 1: Establish the regional water resource status.
2. Step 2: Develop a conceptual model for the abstraction and the surrounding area.
3. Step 3: Identify all potential water features that are susceptible to flow impacts.
4. Step 4: Apportion the likely flow impacts to the water features.
5. Step 5: Allow for the mitigating effects of any discharges, to arrive at net flow impacts.
6. Step 6: Assess the significance of the net flow impacts.
7. Step 7: Define the search area for drawdown impacts.
8. Step 8: Identify all features in the search area that could be impacted by drawdown.
9. Step 9: For all these features, predict the likely drawdown impacts.
10. Step 10: Allow for the effects of measures taken to mitigate the drawdown impacts.
11. Step 11: Assess the significance of the net drawdown impacts.
12. Step 12: Assess the water quality impacts.
13. Step 13: If necessary, redesign the mitigation measures to minimise the impacts.
14. Step 14: Develop a monitoring strategy.

2.4.5 The EA guidance also identifies the inherent difficulties in reliable prediction of impacts in karstic systems, and proposes an alternative eight step approach that can be following, with more emphasis on monitoring and mitigation:

1. Step K1: Establish the regional water resource status.
2. Step K2: Develop a conceptual model for the abstraction and surrounding area.
3. Step K3: Identify sensitive sites.
4. Step K4: Commence preliminary monitoring at those sites.
5. Step K5: Design and demonstrate effective mitigation measures for the sensitive sites.
6. Step K6: Specify trigger levels for the mitigation measures.
7. Step K7: Continue surveillance monitoring at the sensitive sites.
8. Step K8: If necessary, implement mitigation measures when trigger levels have been passed.

2.4.6 The source-pathway-receptor model is applied to water features sensitive to groundwater level, flow and quality changes. In this context, sources include activities such as dewatering or spillages. The pathway is the hydraulic connection between the source and receptor, such as the aquifer that connects the two. The receptors are the groundwater bodies themselves, and/or groundwater dependent features such as public water supplies, springs, abstractions and GWDTE.

Tiered approach

2.4.7 The EA hydrogeological impact appraisal guidance recommends a tiered approach to the HIA, with the level of effort matched to the risks associated with the decision being made.

2.4.8 The tiers can be broadly summarised as follows:

1. Tier 1 (Basic) – conceptual models created based on published information or historical data. The conceptual model would typically be tested using lumped long-term average water balances and simple analytical equations, to arrive at a 'best basic' conceptual model.
2. Tier 2 (intermediate) – conceptual models would be tested by more detailed data, such as time-variant heads and flows, and seasonal or sub-catchment water balances (semi-distributed). More detailed analytical solutions may be used (to investigate the impact of abstraction on river flows, for example), or two-dimensional steady-state groundwater models. Limited field investigations may be required to fill important gaps in the data. Tier-2 assessments are likely to focus on (and be limited to) specific areas of uncertainty that have been highlighted during Tier-1.
3. Tier 3 (Detailed) - where the conceptual model represents a high degree of understanding of the hydrogeological and hydrological system and is likely to be tested using a spatially distributed and time-variant numerical groundwater model, calibrated and validated against historical data. This is likely to require the collection of data from a wide range of sources, including more field investigations.

2.4.9 It is noted that the guidance is aimed at those preparing supporting documentation for applications for transfer and full abstraction licence when a more detailed design is available; at which stage there is a higher burden of evidence required. As such, to inform planning a lower level of detail is required. The Applicant has engaged with the EA and agreed on the approach to the HIA in principle.

2.4.10 For the majority of the Proposed Development, it is considered that the qualitative conceptualisation of the hydrogeology is sufficient to inform impacts, likely significant effects and mitigation measure requirements at the planning stage.

2.4.11 For higher magnitude activities, such as dewatering of shafts within the chalk Principal Aquifer, further quantitative assessment is considered beneficial to ensure that likely significant effects are accurately identified, and mitigation measures incorporated.

2.4.12 It is considered that due to the scale of the Proposed Development and complexity of the hydrogeology, the Proposed Development in its entirety cannot be defined in a full-scale 3D numerical model sufficiently to accurately represent the hydrogeological processes occurring and how they may be affected by the

Proposed Development. However, for the purposes of the ES, it is considered that any likely significant effects can be identified through conceptualisation and localised quantitative assessment, which will be verified by the measures outlined within the ES Appendix 19.9 Outline Water Monitoring Plan, Volume II (Document reference 6.2, DCO Volume 6).

2.4.13 Further assessment of hydrogeological impacts may be required during the abstraction licensing process and environmental permitting process that would be undertaken post-Development Consent Order (DCO) consent.

Flow impacts[1]

2.4.14 Impacts on groundwater flow paths have been assessed qualitatively, including permanent flow impacts from the installation of tunnels and pipelines within the aquifers. Impacts are considered relative to the highest groundwater level recorded or where conceptually the design element of the Proposed Development is likely to intercept groundwater.

2.4.15 Embedded (primary) and best practice (tertiary) mitigation has been identified to mitigate the primary risks to groundwater flow (such as linear preferential pathways), and as such a more detailed assessment is not considered necessary for flow impacts.

Drawdown impacts

2.4.16 For the majority of the Proposed Development, a conservative qualitative assessment (based on the hydrogeological conceptualisation and professional judgement) has been undertaken to identify receptors considered likely to be impacted by drawdown of groundwater levels.

2.4.17 To ensure that likely significant effects have been captured, a quantitative analytical assessment has been undertaken of dewatering impacts for deeper structures within the chalk only (see Annex D); to determine the likely ZoI, predicted flow rates and magnitude of drawdown effects, together with mitigation and monitoring requirements.

2.4.18 The ten elements that have been assessed in more detail are:

1. WRP East Shaft (to Bedhampton Springs)
2. WRP West Shaft (Purbrook Tunnel)
3. WRP South Shaft (to Budds Farm)
4. Budds Farm Shaft
5. Mill Lane East (Bedhampton Pipe-Jack)
6. Mill Lane West (Bedhampton Pipe-Jack)
7. Portsdown Hill Shaft
8. Purbrook Shaft
9. River Wallington Launch and Reception Shafts
10. Poles Lane Stream Launch and Reception Shafts

[1] Flow impacts in this instance referring to alteration of groundwater flow paths, such as from the creation or blocking of preferential pathways, opposed to impacts on water balance.

2.4.19 The quantitative assessment undertakes a staged approach:

1. Conceptualisation to identify dewatering requirements.
2. Tier 1 Analytical Equations to conservatively assess anticipated flow rates and drawdown at distance.
3. Tier 2 testing of conceptualisation with conservative analytical or numerical models to confirm flow rates and drawdown at distance, and sensitivity to hydrogeological parameters.

2.4.20 These activities would ultimately be subject to abstraction licences and environmental permits, and a more detailed assessment is likely required during the application process following detailed design.

Quality impacts

2.4.21 Impacts on groundwater quality have been assessed qualitatively. Embedded and tertiary mitigation has been implemented to mitigate the primary risks to groundwater quality (a pollution incident), and as such a more detailed assessment is not considered.

Groundwater Dependent Terrestrial Ecosystems

2.4.22 Designated GWDTEs have been identified from the EA dataset [3] which covers Sites of Special Scientific Interest (SSSI) only. It is noted that other habitats may be present within the ZoI of the construction activities which have some dependence on groundwater.

2.4.23 A review of potential non-designated GWDTE (including designated sites not included in the EA dataset) within 200m of the Proposed Development has been undertaken in consultation with the Applicant's terrestrial and freshwater biodiversity team, informed by priority habitat, UKHab and National Vegetation Classification (NVC) survey data gathered for the Proposed Development (see ES Chapter 8 Terrestrial and freshwater biodiversity, Volume I (Document reference 6.1, DCO Volume 6).

2.4.24 Assessment of impacts on GWDTE has followed a five step, risk-based approach as per DMRB LA113 [2] Appendix B:

1. Step 1 – Identify potential linkages
2. Step 2 – Assess GWDTE importance
3. Step 3 – Assess potential impacts
4. Step 4 – Establish risk to GWDTE
5. Step 5 – Assessment outcomes and actions

2.4.25 To prevent potential duplication of the reporting of likely significant effects, the potential effects on GWDTE from groundwater impacts has been reported in ES Chapter 8 Terrestrial and freshwater biodiversity, Volume I (Document reference 6.1, DCO Volume 6).

2.5 Data sources

2.5.1 This HIA is based on data and information gathered from the following sources as shown in Table 2-1.

Table 2-1 Data sources accessed or received

Data source	Date received/last accessed	Contents
Proposed Development Data		
Proposed Development Ground Investigations	Monitoring data available up to July 2024	See Table 2-2
Groundwater Features Site Walkover	Completed in October 2023	See paragraph 2.6.3
Third Party Data		
British Geological Society GeoIndex	Last Accessed 23 May 2025	1:50,000 Geological Mapping Historical Borehole Logs
British Geological Society (BGS) Groundwater Flooding Susceptibility Dataset	Received 20 June 2023	Groundwater Flooding Susceptibility Dataset for Proposed Development area
Department for Environment, Food and Rural Affairs (Defra) Data Services Platform	Last accessed 23 May 2025	Light Detection and Ranging (LIDAR) data (where available) for the Proposed Development study area
Defra MAGIC Map	Last Accessed 23 May 2025	Source Protection Zones Aquifer Designation Mapping Groundwater Vulnerability Mapping Statutory and non-statutory designated sites including SSSI, Special Areas of Conservation (SAC), Special Protection Areas (SPA), Ramsar sites and Local Nature Reserves (LNR)
East Hampshire District Council (EHDC) Request for Information	Received 27 August 2025	Private water supplies within East Hampshire district provided (abstractions less than 20m^3/d which do not require a licence from the EA). No private water supplies located within the study area.
Eastleigh Borough Council (EBC) Request for Information	Received 8 September 2025	Private water supplies within the study area (abstractions less than 20m^3/d which do not require a licence from the EA)

Data source	Date received/last accessed	Contents
Abstraction Licensing Strategies (Catchment Abstraction Management Strategy (CAMS) process) Collection	Last Accessed 23 May 2025	East Hampshire Abstraction Licensing Strategy (2019) Test and Itchen Abstraction Licensing Strategy (2019)
EA Catchment Data Explorer	Last Accessed 23 May 2025	WER water body status objectives and classification data (Cycle 3)
EA GWDTE data	Last Accessed 23 May 2025	Designated GWDTEs (England SSSIs only)
EA Hydrology Data Explorer	Last Accessed 23 May 2025	EA monitoring data for selected sites across England
EA Request for Information	Received 8 June 2022	EA Consented Discharges within the Proposed Development study area
	Received 30 August 2022	Selected groundwater model reports and figures for the study area
	Received 31 January 2023	EA Regulated Abstractions within the Proposed Development study area Groundwater level data within the Proposed Development study area Rainfall data within the Proposed Development study area
	Received 20 May 2024	East Hampshire and Chichester Chalk and Test and Itchen Groundwater Models
	Received 12 March 2025	Groundwater quality monitoring data within study area Possible karst features within study area Spring locations within study area Discharge consents within Order Limits Shellfish Water Action Plans Abstraction licences within study area Groundwater monitoring within study area

Data source	Date received/last accessed	Contents
Fareham Borough Council (FBC) Request for Information	Received 5 September 2025	FBC were contacted in regard to private water supplies within the study (abstractions less than 20m^3/d which do not require a licence from the EA). In their response, FBC noted that they only have knowledge of one site in their district which is outside the study area.
Havant Borough Council (HBC) Request for Information	Received 14 August 2025	HBC were contacted in regard to private water supplies within the study area (abstractions less than 20m^3/d which do not require a licence from the EA). In their response, HBC noted that *"they are not aware of any private water supplies in the borough. For the avoidance of doubt, that is we understand there to be none, rather than we do not have the information"*
Met Office	Last Accessed 3 June 2025	Climate Averages Data from the three most proximal Met Office climate stations to the Order Limits excluding the Eastney transfer tunnel (Thorney Island at approximately 6km distance, Solent Maritime Rescue Sub-Centre (MRSC) at 8km distance and Southampton W.C at 11.5km distance) HadUK Gridded Climate Observations over the UK v.1.3.0 (1936-2023)
Ordnance Survey (OS)	Last accessed 23 May 2025	Maps (including historical) showing location of springs.
Portsmouth City Council (PCC) Request for Information	Received 2 September 2025	PCC were contacted in regard to private water supplies within the study (abstractions less than 20m^3/d, which do not require a licence from the EA). In their response, PCC noted that *"PCC do not have any records of private water supply along the pipeline route".*
Portsmouth Water Request for Information	Received 2 August 2022	BGS Commissioned Report CR/19/046 'A review of the hydrogeology of the

Data source	Date received/last accessed	Contents
		Bedhampton and Havant Springs Source Protection Zones' 2019 B.A. Hydro Solutions Report 'Portsmouth Water Head Office Redevelopment Hydrogeological Risk Assessment' November 2014
	Received 6 February 2023	Havant and Bedhampton Springs Location Plan Public Water Supply (PWS) Owned Land
	Received 9 April 2024	Bedhampton Springs Schematic
	Received 15 May 2024	Bedhampton and Havant Springs Abstraction Licence from 28 artesian springs (11/42/26.2/1)
	Received 14 August 2024	Bedhampton Winter Turbidity Data 2019-2024
South Downs National Park Authority (SDNPA) Request for Information	Received 20 October 2022	SDNPA were contacted in regard to private water supplies within the study (abstractions less than 20m^3/d which do not require a licence from the EA). In their response, SDNPA noted that *"we don't hold any information regarding the unlicensed abstractions for private water supplies."*
Southern Water Request for Information	Received 7 November 2023	Data from the Otterbourne WSW
Winchester City Council (WCC) Request for Information	Received 30 September 2025	Private water supplies within the study area (abstractions less than 20m^3/d which do not require a licence from the EA)

2.6 Investigations and surveys

Ground Investigation

2.6.1 Ground Investigation works for the Proposed Development have been split into a number of phases as summarised in Table 2-2. Further information on the Ground Investigation works is outlined in ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6) and its appendices.

Table 2-2 Ground investigation phases

Phase	Phase location	Dates of Ground Investigation	Consideration in this Hydrogeological Impact Assessment iteration
0	Ground Investigation in area of WRP site and Pipelines between Budds Farm WTW and the WRP	Intrusive works undertaken July to September 2022	Phase 0 Borehole Logs and Groundwater Monitoring as per Annex C of this document
1	Ground Investigation in area of deep tunnels at the eastern and western ends of the Proposed Development	Intrusive works undertaken September 2022 to September 2023	Phase 1 Borehole Logs and Groundwater Monitoring as per Annex C of this document
2	Ground Investigation along Proposed Development at key locations (including trenchless crossings of water courses and identified potential contaminated sites)	Intrusive works undertaken February 2023 to June 2023	Phase 2 Borehole Logs and Groundwater Monitoring as per Annex C of this document
3A	Ground Investigation within the Pipelines between the WRP site and Havant Thicket Reservoir section and within Section M of the Pipeline between Havant Thicket Reservoir and Otterbourne WSW (Itchen Crossing)	Intrusive works undertaken between May 2023 and October 2023	Phase 3A Borehole Logs and Groundwater Monitoring as per Annex C of this document
3B	Ground Investigation along Proposed Development (Section E and Section H to Section M of the Pipeline between Havant Thicket Reservoir and Otterbourne WSW)	Intrusive works undertaken between May 2023 and May 2024	Phase 3B Borehole Logs and Groundwater Monitoring as per Annex C of this document
3C	Ground Investigation along Proposed Development (Section E to Section L of the Pipeline between Havant Thicket Reservoir and Otterbourne WSW)	Intrusive works undertaken between May 2023 and May 2024	Phase 3C Borehole Logs and Groundwater Monitoring as per Annex C of this document

2.6.2 Ground Investigation boreholes are shown on ES Figure 19.3 Complete ground investigation, Volume III (Document reference 6.3, DCO Volume 6).

Groundwater features site walkover

2.6.3 In early October 2023, a site walkover was undertaken of a number of sites within and proximal to the Order Limits including the Portsmouth Water Bedhampton Springs PWS Works and the Applicant's existing Otterbourne WSW site. The purpose of these site walkovers was to ground-truth receptors identified from the desk study undertaken as part of the preliminary HIA and liaise with the PWS Operators. Due to the size of the Proposed Development, sensitive receptors were

prioritised (based on their receptor value and/or proximity to the Proposed Development). The scope of the surveys was agreed with the EA.

2.6.4 Information from the site walkovers, where relevant, is summarised in section 4 (Baseline).

2.7 Assumptions and limitations

2.7.1 The HIA has been collated based on a range of publicly available data, information provided by stakeholders and site investigation and survey data available at the time of writing.

2.7.2 Many of the publicly available datasets are at a coarse regional scale, and as such there is a level of uncertainty associated with use of this data as they are unlikely to identify local hydrogeological and hydrological variations at a smaller scale. As an example, the geology within the study area has been assumed to be as per the geological maps available from the BGS which are at a minimum 1:10,000 scale, unless ground-truthed by Ground Investigation works.

2.7.3 Ground Investigation works have been undertaken to inform the ground and groundwater conditions throughout the area of the Proposed Development. Ground Investigation data and monitoring data in selected boreholes has been made available up to July 2024.

2.7.4 It is assumed that there would always be gaps in hydrogeological data where the information is not readily available, particularly with respect to more local and of lesser recognition resources or features. This may include non-designated GWDTE more than 200m away (outside the field survey extent), the location non-mapped springs or unlicensed abstractions (less than 20m^3/day) which are not registered with local planning authorities. Due to unidentified receptors being of relatively low significance (moderate or below) and with tertiary mitigation measures in place to address any unidentified receptors, these gaps are considered unlikely to result in the identification of additional likely significant effects.

2.7.5 The assessment includes the information reasonably required to assess potential environmental effects. The assessment represents a ‘worst case’ and is based on conservative inputs derived from available field or desk study data and published research literature relevant to the study area. It is acknowledged that uncertainty is inherent to the assessment of interaction between surface water and groundwater. It is assumed that there is a potential for groundwater to accumulate in materials of relatively higher permeability and perch over materials of lower permeability (so called ‘perched water’), which is disconnected from the main aquifer, and that this perched water may be encountered in superficial deposits during any below-ground construction works.

2.7.6 Although a maximum depth of pipelines has not been outlined, the assessment has assumed that open-cut excavations and shaft depths would not vary from the preliminary design levels by a depth that would alter the hydrogeological impact assessment findings. Should the open-cut excavations or shafts be at greater depth, it is considered that the mitigation and regulatory requirements are sufficient to prevent a material change in the assessment results.

2.7.7 Due to the complexities of the hydrogeological regime in the study area, it is considered that the Proposed Development cannot be defined in a full scale three-dimensional (3D) numerical model sufficiently to accurately represent the processes occurring and how they may be affected by the Proposed Development. As such conceptual models and analytical assessments have been developed at the ES stage for specific sites (such as shafts requiring dewatering) to ascertain the likely significant impacts of the Proposed Development.

2.7.8 The detailed design and construction methodologies of Proposed Development would progress following the appointment of a Contractor following the granting of the DCO. The current assumptions on design and construction methodology are presented in ES Chapter 3 Description of the Proposed Development, Volume I (Document reference 6.1, DCO Volume 6). The following key assumptions have been made in relation to the construction methodology:

1. Any groundwater abstractions required would be temporary in nature (e.g. construction dewatering), with no permanent groundwater control operations proposed or required.
2. All non-open cut pipeline sections would utilise construction methodologies which exclude groundwater (methods such as closed face tunnelling or closed face micro tunnelling which limit groundwater ingress into the tunnel, so limit drawdown impacts from the tunnelling). As such, temporary groundwater control would only be required for open-cut excavations and trenchless drive and receptions shafts/pits.

2.7.9 Impacts to minor watercourses from groundwater drawdown have been excluded from assessment in the HIA, on the basis that any temporary impacts to baseflow as a result of construction activities are unlikely to result in a likely significant effect, due to the value of the receptors and magnitude of any groundwater baseflow loss relative to run-off.

2.7.10 Decommissioning impacts are considered to be no greater than the impacts identified and assessed during construction, and as such have not been assessed separately within this report.

3 Regional water resource status

3.1 Water resource management

3.1.1 The Proposed Development is located within two Catchment Abstraction Management Strategy (CAMS) areas (water resource management boundaries as defined by the EA). The CAMS areas are listed below and illustrated on ES Figure 19.5 Catchment Abstraction Management Strategy, Volume III (Document reference 6.3, DCO Volume 6):

1. Test and Itchen [4] – Western end of the Pipeline between Havant Thicket Reservoir and Otterbourne WSW (west of Lower Upham).
2. East Hampshire [5] – The remainder of the Pipeline between Havant Thicket Reservoir and Otterbourne WSW (from Havant to Lower Upham).

3.1.2 The Test and Itchen CAMS covers the Test and Itchen catchments in Hampshire, an area of approximately 1,675km^2. Large portions of the catchments are underlain by chalk, which influences the flow regimes and drainage patterns. Many of the tributaries are bournes (intermittent streams flowing from springs), which only flow during high groundwater conditions.

3.1.3 The Test and Itchen CAMS identified that for the groundwater units within the study area of the Proposed Development:

1. The groundwater balance for the 'Itchen Chalk' has restricted water available (no new consumptive licenses would be granted).
2. The groundwater balance for the 'Central Hants Bracklesham Group' has water available (new licenses would be considered on a case-by-case basis).

3.1.4 It is noted that the Central Hants Lambeth Group is not included within the Test and Itchen CAMS.

3.1.5 The East Hampshire catchment covers an area of approximately 517km^2 consisting of rolling chalk downlands to the north and a heavily urbanised coastal plain to the south. As with the Test and Itchen CAMS, the chalk plays an important role, being an important source of water for many of the streams and wetlands.

3.1.6 The East Hampshire CAMS identifies that for the groundwater units located within the study area of the Proposed Development:

1. The groundwater balance for the 'East Hants Chalk' has restricted water available (no new consumptive licenses would be granted).
2. The groundwater balance for the 'South East Hants Bracklesham Group' is illustrated as having water available (new licenses would be considered on a case-by-case basis). However, the CAMS notes that "*it is unlikely that there will be any potential for significant, reliable abstractions from these units. There is no specific policy for these aquifers. Decisions about an application will be made on a case-by-case basis*".
3. The 'East Hants Lambeth Group' and 'South Hants Lambeth Group' are illustrated as having restricted water available. However, the CAMS notes that "*it is unlikely that there will be any potential for significant, reliable abstractions*

from these units. There is no specific policy for these aquifers. Decisions about an application will be made on a case-by-case basis".

4 Conceptual model (baseline)

4.1 Regional understanding

Designations and directives

Water Environment Regulations

4.1.1 The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (WER, as amended) transpose into English and Welsh law the Water Framework Directive (2000/60/EC of the European Parliament and of the Council of 23 October 2000). The Water Framework Directive established a framework for community action in the field of water policy.

4.1.2 The WER require the competent authorities in England and Wales to prevent deterioration and protect and enhance the status of aquatic ecosystems. This means that these authorities must ensure that new activities do not adversely impact upon the status of aquatic ecosystems, and that historical and ongoing activities that are already impacting it need to be addressed. The WER apply to all bodies of water (groundwater and surface water), including those that are artificial.

4.1.3 The WER are discussed in more detail in ES Appendix 19.2 Water Environment Regulations compliance assessment, Volume II (Document reference 6.2, DCO Volume 6). Below is a summary of the WER groundwater status for the Proposed Development.

4.1.4 The Proposed Development is located over a single River Basin District, the South East River Basin District.

4.1.5 The status and objectives of features are based on those set out in the 2022 South East River Basin Management Plan (RBMP) [6].

4.1.6 The study area of the Proposed Development crosses seven WER groundwater bodies, as shown in ES Figure 19.2 Groundwater features, Volume III (Document reference 6.3, DCO Volume 6). A summary of the WER groundwater bodies is presented in Table 4-1 and ES Appendix 19.2 Water Environment Regulations compliance assessment, Volume II (Document reference 6.2, DCO Volume 6).

4.1.7 Superficial deposits are not specifically designated as WER groundwater bodies. However, it is anticipated that they are hydraulically connected to the relevant underlying designated WER groundwater bodies. As such, they are considered to be functionally linked. Therefore, the superficial deposits are considered potential receptors in the context of the Environmental Impact Assessment (EIA).

Table 4-1 Water Environment Regulations groundwater bodies

	River Itchen Chalk	East Hants Chalk	Central Hants Bracklesham Group	South East Hants Bracklesham Group	Central Hants Lambeth Group	East Hants Lambeth Group	South Hants Lambeth Group
Groundwater Body Identification (ID)	GB 40701G505000	GB 40701G502700	GB 40702G500900	GB 40702G503000	GB 40702G503800	GB 40702G500800	GB 40702G503700
River Basin District	South East	South East	South East	South East	South East	South East	South East
Current Overall Status	Poor	Poor	Good	Poor	Good	Good	Good
Current Quantitative	Poor	Poor	Good	Good	Good	Good	Good
Current Chemical Status	Poor	Poor	Good	Poor	Good	Good	Good
Quantitative Objective	Good	Good	Good	Good	Good	Good	Good
Chemical Objective	Good	Good	Good	Good	Good	Good	Good
Source: EA (2025) Catchment Explorer. [7]							

Aquifer designations

4.1.8 Aquifers within the study area of the Proposed Development that have been classified by the EA based on their importance (in terms of utilisation as a resource but also their role in supporting surface water flows and wetland ecosystems) are listed in the following paragraphs and are presented in ES Figure 19.6 Superficial aquifer designations, Volume III (Document reference 6.3, DCO Volume 6) and ES Figure 19.7 Bedrock aquifer designations, Volume III (Document reference 6.3, DCO Volume 6).

4.1.9 The chalk members of the White Chalk Subgroup (see paragraph 4.1.21) are designated by the EA as a Principal aquifer. No superficial deposits are designated as Principal aquifers. Principal aquifers are rocks or soils that provide significant quantities of water and can support water supply and/or baseflow to rivers, lakes and wetlands on a strategic scale. They typically have a high intergranular and/or fracture permeability, meaning they usually provide a high level of water storage.

4.1.10 The Lambeth Group, Bracklesham Group and sand members of the London Clay (e.g. Durley Member and Bognor Member) together with the River Terrace Deposits and Alluvium superficial deposits are designated by the EA as Secondary A aquifers. This designation indicates that the aquifers are *"permeable layers that can support local water supplies and may form an important source of baseflow to rivers".* [8]

4.1.11 No bedrock or superficial deposits are designated by the EA as a Secondary B aquifer. This designation indicates that "*aquifers are mainly lower permeability layers that may store and yield limited amounts of groundwater through characteristics like thin cracks (called fissures) and openings or eroded layers*". [8]

4.1.12 No bedrock is designated as a Secondary undifferentiated aquifer; however, Raised Marine Deposits, Beach and Tidal Flats and Head superficial deposits are designated as Secondary undifferentiated. This designation indicates that *"it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type. These have only a minor value"*. [8]

4.1.13 The London Clay bedrock and Clay with Flints superficial deposits are designated as unproductive strata (strata with negligible significance for water supply or baseflow).

Geology

Superficial deposits

4.1.14 The superficial geology mapped underlying the Proposed Development is presented in ES Figure 11.2 Superficial geology of the study area, Volume III (Document reference 6.3, DCO Volume 6).

4.1.15 Superficial deposits are located intermittently along the Pipeline between Havant Thicket Reservoir and Otterbourne WSW, and comprise of:

1. Alluvium
    a. Holocene Epoch (0.01 million years ago (Ma) – Present). Alluvium is a general term for clay, silt, sand, and gravel. It is the unconsolidated detrital

material deposited by a river, stream, or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its floodplain or delta, or as a cone or fan at the base of a mountain slope. Synonym: alluvial deposits. Normally soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat, and basal gravel. A stronger, desiccated surface zone may be present.

2. River Terrace Deposits
    a. Quaternary Period (2.59Ma – Present). Sands and gravels, locally with lenses of silt, clay or peat.
3. Head Deposits
    a. Holocene Epoch (0.01Ma – Recent). Head is poorly sorted and poorly stratified, angular rock debris and/or clayey hillwash and soil creep, mantling a hillslope and deposited by solifluction and gelifluction processes. Solifluction is the slow viscous downslope flow of waterlogged soil and other unsorted and unsaturated superficial deposits. The term gelifluction is restricted to the slow flow of fluidized superficial deposits during the thawing of seasonally frozen ground. The flow is initiated by meltwater from thawing ice lenses. Polymict deposit comprises gravel, sand and clay depending on upslope source and distance from source. Locally with lenses of silt, clay or peat and organic material.
4. Raised Marine Deposits
    a. Holocene Epoch (0.01Ma – Recent). Raised marine and coastal zone deposits are isostatically uplifted marine and coastal zone deposits, which crop out in part above high-water mark. Variable lithology. Gravel (shingle), sand, silt and clay; commonly charged with organic debris (plant and shell).
5. Beach and Tidal Flat Deposits
    a. Quaternary Period (2.59Ma – Recent). Composite of 'Beach deposits': Shingle, sand, silt, and clay; may be bedded or chaotic; beach deposits may be in the form of dunes, sheets, or banks, and 'Tidal Flat Deposits': commonly silt and clay with sand and gravel layers; possible peat layers; from the tidal zone. [Generic description].
6. Clay with Flints
    a. Palaeogene Period to Pleistocene Epoch (66.0 – 0.012Ma). A residual deposit formed from the dissolution, decalcification, and cryoturbation of bedrock strata of the Chalk Group and Palaeogene formations and, in the extreme west of the outcrop, the Upper Greensand Formation. It is unbedded and heterogenous. The dominant lithology is orange-brown and red-brown sandy clay with abundant nodules and rounded pebbles of flint. Angular flints are derived from the chalk, and rounded flints, sand, and clay from Palaeogene formations. There is commonly a discontinuous basal layer up to 10cm thick, with dark brown to black matrix, stiff, waxy, and fissured, with relatively fresh flint nodules stained black or dark green with manganese or glauconite. The deposit locally includes bodies of yellow fine- to medium-grained sand, reddish brown clayey silt, and sandy clay with beds of well-rounded flint pebbles, derived from Palaeogene formations.

4.1.16 Alluvium and River Terrace Deposits are mapped along the Pipeline, primarily in association with surface water bodies and flood zones and are crossed by the Proposed Development in several locations.

4.1.17 Head Deposits are also mapped along the Pipeline, primarily corresponding to topographic lows at the base of hills and within valleys and would be crossed by the Proposed Development in several locations.

4.1.18 Raised Marine Deposits and Beach and Tidal Flat Deposits are mapped extensively to the south of the Pipeline in association with the coastline, although are only anticipated to be encountered at surface in the area of the WRP site and Budds Farm WTW.

4.1.19 Clay with Flints are primarily mapped north-west of the Pipeline within the southern extent of the Chalk Downs. The deposits are only mapped at the north-western extreme of the study area (north-west of Otterbourne).

Bedrock

4.1.20 The bedrock geology underlying the Proposed Development is presented in ES Figure 11.3 Bedrock geology of the study area, Volume III (Document reference 6.3, DCO Volume 6).

4.1.21 The Proposed Development is underlain by four main bedrock geological groups, from youngest to oldest:

1. Bracklesham Group
    a. Ypresian to Lutetian age (56.0 – 41.2Ma). The Bracklesham Group comprises interbedded and interlaminated clays, silts and mostly fine or medium grained sands. Minor coarse-grained sands, gravelly sands, gravels, sandstones or ironstone concretions occur in places.
2. Thames Group
    a. Ypresian Age (56.0Ma - 47.8Ma) mainly silty clays and clays, with occasional silts, sands, gravels, and calcareous mudstones. Includes the London Clay Formation.
3. Lambeth Group
    a. Thanetian to Ypresian Age (59.2 – 47.8Ma) variable sequences mainly of clay with some sands and gravels, minor limestones and lignites and occasional conglomerates and sandstones. Variable depositional environments including fluvial, estuarine, lagoonal and near-shore marine.
4. White Chalk Subgroup
    a. Late Cretaceous (100.5 - 66.0Ma) chalk with discrete marl seams, nodular chalk, sponge-rich and flint seams throughout.

4.1.22 The Bracklesham Group, the Thames Group and the Lambeth Group are mapped as underlying various sections of the Proposed Development.

4.1.23 The White Chalk Subgroup is mapped and encountered to the north-east of the Proposed Development, in the chalk hills of the South Downs and may be encountered below the superficial deposits at the north-western end of the study area (north-west of Otterbourne). The Portsdown anticline also leads to the chalk

subgroup being observed directly below the superficial deposits in the area north of Portsmouth (e.g. Portsdown hill) and may be encountered below the superficial deposits along south-eastern sections of the Pipelines between the WRP site and Otterbourne WSW, as well as the WRP site and connecting Pipelines to the Budds Farm WTW and the Havant Thicket Reservoir. Chalk in the Hampshire area is commonly 80-150m thick but can be as thick as 400m where uneroded and confined by Palaeogene deposits.

Structural geology

4.1.24 During the Cenozoic Era (66 million years ago to the present), the Hampshire region was impacted by direct south to north compression related to the alpine mountain building event in southern Europe. In general, the exposed uplands of chalk to the north are broadly anticlinal in structure, whilst thicker deposits of Paleogene sands, silts and clays are encountered in the Hampshire basin where the chalk forms a syncline.

4.1.25 In the study area, the main geological structures include the Winchester anticline in the South Downs where chalk exposures are encountered, the Chichester syncline where Paleogene deposits are encountered between the two chalk outcrops (e.g. from Horndean to Bedhampton and Havant), the Portsdown anticline to the north of Portsmouth (e.g. the Portsdown Hill chalk ridge) and the Hampshire basin in the south [9].

4.1.26 The nature of the conduit system beneath the Chichester syncline (which feeds the Bedhampton springs) is influenced by the geology and hydrogeology. The chalk is characterised by many stratigraphical discontinuities including sheet flints, marls and hardgrounds that can act as potential horizons for karst development. The chalk is also highly fractured with well developed joint sets; both conjugate fractures or vertical fractures, together with joints normal to bedding. The spacing of fractures is in the order of tens of centimetres to a couple of metres, with the concentration of fractures an order of magnitude higher than more classic karstic limestones. Due to lithological factors, the conduit system is likely to be developed at or just below the Palaeogene unconformity most of the route from the sinks to the springs. Hardgrounds and sheet flints in the upper part of the Culver Chalk and basal Portsdown Chalk provide key horizons for karstic development. Evidence from accessible relict conduit systems (caves) in the wider region suggest that cave passages are developed on sheet flints, but are also embedded within an extensive network of smaller conduits and dissolutional voids. [10]

4.1.27 Geophysical surveys have also identified a zone of faulting within the Chichester Syncline close to the Havant and Bedhampton Springs; with the springs in the centre of the Bedhampton site considered to be due to, and controlled by, faulting of the Chalk below. This faulting enables groundwater to take the path of least resistance up through the Chalk and superficial deposits to surface. The faulting has resulted in displacement of the Chalk surface, downthrown towards the south of the site. [11]

Hydrogeology

Superficial deposits

4.1.28 Flow through the superficial deposit aquifers is dominated by intergranular flow where the permeability would support it. Groundwater flow through the superficial deposits would be locally variable and limited to more permeable zones.

4.1.29 Superficial deposit aquifers are generally anticipated to be unconfined; however, heterogeneity of deposits means localised confinement of water bearing coarse grained units is likely.

4.1.30 Alluvium and River Terrace Deposits are present across the Proposed Development, associated with main surface watercourses, and are likely to comprise a mixture of clays, silts, sands, and gravels. Deposits can be complex with interdigitations of deposits which may develop separate piezometric levels, although they are generally anticipated to be permeable. Due to their permeability, the deposits are anticipated to be in continuity with associated surface watercourses and features and the chalk bedrock where they directly overlie. River Terrace Deposits generally comprise less fines than Alluvium and thus would generally be more permeable.

4.1.31 Head, Raised Marine Deposits and Beach and Tidal Flat Deposits are likely to more variable and heterogenous (which results in their Secondary undifferentiated designation) although high permeability beds may be encountered. Deposits would be complex with interdigitations of deposits, which may develop separate piezometric levels.

4.1.32 The Clay with Flints deposits are anticipated to generally have a low permeability with limited water bearing potential.

Bedrock

4.1.33 The chalk bedrock is a designated Principal aquifer. It is therefore of hydrogeological significance as it provides an important source of water supply to PWS abstractions and surface water features (including environmentally designated chalk streams).

4.1.34 Chalk is generally referred to as a dual porosity aquifer, where main storage of water occurs in the low-transmissivity porous matrix, whilst flow and transport occur primarily in a pervasive high-transmissivity fractures (or solution features) network.

4.1.35 Regional groundwater flow within the chalk bedrock is generally southerly from the elevated chalk hills of the South Downs in the north towards the shallow Langstone Harbour and Solent in the south. The hydraulic heads from the groundwater source in the north result in groundwater flowing beneath the Palaeogene deposits of the Chichester syncline and emerging as springs to the south of the Chichester syncline, as discussed in further detail in the karst section (paragraph 4.1.44).

4.1.36 The hydrogeology of the Portsdown anticline has not been studied as extensively as Chichester syncline but is becoming better understood [9]. Groundwater is considered to generally flow radially from the anticline supplying springs along the north coast of Portsmouth Harbour and springs feeding the River Wallington [9].

4.1.37 Transmissivity and storage coefficient data from the Hampshire area indicates [12]:

1. Transmissivities ranging from 0.55 to 29,000m^2/d
   a. A geometric mean transmissivity of 1,600m^2/d and median transmissivity of 2,600m^2/d
   b. 25 and 75 percentiles of the transmissivity data of 840m^2/d and 6,100m^2/d respectively
   c. Storage coefficients ranging from $7x10^{-5}$ to 0.06 with a geometric mean of 0.008 and median of 0.009

4.1.38 These measurements may trend towards higher values because of the intensity of testing undertaken in high yielding sites used for river augmentation schemes.

4.1.39 Investigations in the region also illustrated variability of aquifer properties with depth, with studies indicating the majority of flow is within the top 40-50m corresponding with fracture locations with flow generally significantly less below this depth.

4.1.40 The weathered chalk may locally play an important role on the hydrogeology and continuity between the chalk and overlying aquifers and receptors. Where weathered, it is common for the chalk to be weathered to a form of chalk clay known as 'Putty Chalk', which can act as an aquitard. Elsewhere, harder chalk deposits may be weathered to a chalk gravel known as 'Chalk Bearings', which can be highly transmissive.

4.1.41 The Lambeth Group comprises a mixture of clays, silts and sands. In some areas of the Hampshire basin, the formation is predominantly clay and unproductive for water supply. Other areas, consist of sandy strata, which can yield flows in the order of 100m^3/d. Where sandy basal layers within the group are present, they can be important in relation to the underlying chalk as they are thought to lead to enhanced development of dolines (also known as sinkholes) and other solution features [13].

4.1.42 The London Clay Formation of the Thames Group is generally of little significance as an aquifer due to its clayey natures. However, a number of lenticular beds of fine to medium grained sands are present, which may constitute useful aquifers including the Bognor and Whitecliff sand members. Yields of 500m^3/d have been observed from the Whitecliff Sand, although other areas have been significantly less productive [13].

4.1.43 Lateral and vertical heterogeneity in the sand and clay content of the Bracklesham Group have a corresponding effect on aquifer properties. Where sandy beds are developed, reasonable yields may be experienced from wells, although the water may be ferruginous [13].

Karst

4.1.44 Chalk is an unusual karst aquifer in which cave development can be limited, but extensive networks of smaller solutional conduits and fissures that enable rapid groundwater flow are present. The British Geological Society has produced a series of reports which provide an overview of the evidence for karst in the chalk (as well as Jurassic and Permian limestone) across England, with the C5 (Wessex Basin) [14] and C7 (South Downs) [15] reports relevant to the study area.

4.1.45 Dolines, stream sinks, dissolution pipes and springs are common in chalk bedrock with the Bedhampton and Havant spring complex in Hampshire (within the study area) being one of the best examples of karstic springs in the UK, producing a combined flow rate in the order of 600 – 2,000l/s [9].

4.1.46 Up to 45 stream sinks have been mapped to the north of the study area in the Horndean and Rowlands Castle areas. These are found in the area close to the boundary between the chalk and Palaeogene formations and are critical point sources of recharge for the aquifer, as there are no permanent streams in the area. The water that enters the stream sinks is considered to flow through the chalk beneath the Chichester Syncline and then emerge in the Bedhampton and Havant spring complex to the south (approximately 5-6km distance) [10]. Tracer testing undertaken in the 1970s indicated significant groundwater velocities in the order of 2-3km/d and supported the presence of a well-developed conduit system linking the stream sinks north of the Chichester Syncline to the spring complex, with low attenuation and dilution.

4.1.47 Rapid flow has also been detected at Otterbourne [12]. Rapid flow supports the presence of karst features, which has implications for pollution and groundwater quality risks (such as turbidity). Turbidity issues are known to occur at Otterbourne; primarily in abstractions from the shallow adit system.

Rainfall and recharge

4.1.48 Average rainfall at a number of the closest Met Office climate stations to the study area (closest Met Office climate stations all outside study area) are summarised in Table 4-2.

Table 4-2 Average rainfall at proximal climate stations

	Average rainfall (mm) [climate period 1991-2020[2]]		
Month	**Thorney Island E: 476113 N: 102160**	**Solent MRSC E: 455902 N: 101126**	**Southampton W.C E: 442078 N: 111450**
January	84.47	73.86	89.37
February	57.67	52.32	63.86
March	49.85	45.44	56.01
April	49.64	41.45	52.27
May	43.26	41.06	47.37
June	48.20	48.25	56.90
July	46.88	48.30	44.01
August	57.17	55.74	58.90
September	61.40	53.27	60.45
October	85.95	83.40	92.55
November	90.56	90.78	99.93
December	92.62	89.61	96.94
Annual	**767.67**	**723.48**	**818.56**

[2] 1991 – 2020 is the most recent 30 year average available for the climate stations from the Met office data.

4.1.49 Rainfall data from the HadUK Gridded climate dataset[3] for the same 1991-2020 period has also been accessed for Budds Farm WTW and Otterbourne WSW), as summarised in Table 4-3. The data indicates greater annual rainfall at the western end of the Proposed Development.

Table 4-3 HadUK gridded climate data, 1991-2020

	Average rainfall (mm) [climate period 1991-2020]	
Month	**Budds Farm WTW**	**Otterbourne WSW**
January	80.75	95.48
February	56.45	67.94
March	46.58	60.08
April	49.72	58.86
May	40.86	51.88
June	46.44	57.05
July	50.39	54.60
August	54.05	63.99
September	59.56	64.22
October	86.08	99.18
November	87.55	107.44
December	86.13	97.79
Annual	**744.56**	**878.51**

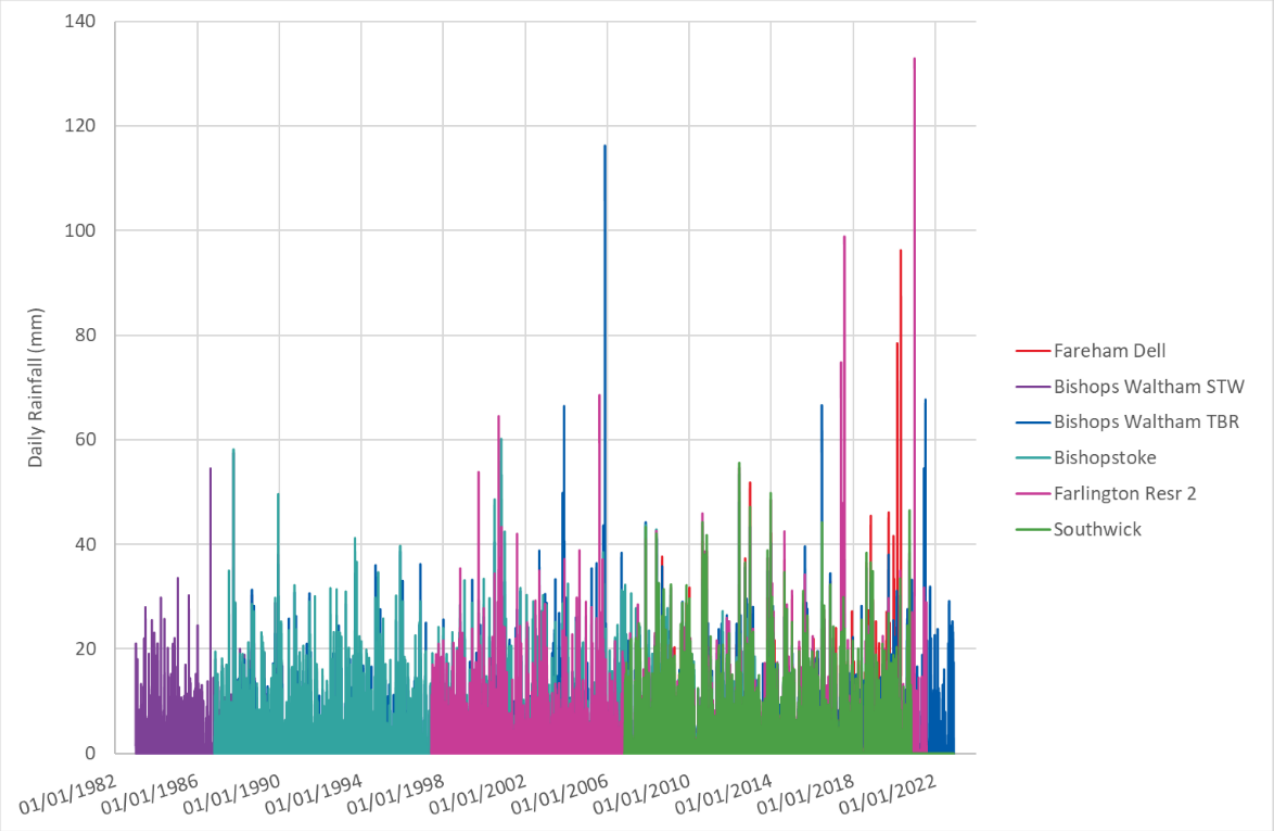
4.1.50 Recharge to groundwater is anticipated to be predominantly north of the study area in the South Downs, where infiltration rates are greater and karst stream sinks are identified (particularly to the north of the Order Limits in the east, above Havant Thicket Reservoir). The lower permeability deposits (e.g. London Clay and the Lambeth Group) and extensive urbanisation that underlies significant sections of the Proposed Development are anticipated to retard groundwater infiltration rates in these areas.

4.1.51 Due to the karstic nature of the chalk, rainfall in the South Downs is known to have an impact on the groundwater quality with turbidity a particular issue at the Havant Springs and Otterbourne following rainfall (implying rapid recharge or a connection with surface water) [12].

4.1.52 Rainfall data from a number of more proximal rainfall stations within the study area have been provided by the EA [16], which is illustrated in Graphic 4-1. The majority of these sites are not currently recording (with the exception of Bishop's Waltham Tipping Bucket Recorder (TBR)).

[3] HadUK refers to the Hadley Centre's Unified UK grid dataset of gridded climate observations for the UK

Graphic 4-1 Rainfall data from stations within the study area (mm/day)



4.2 Local understanding

4.2.1 A summary of the local conditions and receptors within the study area for each section of the Proposed Development are detailed below.

4.2.2 Where the study area is noted in each section, this is discussed in relation to the section only (i.e. 1km from the Order Limits for that section). Receptors may be identified within the study area for multiple sections.

Water Recycling Plant site

4.2.3 The WRP site is located approximately 300m north-west of Budds Farm WTW, to the north of Harts Farm Way, south of the A27 and west of the Hermitage Stream.

4.2.4 The WRP site would receive a total peak volume (during drought conditions) of approximately 82Ml/d of treated wastewater from Budds Farm WTW to provide a total peak output of approximately 60Ml/d of recycled water. Reject water from the WRP process would be combined with the existing Budds Farm WTW treated wastewater flows (that are generated by the existing operation of Budds Farm WTW) and released via the existing Eastney LSO into the Solent using the existing Eastney Transfer Tunnel (TT). Water recycling uses full-advanced treatment process to turn highly treated wastewater into purified recycled water.

4.2.5 The WRP site is expected to consist of a main process building, kiosks for control equipment, administration buildings and parking facilities. Several large holding tanks and chemical storage units would be required for operation of the WRP site.

Topography

4.2.6 The WRP site would be located at an elevation in the order of 5-15m Above Ordnance Datum (AOD).

4.2.7 The topography in the study area[4] for the WRP generally increases gently towards the north towards the Chalk Downs, and steeply to the north-west of the WRP site, where the Portsdown Hill chalk ridge is located. Langstone Harbour is located to the south of the WRP site (approximately 200-300m at its closest) and has an elevation in the order of 2m AOD, which is submerged at high tide.

Environmentally designated sites

4.2.8 A SPZ[5] is located approximately 350m north of the WRP site associated with the chalk springs at Bedhampton, which are used for potable water supply by Portsmouth Water. Parts of the Pipelines between the WRP site and Havant Thicket Reservoir are within an SPZ1 zone (inner zone), which indicates a zone where there is a 50-day travel time of pollutant to source. This SPZ1 zone is approximately 300m wide north to south, north of which is SPZ 1c – which refers to an area with a protective cover of low permeability sat above a unit of high permeability, which if mined or tunnelled into would be representative of SPZ1. In this case, London Clay provides much of the cover above chalk members.

4.2.9 Langstone Harbour is approximately 200-300m south of the WRP site and is an environmentally sensitive site with a number of statutory environmental designations including:

1. SSSI– 'Langstone Harbour' (also noted as a GWDTE)
2. SPA – 'Chichester and Langstone Harbours'
3. Ramsar site – 'Chichester and Langstone Harbours'
4. SAC – 'Solent Maritime'

4.2.10 Environmental designations within the study area are illustrated in ES Figure 8.1 Statutory designated sites within the Order Limits plus a 2km buffer, Volume III (Document reference 6.3, DCO Volume 6), and SPZs shown on ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Surface water bodies

4.2.11 The WRP study area (WRP site order limits plus 1km buffer) includes three surface water catchment areas, as summarised in Table 4-4. The Langstone Harbour

[4] Study area for each section of the Proposed Development taken as 1km from the order limits of that section.

[5] Source protection zones are split into three main zones, and two additional categories as follows:

- SPZ1 (inner zone) – an area where groundwater in the aquifer has a 50 day or less travel time to the source/abstraction;
- SPZ2 (outer zone) – an area where groundwater in the aquifer has a 400 day or less travel time
- SPZ3 (total catchment) – an area around a source/abstraction within which all groundwater recharge is presumed to be discharged at the source/abstraction
- SPZ_c – SPZs ending in a c represent confined areas of the aquifers. As such, they are unlikely to be impacted by surface activities, but may be impacted by activities at depth
- SPZ4 (special interest) – these can represent a surface water catchment which drains into the aquifer, feeding the groundwater supply (suchas as surface water draining into a doline).

transitional water body is immediately adjacent to the WRP site, whilst the Hermitage Stream and Lavant (Hants) catchments are at distance, approximately 450m north and 950m east, respectively[6].

Table 4-4 Surface water catchments in study area – Water Recycling Plant site

	Langstone Harbour transitional water body	Hermitage Stream	Lavant (Hants) catchment
River Basin District	South East	South East	South East
Hydromorphological Designation	Heavily Modified	Heavily Modified	Not designated artificial or heavily modified
Current Ecological	Moderate	Moderate	Poor
Current Chemical	Fail	Fail	Fail
Ecological Objective	Good	Good	Good
Chemical Objective	Good	Good	Good

4.2.12 On the eastern side of the WRP site, the EA Main River 'Hermitage Stream' flows south towards the Langstone Harbour. The last 1km (approximate) of the Hermitage Stream is under tidal influence, including its section adjacent to the WRP site. The Hermitage Stream is fed by smaller watercourses in the area, including Riders Land Stream and Brockhampton Stream, which are anticipated to be primarily groundwater fed by chalk springs. At the eastern edge of the study area, the Lavant (Hants) also flows south towards the Langstone Harbour. No surface watercourses are mapped in the western half of the study area.

4.2.13 Surface water catchments and main rivers are illustrated in ES Figure 19.1 Surface water features, Volume III (Document reference 6.3, DCO Volume 6).

Superficial deposits

4.2.14 Table 4-5 details the superficial geology mapped in the WRP site study area. The WRP site is located on a historic landfill, which is discussed in ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6).

Table 4-5 Superficial deposits within study area – Water Recycling Plant and associated pumping stations

Geology	Description	Location and prevalence	Mapped within the Order Limits
Head	Clay, Silt, Sand and Gravel	Mapped to north of the WRP site (at base of Portsdown Hill) and north-east associated with surface watercourse valleys (e.g. Lavant river)	No
River Terrace Deposits (Undifferentiated)	Sand, Silt and Clay	Mapped north and east of the WRP site	Yes – Northern edge of the WRP site

[6] Note that the WRP is adjacent to the Hermitage Stream as noted in 4.2.12. However, the Hermitage Stream is within the Langstone Harbour transitional water body catchment south of the Portsmouth Water Bedhampton site.

Geology	Description	Location and prevalence	Mapped within the Order Limits
Alluvium	Clay, Silt, Sand and Gravel	To east of the WRP site, associated with the Hermitage Stream, and Lavant watercourses	Yes – Small area in north-east of Order Limits
Raised Marine Deposits	Sand and Gravel	WRP site mapped as being underlain by Raised Marine Deposits which extend to west of the WRP site along the coast	Yes – Majority of the WRP site underlain by Raised Marine Deposits
Beach and Tidal Flat Deposits (Undifferentiated)	Clay, Silt, Sand and Gravel	Mapped to south of the WRP site associated with the sea (e.g. Langstone Harbour)	No
No superficial cover	-	No superficial deposits mapped to the north of the study area, where the topography increases (e.g. Portsdown Hill)	No

4.2.15 Several Ground Investigation boreholes were drilled at the location of the WRP site as part of historic Ground Investigations and the Phase 0 Ground Investigation. Further details are available in ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6) and its associated appendices.

4.2.16 Boreholes RP01 and RP02 in the north of the WRP site identified Made Ground and Landfill overlying the bedrock, which was encountered between approximately -3m AOD and -7m AOD.

4.2.17 Boreholes W001 and W002 in the south-east of the WRP site encountered Raised Marine Deposits below the Made Ground and Landfill, between approximately -0.5m AOD and -6.5m AOD, which overlie the chalk bedrock.

Bedrock geology

4.2.18 Table 4-6 details the bedrock geology mapped in the WRP study area.

Table 4-6 Bedrock geology within study area – Water Recycling Plant and associated pumping stations

Geology	Description	Location and prevalence	Mapped within the Order Limits
Undifferentiated Chalk (Lewes Nodular, Seaford Chalk, Newhaven Chalk, Culver Chalk and Portsdown Chalk Formations)	Chalk	Underlying approximately three quarters of the study area included directly beneath the WRP site	Yes
Newhaven Chalk Formation	Chalk	Mapped in north-west of study area	No
Tarrant Chalk Member	Chalk	Mapped in north-west of study area	No
Spetisbury Chalk Member	Chalk	Mapped in north-west of study area	No

Geology	Description	Location and prevalence	Mapped within the Order Limits
Portsdown Chalk Formation	Chalk	Mapped in north-west of study area	No
Lambeth Group	Clay, Silt and Sand	Mapped in north of study area overlying the chalk	No
London Clay	Clay, Silt and Sand	Mapped in north of study area overlying the Lambeth Group	No

4.2.19 Several Ground Investigation boreholes were drilled at the location of the WRP site as part of historic Ground Investigations and the Phase 0 Ground Investigation. Further details are available in ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6) and its associated appendices.

4.2.20 These boreholes (BH) (BHRP01, BHRP02, BHW001 and BHW002) all identified the Newhaven Chalk Formation below the Superficial Deposits to the base of the boreholes (proven to at least -50m AOD).

Groundwater-surface water interactions (springs, sinks, karst and groundwater dependent terrestrial ecosystems)

4.2.21 The Bedhampton and Havant Springs, as detailed in paragraph 4.1.45 and 4.1.46, are karst-fed chalk springs, with a number of the springs being used for potable water supply as documented in the abstractions section below.

4.2.22 It is anticipated that additional springs may be present within the area around Bedhampton and Havant which have not been identified by available data or site surveys. Springs and seepages are also likely to be present below and in the banks of local surface watercourses.

4.2.23 Potential and ground-truthed springs within the area have been plotted in ES Figure 19.2 Groundwater features, Volume III (Document reference 6.3, DCO Volume 6), based on Ordnance Survey (OS) mapping, data provided by Portsmouth Water and site surveys. No springs have been identified and mapped within the WRP site study area.

4.2.24 Non-designated GWDTE have been identified from priority habitat, NVC and UKHab data as summarised in ES Appendix 8.2 Habitats, Volume II (Document reference 6.2, DCO Volume 6) and ES Figure 8.8 UK Habitat classification for potential groundwater dependent terrestrial ecosystems within the field survey area that have potential to be impacted by the Proposed Development, Volume III (Document reference 6.3, DCO Volume 6).

4.2.25 No karst features have been mapped from data provided by third parties, with the majority of mapped potential karst features to the north of the Proposed Development (within the chalk bedrock of the South Downs).

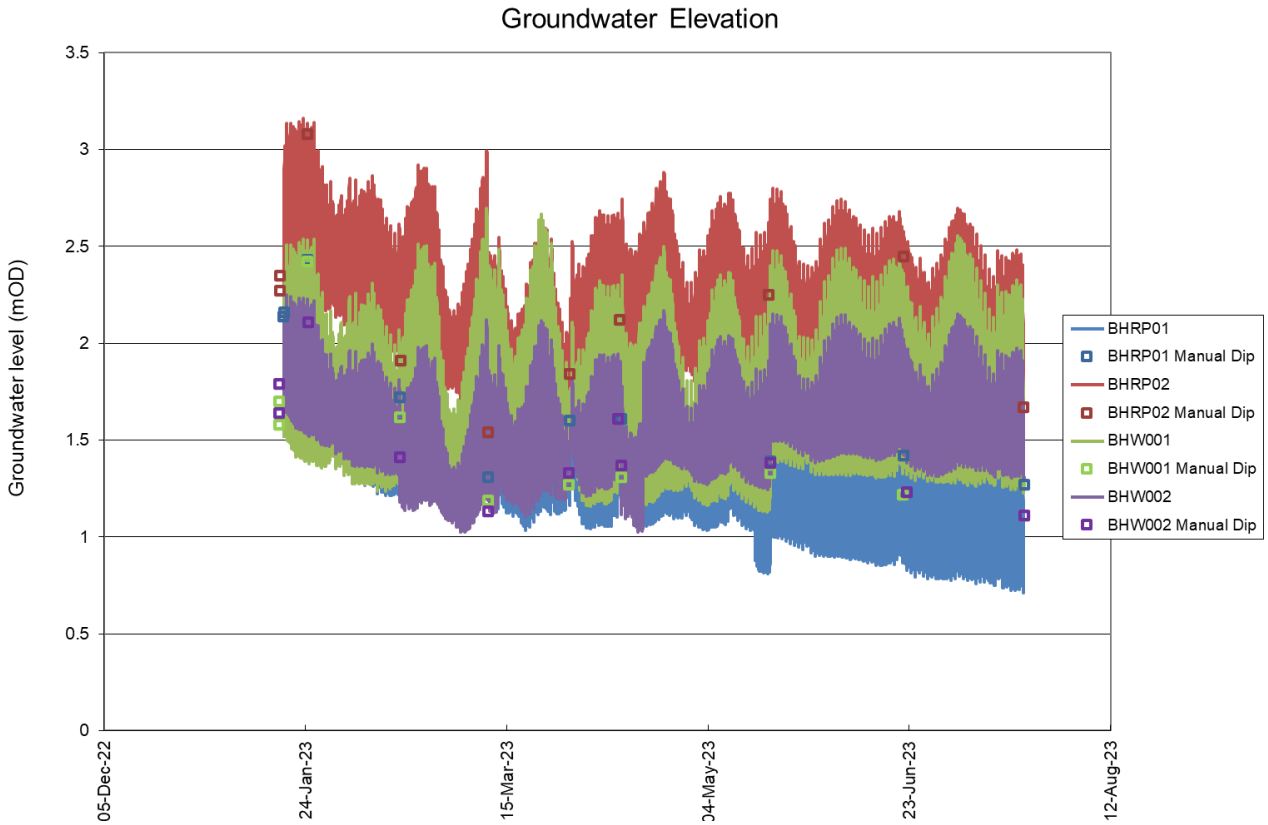
Groundwater levels

4.2.26 The closest EA groundwater monitoring installation to the WRP site is the Portsdown monitoring borehole located on Portsdown Hill at an elevation of

98.56m AOD, approximately 3.5km to the north-west. The Portsdown monitoring well is screened within the chalk aquifer and has been recording since May 1994. The monitoring data shows a clear seasonal variation in groundwater levels, with summer levels generally in the order of 10m AOD and winter levels showing significant variability between years depending on rainfall (ranging from approximately 14m AOD in 1997 to approximately 49m AOD in 2000). In February 2024 (a relatively wet winter), the groundwater level reached approximately 35m AOD. In March 2025 (a drier winter), the groundwater level reached approximately 22.5m AOD.

4.2.27 Site specific groundwater monitoring has been undertaken at the WRP site with data loggers recording from the Phase 0 Ground Investigation boreholes at 15-minute intervals within the chalk. Monitoring data is available between January 2023 and July 2023.

Graphic 4-2 Phase 0 groundwater monitoring at the Water Recycling Plant site



4.2.28 The groundwater monitoring data at the WRP site location shows groundwater levels generally greater than 5.0m below existing ground level (bgl) between 0.75m AOD and 3.5m AOD. The groundwater levels show a clear tidal response, with up to 2.0m tidal variation observed in some borehole between low and high tide.

4.2.29 Based on the heterogenous nature of the superficial deposits, perched groundwater may be encountered within the Made Ground and Landfill deposits, where present (assumed to be present when considering potential impacts). Refer to ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6) for more information regarding encountered groundwater conditions within the WRP site, including the perched water.

Groundwater quality

4.2.30 The Geo-environmental interpretative report – Water Recycling Plant site (see ES Appendix 11.2 Ground investigation report, Volume II (Document reference 6.2, DCO Volume 6)) discusses the groundwater sampling undertaken at the WRP site and provides an assessment of the groundwater quality against Environmental Quality Standards. ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6), discusses water quality impacts from land contamination, which are not duplicated in this HIA.

4.2.31 At this stage, the groundwater within the chalk is assumed to not be saline, due to the dominant flow paths and heads from the north (water is flowing towards the site from inland); see paragraph 4.1.35. Regionally, the vast majority of unconfined groundwaters within the Wessex Basin Chalk are of the Calcium Bicarbonate (Ca-HCO_3) type [9].

4.2.32 The proximity to Langstone Harbour, means that it would be assumed at this stage that shallow groundwater within the superficial deposits may be brackish or saline.

Groundwater flooding

4.2.33 Hampshire has a known history of groundwater flooding, with over 100 towns and villages across the county suffering significant flooding during the winter of 2000/2001. Less significant high groundwater levels have also been experienced during more recent periods, including recent winters (2022/2023 and 2023/2024) where groundwater flood warnings have been in place for below-ground structures and buildings in certain areas.

4.2.34 Due to the significant groundwater flooding risk in the county, Hampshire County Council (HCC) has developed a groundwater management plan [17] to identify the areas at risk and put in place measures to mitigate risk. The plan identified key settlements at risk including Hambledon, Rowlands Castle and Finchdean to the north (located at the southern boundary of the Chalk Downs, outside the study area). These areas at risk are monitored by the EA with flood risk alerts issued, as required.

4.2.35 ES Figure 19.12 Groundwater flooding susceptibility, Volume III (Document reference 6.3, DCO Volume 6), shows the susceptibility to groundwater flooding dataset, which identifies areas where further consideration of groundwater flood risk may need to be considered.

4.2.36 The figure indicates that the WRP site is generally in an area with limited potential for groundwater flooding due to its raised level relative to the surrounding area.

4.2.37 Flooding is discussed in further detail in ES Appendix 19.1 Flood Risk Assessment, Volume II (Document reference 6.2, DCO Volume 6).

Abstractions

4.2.38 Three licensed groundwater abstractions are located within the study area of the WRP site, to the north-east, as documented in Table 4-7. The abstractions are fed by multiple springs as opposed to a single source (see groundwater-surface water interactions, from paragraph 4.2.21). The Portsmouth Water Bedhampton and Havant PWS sites were visited during the site walkover in October 2023.

Table 4-7 Licensed groundwater abstractions – Water Recycling Plant site

Licence holder	Licence number (No.)	Use	Point name
Portsmouth Water	11/42/36.2/1	PWS	Bedhampton Pumping Station (PS) Spring No 1
Portsmouth Water	11/42/36.2/1	PWS	Bedhampton PS Spring No 2
Portsmouth Water	11/42/36.2/1	PWS	Havant PS

4.2.39 HBC was contacted regarding private water supplies (including unlicensed abstractions less than 20m^3/day) within the study area. In their response, HBC noted that there are no private water supplies within the borough to the best of their knowledge.

4.2.40 Abstractions within the study area are illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Discharges

4.2.41 Discharge consents located within the study area are summarised in Annex B and illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Pipelines between Budds Farm Wastewater Treatment Works and the Water Recycling Plant site

4.2.42 A number of Pipelines between Budds Farm WTW and the WRP site would transfer treated wastewater from Budds Farm WTW to the WRP site, and transfer reject water from the WRP site to release via the existing Eastney LSO using the existing Eastney Transfer Tunnel.

4.2.43 One pipeline would divert treated wastewater flows from Budds Farm WTW and transfer at maximum operation approximately 82Ml/d of treated wastewater to the WRP site. Another pipeline would transfer reject water from the WRP site to the Eastney LSO via the Budds Farm WTW site, and this pipeline would be sized to transfer approximately 82Ml/d to ensure sufficient capacity in the unlikely event of an emergency shutdown of the WRP site. A pumping station would be located at Budds Farm WTW to support the transfer of treated wastewater to the WRP site.

Topography

4.2.44 LIDAR data indicates that to the west of the Hermitage Stream, the topography ranges from 5 to 9m AOD. On the east of the Hermitage Stream, LIDAR data indicates the topography ranges from 4 to 7m AOD [18].

4.2.45 A marine geophysical survey (undertaken as part of the Phase 0 Ground Investigation) indicates the riverbed lies between -3 and +1.5m AOD.

Environmentally designated sites

4.2.46 A SPZ is located approximately 550m north of the north-western end of the Pipelines and is associated with the chalk springs at Bedhampton, which are used for potable water supply by Portsmouth Water. The area is an SPZ1 zone (inner zone), which indicates a zone where there is a 50-day travel time of pollutant to

source. This SPZ1 zone is approximately 300m wide north to south, north of which is SPZ 1c – which refers to an area with a protective cover of low permeability sat above a unit of high permeability, which if mined or tunnelled into would be representative of SPZ1. In this case, London Clay provides much of the cover above chalk members.

4.2.47 Langstone Harbour is immediately adjacent to the southern half of the Order Limits, and is an environmentally sensitive site with a number of statutory environmental designations including:

1. SSSI – 'Langstone Harbour' (also noted as a GWDTE)
2. SPA – 'Chichester and Langstone Harbours'
3. Ramsar site – 'Chichester and Langstone Harbours'
4. SAC – 'Solent Maritime'

4.2.48 The Order Limits where the Pipelines would cross the Hermitage Stream also overlap the Langstone Harbour designated site.

4.2.49 Environmental designations along the Pipelines are illustrated in ES Figure 8.1 Statutory designated sites within the Order Limits plus a 2km buffer, Volume III (Document reference 6.3, DCO Volume 6), with SPZs shown on ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Surface water bodies

4.2.50 The Pipelines between Budds Farm WTW and the WRP study area includes three surface water catchment areas, as summarised in Table 4-8. The Pipelines pass beneath the Langstone Harbour transitional water body and when on land are adjacent to the water body, whilst the Hermitage Stream[6] and Lavant (Hants) catchments are at distance (0.7km and 0.8km at closest point to the Pipelines, respectively).

Table 4-8 Surface water catchments in study area - Pipelines between Budds Farm Wastewater Treatment Works and the Water Recycling Plant site

	Langstone Harbour transitional water body	Hermitage Stream	Lavant (Hants) Catchment
Water Body ID	GB580705130000	GB107042016370	GB107042016420
River Basin District	South East	South East	South East
Hydromorphological Designation	Heavily Modified	Heavily Modified	Not designated artificial or heavily modified
Current Ecological	Moderate	Moderate	Poor
Current Chemical	Fail	Fail	Fail
Ecological Objective	Good	Good	Good
Chemical Objective	Good	Good	Good

4.2.51 Passing across the Pipelines study area is the EA main river 'Hermitage Stream', which flows south towards the Langstone Harbour. The Hermitage Stream is fed by a number of smaller watercourses in the area, including Riders Lane Stream and Brockhampton Stream, which are anticipated to be primarily groundwater fed by chalk springs. In the east of the study area, the EA Main River 'Lavant (Hants)'

also flows south towards the Langstone Harbour. No surface watercourses are mapped in the west of the study area.

4.2.52 Surface water catchments and main rivers are illustrated in ES Figure 19.1 Surface water features, Volume III (Document reference 6.3, DCO Volume 6).

Superficial deposits

4.2.53 Geological mapping indicated that the Pipelines between Budds Farm WTW and the WRP site (from the ground in the south-east to the north-west) are underlain by Raised Marine Deposits, Beach and Tidal Flat Deposits and Alluvium. Table 4-9 details the mapped superficial geology in the study area.

Table 4-9 Superficial deposits in study area of Pipelines between Budds Farm Wastewater Treatment Works and the Water Recycling Plant

Geology	Description	Location and prevalence	Mapped within the Order Limits
Head	Clay, Silt, Sand and Gravel	Thin band in the north of the study area, smaller strips in the east of the study area adjacent to Alluvium	No
River Terrace Deposits (RTD) (Undifferentiated)	Sand, Silt and Clay	Half of the north of the study area underlain by RTD when not underlain by Alluvium or Head	No
Alluvium	Clay, Silt, Sand and Gravel	Adjacent to the surface watercourses in the north and east of the study area	Yes – South-eastern end of Pipelines
Raised Marine Deposits	Sand and Gravel	Narrow strip in the west of the study area and a smaller area in the south-east of the study area	Yes –North-western end of Pipelines
Beach and Tidal Flat Deposits (Undifferentiated)	Clay, Silt, Sand and Gravel	Majority of southern half of study area	Yes – Where the Pipelines cross the Hermitage Stream
No superficial cover	-	Small area on northern edge of study area	No

4.2.54 The Phase 0 Ground Investigation included a number of boreholes and window samples[7] along the Pipelines including BHW003 to BHW005 and WSW001 to WSW004.

4.2.55 Borehole BHW003, west of the Hermitage Stream, showed Made Ground and Landfill to -1.64m AOD, which was underlain by a thin layer or Raised Marine Deposits. This in turn was found to overlie chalk at -2.37m AOD.

4.2.56 East of the Hermitage Stream, site investigation boreholes/window samples BHW004, BHW005 and WSW001 to 004, all comprised a layer of Made Ground/Landfill overlying Alluvium. This in turn overlies chalk with the exception of WSW003 which overlies River Terrace Deposits.

[7] Window Sampling is also known as Dynamic Sampling, Mini Boreholes or Windowless Sampling. It is a site investigation technique used for geotechnical and environmental assessment on soft ground and cohesive strata to extract soil, clay, or sand samples for geotechnical or chemical analysis.

Bedrock geology

4.2.57 The Pipelines between Budds Farm WTW and the WRP site to are mapped as being underlain by Undifferentiated Chalk (Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation). The northern edge of the Pipelines study area is underlain with narrow bands of four Chalk formations: Newhaven Chalk Formation, Tarrant Chalk Member, Spetisbury Chalk Member and Portsdown Chalk Formation. This is in addition to a narrow band of Lambeth Group – Clay, Silt and Sand, and a small area of London Clay Formation – Clay, Silt and Sand. Table 4-10 details the bedrock geology in the Pipelines study area.

Table 4-10 Bedrock geology in study area - Pipelines between Budds Farm Wastewater Treatment Works and the Water Recycling Plant site

Geology	Description	Location and prevalence	Mapped within the Order Limits
Undifferentiated Chalk (Lewes Nodular, Seaford Chalk, Newhaven Chalk, Culver Chalk and Portsdown Chalk Formations)	Chalk	Underlying approximately three quarters of the study area included directly beneath the Pipelines	Yes
Newhaven Chalk Formation	Chalk	Mapped in north-west of study area	No
Tarrant Chalk Member	Chalk	Mapped in north-west of study area	No
Spetisbury Chalk Member	Chalk	Mapped in north-west of study area	No
Portsdown Chalk Formation	Chalk	Mapped in north-west of study area	No
Lambeth Group	Clay, Silt and Sand	Mapped in north of study area overlying the chalk	No
London Clay	Clay, Silt and Sand	Mapped in north of study area overlying the Lambeth Group	No

4.2.58 The Phase 0 Ground Investigation undertaken along the Pipelines route identified the Newhaven Chalk Formation below the superficial deposits to the base of the boreholes.

Groundwater-surface water interactions (springs, sinks, karst and groundwater dependent terrestrial ecosystems)

4.2.59 The Bedhampton and Havant springs, as detailed in paragraph 4.1.45, are karst-fed Chalk springs, with a number of the springs being used for potable water supply as documented in the abstractions section below.

4.2.60 It is anticipated that additional springs may be present within the area around Bedhampton and Havant which have not been identified by available data or site surveys. Springs and seepages are likely to be present below and in the banks of local surface watercourses.

4.2.61 Potential and ground-truthed springs within the area have been plotted in ES Figure 19.2 Groundwater features, Volume III (Document reference 6.3, DCO Volume 6), based on OS mapping, data provided by Portsmouth Water and site surveys. No springs have been identified and mapped along the Pipelines route.

4.2.62 Non-designated GWDTE have been identified from priority habitat, NVC and UKHab data as summarised in ES Appendix 8.2 Habitats, Volume II (Document reference 6.2, DCO Volume 6) and ES Figure 8.8 UK Habitat classification for potential groundwater dependent terrestrial ecosystems within the field survey area that have potential to be impacted by the Proposed Development, Volume III (Document reference 6.3, DCO Volume 6).

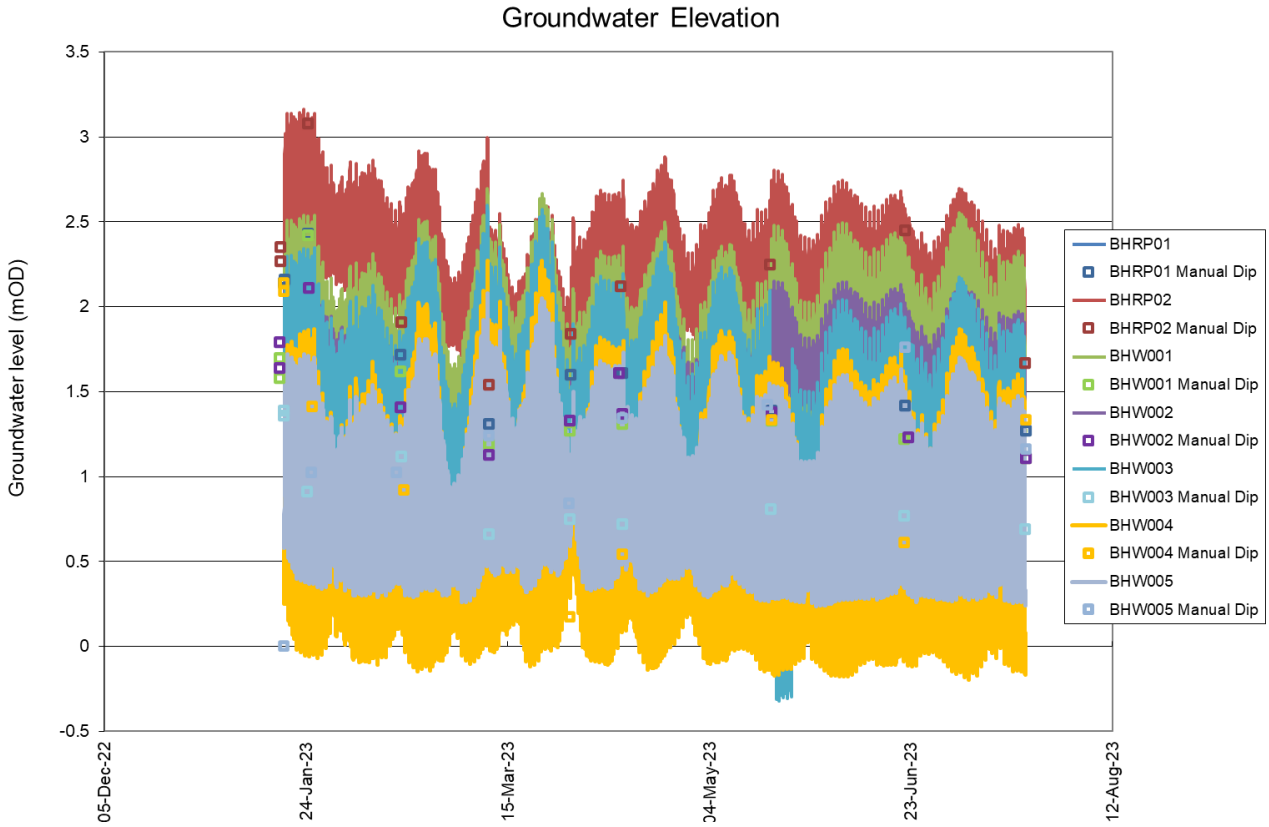
4.2.63 No karst features have been mapped from data provided by third parties, with the majority of mapped potential Karst features to the north of the study area (within the Chalk bedrock of the South Downs). However, the chalk is known to be karstic.

Groundwater levels

4.2.64 The closest EA groundwater monitoring installation to the Pipelines between Budds Farm WTW and the WRP site is the Portsdown monitoring borehole located on Portsdown Hill at an elevation of 98.56m AOD, approximately 3.5km to the north-west. The Portsdown monitoring well is screened within the chalk aquifer and has been recording since May 1994. The monitoring data shows a clear seasonal variation in groundwater levels, with summer levels generally in the order of 10m AOD and winter levels showing significant variability between years depending on rainfall (ranging from approximately 14m AOD in 1997 to approximately 49m AOD in 2000). In February 2024 (a relatively wet winter), the groundwater level reached approximately 35m AOD. In March 2025 (a drier winter), the groundwater level reached approximately 22.5m AOD.

4.2.65 Site specific groundwater monitoring has been undertaken at the Pipelines with data loggers recording from the Phase 0 Ground Investigation boreholes at 15-minute intervals within the chalk. Monitoring data is available between January 2023 and July 2023.

Graphic 4-3 Phase 0 groundwater level monitoring - Pipelines between Budds Farm Wastewater Treatment Works and the Water Recycling Plant site



4.2.66 The groundwater monitoring data at the Pipelines shows groundwater levels generally between -0.5m AOD and 2.5m AOD, with water levels closer to sea levels towards the south-east. The groundwater levels show a clear tidal response, with more than 2.0m tidal variation observed in some borehole between low and high tide. No monitoring is available beneath the Hermitage Stream, although it is expected that groundwater levels would closely resemble the tidal levels.

4.2.67 Perched groundwater may be encountered within the overlying Made Ground and superficial deposits, where present (assumed to be present when considering potential impacts).

Groundwater quality

4.2.68 The Geo-environmental interpretative report – Water Recycling Plant site (see ES Appendix 11.2 Ground investigation report, Volume II (Document reference 6.2, DCO Volume 6)) discusses the groundwater sampling undertaken at the WRP site and provides an assessment of the groundwater quality against Environmental Quality Standards. ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6), discusses water quality impacts from land contamination, which are not duplicated in this HIA.

4.2.69 The groundwater within the chalk is not anticipated to be saline, due to the dominant flow paths and heads from the north. Regionally the vast majority of unconfined groundwaters within the Wessex Basin Chalk are of the Ca-HCO_3 type [9].

4.2.70 The proximity to the sea, means that shallow groundwater within the superficial deposits may be brackish or saline.

Groundwater flooding

4.2.71 Hampshire has a known history of groundwater flooding as discussed in paragraphs 4.2.33 and 4.2.34.

4.2.72 ES Figure 19.12 Groundwater flooding susceptibility, Volume III (Document reference 6.3, DCO Volume 6) shows the susceptibility to groundwater flooding dataset, which identifies areas where further consideration of groundwater flood risk may need to be considered.

4.2.73 The figure indicates that the Pipelines are generally in an area with either limited potential for groundwater flooding or potential for groundwater flooding of property situated below-ground level.

4.2.74 Flooding is discussed in further detail in ES Appendix 19.1 Flood Risk Assessment, Volume II (Document reference 6.2, DCO Volume 6).

Abstractions

4.2.75 Three licensed groundwater abstraction are located within the study area of the Pipelines, to the north-east, as documented in Table 4-11.

Table 4-11 Licensed groundwater abstractions - Pipelines between Budds Farm Wastewater Treatment Works and the Water Recycling Plant site

Licence holder	Licence No.	Use	Point name
Portsmouth Water	11/42/36.2/1	PWS	Bedhampton PS Spring No 1
Portsmouth Water	11/42/36.2/1	PWS	Bedhampton PS Spring No 2
Portsmouth Water	11/42/36.2/1	PWS	Havant PS

4.2.76 HBC were contacted regarding private water supplies (including unlicensed abstractions less than 20m^3/day) within the area. In their response, HBC noted that there are no private water supplies within the borough to the best of their knowledge.

4.2.77 Abstractions within the study area are illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Discharges

4.2.78 Discharge consents located within the study area are summarised in Annex B and illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Pipelines between the Water Recycling Plant site and Havant Thicket Reservoir

4.2.79 The Pipelines between the WRP site and Havant Thicket Reservoir would transfer recycled water from the WRP site to Havant Thicket Reservoir and source water from Havant Thicket Reservoir back to the WRP site (before transfer to Otterbourne WSW).

4.2.80 The transfer would be split into two separate sections; one part between the WRP site to Bedhampton springs and a one part between Bedhampton Springs and Havant Thicket Reservoir which utilises Portsmouth Water's pipelines (which are subject to a separate planning consent).

4.2.81 This section outlines the baseline for the WRP site to Bedhampton Springs. The Pipelines between the WRP site and Bedhampton Springs would include an above-ground section within the Bedhampton Springs site to avoid below-ground construction within the SPZ1 associated with the Bedhampton Springs PWS.

Topography

4.2.82 The topography from the south-western end of the Pipelines (at the WRP site) falls from around 14m AOD to around 4m AOD. It then remains relatively level (between 4m AOD and 6.5m AOD), except where it crosses a tributary of the Hermitage Stream.

Environmentally designated sites

4.2.83 The Pipelines are situated within a SPZ1 in the north. This SPZ is associated with the chalk springs at Bedhampton, which are used for potable water supply by Portsmouth Water and where the Pipelines would connect into the pipelines being delivered by Portsmouth Water. The Pipelines are expected to be overground in the area designated as an SPZ1.

4.2.84 Langstone Harbour approximately 400m south of the southern end of the alignment and is an environmentally sensitive site and has a number of statutory environmental designations including:

1. SSSI – 'Langstone Harbour' (also noted as a GWDTE)
2. SPA – 'Chichester and Langstone Harbour'
3. Ramsar site – 'Chichester and Langstone Harbours'
4. SAC – 'Solent Maritime'

4.2.85 Environmental designations along the Pipelines are illustrated in ES Figure 8.1 Statutory designated sites within the Order Limits plus a 2km buffer, Volume III (Document reference 6.3, DCO Volume 6), with SPZs shown on ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Surface water bodies

4.2.86 The Pipelines study area includes three surface water catchment areas, as summarised in Table 4-12. The Pipelines enter the Hermitage Stream water body catchment towards the north of the Order Limits, whilst the Langstone Harbour Transitional Water Body and Lavant (Hants) catchments are at distance (less than 25m and 800m respectively at their closest).

Table 4-12 Surface water catchments in study area - Pipelines between the Water Recycling Plant site and Havant Thicket Reservoir

	Langstone Harbour transitional water Body	Hermitage Stream	Lavant (Hants) Catchment
Water Body ID	GB580705130000	GB107042016370	GB107042016420
River Basin District	South East	South East	South East

	Langstone Harbour transitional water Body	Hermitage Stream	Lavant (Hants) Catchment
Hydromorphological Designation	Heavily Modified	Heavily Modified	Not designated artificial or heavily modified
Current Ecological	Moderate	Moderate	Poor
Current Chemical	Fail	Fail	Fail
Ecological Objective	Good	Good	Good
Chemical Objective	Good	Good	Good

4.2.87 Passing across the Pipelines study area is the Hermitage Stream, an EA main river, which flows south towards the Langstone Harbour. The Hermitage Stream is fed by a number of smaller watercourses in the area, including Brockhampton Stream, which are anticipated to be primarily groundwater fed by chalk springs. The Pipelines alignment crosses a tributary of the Hermitage Stream, and Old Mill Dam adjacent to the Hermitage Stream. At the eastern part of the study area, the Lavant (Hants) main river also flows south towards the Langstone Harbour.

4.2.88 Surface water catchments and main rivers are illustrated in ES Figure 19.1 Surface water features, Volume III (Document reference 6.3, DCO Volume 6).

Superficial deposits

4.2.89 The Pipelines from south-west to north-east are mapped as being underlain by Raised Marine Deposits, Beach, River Terrace Deposits and Alluvium. In the north of the study area are Head deposits, together with areas of no mapped superficial cover. Table 4-13 details the superficial geology mapped in the study area.

Table 4-13 Superficial deposits in study area - Pipelines between the Water Recycling Plant site and Havant Thicket Reservoir

Geology	Description	Location and prevalence	Mapped within the Order Limits
Head	Clay, Silt, Sand and Gravel	In the north of the study area	No
River Terrace Deposits (Undifferentiated)	Sand, Silt and Clay	A band extending east to west, adjacent to the Alluvial deposits	Yes
Alluvium	Clay, Silt, Sand and Gravel	Associated with the surface water courses, including the Hermitage Stream	Yes
Raised Marine Deposits	Sand and Gravel	Narrow strip at the southern end of the Pipeline	Yes
Beach and Tidal Flat Deposits (Undifferentiated)	Clay, Silt, Sand and Gravel	Covers all of the most southerly end of the study area	No
No superficial cover	-	Areas in north-west of study area	No

4.2.90 Phase 0 Ground Investigation works have confirmed the superficial deposits at the southern end of the Pipelines (see paragraph 4.2.54), whilst Phase 1 Ground

Investigation boreholes BH101 and BH102 have confirmed the superficial deposits to the north of the Pipeline:

1. BH101: 0.55m of Topsoil underlain by soft to very stiff clay to 2.1m bgl. Chalk bedrock at 2.10m bgl (6.32m AOD).
2. BH102/102A: 0.3m of Topsoil and Made Ground underlain by firm to stiff clay. Lambeth Group bedrock encountered at 1.2m bgl (8.24m AOD).

4.2.91 Phase 3A Ground Investigation boreholes have confirmed the superficial deposits along the route of the Pipeline (between the WRP and Bedhampton Springs):

1. BHP01: 0.65m of Made Ground underlain by clay (River Terrace Deposits) to 4.00m bgl. Chalk bedrock at 4.00m bgl (0.8m AOD).
2. BHP02: 0.25m of Made Ground underlain by silt (River Terrace Deposits) to 1.7m bgl and clay (River Terrace Deposits) to 3.4m bgl. Chalk bedrock at 3.40m bgl (1.96m AOD).
3. BHP05: 0.60m of Made Ground underlain by clay to 4.3m bgl (-0.01m AOD).
4. BHP06: 0.80m of Topsoil and Made Ground underlain by clay (Head) to 1.5m bgl and subsequently clayey gravels and sands to 6.2m bgl (-2.29m AOD).

Bedrock geology

4.2.92 The Order Limits are underlain by Undifferentiated Chalk (Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation). In the north of the study area, there is a narrow band of Lambeth Group (which overlies the Chalk), before the London Clay Formation (Clay Silt and Sand) together with sand members of the London Clay. Table 4-14 details the bedrock geology in the study area.

Table 4-14 Bedrock geology in study area - Pipelines between the Water Recycling Plant site and Havant Thicket Reservoir

Geology	Description	Location and prevalence	Mapped within Order Limits
Undifferentiated Chalk (Lewes Nodular, Seaford Chalk, Newhaven Chalk, Culver Chalk and Portsdown Chalk Formations)	Chalk	Underlying Pipeline	Yes
Lambeth Group	Clay, Silt and Sand	Narrow band directly north of Lewes Nodular, Seaford Chalk, Newhaven Chalk, Culver Chalk and Portsdown Chalk Formations Chalk	No
London Clay Formation	Clay, Silt and Sand	North of the study area (overlying the Lambeth Group)	No
London Clay Formation	Sand	Small area in the north of the study area	No
Bognor Sand Member	Sand	Narrow band in the north of the study area	No

Geology	Description	Location and prevalence	Mapped within Order Limits
Newhaven Chalk Formation	Chalk	Narrow band on western edge of western end of study area	No
Tarrant Chalk Member	Chalk	Narrow band on western edge of western end of study area	No
Spetisbury Chalk Member	Chalk	Narrow band on western edge of western end of study area	No
Portsdown Chalk Member	Chalk	Narrow band on western edge of western end of study area	No

4.2.93 Phase 0 Ground Investigation works have confirmed the bedrock at the southern end of the Pipelines (see paragraph 4.2.58), whilst Phase 1 Ground Investigation boreholes BH101 and BH102 have confirmed the bedrock to the north of the Pipeline:

1. BH101: White Chalk bedrock encountered at 2.10m bgl (6.32m AOD). Chalk bedrock extends to base of borehole at 30.3m bgl (-21.88m AOD).
2. BH102/102A: Lambeth Group bedrock encountered at 1.2m bgl (8.24m AOD). The Upnor Formation of the Lambeth Group was possibly encountered between 20.6 and 21.3m bgl (-11.2 to -11.9m AOD), which was subsequently underlain by the White Chalk (Culver Formation). The White Chalk (Culver and Newhaven Formations) extended to the base of the borehole at 50.3m bgl (-40.9m AOD).

4.2.94 Phase 3A Ground Investigation boreholes have confirmed the bedrock along the route of the Pipeline (between the WRP and Bedhampton Springs):

1. BHP01: Chalk (possible Newhaven Chalk Formation) encountered at 4.0m bgl (0.8m AOD). Chalk extends to base of borehole at 30.8m bgl (-26.0m AOD).
2. BHP02: Chalk (possible Newhaven Chalk Formation) encountered at 3.4m bgl (1.96m AOD). Chalk extends to base of borehole at 26.1m bgl (-20.74m AOD).
3. BHP05: Chalk encountered at 4.3m bgl (-0.01m AOD). Chalk extends to base of borehole at 26.2m bgl (-21.91m AOD).
4. BHP06: Chalk encountered at 6.2m bgl (-2.29m AOD). Chalk extends to base of borehole at 35.2m bgl (-31.29m AOD).

Groundwater-surface water interactions (springs, sinks, karst and groundwater dependent terrestrial ecosystems)

4.2.95 The Bedhampton and Havant springs, as detailed in paragraph 4.1.45, are karst-fed chalk springs, with a number of the springs being used for potable water supply as documented in the abstractions section below.

4.2.96 It is anticipated that additional springs are present within the area around Bedhampton and Havant which have not been identified by available data or site surveys. Springs and seepages are likely to be present below and in the banks of local surface watercourses.

4.2.97 Potential and ground-truthed springs within the area have been plotted in ES Figure 19.2 Groundwater features, Volume III (Document reference 6.3, DCO

Volume 6), based on OS mapping, data provided by Portsmouth Water and site surveys. No springs have been identified and mapped within the WRP site area.

4.2.98 Non-designated GWDTE have been identified from priority habitat, NVC and UKHab data as summarised in ES Appendix 8.2 Habitats, Volume II (Document reference 6.2, DCO Volume 6) and ES Figure 8.8 UK Habitat classification for potential groundwater dependent terrestrial ecosystems within the field survey area that have potential to be impacted by the Proposed Development, Volume III (Document reference 6.3, DCO Volume 6).

4.2.99 No karst features have been mapped from data provided by third parties, with the majority of mapped potential karst features to the north of the Proposed Development (within the Chalk bedrock of the South Downs). However, the chalk is known to be karstic.

4.2.100 Geophysical surveys were undertaken as part of Ground Investigations in the Havant Playing Field area north-west of the Pipelines (within the SPZ). This included 13 electrical resistivity tomography (ERT) transects. Downhole geophysical surveys were also undertaken.

4.2.101 These surveys have shown a number of areas of low resistivity, and other areas of high resistivity. Low resistivity can indicate the potential for karstic systems.

4.2.102 These features tend to be bell-shaped, tapering towards the surface, proven to be at least 20m across (but likely to be wider at greater depths), and proven to depths of -15m AOD (but likely to extend much deeper). Some of these features are located closed to mapped geological fold axes.

4.2.103 The low resistivity features show variable potential to be connected with the surface or with shallow, low permeability superficial deposits. One large feature extends to the surface proximal to the Hermitage Stream, and several others extend to at/near surface along the Bedhampton Spring line.

4.2.104 Given that the full extent, geometry and interconnectivity of these features is not fully known from the current geophysical surveying, and subterranean works within the Chalk could encounter these low resistivity features.

4.2.105 Downhole geophysical surveys undertaken in BH101 and BH102A recorded several discontinuities in each. BH101 showed repeated discontinuities between approximately 11 and 16mbgl, and a single discontinuity at 27mbgl. BH102A showed discontinuities between approximately 28 and 46mbgl.

Groundwater levels

4.2.106 The closest EA groundwater monitoring location to the Pipelines is the Portsdown groundwater monitoring location (discussed in paragraph 4.2.64), which is 3-4km to the west.

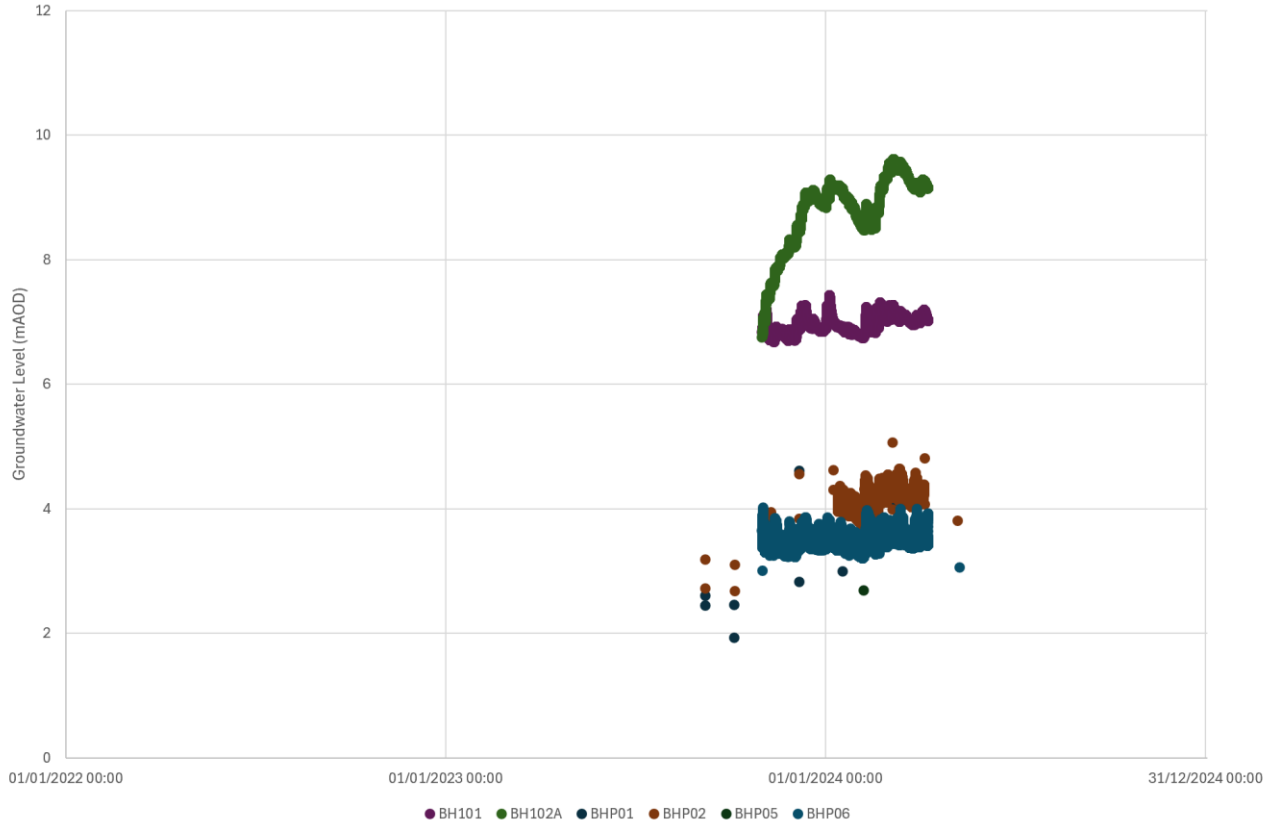
4.2.107 Site specific groundwater monitoring has been undertaken in a number of the Ground Investigation boreholes as summarised below:

1. BH101: Standpipe with response zone 17.5 to 30.0m bgl (screened in the chalk bedrock).
2. BH102A: Standpipe with response zone 24.0 to 29.1m bgl (screened in the chalk bedrock).

3. BHP01: Two standpipes with response zones 1.3 to 3.4 and 15.8 to 21.4m bgl respectively (screened in the River Terrace Deposits and chalk bedrock).
4. BHP02: Two standpipes with response zones 1.2 to 3m bgl and 6.0 to 11.6m bgl respectively (screened in the River Terrace Deposits and chalk bedrock).
5. BHP05: Standpipe with response zone 5.0 to 10.6m bgl (screened in the chalk bedrock).
6. BHP06: Standpipe with response zone 7.0 to 12.6m bgl (screened in the chalk bedrock).

4.2.108 Available data is presented in Graphic 4-4.

Graphic 4-4 Groundwater monitoring in area within the Pipelines between the Water Recycling Plant site and Havant Thicket Reservoir



4.2.109 Perched groundwater may be encountered within overlying superficial deposits where present (assumed to be present when considering potential impacts).

Groundwater quality

4.2.110 The geo-environmental interpretative report for Phase 1 and 3A Ground Investigation (Shafts and Tunnels) (see ES Appendix 11.2 Ground investigation reports, Volume II (Document reference 6.2, DCO Volume 6)) discusses the groundwater sampling undertaken at the Phase 1 and 3A boreholes and provides an assessment of the groundwater quality against Environmental Quality Standards. ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6), discusses water quality impacts from land contamination, which are not duplicated in this HIA.

4.2.111 The groundwater within the chalk is not anticipated to be saline, due to the dominant flow paths and heads from the north. Regionally the vast majority of unconfined groundwaters within the Wessex Basin Chalk are of the Ca-HCO_3 type [9]. The groundwater quality of the superficial deposits are likely to be more variable, with shallower groundwaters in the superficial deposits more susceptible to anthropogenic activities.

4.2.112 The proximity to the sea in the south, means that shallow groundwater within the superficial deposits may be brackish or saline towards the coast.

Groundwater flooding

4.2.113 Hampshire has a known history of groundwater flooding as discussed in paragraphs 4.2.33 and 4.2.34.

4.2.114 ES Figure 19.12 Groundwater flooding susceptibility, Volume III (Document reference 6.3, DCO Volume 6) shows the susceptibility to groundwater flooding dataset, which identifies areas where further consideration of groundwater flood risk may need to be considered.

4.2.115 The figure indicates that the groundwater flood risk increases from south to north with areas of limited potential for groundwater flooding (at the location of the WRP) to areas with potential for groundwater flooding to occur at surface (in the area of Bedhampton Springs).

4.2.116 Flooding is discussed in further detail in ES Appendix 19.1 Flood Risk Assessment, Volume II (Document reference 6.2, DCO Volume 6).

Abstractions

4.2.117 Three licensed groundwater abstractions are located within the study area of the Pipeline, as documented in Table 4-15.

4.2.118 The Pipeline terminates on the Portsmouth Water Bedhampton Springs PWS site, where it would connect to pipelines being delivered by Portsmouth Water.

Table 4-15 Licensed groundwater abstractions - Pipelines between the Water Recycling Plant site and Havant Thicket Reservoir

Licence holder	Licence no.	Use	Point name
Portsmouth Water	11/42/36.2/1	PWS	Bedhampton PS Spring No 1
Portsmouth Water	11/42/36.2/1	PWS	Bedhampton PS Spring No 2
Portsmouth Water	11/42/36.2/1	PWS	Havant PS

4.2.119 HBC and EHDC were both contacted regarding private water supplies (including unlicensed abstractions less than 20m^3/day). Both local planning authorities responded that no sites were identified within the study area.

4.2.120 Abstractions within the study area are illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Discharges

4.2.121 Discharge consents located within the study area are summarised in Annex B and illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Pipeline between Water Recycling Plant and Otterbourne Water Supply Works

4.2.122 The Pipeline (which is anticipated to be approximately 35km long) would transfer approximately 90Ml/d of source water at the peak of a drought from Havant Thicket Reservoir to Otterbourne WSW. Outside of drought conditions, the Pipeline would transfer at least 20Ml/d of water from Havant Thicket Reservoir to Otterbourne WSW.

4.2.123 The Pipeline between the WRP site and Otterbourne WSW (hereafter referred to as the 'Pipeline') is divided into nine sections, labelled D to M, as shown on ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6):

1. Section D: The WRP to Portsdown Hill
2. Section E: Portsdown Hill to Boarhunt
3. Section F: Boarhunt to Crockerhill
4. Section G: Crockerhill to Wickham
5. Section H: Wickham to Shedfield
6. Section I: Not used
7. Section J: Shedfield to the River Hamble
8. Section K: The River Hamble to Lower Upham
9. Section L: Lower Upham to Brambridge
10. Section M: Brambridge to Otterbourne WSW

Section D: The Water Recycling Plant site to Portsdown Hill

4.2.124 Section D of the Pipeline comprises a pipeline corridor that broadly follows Portsdown Hill Road (B2177) and would be tunnelled.

Topography

4.2.125 The main feature of the topography is the increase in ground level elevation from around 20m AOD to 50m AOD over a relatively short distance (~1km) before a more gradual increase in elevation to 90m AOD, before finally going downhill to an elevation of ~65m AOD at the northern end. The higher topographical elevation corresponds to the chalk Portsdown Hill.

Environmentally designated sites

4.2.126 Section D of the Pipeline avoids directly crossing the SPZ associated with the chalk springs at Bedhampton, which are used for potable water supply by Portsmouth Water. In the north-east of the study area (around 100m at closest to Pipeline

alignment) is an SPZ1 zone (inner zone) which indicates a zone where there is a 50-day travel time of pollutant to source. North and west of the SPZ1 zone is a SPZ 1c – which refers to an area with a protective cover of low permeability sat above a unit of high permeability, which if mined or tunnelled into would be representative of SPZ1. In this case, London Clay provides much of the cover above chalk members.

4.2.127 Langstone Harbour is approximately 400m south of the south-eastern end of the Pipeline alignment and is an environmentally sensitive site and has a number of statutory environmental designations including:

1. SSSI – 'Langstone Harbour' (also noted as a GWDTE)
2. SPA – 'Chichester and Langstone Harbour'
3. Ramsar site – 'Chichester and Langstone Harbours'
4. SAC – 'Solent Maritime'

4.2.128 Portsdown SSSI is approximately 400m south-west of the Pipeline where it diverts northwards near the A3. The site is designated as a SSSI owing to the chalk grassland habitat.

4.2.129 Environmental designations along the Pipeline are illustrated in ES Figure 8.1 Statutory designated sites within the Order Limits, Volume III (Document reference 6.3, DCO Volume 6), with SPZs shown on ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Surface water bodies

4.2.130 The Pipeline study area includes three surface water catchment areas, as summarised in Table 4-16[8]. The Pipeline pass through the Potwell Tributary water body catchment in the western end of the study area, whilst the Langstone Harbour Transitional Water Body and Hermitage Stream catchments are at distance.

Table 4-16 Surface water catchments in study area – Section D: The Water Recycling Plant site to Portsdown Hill

	Potwell Tributary water body	Langstone Harbour transitional water body	Hermitage Stream
Water Body ID	GB107042016400	GB580705130000	GB107042016370
River Basin District	South East	South East	South East
Hydromorphological Designation	Heavily Modified	Heavily Modified	Heavily Modified
Current Ecological	Moderate	Moderate	Moderate
Current Chemical	Fail	Fail	Fail
Ecological Objective	Good	Good	Good
Chemical Objective	Good	Good	Good

4.2.131 No main rivers are crossed by the Pipeline in Section D. Passing through the east of the Pipeline study area is the Hermitage Stream, which flows south towards the

[8] It is noted that the Hydrogeological Impact Assessment baseline includes all surface water catchments within the 1km study area, and as such includes non-hydraulically connected water bodies not listed within the chapter or WER compliance assessment.

Langstone Harbour. The Hermitage Stream is fed by a number of smaller watercourses in the area, including Brockhampton Stream, which are assumed to be primarily groundwater fed by chalk springs. In the north-western part of the study area, the Potwell Tributary flows west towards Southwick Park Lake.

4.2.132 Surface water catchments and main rivers are illustrated in ES Figure 19.1 Surface water features, Volume III (Document reference 6.3, DCO Volume 6).

Superficial deposits

4.2.133 Section D of the Pipeline is mapped as being underlain by Raised Marine Deposits, River Terrace Deposits and Head in the south-east, whilst much of the mid-section and north-western Section D of the Pipeline have no superficial cover, other than small areas of Head.

4.2.134 In the study area for Section D of the Pipeline, most of the north of the study area has no superficial deposits, with discrete areas of Head deposits and a small amount of Alluvium. Most of the southern and south-eastern region of the study area has superficial cover, with bands of Head, River Terrace Deposits, Raised Marine Deposits and Beach and Tidal Flat Deposits. East of the Pipeline within the study area exists an area of Alluvium, Head and River Terrace Deposits. Table 4-17 details the superficial geology in the study area.

Table 4-17 Superficial deposits in study area – Section D: The Water Recycling Plant site to Portsdown Hill

Geology	Description	Location and prevalence	Mapped within the Order Limits
Head	Clay, Silt, Sand and Gravel	A wide band south of the east to west Section D of the Pipeline, and irregularly shaped areas in the north of the study area. Pipeline crosses in south-east and five small sections in the north	Yes
River Terrace Deposits (Undifferentiated)	Sand, Silt and Clay	A band south of the band of Head. Pipeline crosses in the south-eastern end	Yes
Alluvium	Clay, Silt, Sand and Gravel	Small section in north-west of study area and larger area in south-east	No
Raised Marine Deposits	Sand and Gravel	Small area in south-east of study area, Pipeline crosses at south-eastern end	Yes
Beach and Tidal Flat Deposits (Undifferentiated)	Clay, Silt, Sand and Gravel	Small area in south-east of study area	No
No superficial cover	-	Much of the northern half of the study area has no superficial cover, including most of the Pipeline	Yes

4.2.135 Phase 1 Ground Investigation boreholes BH202 and BH301 to BH303 have confirmed the superficial deposits at selected locations along the Pipeline route within Section D (from west to east):

1. BH202: 2.52m of Topsoil and Made Ground underlain by clay and sand (Head Deposits). Chalk bedrock encountered at 5.9m bgl (8.08m AOD).
2. BH301/301A: 0.16m of Topsoil underlain by sand and gravel (Head Deposits). Chalk bedrock encountered at 0.6m bgl (63.59m AOD).
3. BH302: 1.2m of Topsoil and Made Ground. Chalk bedrock encountered at 1.2m bgl (74.97m AOD).
4. BH303: 0.5m of Topsoil underlain by clay (Head Deposits). Chalk bedrock encountered at 2.9m bgl (66.27m AOD).

Bedrock geology

4.2.136 The Pipeline is mapped as being underlain from south-east to north-west by Undifferentiated Chalk (Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation), narrow bands of Newhaven Chalk Formation, Tarrant Chalk Member, Spetisbury Chalk Member, Portsdown Chalk Member and Lambeth Group. The Pipeline subsequently goes into a larger area of London Clay Formation (Clay Silt and Sand) broken up by the narrow bands of the Bognor Sand Member and the Wittering Formation (Sand, Silt and Clay).

4.2.137 Table 4-18 details the bedrock geology in the Pipeline study area.

Table 4-18 Bedrock geology in study area – Section D: The Water Recycling Plant site to Portsdown Hill

Geology	Description	Location and prevalence	Mapped within the Order Limits
Undifferentiated Chalk (Lewes Nodular, Seaford Chalk, Newhaven Chalk, Culver Chalk and Portsdown Chalk Formations)	Chalk	Majority of the south-eastern end of the study area	Yes
Lambeth Group	Clay, Silt and Sand	Narrow band directly north of the chalk formations, running east to west, directly south of the London Clay Formation	Yes
London Clay Formation	Clay, Silt and Sand	Half of the study area north of the Lambeth Group is underlain by London Clay Formation	Yes
Wittering Formation	Sand, Silt and Clay	A large amount of the north of the study area is underlain by Wittering Formation, including two sections, which the northern pipeline corridor passes over	Yes

Geology	Description	Location and prevalence	Mapped within the Order Limits
Bognor Sand Member	Sand	A narrow band east to west, parallel but north of the Lambeth Group and the southern area of London Clay Formation	Yes
Newhaven Chalk Formation	Chalk	A narrow band east to west, Pipeline crosses in eastern end. Directly south of the Tarrant Chalk Member	Yes
Tarrant Chalk Member	Chalk	A narrow band east to west, Pipeline crosses in eastern end. Directly south of the Spetisbury Chalk Member	Yes
Spetisbury Chalk Member	Chalk	A narrow band east to west, Pipeline crosses in eastern end. Directly south of the Portsdown Chalk Member	Yes
Portsdown Chalk Member	Chalk	A narrow band east to west. Directly south of the Lambeth Group	Yes
Whitecliff Sand Member	Sand	Small area in the north of the study area, north of the Pipeline, and to the south of the north-western area of Wittering Formation	No
Wittering Formation	Sand, Silt and Clay	Two main areas of Wittering Formation in the study area, one in the extreme north of the study area, and the second near the northern end of the Pipeline and north of study area (in five distinct sections). Two of these underlie the Pipeline at the extreme northern end	Yes
Wittering Formation	Sand	Small section in the extreme north of the study area, in between areas of Wittering Formation (Sand, Silt and Clay)	No

4.2.138 Phase 1 Ground Investigation boreholes BH202 and BH301 to BH303 have confirmed the bedrock at selected locations along the Pipeline route within Section D (from west to east):

1. BH202: Chalk bedrock encountered at 5.9m bgl (8.08m AOD), which extends to base of borehole at 60.5m bgl (-46.52m AOD).
2. BH301/301A: Chalk bedrock encountered at 0.6m bgl (63.59m AOD), which extends to base of borehole at 100.3m bgl (-35.96m AOD).
3. BH302: Chalk bedrock encountered at 1.2m bgl (74.97m AOD), which extends to base of borehole at 91.5m bgl (-15.33m AOD).
4. BH303: Chalk bedrock encountered at 2.9m bgl (66.27m AOD), which extends to base of borehole at 115.0m bgl (-45.83m AOD).

Groundwater-surface water interactions (springs, sinks, karst and groundwater dependent terrestrial ecosystems)

4.2.139 The Bedhampton and Havant springs, as detailed in paragraph 4.1.45, are karst-fed chalk springs, with a number of the springs being used for potable water supply as documented in the abstractions section below.

4.2.140 It is anticipated that additional springs are present within the area around Bedhampton and Havant. Springs and seepages are likely to be present below and in the banks of local surface watercourses.

4.2.141 Potential and ground-truthed springs within the area have been plotted in ES Figure 19.2 Groundwater features, Volume III (Document reference 6.3, DCO Volume 6), based on OS mapping, data provided by Portsmouth Water and site surveys. Springs may be present on the slopes of Portsdown Hill but are less likely along the ridge.

4.2.142 Non-designated GWDTE have been identified from priority habitat, NVC and UKHab data as summarised in ES Appendix 8.2 Habitats, Volume II (Document reference 6.2, DCO Volume 6) and ES Figure 8.8 UK Habitat classification for potential groundwater dependent terrestrial ecosystems within the field survey area that have potential to be impacted by the Proposed Development, Volume III (Document reference 6.3, DCO Volume 6).

4.2.143 No karst features have been mapped from data provided by third parties, with the majority of mapped potential karst features to the north of the Proposed Development (within the Chalk bedrock of the South Downs).

Groundwater levels

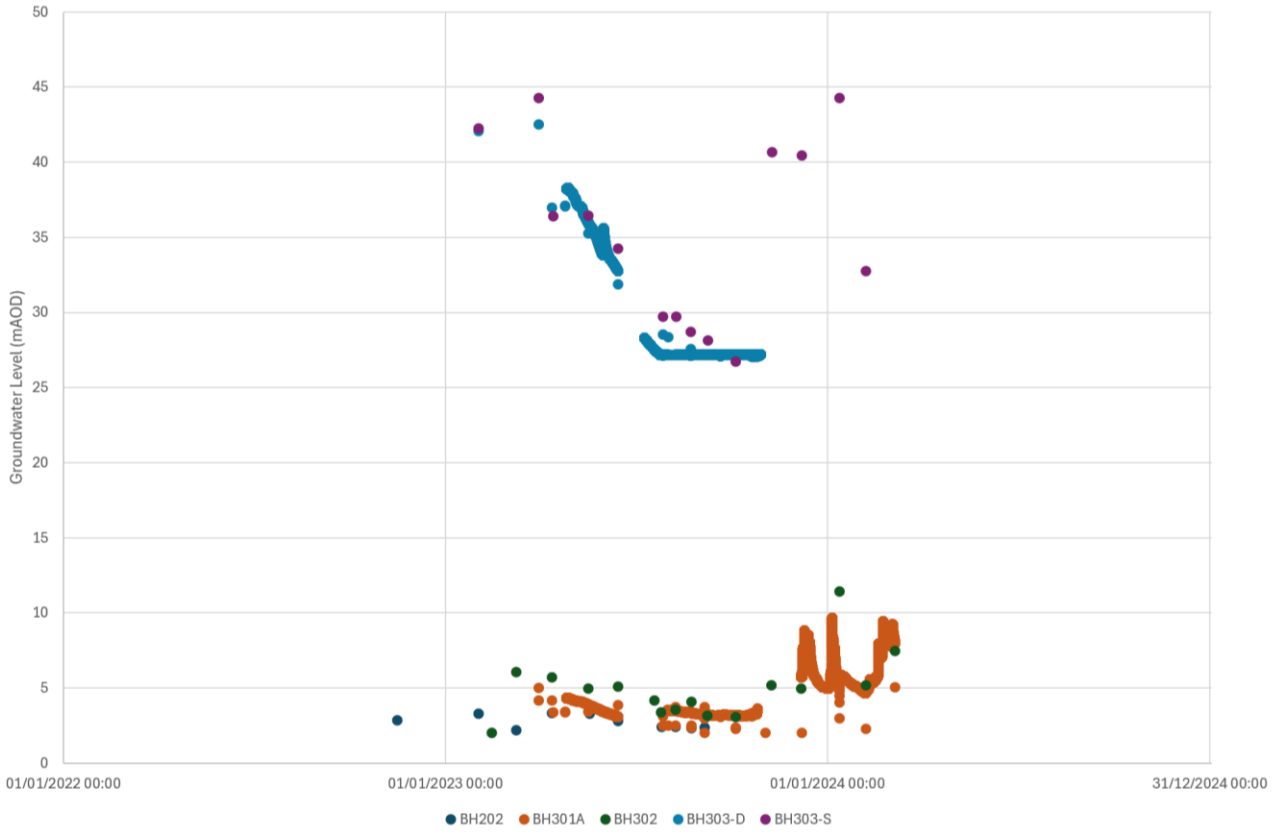
4.2.144 The EA groundwater monitoring borehole 'Portsdown' is located adjacent to the western end of Section D (less than 100m from the Order Limits). The Portsdown borehole and monitoring data is described in further detail in paragraph 4.2.64.

4.2.145 Site specific groundwater monitoring has been undertaken in a number of the Phase 1 Ground Investigation boreholes as summarised below:

1. BH202: Standpipe with response zone 17.5 to 25.4m bgl (screened in the chalk bedrock). Manually dipped monthly.
2. BH301A: Two standpipes with response zones 34.5 to 41.1m bgl (screened in the chalk bedrock) and 61.0 to 66.6m bgl (screened in the chalk bedrock). Data logger installed in deeper standpipe with shallower standpipe manually dipped monthly (although always dry during visits).
3. BH302: Standpipe with response zone 67.1 to 76.0m bgl (screened in the chalk bedrock). Manually dipped monthly.
4. BH303: Two standpipes with response zones 36.0 to 46.6m bgl (screened in the chalk bedrock) and 63.0 to 67.9m bgl (screened in the chalk bedrock). Data logger installed in deeper standpipe with shallower standpipe manually dipped monthly.

4.2.146 Available data from the Phase 1 boreholes in the section is illustrated in Graphic 4-5.

Graphic 4-5 Phase 1 Datalogger groundwater monitoring (up to March 2024) – Section D: The Water Recycling Plant site to Portsdown Hill



4.2.147 It is assumed that perched groundwater could be encountered within the overlying superficial deposits, where present (assumed to be present when considering potential impacts).

Groundwater quality

4.2.148 The geo-environmental interpretative report for Phase 1 and 3A Ground Investigation (Shafts and Tunnels) (see ES Appendix 11.2 Ground investigation reports, Volume II (Document reference 6.2, DCO Volume 6)) discusses the groundwater sampling undertaken at the Phase 1 and Phase 3A boreholes and provides an assessment of the groundwater quality against Environmental Quality Standards. ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6), discusses water quality impacts from land contamination, which are not duplicated in this HIA.

4.2.149 The groundwater within the chalk is not anticipated to be saline, due to the dominant flow paths and heads from the north. Regionally the vast majority of unconfined groundwaters within the Wessex Basin Chalk are of the Ca-HCO_3 type [9]. The groundwater quality of the superficial deposits and London Clay are likely to be more variable, with shallower groundwaters in the superficial deposits more susceptible to anthropogenic activities.

Groundwater flooding

4.2.150 Hampshire has a known history of groundwater flooding as discussed in paragraphs 4.2.33 and 4.2.34.

4.2.151 ES Figure 19.12 Groundwater flooding susceptibility, Volume III (Document reference 6.3, DCO Volume 6) shows the susceptibility to groundwater flooding dataset, which identifies areas where further consideration of groundwater flood risk may need to be considered.

4.2.152 The figure indicates that, due to its elevation, the section has limited potential for groundwater flooding to occur.

4.2.153 Flooding is discussed in further detail in ES Appendix 19.1 Flood Risk Assessment, Volume II (Document reference 6.2, DCO Volume 6).

Abstractions

4.2.154 Three licensed groundwater abstractions are located within the study area of Section D of the Pipeline to the south-east, as documented in Table 4-19.

Table 4-19 Licensed groundwater abstractions – Section D: The Water Recycling Plant site to Portsdown Hill

Licence holder	Licence No.	Use	Point name
Portsmouth Water	11/42/36.2/1	PWS	Bedhampton PS Spring No 1
Portsmouth Water	11/42/36.2/1	PWS	Bedhampton PS Spring No 2
Portsmouth Water	11/42/36.2/1	PWS	Havant PS

4.2.155 HBC and PCC were contacted regarding private water supplies (including unlicensed abstractions less than 20m^3/day) within the area. In HBC's response, they noted that there are no private water supplies within the borough to the best of their knowledge. In PCC's response, they noted as far as they are aware there are not any registered private abstractions in their boundary.

4.2.156 WCC has provided details on private water supplies (including unlicensed abstractions) within their area, but none are recorded within Section D.

4.2.157 Abstractions within the study area are illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Discharges

4.2.158 Discharge consents located within the study area are summarised in Annex B and illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Section E: Portsdown Hill to Boarhunt

Topography

4.2.159 Section E of the Pipeline sits on the northern flank of Portsdown Hill. The topography undulates along the Pipeline between approximately 50m AOD and 70m AOD.

4.2.160 The topography reduces perpendicular to the Pipeline at a steep gradient from south to north away from the ridge of the Portsdown chalk hill.

Environmentally designated sites

4.2.161 In the west of the study area, for Section E of the Pipeline, is the SPZ (Zones 1 to 3) of the Portsmouth Water Maindell Pumping Station. This SPZ is crossed in Section F and discussed further in paragraph 4.2.199.

4.2.162 The SPZ 1c in relation to the Bedhampton Springs is located in the north-east of the study area for Section E of the Pipeline.

4.2.163 A number of SSSIs are located outside the Order Limits but are within the study area, including:

Hook Heath Meadows SSSI – located north of the Order Limits and adjacent to Potwell Tributary. Designated as a GWDTE.

Portsdown SSSI – located south of the Order Limits.

4.2.164 Environmental designations along the Pipeline are illustrated in ES Figure 8.1 Statutory designated sites within the Order Limits plus a 2km buffer, Volume III (Document reference 6.3, DCO Volume 6), with SPZs shown on ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Surface water bodies

4.2.165 The study area includes a number of surface water catchment areas, as summarised in Table 4-20.

Table 4-20 Surface water catchments within study area – Section E: Portsdown Hill to Boarhunt

	Wallington below Southwick	Upper Wallington	Potwell Tributary
Water Body ID	GB107042016360	GB107042016350	GB107042016400
River Basin District	South East	South East	South East
Hydromorphological Designation	Not designated artificial or heavily modified	Not designated artificial or heavily modified	Heavily Modified
Current Ecological	Moderate	Moderate	Moderate
Current Chemical	Fail	Fail	Fail
Ecological Objective	Good	Good	Good
Chemical Objective	Good	Good	Good

4.2.166 Potwell Tributary flows westerly north of the Pipeline (outside the Order Limits) and joins with the Wallington near Southwick. The river continues to flow westerly before diverting south crossing the Pipeline in Section F. No WER surface water bodies are crossed in Section E of the Pipeline.

4.2.167 Surface water catchments and main rivers are illustrated in ES Figure 19.1 Surface water features, Volume III (Document reference 6.3, DCO Volume 6).

Superficial deposits

4.2.168 Table 4-21 details the superficial geology in the study area.

Table 4-21 Superficial deposits in study area – Section E: Portsdown Hill to Boarhunt

Geology	Description	Location and prevalence	Mapped Within the Order Limits
Head	Clay, Silt, Sand and Gravel	Head deposits mapped in the northern half of the study area associated with river valleys, with the Pipeline crossing at numerous locations. Head deposits also mapped in the south-east of the study area, at the foot of Portsdown Hill	Yes
River Terrace Deposits	Gravel, Sand and Silt	Mapped at distance from the Order Limits in the north-west of the study area associated with the Wallington River	No
River Terrace Deposits (Undifferentiated)	Sand, Silt and Clay	Mapped in small area in south-east of study area at distance from the Order Limits	No
Alluvium	Clay, Silt, Sand and Gravel	Mapped within the study area in areas associated with watercourses (Potwell Tributary and the Wallington River)	No
No superficial cover mapped	-	No superficial deposits mapped along the majority of the Pipeline, with bedrock anticipated to be at or close to ground level	Yes

4.2.169 Phase 1 borehole BH303 is located just to the east of Section E of the Pipeline, within Section D.

4.2.170 Phase 2 boreholes 2E3000RC, 2E3001RC and 2E3002RC are within the east of the Order Limits, whilst Phase 2 borehole 2F3500DS is just to the west of Section E of the Pipeline:

1. 2E3000RC: 0.2m of Topsoil. Chalk bedrock (Portsdown Chalk Formation) encountered 0.2m bgl (91.37m AOD).
2. 2E3001RC: 0.2m of Topsoil. Chalk bedrock (Portsdown Chalk Formation) encountered 0.2m bgl (84.91m AOD).
3. 2E3002RC: 0.2m of Topsoil. Chalk bedrock (Portsdown Chalk Formation) encountered 0.2m bgl (91.81m AOD).
4. 2F3500DS: 0.35m of Topsoil underlain by silts and clays (Made Ground and Alluvium). Chalk bedrock encountered 3.25m bgl (52.87m AOD).

4.2.171 Phase 3 Ground Investigation supported the previous Ground Investigation findings that superficial deposits are absent for the majority of Section E, apart from localised areas of Head deposits infilling minor chalk valleys.

Bedrock geology

4.2.172 Table 4-22 details the bedrock geology in the study area.

Table 4-22 Bedrock geology in study area – Section E: Portsdown Hill to Boarhunt

Geology	Description	Location and prevalence	Mapped Within the Order Limits
Undifferentiated Chalk (Lewes Nodular, Seaford Chalk, Newhaven Chalk, Culver Chalk and Portsdown Chalk Formations)	Chalk	Mapped in the south-east of the study area	No
Lambeth Group	Clay, Silt and Sand	Narrow band directly north of the chalk formations, approximately east to west Underlies the Pipeline where the route travels northwards around Fort Widley	Yes
London Clay Formation	Clay, Silt and Sand	Mapped to the north of the Lambeth Group. London Clay mapped over majority of the northern half of the study area	No
Bognor Sand Member	Sand	A narrow band, approximately east to west, within the London Clay Formation	No
Newhaven Chalk Formation	Chalk	Mapped as a band approximately east to west, to the south of the Pipeline, in the east of the study area	No
Tarrant Chalk Member	Chalk	Mapped as a narrow band approximately east to west, to the south of the Pipeline, in the east of the study area	No
Spetisbury Chalk Member	Chalk	A band approximately east to west in the south of the study area, which the Pipeline crosses in a number of areas	Yes
Portsdown Chalk Member	Chalk	A band approximately east to west and underlying the majority of the Order Limits	Yes
Whitecliff Sand Member	Sand	In the north of the study area. Part of the London Clay Formation	No
Wittering Formation	Sand, Silt and Clay	Area at distance from the Order Limits in the north and north-east of the study area	No
Wittering Formation	Sand	Some small areas in the north-east of the study area, in between areas of Wittering Formation (Sand, Silt and Clay)	No

4.2.173 Phase 1 borehole BH303 is located just to the east of the section, within Section D.

4.2.174 Phase 2 boreholes 2E3000RC, 2E3001RC and 2E3002RC are within the east of the Order Limits, whilst Phase 2 borehole 2F3500DS is just to the west of Section E of the Pipeline:

1. 2E3000RC: Chalk bedrock encountered at 0.2m bgl (91.37m AOD), which extends to base of borehole at 30.85m bgl (60.72m AOD).

2. 2E3001RC: Chalk bedrock encountered at 0.2m bgl (84.91m AOD), which extends to base of borehole at 8.30m bgl (76.81m AOD).
3. 2E3002RC: Chalk bedrock encountered at 0.2m bgl (91.81m AOD), which extends to base of borehole at 30.80m bgl (61.21m AOD).
4. 2F3500DS: Chalk bedrock encountered at 3.25m bgl (52.87m AOD), which extends to base of borehole at 4.30m bgl (51.82m AOD).

4.2.175 Phase 3 Ground Investigation supported the previous Ground Investigation findings and mapping that the majority of the section is underlain by White Chalk Subgroup. Lambeth Group bedrock is present in the east of Section E.

Groundwater-surface water interactions (springs, sinks, karst, groundwater dependent terrestrial ecosystems)

4.2.176 Springs and seepages are likely to be present below and in the banks of local surface watercourses.

4.2.177 Known potential and ground-truthed springs within the area have been plotted in ES Figure 19.2 Groundwater features, Volume III (Document reference 6.3, DCO Volume 6), based on OS mapping, data provided by Portsmouth Water and site surveys completed in October 2023.

4.2.178 Non-designated GWDTE have been identified from priority habitat, NVC and UKHab data as summarised in ES Appendix 8.2 Habitats, Volume II (Document reference 6.2, DCO Volume 6) and ES Figure 8.8 UK Habitat classification for potential groundwater dependent terrestrial ecosystems within the field survey area that have potential to be impacted by the Proposed Development, Volume III (Document reference 6.3, DCO Volume 6).

4.2.179 No karst features have been mapped from data provided by third parties, with the majority of mapped potential karst features to the north of the Proposed Development (within the chalk bedrock of the South Downs).

Groundwater levels

4.2.180 The EA Portsdown BH groundwater monitoring installation is located adjacent to the Order Limits at the eastern end of Section E of the Pipeline, as described in paragraph 4.2.64.

4.2.181 Moving westward EA monitoring borehole Pinsley Lodge is approximately 300m north (downgradient) of the Order Limits adjacent to the B2177. The datum for this borehole is 46.44m AOD, and the 50m bgl borehole is screened in the Chalk Group (undivided). The installation has been dipped monthly since 1996 and shows a clear seasonal variation in groundwater levels. Generally, the groundwater level is close to surface (less than 6m below-ground) and becomes artesian in the summer and autumn months.

4.2.182 EA monitoring borehole Portsdown Hill is located more than 1km south of the Order Limits on the southern side of Portsdown Hill close to where Skew Road crosses over the M27. The datum for the borehole is 78.4m AOD, with the well installed 80.3m deep, monitoring in the Chalk Group (undivided). The borehole has been monitored since March 2015 with monthly dips, and like the other chalk installations shows a clear seasonal variation. In summer/early autumn, the

groundwater level trends towards approximately 14m AOD before rising up to approximately 29m AOD in late winter/early spring (with an anomalously high reading in October 2023 of approximately 43m AOD.

4.2.183 EA monitoring borehole Downbarn Farm is located at the western end Section E of the Pipeline, just north-west of the M27-A27 junction, approximately 900m south-west of the Order Limits at Section E of the Pipeline. This borehole has a datum of 23.9m AOD and extends to approximately 22.6m bgl monitoring the Portsdown Chalk Member. The borehole has been monitored monthly since 1967 and shows seasonal variation. The groundwater levels range between 0.61 and 8.5m AOD, although generally fall between 1.0 and 6.0m AOD.

4.2.184 Phase 1 borehole BH303 is just to the east of Section E of the Pipeline with groundwater monitoring summarised in paragraphs 4.2.184 and 4.2.186. Groundwater level monitoring in Phase 2 and 3 boreholes in Section E indicate groundwater levels in the order of 54.5m AOD to 63.0m AOD.

4.2.185 It is assumed that perched groundwater may be encountered within the overlying superficial deposits, where present (assumed to be present when considering potential impacts).

Groundwater quality

4.2.186 The geotechnical and geo-environmental interpretative report for Ground Investigation in Section E (Phase 2 and Phase 3B/3C) (see ES Appendix 11.2 Ground investigation reports, Volume II (Document reference 6.2, DCO Volume 6)) discusses the groundwater sampling undertaken in Section E and provides an assessment of the groundwater quality against Environmental Quality Standards. ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6), discusses water quality impacts from land contamination, which are not duplicated in this HIA.

4.2.187 Regionally the vast majority of unconfined groundwaters within the Wessex Basin Chalk are of the Ca-HCO_3 type [9]. The groundwater quality of the superficial deposits and other bedrock strata are likely to be more variable, with shallower groundwaters in the superficial deposits more susceptible to anthropogenic activities.

Groundwater flooding

4.2.188 Hampshire has a known history of groundwater flooding as discussed in paragraphs 4.2.33 and 4.2.34.

4.2.189 ES Figure 19.12 Groundwater flooding susceptibility, Volume III (Document reference 6.3, DCO Volume 6) shows the susceptibility to groundwater flooding dataset, which identifies areas where further consideration of groundwater flood risk may need to be considered.

4.2.190 The figure indicates that the majority of Section E of the Pipeline has limited potential for groundwater flooding to occur, except in the north of the study area towards the water courses.

4.2.191 Flooding is discussed in further detail in ES Appendix 19.1 Flood Risk Assessment, Volume II (Document reference 6.2, DCO Volume 6).

Abstractions

4.2.192 One licensed groundwater abstraction is located within the study area (approximately 150m north of the Order Limits), as documented in Table 4-23.

Table 4-23 Licensed groundwater abstractions – Section E: Portsdown Hill to Boarhunt

Licence holder	Licence No.	Use	Point name
Southwick Estate	11/42/33.5/5	Private Water Supply	Offwell Farm, Southwick

4.2.193 A surface water abstraction (Southwick Lake on the River Wallington – Licence No. 11/42/33.5/23) is located north of the Pipeline. The abstraction is utilised for direct spray irrigation in the summer months.

4.2.194 HBC, PCC and FBC were contacted in regard to private water supplies (including unlicensed abstractions less than $20m^3$/day) within their administrative boundaries, but no sites were identified in the study area.

4.2.195 WCC provided details on a number of licensed and unlicensed abstractions within their administrative boundary. One private water supply was identified within the study area:

The Southwick Estate abstraction, which is licensed (see Table 4-23).

4.2.196 Abstractions within the study area are illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Discharges

4.2.197 Discharge consents located within the study area are summarised in Annex B and illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Section F: Boarhunt to Crockerhill

Topography

4.2.198 From east to west, the topography initially falls as the Pipeline descends the western flank of Portsdown Hill. At the base of Hill, the Pipeline crosses the River Wallington at the lowest elevation of the section; approximately 7m AOD. The topography rises to the west of the Wallington to a level of approximately 60m AOD at its western end.

Environmentally designated sites

4.2.199 In the east of Section F, the Pipeline crosses a SPZ 2, 2c and 3. Zone 1 of the SPZ is located to the south of the corridor and is associated with the Maindell Pumping Station (PS) (see 'Abstractions' paragraph 4.2.221 – Maindell is currently not abstracting but during the groundwater feature survey walkover Portsmouth Water noted that they are looking to recommence abstraction in the future).

4.2.200 Environmental designations along the Pipeline are illustrated in ES Figure 8.1 Statutory designated sites within the Order Limits plus a 2km buffer, Volume III

(Document reference 6.3, DCO Volume 6), with SPZs shown on ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Surface water bodies

4.2.201 The study area includes a number of surface water catchment areas, as summarised in Table 4-24.

Table 4-24 Surface water catchments within study area – Section F: Boarhunt to Crockerhill

	Wallington below Southwick	River Meon
Water Body ID	GB107042016360	GB107042016640
River Basin District	South East	South East
Hydromorphological Designation	Not designated artificial or heavily modified	Not designated artificial or heavily modified
Current Ecological	Moderate	Good
Current Chemical	Fail	Fail
Ecological Objective	Good	Good
Chemical Objective	Good	Good

4.2.202 The Wallington flows westerly north-east of the Pipeline before diverting south. The Pipeline crosses the Wallington as it flows south towards the coast.

4.2.203 Surface water catchments and main rivers are illustrated in ES Figure 19.1 Surface water features, Volume III (Document reference 6.3, DCO Volume 6).

Superficial deposits

4.2.204 Table 4-25 details the superficial geology in the study area.

Table 4-25 Superficial deposits in study area – Section F: Boarhunt to Crockerhill

Geology	Description	Location and prevalence	Mapped Within the Order Limits
Head	Clay, Silt, Sand and Gravel	Head deposits primarily mapped in the sides of the valley associated with the Wallington River, which would be crossed by the Pipeline. Additional small bands of Head deposits within the study area in the east and north	Yes
River Terrace Deposits	Gravel, Sand and Silt	Mapped in association with the Wallington River. A few other isolated areas in the west of the study area	Yes
Alluvium	Clay, Silt, Sand and Gravel	Crosses the Pipeline, alongside Wallington River	Yes
No superficial cover	-	No superficial deposits mapped along the majority of the Pipeline	Yes

4.2.205 Phase 2, 3B and 3C Ground Investigation boreholes have locally confirmed the superficial deposits in a number of locations:

1. 2F3500DS: 0.35m of Topsoil underlain by silts and clays (Made Ground and Alluvium). Chalk bedrock encountered 3.25m bgl (52.87m AOD).
2. 2F3501DS: 0.30m of Topsoil underlain by clay (Alluvium). Chalk bedrock encountered at 3.20m bgl (41.16m AOD).
3. 2F3502SA (east of the Wallington River): 0.3m of Topsoil underlain by 0.65m band of sand (logged as Head Deposits). Clay Alluvium encountered from 0.95m bgl (8.17m AOD). Chalk bedrock encountered 2.5m bgl (6.62m AOD).
4. 2F3503SA (west of the Wallington River): 0.3m of Topsoil underlain by 1.5m thick band of sand (logged as Head Deposits). Clay and silt deposits (Alluvium) encountered at 1.8m bgl (6.72m AOD). Chalk bedrock encountered 3.5m bgl (5.02m AOD).
5. 2F3504DS: 0.20m of Topsoil underlain by clay (Alluvium). Chalk bedrock encountered at 1.20m bgl (21.34m AOD).
6. 2F3505DS: 0.30m of Topsoil overlying bedrock. Chalk bedrock encountered at 0.30m bgl (23.17m AOD).
7. 3F3517DS: 0.30m of Topsoil overlying Made Ground to 1.2m bgl. Chalk bedrock encountered at 1.2m bgl (46.26m AOD).
8. 3F3523DR: 0.28m of Made Ground overlying Head Deposits to 6.25m bgl. Chalk bedrock encountered 6.25m bgl (13.27m AOD).
9. 3F3524DR: 0.35m of Topsoil overlying Head Deposits to 1.55m bgl. Chalk bedrock encountered at 1.55m bgl (19.96m AOD).
10. 3W8553DS: Head Deposits from surface overlying chalk bedrock at 1.4m bgl (18.83m AOD).
11. 3W8554DS: Head Deposits from surface overlying chalk bedrock at 1.45m bgl (21.41m AOD).
12. 3W8556DS: 0.35m of Topsoil overlying Lambeth Group (Clay) at 67.05m AOD.
13. 3W8558SA: 0.3m of Topsoil overlying Made Ground to 3.5m bgl. Made Ground underlain by Lambeth Group at 33.49m AOD.
14. 3W8567SA: 0.3m of Topsoil overlying Made Ground to 2.4m bgl. Made Ground underlain by London Clay at 47.74m AOD.

Bedrock geology

4.2.206 Table 4-26 details the bedrock geology in the study area.

Table 4-26 Bedrock geology in study area – Section F: Boarhunt to Crockerhill

Geology	Description	Location and prevalence	Mapped Within the Order Limits
Spetisbury Chalk Member	Chalk	Mapped as underlying the Order Limits west of the Wallington River before the Pipeline diverts northwards	Yes
Portsdown Chalk Member	Chalk	Majority of the Order Limits east of Wallington River mapped as being	Yes

Geology	Description	Location and prevalence	Mapped Within the Order Limits
		underlain by the Portsdown Chalk Member. Also mapped in south-west of study area	
Lambeth Group	Clay, Silt and Sand	Band north of the chalk formations, trending approximately east to west. Pipeline crosses Lambeth Group as it travels north	Yes
London Clay Formation	Clay, Silt and Sand	Directly north of the Lambeth Group is the London Clay Formation. Pipeline north of Crockerhill mapped as being underlain by London Clay Formation and associated members	Yes
Bognor Sand Member	Sand	Small band in the north-east of the study area at distance from the Order Limits	No
Whitecliff Sand Member	Sand	Mapped in the north of the study area	No
Wittering Formation	Sand, Silt and Clay	Mapped in the north of the study area	No
Wittering Formation	Sand	Small areas mapped in the north of the study area at distance from the Order Limits, in between areas of Wittering Formation (Sand, Silt and Clay)	No

4.2.207 Phase 2 Ground Investigation boreholes have locally confirmed the bedrock in a number of locations:

1. 2F3500DS: Chalk bedrock encountered at 3.25m bgl (52.87m AOD), which extends to base of borehole at 4.30m bgl (51.82m AOD).
2. 2F3501DS: Chalk bedrock encountered at 3.20m bgl (41.16m AOD), which extends to base of boreholes at 4.30m bgl (40.06m AOD).
3. 2F3502SA (east of the Wallington River): Chalk bedrock encountered from 2.5m bgl (6.62m AOD) to base of borehole 20.45m bgl (-11.33m AOD).
4. 2F3503SA (west of the Wallington River): Chalk bedrock encountered from 3.5m bgl (5.02m AOD) to base of borehole 20.0m bgl (-11.48m AOD).
5. 2F3504DS: Chalk bedrock encountered at 1.20m bgl (21.34m AOD), which extends to base of borehole at 6.45m bgl (16.10m AOD).
6. 2F3505DS: Chalk bedrock encountered at 0.30m bgl (23.17m AOD), which extends to base of borehole at 6.45m bgl (17.02m AOD).
7. 3F3517DS: Chalk bedrock encountered at 1.2m bgl (46.26m AOD) to base of borehole at 2.34m bgl (45.12m AOD).
8. 3F3523DR: Chalk bedrock encountered 6.25m bgl (13.27m AOD) to base of boreholes at 30.2m bgl (-10.68m AOD).
9. 3F3524DR: Chalk bedrock encountered 1.55m bgl (19.96m AOD) to base of boreholes at 30.2m bgl (-8.69m AOD).
10. 3W8553DS: Chalk bedrock encountered at 1.4m bgl (18.83m AOD) to base of borehole 6.45m bgl (13.78m AOD).

11. 3W8554DS: Chalk bedrock encountered at 1.45m bgl (21.41m AOD) to base of borehole 6.45m bgl (16.41m AOD).
12. 3W8556DS: Lambeth Group (Clay) encountered 0.35m bgl (67.05m AOD) to base of boreholes at 5.45m bgl (61.95m AOD).
13. 3W8558SA: Lambeth Group encountered at 3.5m bgl (33.49m AOD). Lambeth Group underlain by White Chalk Subgroup at 6.7m bgl (29m AOD) to base of borehole at 10.0m bgl (26.99m AOD).
14. 3W8567SA: London Clay encountered at 2.4m bgl (47.74m AOD).

Groundwater-surface water interactions (springs, sinks, karst, groundwater dependent terrestrial ecosystems)

4.2.208 Springs and seepages are likely to be present below and in the banks of local surface watercourses (such as the Wallington).

4.2.209 Known potential and ground-truthed springs within the area have been plotted in ES Figure 19.2 Groundwater features, Volume III (Document reference 6.3, DCO Volume 6), based on OS mapping, data provided by Portsmouth Water and site surveys.

4.2.210 Non-designated GWDTE have been identified from priority habitat, NVC and UKHab data as summarised in ES Appendix 8.2 Habitats, Volume II (Document reference 6.2, DCO Volume 6) and ES Figure 8.8 UK Habitat classification for potential groundwater dependent terrestrial ecosystems within the field survey area that have potential to be impacted by the Proposed Development, Volume III (Document reference 6.3, DCO Volume 6).

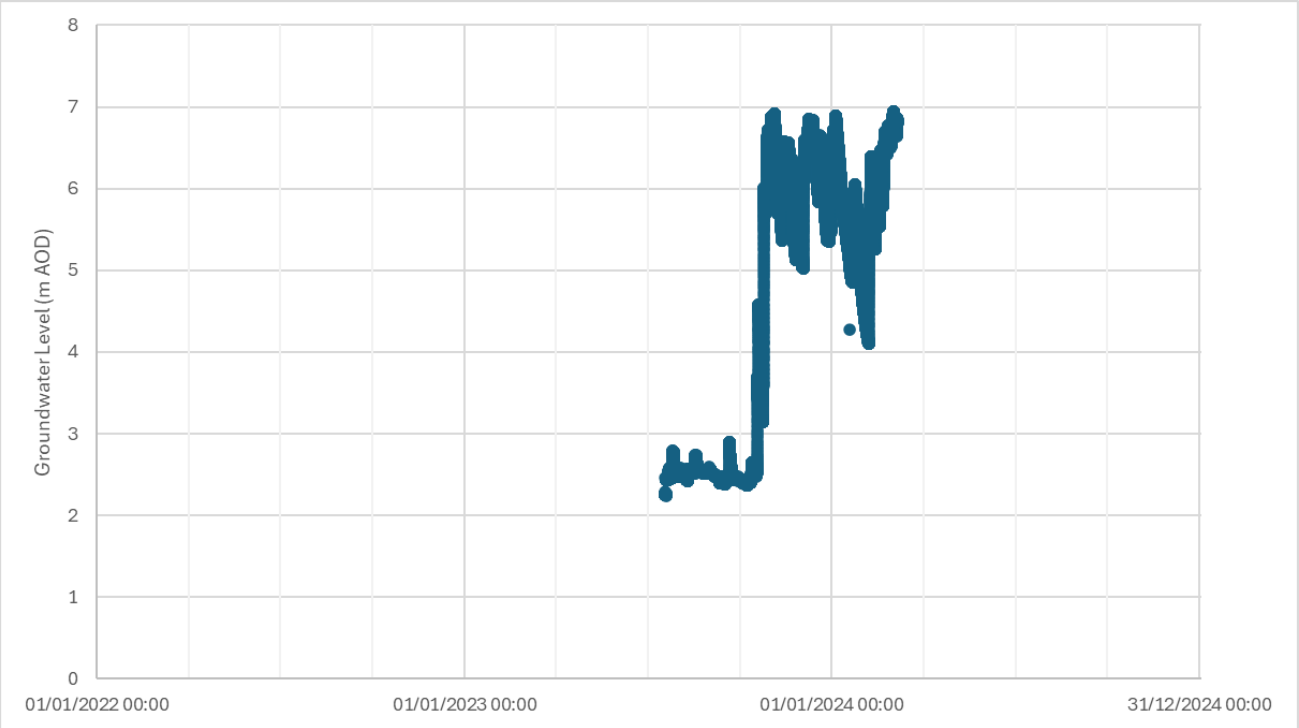
4.2.211 No karst features have been mapped from data provided by third parties, with the majority of mapped potential karst features to the north of the Proposed Development (within the chalk bedrock of the South Downs). However, the chalk is known to be karstic in areas.

Groundwater levels

4.2.212 EA monitoring borehole Downbarn Farm is located at the eastern end of Section F of the Pipeline, just north-west of the M27-A27 junction, approximately 800m south of the Order Limits. This borehole has a datum of 23.9m AOD and extends to approximately 22.6m bgl monitoring the Portsdown Chalk Member. The borehole has been monitored monthly since 1967 and shows seasonal variation. The groundwater levels range between 0.61 and 8.5m AOD, although generally fall between 1.0 and 6.0m AOD.

4.2.213 Limited site-specific groundwater monitoring data is available for Section F with the majority of standpipes being dry during monitoring. Data logger data from 2F3502SA near to the River Wallington crossing is shown in Graphic 4-6, with maximum groundwater levels observed approximately 2m bgl.

Graphic 4-6 Datalogger data from 2F3502SA adjacent to River Wallington (July 2023 to March 2024)



4.2.214 It is assumed that perched groundwater could be encountered within the overlying superficial deposits, where present (assumed to be present when considering potential impacts).

Groundwater quality

4.2.215 The geotechnical and geo-environmental interpretative report for Ground Investigation in Section F (Phase 2 and Phase 3B/3C) (see ES Appendix 11.2 Ground investigation reports, Volume II (Document reference 6.2, DCO Volume 6)) discusses the groundwater sampling undertaken in Section F and provides an assessment of the groundwater quality against Environmental Quality Standards. ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6), discusses water quality impacts from land contamination, which are not duplicated in this HIA.

4.2.216 Regionally the vast majority of unconfined groundwaters within the Wessex Basin Chalk are of the Ca-HCO_3 type [9]. The groundwater quality of the superficial deposits and other bedrock strata are likely to be more variable, with shallower groundwaters in the superficial deposits more susceptible to anthropogenic activities.

Groundwater flooding

4.2.217 Hampshire has a known history of groundwater flooding as discussed in paragraphs 4.2.33 and 4.2.34.

4.2.218 ES Figure 19.12 Groundwater flooding susceptibility, Volume III (Document reference 6.3, DCO Volume 6) shows the susceptibility to groundwater flooding

dataset, which identifies areas where further consideration of groundwater flood risk may need to be considered.

4.2.219 The figure indicates that the majority of Section F of the Pipeline has limited potential for groundwater flooding to occur except in the valley where the Wallington River is located.

4.2.220 Flooding is discussed in further detail in ES Appendix 19.1 Flood Risk Assessment, Volume II (Document reference 6.2, DCO Volume 6).

Abstractions

4.2.221 No licensed groundwater abstractions are located within the study area. However, the Pipeline crosses the SPZ associated with the Portsmouth Water Maindell PWS.

4.2.222 During the site visit of Bedhampton Springs, Portsmouth Water noted that Maindell Pumping Station is not currently pumping, although Portsmouth Water are looking to recommence pumping in the future.

4.2.223 FBC were contacted in regard to private water supplies (including unlicensed abstractions less than 20m^3/day). In their response, no private water supplies were identified within their administrative boundary.

4.2.224 WCC provided details on a number of licensed and unlicensed abstractions within their administrative boundary One private water supply was identified within the study area:

1. 1 and 2 The Cottage, approximately 600m east of the Order Limits adjacent to Wickham Common.

4.2.225 Abstractions within the study area are illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Discharges

4.2.226 Discharge consents located within the study area are summarised in Annex B and illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Section G: Crockerhill to Wickham

Topography

4.2.227 From east to west, the topography falls from approximately 60m AOD to 30m AOD in the first 500m of Section G of the Pipeline. The elevation remains relatively stable between 30m AOD and 40m AOD before falling to the River Meon which sits at an elevation of approximately 17m AOD. The topography gradually rises to the west of the River Meon before plateauing between 50 and 55m AOD.

Environmentally designated sites

4.2.228 South Downs National Park (SDNP) is to the north-east of the Pipeline, approximately 580m from Section G of the Pipeline at its closest.

4.2.229 The south-east of the study area for Section G intercepts the SPZ3 and SPZ2 associated with the Maindell PS abstraction (see Section F).

4.2.230 Environmental designations along the Pipeline are illustrated in ES Figure 8.1 Statutory designated sites within the Order Limits plus a 2km buffer, Volume III (Document reference 6.3, DCO Volume 6), with SPZs shown on ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Surface water bodies

4.2.231 The study area includes three surface water catchment areas, as summarised in Table 4-27.

Table 4-27 Surface water catchments in study area – Section G: Crockerhill to Wickham

	Wallington below Southwick	River Meon	Coastal catchment associated with Southampton Water
Water Body ID	GB107042016360	GB107042016640	GB520704202800
River Basin District	South East	South East	South East
Hydromorphological Designation	Not designated artificial or heavily modified	Not designated artificial or heavily modified	Heavily modified
Current Ecological	Moderate	Good	Moderate
Current Chemical	Fail	Fail	Fail
Ecological Objective	Good	Good	Moderate
Chemical Objective	Good	Good	Good

4.2.232 The River Meon is a chalk stream, which rises at East Meon before flowing approximately 34km in a generally south or south-westerly direction towards the sea. The Pipeline crosses the River Meon south-west of Wickham.

4.2.233 The Wallington catchment is in the east of the study area (crossing the Pipeline in Section F).

4.2.234 Surface water catchments and main rivers are illustrated in ES Figure 19.1 Surface water features, Volume III (Document reference 6.3, DCO Volume 6).

Superficial deposits

4.2.235 Table 4-28 details the superficial geology mapped in the study area.

Table 4-28 Superficial deposits in study area – Section G: Crockerhill to Wickham

Geology	Description	Location and prevalence	Mapped within the Order Limits
Alluvium	Clay, Silt, Sand and Gravel	Underlies the Pipeline at the point it crosses the River Meon. Alluvium is present within the study area along the route of the River Meon, which travels north-east to south-west	Yes

Geology	Description	Location and prevalence	Mapped within the Order Limits
River Terrace Deposits	Gravel, Sand and Silt	Mapped adjacent to Alluvium deposits, associated with the River Meon. Majority of Pipeline west of the River Meon mapped as being underlain by River Terrace Deposits	Yes
Head	Clay, Silt, Sand and Gravel	Head deposits mapped on the sides of the valley associated with the River Meon	Yes
No superficial cover	-	No superficial deposits mapped over large portions of the study area, including approximately 1.5km of the Pipeline in the east Section G.	Yes

4.2.236 Phase 2, 3B and 3C Ground Investigation boreholes have locally confirmed the superficial deposits in a number of locations, although it is noted the River Meon Phase 2 boreholes are approximately 700m downstream of the proposed crossing point:

1. 2G4000SA (east of the River Meon): 0.3m of Topsoil and Made Ground underlain by firm clay (Head Deposits). Clay (River Terrace Deposits) encountered at 1.3m bgl (17.99m AOD) underlain by possible Lambeth Group bedrock at 2.5m bgl (16.79m AOD).
2. 2G4001SA (west of the River Meon): 0.25m of Topsoil underlain by sand (River Terrace Deposits). Clay (Alluvium) encountered from 0.7m bgl (13.63m AOD). Possible London Clay Formation encountered at 3.5m bgl (10.83m AOD).
3. 2G4002DS: 0.40m of Made Ground underlain by clay (possible River Terrace Deposits) to 0.55m bgl. Possible clay bedrock (Earnley Formation and Wittering Formation) encountered to the base of the borehole 3.0m bgl (42.42m AOD).
4. 2G4003DS: 0.40m of Made Ground underlain by clay (possible River Terrace Deposits) to 0.65m bgl. Possible clay bedrock (Earnley Formation and Wittering Formation) encountered to the base of the borehole 4.0m bgl (42.22m AOD).
5. 2G4004DS: 0.40m of Made Ground underlain by River Terrace Deposits to 0.65m bgl (44.80m AOD). Earnley Sand Formation encountered at 0.65m bgl (44.80m AOD).
6. 3G4022DS: 3.60m of River Terrace Deposits to base of borehole (51.47m AOD).
7. 3G4024DS: 0.30m of Topsoil underlain by River Terrace Deposits to 1.7m bgl (54.12m AOD). Earnley Sand Formation encountered at 1.7m bgl (54.12m AOD).
8. 3G4037DS: 1.20m of Made Ground underlain by River Terrace Deposits to 3.65m bgl (49.31m AOD). Earnley Sand Formation encountered at 3.65m bgl (49.31m AOD).
9. 3G4038DS: 0.30m of Made Ground underlain by River Terrace Deposits to 5.6m bgl (46.96m AOD). Earnley Sand Formation encountered at 5.6m bgl (46.96m AOD).

10. 3G4102SA: 0.35m of Topsoil underlain by River Terrace Deposits to 4.0m bgl (51.20m AOD). Wittering Formation encountered at 4.0m bgl (51.20m AOD).
11. 3G4105SA: 2.50m of River Terrace Deposits underlain by Earnley Sand Formation. Earnley Sand Formation encountered at 2.5m bgl (49.24m AOD).
12. 3G4106SA: 0.30m of Topsoil underlain by River Terrace Deposits to 3.8m bgl. Earnley Sand Formation encountered at 3.8m bgl (48.97m AOD).
13. 3W8529SA: 0.35m of Topsoil underlain by Wittering Formation. Wittering Formation encountered at 0.35m bgl (30.74m AOD).
14. 3W8530SA: 0.20m of Topsoil underlain by Wittering Formation. Wittering Formation encountered at 0.2m bgl (29.90m AOD).
15. 3W8534DS: 2.20m of Made Ground underlain by River Terrace Deposits to 3.15m bgl. Earnley Sand Formation encountered at 3.15m bgl (49.99m AOD).
16. 3W8535SA: 0.30m of Made Ground underlain by Head Deposits to 2.5m bgl. Wittering Formation encountered at 2.5m bgl (49.42m AOD).
17. 3W8536SA: 0.35m of Made Ground underlain by River Terrace Deposits to 3.6m bgl. London Clay (Whitecliff Sand Member) encountered at 3.6m bgl (20.05m AOD).
18. 3W8539DS: 0.85m of Made Ground underlain by River Terrace Deposits to base of borehole 2.0m bgl (35.56m AOD).

Bedrock geology

4.2.237 Table 4-29 details the bedrock geology in the study area.

Table 4-29 Bedrock geology in study area – Section G: Crockerhill to Wickham

Geology	Description	Location and prevalence	Mapped within the Order Limits
Spetisbury Chalk Member	Chalk	Mapped in the south of the study area at distance from the Order Limits	No
Lambeth Group	Clay, Silt and Sand	Mapped to the south of the study area at distance from the Order Limits	No
London Clay Formation	Clay, Silt and Sand	London Clay Formation mapped predominantly in south-east of study area, including where the Pipeline crosses the River Meon	Yes
Whitecliff Sand Member	Sand	Sand member of the London Clay Formation mapped adjacent to the Bracklesham Group Formations which is crossed by the Pipeline in a number of areas	Yes
Wittering Formation	Sand, Silt and Clay	Mapped within Order Limits where the Pipeline diverts west around Bramble Cottage (west of Wickham Common) and north-west of the River Meon (such as within Wickham Golf Club)	Yes
Wittering Formation	Sand	Mapped within Order Limits north-west of the River Meon (within Wickham Golf Club)	Yes

Geology	Description	Location and prevalence	Mapped within the Order Limits
Earnley Sand Formation	Sand, Silt and Clay	Mapped in the north-west of the Order Limits	Yes

4.2.238 Phase 2, 3B and 3C Ground Investigation boreholes have locally confirmed the bedrock in a number of locations, although it is noted the River Meon Phase 2 boreholes are approximately 700m downstream of the proposed crossing point:

1. 2G4000SA (east of the River Meon): Possible Lambeth Group bedrock encountered at 2.5m bgl (16.79m AOD) and logged to base of borehole 20.0m bgl (-0.71m AOD).
2. 2G4001SA (west of the River Meon): Possible London Clay Formation encountered at 3.5m bgl (10.83m AOD). Possible Lambeth Group logged from 10.9m bgl (3.43m AOD) to base of borehole 20.45m bgl (-6.12m AOD).
3. 2G4002DS: Possible Earnley Formation encountered from 0.65m bgl (45.57m AOD) to 1.20m bgl (45.02m AOD) underlain by possible Wittering Formation to base of borehole 4.0m bgl (42.22m AOD).
4. 2G4003DS: Possible Earnley Formation encountered from 0.55m bgl (44.86m AOD) to 1.20m bgl (44.22m AOD) underlain by possible Wittering Formation to base of borehole 3.0m bgl (42.42m AOD).
5. 3G4024DS: Earnley Sand Formation encountered at 1.7m bgl (54.12m AOD) to base of borehole 6.45m bgl (49.37m AOD).
6. 3G4037DS: Earnley Sand Formation encountered at 3.65m bgl (49.31m AOD) to base of borehole 6.0m bgl (46.96m AOD).
7. 3G4038DS: Earnley Sand Formation encountered at 5.6m bgl (46.96m AOD) to base of borehole 6.45m bgl (46.11m AOD).
8. 3G4102SA: Wittering Formation encountered 4.0m bgl (51.20m AOD) to 13.1m bgl and underlain by London Clay Formation to base of borehole 20.45m bgl (34.75m AOD).
9. 3G4105SA: Earnley Sand Formation encountered from 2.5m bgl (49.24m AOD) to 27.8m bgl (23.96m AOD) and underlain by Wittering Formation to base of borehole 30.45m bgl (21.29m AOD).
10. 3G4106SA: Earnley Sand Formation encountered 3.8m bgl (48.97m AOD) to 27.0m bgl and underlain by Witterinf Formation to base of borehole 30.0m bgl (22.77m AOD).
11. 3W8529SA: Wittering Formation encountered 0.35m bgl (30.74m AOD) to 9.0m bgl and underlain by Whitecliff Sand Member (London Clay) to base of borehole 20.0m bgl (11.09m AOD).
12. 3W8530SA: Wittering Formation encountered 0.2m bgl (29.90m AOD) to 6.0m bgl and underlain by Whitecliff Sand Member (London Clay Formation) to base of borehole 20.0m bgl (10.10m AOD).
13. 3W8534DS: Earnley Sand Formation encountered at 3.15m bgl (49.99m AOD) to base of borehole 4.00m bgl (49.14m AOD).

14. 3W8535SA: Wittering Formation encountered 2.5m bgl (49.42m AOD) to 10.5m bgl. London Clay (Whitecliff Sand Member) encountered 10.5 to 12.4m bgl and underlain by London Clay to base of borehole 20.05m bgl (1.87m AOD).
15. 3W8536SA: London Clay (Whitecliff Sand Member) encountered at 3.6m bgl (20.05m AOD) to base of borehole 20.45m bgl (3.2m AOD).

Groundwater-surface water interactions (springs, sinks, karst, groundwater dependent terrestrial ecosystems)

4.2.239 Springs and seepages are likely to be present below and in the banks of local surface watercourses.

4.2.240 Known potential and ground-truthed springs within the area have been plotted in ES Figure 19.2 Groundwater features, Volume III (Document reference 6.3, DCO Volume 6), based on OS mapping, data provided by Portsmouth Water and site surveys.

4.2.241 Non-designated GWDTE have been identified from priority habitat, NVC and UKHab data as summarised in ES Appendix 8.2 Habitats, Volume II (Document reference 6.2, DCO Volume 6) and ES Figure 8.8 UK Habitat classification for potential groundwater dependent terrestrial ecosystems within the field survey area that have potential to be impacted by the Proposed Development, Volume III (Document reference 6.3, DCO Volume 6).

4.2.242 No karst features have been mapped from data provided by third parties, with the majority of mapped potential karst features to the north of the Proposed Development (within the chalk bedrock of the South Downs).

Groundwater levels

4.2.243 EA groundwater monitoring borehole 'Frith Lane End' is located approximately 1km north-east of the Order Limits in Section G of the Pipeline, adjacent to Frist Lane. The borehole has a datum of 61.88m AOD and is 299m deep, screened in the Chalk Group (undivided). The installation has been dipped manually since 2001, with levels monitored between 29.20m AOD (2024) and 38.05m AOD (2014).

4.2.244 A datalogger was installed in monitoring well 2G4000SA which recorded groundwater levels between -0.06m bgl and 11.88m bgl between June 2023 and March 2024. It is noted this borehole is over 750m south-west of the Pipeline. Groundwater levels monitored in other boreholes (by monthly hand dips) across Section G were generally measured at shallow depth (regularly less than 1.0m bgl).

4.2.245 It is assumed perched groundwater could be encountered within the overlying superficial deposits, where present (assumed to be present when considering potential impacts).

Groundwater quality

4.2.246 The geotechnical and geo-environmental interpretative report for Ground Investigation in Section G (Phase 2 and Phase 3B/3C) (see ES Appendix 11.2 Ground investigation reports, Volume II (Document reference 6.2, DCO Volume

6)) discusses the groundwater sampling undertaken in Section G and provides an assessment of the groundwater quality against Environmental Quality Standards. ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6), discusses water quality impacts from land contamination, which are not duplicated in this HIA.

Groundwater flooding

4.2.247 Hampshire has a known history of groundwater flooding as discussed in paragraphs 4.2.33 and 4.2.34.

4.2.248 ES Figure 19.12 Groundwater flooding susceptibility, Volume III (Document reference 6.3, DCO Volume 6) shows the susceptibility to groundwater flooding dataset, which identifies areas where further consideration of groundwater flood risk may need to be considered.

4.2.249 The figure indicates that the majority of Section G of the Pipeline has limited potential for groundwater flooding to occur, except in the valleys where the River Meon and upper reaches of the River Hamble tributaries (northern end of study area at distance from Order Limits) are located.

4.2.250 Flooding is discussed in further detail in ES Appendix 19.1 Flood Risk Assessment, Volume II (Document reference 6.2, DCO Volume 6).

Abstractions

4.2.251 A single licensed groundwater abstraction is located within the Order Limits, as documented in Table 4-30. This abstraction was ground-truthed during the water features survey undertaken week commencing 2 October 2023.

Table 4-30 Licensed groundwater abstractions – Section G: Crockerhill to Wickham

Licence holder	Licence no.	Use	Point name
Golfpartners International Limited	29/058/R01	Spray Irrigation - Direct	Borehole at Wickham Park Golf Club

4.2.252 WCC provided details on a number of licensed and unlicensed abstractions (less than 20m^3/d) within their district boundary. Two unlicensed abstractions are located outside the Order Limits but within the study area, as summarised below:

1. The Bungalow (now The Garden House) unlicensed abstraction approximately 580m north of the Pipeline in Section G of the Pipeline.
2. 1 and 2 The Cottage unlicensed abstraction approximately 500m east of the Pipeline in Section G of the Pipeline.

4.2.253 FBC were contacted in regard to private water supplies (including unlicensed abstractions less than 20m^3/day). In their response, no sites were identified within the study area.

4.2.254 Abstractions within the study area are illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Discharges

4.2.255 Discharge consents located within the study area are summarised in Annex B and illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Section H: Wickham to Shedfield

Topography

4.2.256 The southern end of Section H of the Pipeline is at an elevation in the order of 55m AOD. As the Pipeline heads east and subsequently northwards, the topography remains relatively level varying between 50m AOD and 60m AOD until it reaches a river valley south-east of Shedfield. The topography falls relatively steeply to approximately 38m AOD before steadily rising again to the north. The topography rises to approximately 66m AOD at Shirrel Heath High Street before gradually falling to approximately 50m AOD at the northern end of Section H.

Environmentally designated sites

4.2.257 SDNP is to the east of the Pipeline, less than 50m from Section H of the Pipeline at its closest point.

4.2.258 Waltham Chase Meadows is a SSSI approximately 900m north of the Order Limits and designated a GWDTE.

4.2.259 Environmental designations along the Pipeline are illustrated in ES Figure 8.1 Statutory designated sites within the Order Limits plus a 2km buffer, Volume III (Document reference 6.3, DCO Volume 6), with SPZs shown on ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Surface water bodies

4.2.260 The study area includes three surface water catchment areas, as summarised in Table 4-31.

Table 4-31 Surface water catchments in study area – Section H: Wickham to Shedfield

	River Meon	Moors Stream	Coastal catchment associated with Southampton Water
Water Body ID	GB107042016640	GB107042016260	GB520704202800
River Basin District	South East	South East	South East
Hydromorphological Designation	Not designated artificial or heavily modified	Not designated artificial or heavily modified	Heavily modified
Current Ecological	Good	Good	Moderate
Current Chemical	Fail	Fail	Fail
Ecological Objective	Good	Good	Moderate
Chemical Objective	Good	Good	Good

4.2.261 South-east of Shirrel Heath the Pipeline would cross an upper reach of the River Hamble (not designated a main river at this point, although is designated a main river immediately downstream of the Pipeline).

4.2.262 Surface water catchments and main rivers are illustrated in ES Figure 19.1 Surface water features, Volume III (Document reference 6.3, DCO Volume 6).

Superficial deposits

4.2.263 Table 4-32 details the superficial geology mapped in the study area.

Table 4-32 Superficial deposits in study area – Section H: Wickham to Shedfield

Geology	Description	Location and prevalence	Mapped Within the Order Limits
Alluvium	Clay, Silt, Sand and Gravel	Mapped in the south-east and north-west of the study area, associated with the River Meon and Shawfords Lake (a tributary of the River Hamble)	No
River Terrace Deposits	Gravel, Sand and Silt	Mapped in the south of the study area in association with the River Meon. South of the Order Limits mapped within River Terrace Deposits	Yes
Head	Clay, Silt, Sand and Gravel	Mapped in relation to river valleys including the upper reaches of the River Hamble which is crossed by the Pipeline south-east of Shedfield	Yes
No superficial cover	-	No superficial deposits are mapped over the majority of the study area including the Order Limits	Yes

4.2.264 Phase 2, 3B and 3C Ground Investigation boreholes have locally confirmed the superficial deposits in a number of locations:

1. 2H4500DR: 0.25m of Topsoil underlain by clay (Head Deposits). Whitecliff Sand Member of London Clay Formation bedrock encountered at 0.8m bgl (60.53m AOD).
2. 2H4501DR: 0.42m of Topsoil underlain by bedrock. London Clay encountered at 0.42m bgl (65.74m AOD).
3. 2H4502DS: 0.28m of Topsoil underlain by bedrock. Whitecliff Sand Member encountered at 0.28m AOD (61.18m AOD).
4. 2H4503DS: 0.15m of Topsoil underlain by clay (Head Deposits). Whitecliff Sand Member encountered at 5.45m bgl (54.58m AOD).
5. 3H4517SA: 0.25m of Made Ground underlain by Whitecliff Sand Member (London Clay). Whitecliff Sand Member encountered at 0.25m bgl (54.37m AOD).
6. 3H4600SA: 0.4m of Topsoil underlain by River Terrace Deposits to 1.7m bgl. Wittering Formation encountered at 1.7m bgl (52.51m AOD).

Bedrock geology

4.2.265 Table 4-33 details the bedrock geology in the study area.

Table 4-33 Bedrock geology in study area – Section H: Wickham to Shedfield

Geology	Description	Location and prevalence	Mapped Within the Order Limits
London Clay Formation	Clay, Silt and Sand	London Clay is mapped over large portions of the study area in the east and north. London Clay is mapped beneath the Order Limits where the Pipeline crosses the upper reaches of the River Hamble	Yes
Whitecliff Sand Member	Sand	Mapped as underlying the majority of the Pipeline in the north of Section H (north of the River Hamble crossing)	Yes
Wittering Formation	Sand, Silt and Clay	Mapped in the south of the study area. Order Limits mapped as underlain by Wittering Formation over approximately 800m of the Pipeline in the south of Section H	Yes
Wittering Formation	Sand	Order Limits mapped as underlain by sand band of Wittering Formation between Prickets Hill and Blind Lane (less than 100m of Pipeline)	Yes
Earnley Sand Formation	Sand, Silt and Clay	Mapped in the south-west of the study area	No

4.2.266 Phase 2, 3B and 3C Ground Investigation boreholes have locally confirmed the bedrock in a number of locations:

1. 2H4500DR: Whitecliff Sand Member of London Clay Formation bedrock encountered at 0.8m bgl (60.53m AOD) down to 5.2m bgl (56.13m AOD). Whitecliff Sand Member underlain by London Clay to 18.5m bgl (42.83m AOD). Gravel (possible Harwich Formation) encountered at 18.5m bgl to base of borehole 20.0m bgl (41.33m AOD).
2. 2H4501DR: London Clay Formation bedrock encountered at 0.42m bgl (65.74m AOD) down to 5.45m bgl (60.71m AOD). Whitecliff Sand Member encountered from 5.45m bgl to 11.75m bgl (54.41m AOD). Underlain by London Clay to base of borehole 20.2m bgl (45.96m AOD).
3. 2H4502DS: Whitecliff Sand Member of London Clay Formation encountered at 0.28m bgl (61.18m AOD) to base of borehole 4.0m bgl (57.46m AOD).
4. 2H4503DS: Whitecliff Sand Member of London Clay Formation encountered at 3.95m bgl (56.08m AOD) to base of borehole 5.45m bgl (54.58m AOD).
5. 3H4517SA: Whitecliff Sand Member encountered 0.25m bgl (54.37m AOD) to 7.7m bgl and underlain by London Clay Formation to base of borehole 18.5m bgl (36.12m AOD).
6. 3H4600SA: Wittering Formation encountered 1.7m bgl (52.51m AOD) to 10.0m bgl underlain by London Clay to base of borehole 20.0m bgl (34.21m AOD).

Groundwater-surface water interactions (springs, sinks, karst, groundwater dependent terrestrial ecosystems)

4.2.267 Springs and seepages are likely to be present below and in the banks of local surface watercourses.

4.2.268 Known potential and ground-truthed springs within the area have been plotted in ES Figure 19.2 Groundwater features, Volume III (Document reference 6.3, DCO Volume 6), based on OS mapping, data provided by Portsmouth Water and site surveys.

4.2.269 Non-designated GWDTE have been identified from priority habitat, NVC and UKHab data as summarised in ES Appendix 8.2 Habitats, Volume II (Document reference 6.2, DCO Volume 6) and ES Figure 8.8 UK Habitat classification for potential groundwater dependent terrestrial ecosystems within the field survey area that have potential to be impacted by the Proposed Development, Volume III (Document reference 6.3, DCO Volume 6).

4.2.270 No karst features have been mapped from data provided by third parties, with the majority of mapped potential karst features to the north of the Proposed Development (within the chalk bedrock of the South Downs).

Groundwater levels

4.2.271 EA groundwater monitoring borehole 'Frith Lane End' is located approximately 400-500m east of the Order Limits adjacent to Frist Lane. The borehole has a datum of 61.88m AOD and is 299m deep, screened in the Chalk Group (undivided). The installation has been dipped manually since 2001, with levels monitored between 29.20m AOD (2024) and 38.05m AOD (2014).

4.2.272 No dataloggers have been installed in Section H with groundwater levels from hand dips variable across the Section, from 0.61m bgl in 2H4503DS to 8.05m bgl in 2H4501DR.

4.2.273 It is assumed that perched groundwater could be encountered within the overlying superficial deposits, where present (assumed to be present when considering potential impacts).

Groundwater quality

4.2.274 The geotechnical and geo-environmental interpretative report for Ground Investigation in Section H (Phase 2 and Phase 3B/3C) (see ES Appendix 11.2 Ground investigation reports, Volume II (Document reference 6.2, DCO Volume 6)) discusses the groundwater sampling undertaken in Section H and provides an assessment of the groundwater quality against Environmental Quality Standards. ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6), discusses water quality impacts from land contamination, which are not duplicated in this HIA.

Groundwater flooding

4.2.275 Hampshire has a known history of groundwater flooding as discussed in paragraphs 4.2.33 and 4.2.34.

4.2.276 ES Figure 19.12 Groundwater flooding susceptibility, Volume III (Document reference 6.3, DCO Volume 6) shows the susceptibility to groundwater flooding dataset, which identifies areas where further consideration of groundwater flood risk may need to be considered.

4.2.277 The figure indicates that the majority of Section H of the Pipeline has limited potential for groundwater flooding to occur, except in the valleys where the upper reaches of the River Hamble tributaries are located.

4.2.278 Flooding is discussed in further detail in ES Appendix 19.1 Flood Risk Assessment, Volume II (Document reference 6.2, DCO Volume 6).

Abstractions

4.2.279 A single licensed groundwater abstraction is located within the study area of Section H of the Pipeline, as documented in Table 4-34. This abstraction was ground-truthed during the water features survey undertaken week commencing 2 October 2023.

Table 4-34 Licensed groundwater abstractions – Section H: Wickham to Shedfield

Licence holder	Licence no.	Use	Point name
Golfpartners International Limited	29/058/R01	Spray Irrigation - Direct	Borehole at Wickham Park Golf Club

4.2.280 WCC provided details on a number of licensed and unlicensed abstractions (less than 20m^3/d) within their area. An unlicensed abstraction is located within the study area, The Bungalow (now The Garden House) unlicensed abstraction approximately 50m west of Section H of the Pipeline.

4.2.281 FBC were contacted in regard to private water supplies (including unlicensed abstractions less than 20m^3/day). In their response, no sites were identified within the study area.

4.2.282 Abstractions within the study area are illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Discharges

4.2.283 Discharge consents located within the study area are summarised in Annex B and illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Section J: Shedfield to the River Hamble

Topography

4.2.284 The south-eastern end of the Order Limits at Section J of the Pipeline is at an elevation of approximately 50m AOD. As the Pipeline travels north-west the topography falls to approximately 30m AOD (valley associated with Shawfords Lake tributary of the River Hamble) before steadily rising to approximately 60m AOD around Curdridge Lane. The topography then steadily falls towards the River Hamble to the north.

Environmentally designated sites

4.2.285 Waltham Chase Meadows SSSI (a GWDTE) is located approximately 450m north-east of the Pipeline.

4.2.286 No SPZs are located within the study area.

4.2.287 Environmental designations along the Pipeline are illustrated in ES Figure 8.1 Statutory designated sites within the Order Limits plus a 2km buffer, Volume III (Document reference 6.3, DCO Volume 6), with SPZs shown on ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Surface water bodies

4.2.288 The study area includes a number of surface water catchment areas, as summarised in Table 4-35.

Table 4-35 Surface water catchments in study area – Section J: Shedfield to the River Hamble

	Main River Hamble	Moors Stream	Upper Hamble	Coastal catchment associated with Southampton Water
Water Body ID	GB107042016250	GB107042016260	GB107042016280	GB520704202800
River Basin District	South East	South East	South East	South East
Hydromorphological Designation	Not designated artificial or heavily modified	Not designated artificial or heavily modified	Not designated artificial or heavily modified	Heavily modified
Current Ecological	Moderate	Good	Moderate	Moderate
Current Chemical	Fail	Fail	Fail	Fail
Ecological Objective	Moderate	Good	Good	Moderate
Chemical Objective	Good	Good	Good	Good

4.2.289 Section J is at the upper reaches of the Hamble catchment and contains a number of minor water courses. These minor (i.e. non-WER) water courses may be intermittently flowing (e.g. flowing during wetter periods) and crossed by the Pipeline, in particular south-west of Waltham Chase.

4.2.290 Surface water catchments and main rivers are illustrated in ES Figure 19.1 Surface water features, Volume III (Document reference 6.3, DCO Volume 6).

Superficial deposits

4.2.291 Table 4-36 details the superficial geology mapped in the study area.

Table 4-36 Superficial deposits in study area – Section J: Shedfield to the River Hamble

Geology	Description	Location and prevalence	Mapped within the Order Limits
Alluvium	Clay, Silt, Sand and Gravel	Alluvium is mapped within the study area in association with water courses (such as the Main River Hamble and Shawfords Lake). Alluvium is mapped underlying the Order Limits where the Pipeline crosses the upper reaches of Shawfords Lake and in the north-west section associated with tributaries of the Main River Hamble	Yes
River Terrace Deposits	Gravel, Sand and Silt	River Terrace Deposits mapped in the north and west of the study area associated with the Main River Hamble. Small area mapped underlying the Pipeline in the north-west of the section adjacent to Botley Road	Yes
Head	Clay, Silt, Sand and Gravel	Head mapped in the south-west of the study area (predominantly south-west of Waltham Chase) associated with valleys containing tributaries of the River Hamble (including Shawfords Lake). Mapped underlying the Order Limits in discrete areas south and south-west of Waltham Chase	Yes
No superficial cover	-	No superficial deposits are mapped in the majority of the study area and underlying the Order Limits	Yes

4.2.292 Phase 3B and 3C Ground Investigation boreholes have locally confirmed the superficial deposits in Section J:

1. 3J5002SA: 0.2m of Topsoil underlain by Whitecliff Sand Member. Whitecliff Sand Member encountered at 0.2m bgl (50.37m AOD).
2. 3J5004DS: 0.35m of Topsoil underlain by Made Ground to 2.0m bgl. Made Ground underlain by Head Deposits to base of borehole 5.0m bgl (35.84m AOD).
3. 3J5007DS: 3.6m of Made Ground underlain by Head Deposits to base of borehole 6.45m bgl (32.94m AOD).
4. 3J5015SA: 6.0m of Made Ground underlain by Whitecliff Sand Member. Whitecliff Sand Member encountered at 6.0m bgl (42.33m AOD).
5. 3J5027DS: 0.3m of Topsoil underlain by Wittering Formation. Wittering Formation encountered at 0.3m bgl (54.97m AOD).
6. 3J5028DS: 0.3m of Topsoil underlain by Head Deposits to 1.9m bgl. London Clay Formation encountered at 1.9m bgl (52.12m AOD).

Bedrock geology

4.2.293 Table 4-37 details the bedrock geology in the study area.

Table 4-37 Bedrock geology in study area – Section J: Shedfield to the River Hamble

Geology	Description	Location and prevalence	Mapped within Order Limits
London Clay Formation	Clay, Silt and Sand	Covers most of the north and north-east of the study area. Underlies corridor for most of the northern third and the valley associated with Shawfords Lake	Yes
London Clay Formation	Sand	Small areas non-continuous areas in the north of the study area, two of which partly underlie the Pipeline. Potentially avoided by micro-siting	Yes
Whitecliff Sand Member	Sand	Approximately half of the southern half of the study area is underlain by Whitecliff Sand Member. The south-eastern end and parts of the middle of the Pipeline are underlain by this formation	Yes
Wittering Formation	Sand, Silt and Clay	The Wittering Formation is mapped in the west of the study area, and mapped within the Order Limits in the middle	Yes
Wittering Formation	Sand	Bands of sand deposits within the Wittering Formation are mapped in the west of the study area, and are mapped as underlying the Order Limits in the area of Curdridge Lane	Yes

4.2.294 Phase 3B and 3C Ground Investigation boreholes have locally confirmed the bedrock in Section J:

1. 3J5002SA: Whitecliff Sand Member encountered 0.2m bgl (50.37m AOD) to 7.1m bgl and underlain by London Clay Formation to 17.7m bgl. Possible basal beds encountered to base of borehole 20.0m bgl (30.57m AOD).
2. 3J5015SA: Whitecliff Sand Member encountered 6.0m bgl (42.33m AOD) to 8.0m bgl and underlain by London Clay Formation to base of borehole 10.45m bgl (27.88m AOD).
3. 3J5027DS: Wittering Formation encountered at 0.3m bgl (54.97m AOD) to base of borehole 4.5m bgl (50.77m AOD).
4. 3J5028DS: London Clay Formation encountered at 1.9m bgl (52.12m AOD) to base of borehole 5.45m bgl (48.57m AOD).

Groundwater-surface water interactions (springs, sinks, karst, groundwater dependent terrestrial ecosystems)

4.2.295 Springs and seepages are likely to be present below and in the banks of local surface watercourses.

4.2.296 Known potential and ground-truthed springs within the area have been plotted in ES Figure 19.2 Groundwater features, Volume III (Document reference 6.3, DCO Volume 6), based on OS mapping, data provided by Portsmouth Water and site surveys.

4.2.297 Non-designated GWDTE have been identified from priority habitat, NVC and UKHab data as summarised in ES Appendix 8.2 Habitats, Volume II (Document reference 6.2, DCO Volume 6) and ES Figure 8.8 UK Habitat classification for potential groundwater dependent terrestrial ecosystems within the field survey area that have potential to be impacted by the Proposed Development, Volume III (Document reference 6.3, DCO Volume 6).

4.2.298 No karst features have been mapped from data provided by third parties, with the majority of mapped potential karst features to the north of the Proposed Development (within the chalk bedrock of the South Downs).

Groundwater levels

4.2.299 Groundwater monitoring within the Section has been undertaken in a selection of Phase 3B and 3C wells with levels monitored at relatively shallow depths between 0.0m bgl (at 3J5004DS and 3J5028DS) and 3.05m bgl (at 3J5015SA)

4.2.300 A number of active EA groundwater monitoring boreholes are located north of the study area around Bishop's Waltham, together with the Frith Lane End borehole summarised in paragraph 4.2.243.

4.2.301 Sandboils Sand is a shallow groundwater monitoring installation located in the Moors, Bishop's Waltham SSSI at the head of the River Hamble approximately 2km upstream. The Sandboils Sand borehole has a datum of 30.54m AOD and extends to 5.0m bgl monitoring the near surface groundwater levels. The borehole has been monitored since 1996 at monthly intervals with levels ranging from 29.11m AOD to 30.54m AOD (assumed artesian).

4.2.302 Co-located with the Sandboils Sand site, the Sandboils Chalk monitoring installation is 18m bgl and has been recording since 1997. The monthly monitoring ranges from 29.2m AOD to 30.54m AOD (assumed artesian). The levels in both installations broadly correlate.

4.2.303 Northbrook is located on the northern side of Bishop's Waltham adjacent to the B3035. The borehole has a datum of 36.04m AOD and is 15.0m deep, monitoring the Lewes Nodular Chalk Member. Monitoring has been undertaken monthly since 1996 with a seasonal range in groundwater levels. Groundwater levels has been recorded between 28.47m AOD and 35.69m AOD.6

4.2.304 Perched groundwater may be encountered within overlying superficial deposits at a higher elevation than the general groundwater table, where present (assumed to be present when considering potential impacts).

Groundwater quality

4.2.305 The geotechnical and geo-environmental interpretative report for Ground Investigation in Section J (Phase 2 and Phase 3B/3C) (see ES Appendix 11.2 Ground investigation report, Volume II (Document reference 6.2, DCO Volume 6)) discusses the groundwater sampling undertaken in Section J and provides an assessment of the groundwater quality against Environmental Quality Standards. ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6), discusses water quality impacts from land contamination, which are not duplicated in this HIA.

Groundwater flooding

4.2.306 Hampshire has a known history of groundwater flooding as discussed in paragraphs 4.2.33 and 4.2.34.

4.2.307 ES Figure 19.12 Groundwater flooding susceptibility, Volume III (Document reference 6.3, DCO Volume 6) shows the susceptibility to groundwater flooding dataset, which identifies areas where further consideration of groundwater flood risk may need to be considered.

4.2.308 The figure indicates that the majority of Section J of the Pipeline has limited or no potential for groundwater flooding to occur except in the valleys where water courses are located (such as the River Hamble and Shawfords Lake).

4.2.309 Flooding is discussed in further detail in ES Appendix 19.1 Flood Risk Assessment, Volume II (Document reference 6.2, DCO Volume 6).

Abstractions

4.2.310 No licensed groundwater abstractions are mapped within the study area.

4.2.311 A licensed surface water abstraction is mapped within the study area but outside the Order Limits, downstream of the River Hamble crossing, License 11/42/25.2/54: River Hamble at Durley – For agriculture/irrigation.

4.2.312 WCC provided details on a number of licensed and unlicensed abstractions (less than 20m^3/d) within their administrative area. Unlicensed abstractions are located within the study area but outside the Order Limits, as summarised below:

1. Yewtree Cottage unlicensed abstraction approximately 400m north-east of the Pipeline.
2. Woodman's Farmhouse unlicensed abstraction approximately 80m south-west of the Pipeline.
3. The Granary unlicensed abstraction approximately 900m south-west of the Pipeline (proximal to Main River Hamble).

4.2.313 Abstractions within the study area are illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Discharges

4.2.314 Discharge consents located within the study area are summarised in Annex B and illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Section K: The River Hamble to Lower Upham

Topography

4.2.315 The south of Section K of the Pipeline commences at the River Hamble crossing at an elevation of approximately 15m AOD, before rising steadily (with some undulation) to approximately 60m AOD around Winters Hill. The topography falls slowly to the north, with an elevation of approximately 45m AOD where the Pipeline crosses the B3037.

Environmentally designated sites

4.2.316 The SDNP is located to the north-east of the Pipeline (immediately adjacent to the Order Limits where the Pipeline crosses Sciver's Lane south of Lower Upham).

4.2.317 Bishop's Waltham Branch Line LNR is located to the north-east of the Pipeline at the southern end of Section K of the Pipeline.

4.2.318 In the north-west of Section K of the Pipeline, the Pipeline crosses through a SPZ1c and 2c (east of Horton Heath stream) associated with the Portsmouth Water PWS abstraction at Lower Upham. The SPZ1 is located just to the south-west of the Pipeline, with the SPZ2 present in the north-east towards the edge of the study area.

4.2.319 Environmental designations along the Order Limits are illustrated in ES Figure 8.1 Statutory designated sites within the Order Limits plus a 2km buffer, Volume III (Document reference 6.3, DCO Volume 6), with SPZs shown on ES Figure 19.8 Water resources in Volume III (Document reference 6.3, DCO Volume 6).

Surface water bodies

4.2.320 The study area includes a number of surface water catchment areas, as summarised in Table 4-38.

Table 4-38 Surface water catchments in study area – Section K: The River Hamble to Lower Upham

	Main River Hamble	Moors Stream	Horton Heath Stream	Upper Hamble	Bow Lake
Water Body ID	GB107042016250	GB107042016260	GB107042016270	GB107042016280	GB107042016650
River Basin District	South East	South East	South East	South East	South East
Hydromorphological Designation	Not designated artificial or heavily modified	Not designated artificial or heavily modified	Heavily Modified	Not designated artificial or heavily modified	Not designated artificial or heavily modified
Current Ecological	Moderate	Good	Good	Moderate	Bad
Current Chemical	Fail	Fail	Fail	Fail	Fail
Ecological Objective	Moderate	Good	Good	Good	Good
Chemical Objective	Good	Good	Good	Good	Good

4.2.321 The Pipeline crosses the River Hamble at the south of Section K of Pipeline.

4.2.322 Surface water catchments and main rivers are illustrated in ES Figure 19.1 Surface water features in Volume III (Document reference 6.3, DCO Volume 6).

Superficial deposits

4.2.323 Table 4-39 details the superficial geology in the study area.

Table 4-39 Superficial deposits in study area – Section K: The River Hamble to Lower Upham

Geology	Description	Location and prevalence	Mapped within the Order Limits
Alluvium	Clay, Silt, Sand and Gravel	Alluvium deposits mapped in association with main rivers (such as the Main River Hamble) and minor watercourses and tributaries	Yes
River Terrace Deposits	Gravel, Sand and Silt	Mapped in the south of the study area and Order Limits associated with the River Hamble and in the north of the study area associated with Bow Lake	Yes
Head	Clay, Silt, Sand and Gravel	Small areas of Head Deposits mapped in valleys. Head Deposits mapped within Order Limits in south-east of Section K (associated with River Hamble)	Yes
Clay-With-Flints-Formation	Clay, Silt, Sand and Gravel	Areas of Clay-With-Flints mapped in the north-east of the study area, at distance from the Pipeline	No
No superficial cover	-	No superficial deposits are mapped for the majority of the study area and Order Limits. Superficial deposits within the study area primarily associated with water courses	Yes

4.2.324 Phase 2, 3B and 3C Ground Investigation boreholes have locally confirmed the superficial deposits in Section K:

1. 2K5500SR: 0.70m of Made Ground underlain by River Terrace Deposits to 4.9m bgl. London Clay Formation encountered at 4.9m bgl (18.26m AOD).
2. 2K5501SR: 0.12m of Topsoil underlain by Head Deposits to 2.0m bgl. London Clay Formation encountered at 2.0m bgl (15.75m AOD).
3. 2K5502DS: 0.15m of Topsoil underlain by Made Ground to 0.6m bgl and subsequently Alluvium to base of borehole 0.7m bgl (43.13m AOD).
4. 2K5503DS: 0.18m of Topsoil underlain by Alluvium to the base at 0.9m bgl (42.83m AOD).
5. 2K5534DS: 0.17m of Topsoil underlain by Alluvium to the base at 0.7m bgl (43.11m AOD).
6. 2K5535DS: 0.15m of Topsoil underlain by Alluvium to the base at 0.7m bgl (43.29m AOD).
7. 3K5511DS:1.6m of Made Ground underlain by London Clay Formation. London Clay encountered at 1.6m bgl (34.4m AOD).
8. 3K5525DR: 0.2m of Topsoil underlain by Alluvium to 3.0m bgl. London Clay encountered at 3.0m bgl (69.19m AOD).
9. 3K5527DR: 0.15m of Topsoil underlain by Alluvium to 2.5m bgl. London Clay encountered at 2.5m bgl (64.73m AOD).
10. 3K5531DS: 0.15m of Topsoil underlain by London Clay Formation. London Clay encountered at 0.15m bgl (44.66m AOD).

Bedrock geology

4.2.325 Table 4-40 details the bedrock geology in the study area.

Table 4-40 Bedrock geology in study area – Section K: The River Hamble to Lower Upham

Geology	Description	Location and prevalence	Mapped within the Order Limits
London Clay Formation	Clay, Silt and Sand	Majority of the study area and all the Order Limits mapped as being underlain by London Clay Formation (with the exception of a small area where the Main River Hamble is crossed)	Yes
London Clay Formation	Sand	Discrete areas of sand bands within the London Clay Formation are mapped in the south and west of the study area, primarily at distance from the Order Limits. Sand mapped underlying the Order Limits where the Pipeline crosses the Main River Hamble	Yes
Whitecliff Sand Member	Sand	Mapped south and west of the Order Limits	No
Durley Sand Member	Sand	Mapped in the west of the study area at distance from the Order Limits	No
Bognor Sand Member	Sand	Mapped in the east of the study area at distance from the Order Limits	No
Wittering Formation	Sand, Silt and Clay	Mapped in the south of the study area	No
Wittering Formation	Sand	Mapped in the south of the study area	No
Lambeth Group	Clay, Silt and Sand	Mapped north-east of the Pipeline after Winters Hill. More than 150m from the Order Limits at its closest	No
Lambeth Group	Sand	Mapped in the north-east of the study area (east of Lower Upham)	No
Tarrant Chalk Member	Chalk	Mapped in the north-east of the study area at distance from the Pipeline	No

4.2.326 Phase 2, 3B and 3C Ground Investigation boreholes have locally confirmed the bedrock in Section K:

1. 2K5500SR: London Clay Formation encountered at 4.9m bgl (18.26m AOD) to base of borehole 20.2m bgl (2.96m AOD).
2. 2K5501SR: London Clay Formation encountered at 2.0m bgl (15.75m AOD) to base of borehole 20.0m bgl (-2.25m AOD).
3. 3K5511DS: London Clay encountered at 1.6m bgl (34.4m AOD) to base of borehole 6.45m bgl (29.55m AOD).

4. 3K5525DR: London Clay encountered at 3.0m bgl (69.19m AOD) to base of borehole 30.5m bgl (41.69m AOD).
5. 3K5527DR: London Clay encountered at 2.5m bgl (64.73m AOD) to base of borehole 8.45m bgl (58.78m AOD).
6. 3K5531DS: London Clay encountered at 0.15m bgl (44.66m AOD) to base of borehole 6.0m bgl (38.81m AOD).

Groundwater-surface water interactions (springs, sinks, karst, groundwater dependent terrestrial ecosystems)

4.2.327 Springs and seepages are likely to be present below and in the banks of local surface watercourses. Known potential and ground-truthed springs within the area have been identified and plotted in ES Figure 19.2 Groundwater features, Volume III (Document reference 6.3, DCO Volume 6), based on OS mapping, data provided by Portsmouth Water and site surveys.

4.2.328 Non-designated GWDTE have been identified from priority habitat, NVC and UKHab data as summarised in ES Appendix 8.2 Habitats, Volume II (Document reference 6.2, DCO Volume 6) and ES Figure 8.8 UK Habitat classification for potential groundwater dependent terrestrial ecosystems within the field survey area that have potential to be impacted by the Proposed Development, Volume III (Document reference 6.3, DCO Volume 6).

4.2.329 No karst features have been mapped from data provided by third parties, with the majority of mapped potential karst features to the north of the Proposed Development (within the chalk bedrock of the South Downs).

Groundwater levels

4.2.330 Multiple active EA groundwater monitoring boreholes are located in the wider area around Section K of the Pipeline.

4.2.331 At the eastern end of Section K of the Pipeline, the Sandboils and Northbrook monitoring wells are located north-east of the Pipeline, as described in paragraphs 4.2.301 to 4.2.303.

4.2.332 The Winters Hill Chalk borehole is located north-east of the Pipeline, adjacent to Winters Hill Road. The borehole has a datum of 41.95m AOD, and is 40.13m deep, recording in the Lewes Nodular Chalk Member. The borehole has been monitored since 2001 twice annually (spring and autumn). Groundwater levels have varied from 33.87m AOD to 41.95m AOD (ground level).

4.2.333 Durley Hall Road is located south of the Pipeline. The borehole has a datum of 60.2m AOD and is 116m deep, recording in the Chalk Group (undivided). The borehole has been monitored since 2001 multiple times a year. Groundwater levels have varied from 14.46m AOD to 46.18m AOD but are generally in the order of 30-40m AOD. Based on the data, the lower groundwater levels on the hydrograph are assumed to be influenced by an anthropogenic source (such as local abstraction).

4.2.334 Hatchley Lane borehole is located to the north-west and has a datum of 40.23m AOD. The borehole extends to 40m bgl and screened in the Lambeth Group sands (undivided). The monitoring data commences in 2001 and ranges from 27.89m AOD to 40.23m AOD (ground level).

4.2.335 Site specific groundwater levels from the Ground Investigation boreholes indicate relatively shallow groundwater levels from 0.0m bgl (in 2K5501SR) to 2.28m bgl (in 2K5500SR).

4.2.336 Perched groundwater may be encountered within overlying superficial deposits at a higher elevation than the general groundwater table, where present (assumed to be present when considering potential impacts).

Groundwater quality

4.2.337 The geotechnical and geo-environmental interpretative report for Ground Investigation in Section K (Phase 2 and Phase 3B/3C) (see ES Appendix 11.2 Ground investigation reports, Volume II (Document reference 6.2, DCO Volume 6)) discusses the groundwater sampling undertaken in Section K and provides an assessment of the groundwater quality against Environmental Quality Standards. ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6), discusses water quality impacts from land contamination, which are not duplicated in this HIA.

Groundwater flooding

4.2.338 Hampshire has a known history of groundwater flooding as discussed in paragraphs 4.2.33 and 4.2.34.

4.2.339 ES Figure 19.12 Groundwater flooding susceptibility, Volume III (Document reference 6.3, DCO Volume 6) shows the susceptibility to groundwater flooding dataset, which identifies areas where further consideration of groundwater flood risk may need to be considered.

4.2.340 The figure indicates that there is no, or limited susceptibility to groundwater flooding in the majority of Section K of the Pipeline. Some susceptibility to groundwater flooding is identified in association with the Main River Hamble and its tributaries.

4.2.341 Flooding is discussed in further detail in ES Appendix 19.1 Flood Risk Assessment, Volume II (Document reference 6.2, DCO Volume 6).

Abstractions

4.2.342 One licensed groundwater abstraction is located within the study area, as documented in Table 4-41.

Table 4-41 Licensed groundwater abstractions – Section K: The River Hamble to Lower Upham

Licence holder	Licence no.	Use	Point name
Portsmouth Water	11/42/25.2/50	PWS	Lower Upham

4.2.343 A licensed surface water abstraction is mapped within the study area, downstream of the River Hamble crossing, Licence 11/42/25.2/54: River Hamble at Durley – For agriculture/irrigation.

4.2.344 WCC provided details on a number of licensed and unlicensed abstractions (less than 20m^3/d) within their administrative area. One unlicensed abstraction is located

within the study area, The Granary unlicensed abstraction approximately 900m south-west of the Pipeline (proximal to Main River Hamble).

4.2.345 Abstractions within the study area are illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Discharges

4.2.346 Discharge consents located within the study area are summarised in Annex B and illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Section L: Lower Upham to Brambridge

Topography

4.2.347 Travelling from east to west of Section L of the Pipeline, over the first approximately 3km the topography undulates and gradually falls from approximately 45m AOD to 30m AOD. The elevation rises relatively rapidly at Crowdhill to approximately 50m AOD before falling to approximately 20m AOD as the Pipeline crosses Bow Lake. The topography subsequently undulates between 20m AOD and 33m AOD before falling to approximately 20m AOD where the Pipeline crosses a tributary of the River Itchen.

Environmentally designated sites

4.2.348 The SDNP is located to the north-east of the Pipeline.

4.2.349 The River Itchen in the west of the study area is a SSSI and SAC designated chalk river. The EA also designates the River Itchen as a GWDTE.

4.2.350 No SPZs directly underlie the Order Limits, although the majority of the northern half of the study area is covered by SPZs in relation to the Applicant's Otterbourne and private Fisher's Pond abstractions. In the east of the study area, the Lower Upham abstraction SPZ is mapped as discussed in paragraph 4.2.318.

4.2.351 Environmental designations along the Order Limits are illustrated in ES Figure 8.1 Statutory designated sites within the Order Limits plus a 2km buffer, Volume III (Document reference 6.3, DCO Volume 6), with SPZs shown on ES Figure 19.8 Water resources in Volume III (Document reference 6.3, DCO Volume 6).

Surface water bodies

4.2.352 The study area includes a number of surface water catchment areas, as summarised in Table 4-42.

Table 4-42 Surface water catchments in study area – Section L: Lower Upham to Brambridge

	Horton Heath Stream	Upper Hamble	Bow Lake	Itchen River	Itchen Navigation
Water Body ID	GB107042016270	GB107042016280	GB107042016650	GB10704202 25	GB707100 08

	Horton Heath Stream	Upper Hamble	Bow Lake	Itchen River	Itchen Navigation
River Basin District	South East	South East	South East	South East	South East
Hydromorphological Designation	Heavily Modified	Not designated artificial or heavily modified	Not designated artificial or heavily modified	Not designated artificial or heavily modified	Heavily modified (Canal)
Current Ecological	Good	Moderate	Bad	Good	Good
Current Chemical	Fail	Fail	Fail	Fail	Fail
Ecological Objective	Good	Good	Good	Good	Good
Chemical Objective	Good	Good	Good	Good	Good

4.2.353 The Pipeline crosses two main surface watercourses in Section L of the Pipeline:

Bow Lake

River Itchen

4.2.354 Surface water catchments and main rivers are illustrated in ES Figure 19.1 Surface water features, Volume III (Document reference 6.3, DCO Volume 6).

Superficial deposits

4.2.355 Table 4-43 details the superficial geology in the study area.

Table 4-43 Superficial deposits within study area – Section L: Lower Upham to Brambridge

Geology	Description	Location and prevalence	Mapped within the Order Limits
Alluvium	Clay, Silt, Sand and Gravel	Alluvium is mapped primarily in the west of the study area associated with the River Itchen and its tributaries, together with along Bow Lake. Alluvium is mapped within the Order Limits where the Pipeline crosses Bow Lake	Yes
Tufa	Tufa, Calcareous	Small area of Tufa in the north-west of the study area associated with the River Itchen	No
River Terrace Deposits	Sand and Gravel	Mapped in the west of the study area associated with the River Itchen, and in the north-east of the study area associated with the upper reaches of Bow Lake. Underlying the Order Limits in the west of Section L, where the Pipeline crosses the tributary of the River Itchen	Yes

Geology	Description	Location and prevalence	Mapped within the Order Limits
Head	Clay, Silt, Sand and Gravel	Mapped to the north-east of the Pipeline around Fisher's Pond and also to the north-east of the east of Section L.	No
Clay-With-Flints-Formation	Clay, Silt, Sand and Gravel	Mapped in the north-east of the study area upgradient of the Pipeline	No
No superficial cover	-	No superficial deposits are mapped in the majority of the study area, including underlying the Order Limits except where the Pipeline crosses Bow Lake and towards the River Itchen	Yes

4.2.356 Phase 1, 2, 3B and 3C Ground Investigation data has been accessed in a number of locations within Section L of the Pipeline, which has confirmed the local nature of the superficial deposits:

1. BH501 (west of the River Itchen tributary crossing, east of the main River Itchen crossing): 0.4m of Topsoil is underlain by gravels (River Terrace Deposits). The gravels extend down to 3.5m bgl (19.86m AOD) where the London Clay bedrock is encountered.
2. 2L6002SA: 0.25m of Made Ground underlain by bedrock. London Clay Formation encountered at 0.25m bgl (42.50m AOD).
3. 2L6003SA: 0.15m of Made Ground underlain by bedrock. London Clay Formation encountered at 0.15m bgl (41.12m AOD).
4. 2L6005SA: 0.70m of Made Ground underlain by bedrock. London Clay Formation encountered at 0.70m bgl (34.84m AOD).
5. 2L6007DR: 0.20m of Made Ground underlain by clay (Alluvium). Alluvium extends to 2.0m bgl (23.02m AOD) where it is underlain by bedrock (London Clay).
6. 2L6008DR: 0.30m of Made Ground underlain by clay (Alluvium). Alluvium underlain by clay (River Terrace Deposits) at 1.80m bgl (23.22m AOD) which sits on bedrock (London Clay) at 2.75m bgl (22.27m AOD).
7. 2L6009DR (south of Bow Lake): 0.4m of Made Ground underlain by clay (Alluvium) to 0.7m bgl (22.42m AOD). Alluvium underlain by gravel (River Terrace Deposits) to 0.9m bgl (22.22m AOD). Clay (possible Head Deposits) underlies the River Terrace Deposits to 2.55m bgl (20.57m AOD) where London Clay bedrock is encountered. c2L6010DR (north of Bow Lake): 0.4m of Topsoil is underlain by clays and gravels (River Terrace Deposits) to 3.9m bgl (19.68m AOD). London Clay bedrock encountered below the River Terrace Deposits.
8. 2L6011SR (east of the River Itchen tributary crossing): 0.50m of Made Ground is underlain by clayey gravel (River Terrace Deposits). The gravel extends to bedrock (London Clay Formation) 2.2m bgl (19.15m AOD).

9. 2L6012SR (west of the River Itchen tributary crossing):0.15m of Made Ground is underlain by sands and clays (River Terrace Deposits). The River Terrace Deposits extend to 2.4m bgl (18.26m AOD) where they overlie bedrock (London Clay Formation).
10. 3L6101DS: 0.29m of Topsoil underlain by London Clay Formation. London Clay encountered at 0.29m (40.77m AOD).
11. 3L6106DS: 0.35m of Made Ground underlain by London Clay Formation. London Clay encountered at 0.35m bgl (36.52m AOD).
12. 3L6107DS: 0.3m of Made Ground underlain by Lambeth Group. Lambeth Group encountered at 0.35m bgl (35.65m AOD).

Bedrock geology

4.2.357 Table 4-44 details the bedrock geology in the study area.

Table 4-44 Bedrock geology in study area – Section L: Lower Upham to Brambridge

Geology	Description	Location and prevalence	Mapped within Order Limits
London Clay Formation	Clay, Silt and Sand	Covers most of the study area and nearly all of the Pipeline (with the exception being a small area in the north-east of the Order Limits)	Yes
Whitecliff Sand Member	Sand	Mapped in the south of the study area at distance from the Order Limits	No
Durley Sand Member	Sand	Mapped in small area (east of Hall Lands Copse) in the south of study area at distance from the Order Limits	No
Wittering Formation	Sand, Silt and Clay	Mapped in small area (around Crowd Hill) in the south of the study area at distance from the Order Limits	No
Lambeth Group	Clay, Silt and Sand	Mapped as a thick band across the north of the study area. Mapped underlying the Order Limits in the north-east (where the Order Limits connect to Portsmouth Road)	Yes
Lambeth Group	Sand	Mapped in the north-west of the study area	No
Tarrant Chalk Member	Chalk	Mapped in the South Downs, to the north-east and north-west of the study area	No

4.2.358 Phase 1, 2, 3B and 3C Ground Investigation data has been accessed in a number of locations within Section L of the Pipeline, which has confirmed the local nature of the bedrock:

1. 2L6002SA: London Clay bedrock encountered at 0.25m bgl (42.50m AOD) which extends to the base of the borehole 15.45m bgl (27.30m AOD).
2. 2L6003SA: London Clay bedrock encountered 0.15m bgl (41.12m AOD) which extends to the base of the borehole 15.95m bgl (25.32m AOD).

3. 2L6005SA: London Clay bedrock encountered 2.4m bgl (33.14m AOD) which extends to the base of the borehole 10.0m bgl (25.54m AOD).
4. 2L6007DR: London Clay bedrock encountered at 2.0m bgl (23.02m AOD) which extends to 17.85m bgl (7.17m AOD). The Lambeth Group underlies the London Clay to the base of the borehole 20.0m bgl (5.02m AOD).
5. 2L6008DR: London Clay bedrock encountered at 2.75m bgl (22.27m AOD) which extends to 15.8m bgl (9.22m AOD). Underlying the London Clay is the Harwich Formation (Swanscombe Member) which extends to 18.65m bgl (6.37m AOD). Lambeth Group underlies the Harwich Formation to the base of the borehole 20.1m bgl (4.92m AOD).92L6009DR (south of Bow Lake): London Clay bedrock encountered 2.55m bgl (20.57m AOD) which extends to the base of the borehole 20.0m bgl (3.12m AOD).
6. 2L6010DR (north of Bow Lake): London Clay bedrock encountered below the River Terrace Deposits at 3.9m bgl (19.68m AOD) which extends to 17.8m bgl (5.78m AOD). Underlying the London Clay is the Lambeth Group which extends to the base of the borehole 20.0m bgl (3.58m AOD).
7. BH501 (east of the main River Itchen crossing, west of the River Itchen tributary crossing): London Clay bedrock is encountered at 3.7m bgl (19.76m AOD) which extends to 17.25m bgl (6.01m AOD). The Lambeth Group underlies the London Clay to 42.05m bgl (-18.79m AOD) where the chalk is encountered to the base of the borehole at 45.15m bgl (-21.89m AOD).t2L6011SR (east of the River Itchen tributary crossing): London Clay bedrock encountered at 2.2m bgl (19.15m AOD). The London Clay extends to 12.4m bgl (8.95m AOD) where it overlies the Harwich Formation (identified as possible Harwich Formation Swanscombe Member or Lambeth Group). The Harwich Formation overlies sands and clays of the Lambeth Group at 16.1m bgl (5.25m AOD). The Lambeth Group extends to the base of the borehole 20.0m bgl (1.35m AOD).t2L6012SR (west of the River Itchen tributary crossing): London Clay bedrock encountered at 2.4m bgl (18.26m AOD). London Clay extends to 15.35m bgl (5.31m AOD) where the Harwich Formation is encountered. The Harwich Formation overlies sands and clays of the Lambeth Group at 15.6m bgl (5.06m AOD). The Lambeth Group extends to the base of the borehole 20.0m bgl (0.66m AOD).
8. 3L6101DS: London Clay encountered at 0.29m (40.77m AOD) to 2.0m bgl where underlain by Lambeth Group to base of borehole 6.45m bgl (34.61m AOD).
9. 3L6106DS: London Clay encountered at 0.35m bgl (36.52m AOD) to base of borehole 6.45m bgl (30.42mAOD).
10. 3L6107DS: Lambeth Group encountered at 0.35m bgl (35.65m AOD) to base of borehole 6.45m bgl (29.55m AOD).

Groundwater-surface water interactions (springs, sinks, karst, groundwater dependent terrestrial ecosystems)

4.2.359 The River Itchen is a groundwater dependent SSSI and SAC designated chalk stream.

4.2.360 Springs and seepages are likely to be present below and in the banks of local surface watercourses. Known potential and ground-truthed springs within the area have been identified and plotted in ES Figure 19.2 Groundwater features, Volume III (Document reference 6.3, DCO Volume 6), based on OS mapping, data provided by Portsmouth Water and site surveys.

4.2.361 Non-designated GWDTE have been identified from priority habitat, NVC and UKHab data as summarised in ES Appendix 8.2 Habitats, Volume II (Document reference 6.2, DCO Volume 6) and ES Figure 8.8 UK Habitat classification for potential groundwater dependent terrestrial ecosystems within the field survey area that have potential to be impacted by the Proposed Development, Volume III (Document reference 6.3, DCO Volume 6).

4.2.362 No karst features have been mapped from data provided by third parties, with the majority of mapped potential karst features to the north of the Proposed Development (within the chalk bedrock of the South Downs).

Groundwater levels

4.2.363 EA groundwater monitoring borehole Hatchley Lane is located to the north of the Pipeline and has a datum of 40.23m AOD. The borehole extends to 40m bgl and is screened in the Lambeth Group sands (undivided). The monitoring data commences in 2001 and ranges from 27.89m AOD to 40.23m AOD (ground level).

4.2.364 Site-specific groundwater monitoring from the Ground Investigation boreholes indicate seasonally influenced shallow groundwater levels from 0.0m bgl (2L6007DR, 2L6008DR, 2L6009DR, 2L6011SR) to 1.86m bgl (BH501). The monitoring data for BH501 at the western end of the Pipeline is discussed in paragraph 4.2.398.

4.2.365 Perched groundwater may be encountered within overlying superficial deposits at a higher elevation than the general groundwater table, where present (assumed to be present when considering potential impacts).

Groundwater quality

4.2.366 The geotechnical and geo-environmental interpretative report for Ground Investigation in Section L (Phase 2 and Phase 3B/3C) (see ES Appendix 11.2 Ground investigation reports, Volume II (Document reference 6.2, DCO Volume 6)) discusses the groundwater sampling undertaken in Section L and provides an assessment of the groundwater quality against Environmental Quality Standards. ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6), discusses water quality impacts from land contamination, which are not duplicated in this HIA.

Groundwater flooding

4.2.367 Hampshire has a known history of groundwater flooding as discussed in paragraphs 4.2.33 and 4.2.34.

4.2.368 ES Figure 19.12 Groundwater flooding susceptibility, Volume III (Document reference 6.3, DCO Volume 6) shows the susceptibility to groundwater flooding

dataset, which identifies areas where further consideration of groundwater flood risk may need to be considered.

4.2.369 The figure indicates that there is generally no or limited susceptibility to groundwater flooding in the majority of Section L of the Pipeline, except around Bow Lake and the River Itchen (and associated tributaries).

4.2.370 Flooding is discussed in further detail in ES Appendix 19.1 Flood Risk Assessment, Volume II (Document reference 6.2, DCO Volume 6).

Abstractions

4.2.371 Six licensed groundwater abstractions are located within the study area, as documented in Table 4-45.

4.2.372 It is noted that the point names on the EA licenses do not always correlate to the site operational names for the wells and boreholes, and that the grid references for the abstraction licenses provided by the EA do not correlate with the actual locations of the infrastructure (for security reasons accurate grid references are not provided).

Table 4-45 Licensed groundwater abstractions – Section L: Lower Upham to Brambridge

Licence holder	Licence no.	Use	Point name
Fisher's Pond Ltd	11/42/22.9/160	Agriculture – Fish Farm/Cress Pond Throughflow	Fisher's Pond Point A
Fisher's Pond Ltd	11/42/22.9/160	Agriculture – Fish Farm/Cress Pond Throughflow	Fisher's Pond Borehole C
Fisher's Pond Ltd	31/089	Agriculture – Fish Farm/Cress Pond Throughflow	Swifts Farm, Fisher's Pond
Hampshire Carp Hatcheries	SO/042/0031/030	Agriculture – Fish Farm/Cress Pond Throughflow	Bowlake Fish Farm Borehole at Point A
Southern Water Services	11/42/22.7/94	Environmental – Make-up or top up water	Otterbourne PS Point E
Southern Water Services	11/42/22.7/94	Environmental – Make-up or top up water	Otterbourne PS Point F

4.2.373 During the groundwater feature surveys, the Otterbourne WSW site was visited with the location of abstraction boreholes (referenced A to H) and abstraction wells (referenced A to F) identified on-site. A number of the wells, such as Otterbourne PS Point E and Point F, are within the 1km study area of Section L.

4.2.374 A number of licensed surface water abstractions are also located within the study area for Section L of the Pipeline, as follows:

1. Licence SO/042/0031/007: Fisher's Pond Ltd – Point A, Marwell Manor Farm, Fisher's Pond - Agriculture: Fish Farm/Cress Pond Throughflow.
2. Licence 31/090: Fisher's Pond Ltd – Thompson Lane, Fisher's Pond (Points A and B) - Agriculture: Fish Farm/Cress Pond Throughflow.

3. Licence 11/42/22.9/159: Fisher's Pond Ltd – Trib of Bow Lake Stream at Fisher's Pond - Agriculture: Fish Farm/Cress Pond Throughflow.
4. Licence 11/42/22.9/163: Hampshire Carp Hatcheries – Bow Lake Stream at Stoke Common – Agriculture: Fish Farm/Cress Pond Throughflow.

4.2.375 WCC and EBC provided details on a number of licensed and unlicensed abstractions (less than 20m^3/d) within their administrative areas. Three unlicensed abstractions are located within the study area, as summarised below:

1. Lowhill Farmhouse private water supply approximately 60m south of the Pipeline.
2. Marwell Manor private water supply approximately 500m north-east of the Pipeline.
3. Stoke Park Farm private water supply approximately 700m south-west of the Pipeline.

4.2.376 Abstractions within the study area are illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Discharges

4.2.377 Discharge consents located within the study area are summarised in Annex B and illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Section M: Brambridge to Otterbourne Water Supply Works

Topography

4.2.378 As the Pipeline travels from east to west underneath the River Itchen, topography undulates between approximately 17.0m AOD and 21.0m AOD. As the Pipeline diverts north, it rises to approximately 25.0m AOD. The topography remains relatively level between 23.0m AOD and 28.0m AOD, before falling where Pipeline crosses the River Itchen tributary south of Otterbourne WSW.

Environmentally designated sites

4.2.379 The SDNP is located to the east and north-east of the Pipeline.

4.2.380 The River Itchen, which is crossed by the Order Limits, is a SSSI and SAC designated chalk river. The EA also designates the River Itchen as a GWDTE.

4.2.381 The Order Limits are underlain by either the SPZ1c (south of Kiln Lane) or SPZ1 (north of Kiln Lane) associated with the Applicant's Otterbourne WSW abstractions.

4.2.382 Environmental designations along the Order Limits are illustrated in ES Figure 8.1 Statutory designated sites within the Order Limits plus a 2km buffer, Volume III (Document reference 6.3, DCO Volume 6), with SPZs shown on ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Surface water bodies

4.2.383 The study area includes a number of surface water catchment areas, as summarised in Table 4-46.

Table 4-46 Surface water catchments in study area – Section M: Brambridge to Otterbourne Water Supply Works

	Monks Brook	Bow Lake	River Itchen	Itchen Navigation
Water Body ID	GB107042016310	GB107042016650	GB1070420225	GB70710008
River Basin District	South East	South East	South East	South East
Hydromorphological Designation	Heavily Modified	Not designated artificial or heavily modified	Not designated artificial or heavily modified	Heavily modified (Canal)
Current Ecological	Moderate	Bad	Good	Good
Current Chemical	Fail	Fail	Fail	Fail
Ecological Objective	Good	Good	Good	Good
Chemical Objective	Good	Good	Good	Good

4.2.384 Section M of the Pipeline crosses the River Itchen (designated SSSI and SAC chalk stream) and the Itchen Navigation. A tributary of the River Itchen (Poles Lane Stream) is also crossed within the SPZ1 associated with the Otterbourne WSW.

4.2.385 Surface water catchments and main rivers are illustrated in ES Figure 19.1 Surface water features, Volume III (Document reference 6.3, DCO Volume 6).

Superficial deposits

4.2.386 Table 4-47 details the superficial geology in the study area.

Table 4-47 Superficial deposits in study area – Section M: Brambridge to Otterbourne Water Supply Works

Geology	Description	Location and prevalence	Mapped within Order Limits
Alluvium	Clay, Silt, Sand and Gravel	Mapped extensively within the study area associated with the River Itchen and its tributaries. Alluvium mapped underlying the Order Limits at the River Itchen crossing and the tributary crossing south of Otterbourne WSW	Yes
Tufa	Tufa, Calcareous	Mapped in the north-east of the study area, associated with the River Itchen	No
River Terrace Deposits	Sand and Gravel	Mapped extensively within the study area, in associated with the River Itchen and its tributaries. River Terrace Deposits mapped	Yes

Geology	Description	Location and prevalence	Mapped within Order Limits
		underlying the Order Limits at both the main River Itchen crossing (including at the drive and reception shafts/pits) and the crossing of the tributary just south of Otterbourne WSW	
Head	Clay, Silt, Sand and Gravel	Mapped in the north of the study area, with a small area mapped within the Order Limits at Otterbourne WSW	Yes
Clay-With-Flints-Formation	Clay, Silt, Sand and Gravel	Mapped in the north of the study area, with a limited area mapped within the Order Limits (north-east and north-west of Otterbourne WSW site)	Yes
No superficial cover	-	No superficial deposits mapped in the west of the study area, including in the location of the Order Limits as it travels northwards and crosses Kiln Lane	Yes

4.2.387 Phase 1, 2 and 3A Ground Investigation data has been accessed in a number of locations within Section M of the Pipeline, which has confirmed the local nature of the superficial deposits. A summary of a selection of these is noted below:

1. BH501 (east of the River Itchen): 0.4m of Topsoil is underlain by gravels (River Terrace Deposits). The gravels extend down to 3.5m bgl (19.86m AOD) where the London Clay bedrock is encountered.
2. BH502 (west of the River Itchen): 0.3m of Topsoil is underlain by gravels (River Terrace Deposits). The gravels extend to 4.25m bgl (12.84m AOD) where the London Clay bedrock is encountered.
3. BH503 (west of the River Itchen): 0.2m of Topsoil is underlain by clays and gravels (Alluvium). The Alluvium extends to 2.1m bgl (18.36m AOD) where the London Clay bedrock is encountered.
4. BH504 (west of the River Itchen): 0.25m of Topsoil is underlain by clays and silts (River Terrace Deposits). The River Terrace Deposits extend to 2.89m bgl (21.12m AOD) where the London Clay bedrock is encountered.
5. 2M6507SA (south of the River Itchen tributary south of Otterbourne WSW): 0.3m of Topsoil is underlain by sands (River Terrace Deposits) down to 5.7m bgl (20.45m AOD). Lambeth Group bedrock is encountered beneath the River Terrace Deposits.
6. 2M6508SA (north of the River Itchen tributary south of Otterbourne WSW): 0.3m of Topsoil is underlain by clay (Alluvium) down to 2.55m bgl (20.7m AOD). Sand (River Terrace Deposits) is encountered beneath the clay to a depth of 4.5m bgl (18.75m AOD) at which chalk bedrock is encountered.
7. BH505: 0.35m of Topsoil overlying River Terrace Deposits to 5.45m bgl. London Clay encountered at 5.45m bgl (11.56m AOD).
8. BH506: 0.40m of Topsoil overlying Head Deposits to 1.0m bgl and subsequently River Terrace Deposits to 1.3m bgl. London Clay encountered at 1.3m bgl (21.37m AOD).

9. BH507-D: 0.86m of Made Ground overlying possible Alluvium to 3.4m bgl. London Clay encountered at 3.4m bgl (16.09m AOD).

Bedrock geology

4.2.388 Table 4-48 details the bedrock geology in the study area.

Table 4-48 Bedrock geology in study area – Section M: Brambridge to Otterbourne Water Supply Works

Geology	Description	Location and prevalence	Mapped Within the Order Limits
London Clay Formation	Clay, Silt and Sand	Mapped in the majority of the southern half of the study area, including underlying the Order Limits at the main River Itchen crossing	Yes
Whitecliff Sand Member	Sand	Mapped in the south-west of the study area within the London Clay	No
Whitecliff Sand Member	Sand and Gravel	Mapped in the west of the study area within the London Clay	No
Wittering Formation	Sand, Silt and Clay	Two isolated areas along the south-western edge of the study area	No
Lambeth Group	Clay, Silt and Sand	Mapped as a band trending south-east-north-west across the study area. Mapped within the Order Limits south-west of Otterbourne WSW including partly underlying the tributary of the River Itchen crossing	Yes
Lambeth Group	Sand	Mapped as a band trending south-east-north-west across the study area. Mapped within the Order Limits as the Pipeline travels north towards Otterbourne, including at the Kiln Lane crossing	Yes
Tarrant Chalk Member	Chalk	Mapped in the north-east of the study area	No
Culver Chalk Formation	Chalk	Mapped in the north of the study area, including underlying the majority of Otterbourne WSW within the Order Limits	Yes
Newhaven Chalk Formation	Chalk	North of the Culver Chalk Formation and Tarrant Chalk Member, in the north-east of the study area	No

4.2.389 Phase 1, 2 and 3A Ground Investigation data has been accessed in a number of locations within Section M of the Pipeline, which has confirmed the local nature of the bedrock. A summary of a selection of these is noted below:

1. BH501 (east of the River Itchen): London Clay bedrock is encountered at 3.7m bgl (19.76m AOD) which extends to 17.25m bgl (6.01m AOD). The Lambeth

Group underlies the London Clay to 42.05m bgl (-18.79m AOD) where the chalk is encountered to the base of the borehole at 45.15m bgl (-21.89m AOD).

2. BH502 (west of the River Itchen): London Clay is encountered at 4.25m bgl (12.84m AOD) which extends to the base of the borehole 25.0m bgl (-7.91m AOD) A number of sand bands (Bognor Sand Member) and zones of core loss were recorded within the borehole.
3. BH503 (west of the River Itchen): London Clay bedrock is encountered 2.1m bgl (18.36m AOD) which extends to 28.55m bgl (-8.09m AOD) and includes thick sand beds (Bognor Sand Member). Underlying the London Clay is the Lambeth Group which extends to 44.05m bgl (-23.59m AOD). Chalk underlies the Lambeth Group to the base of the borehole 55.0m bgl (-34.54m AOD).
4. BH504 (west of the River Itchen): London Clay bedrock is encountered 2.89m bgl (21.12m AOD) which extends to approximately 24.5m bgl (-0.49m AOD) and includes significant beds of sand (Bognor Sand Member). The Lambeth Group underlies the London Clay and extends to approximately 36.5m bgl (-12.49m AOD). The Lambeth Group overlies the chalk bedrock.
5. 2M6507SA (south of the River Itchen tributary south of Otterbourne WSW): Lambeth Group bedrock is encountered beneath the River Terrace Deposits at 5.7m bgl (20.45m AOD). The Lambeth Group is underlain by the chalk at 14.1m bgl (12.05m AOD) to the base of the borehole 20.0m bgl (6.15m AOD).
6. 2M6508SA (north of the River Itchen tributary south of Otterbourne WSW): chalk bedrock encountered at 4.5m bgl (18.75m AOD) which extends to the base of the boreholes 20.45m bgl (2.80m AOD).
7. BH505: London Clay encountered at 5.45m bgl (11.56m AOD) to base of borehole 16.5m bgl (0.51m AOD).
8. BH506: London Clay encountered 1.3m bgl (21.37m AOD) to 29.75m bgl and underlain by Lambeth Group (Reading Formation) to 42.0m bgl. Upnor Formation encountered from 42.0m bgl to 43.75m bgl with White Chalk subgroup underlying (Culver Chalk Formation) to base of hole 55.7m bgl (-33.03m AOD).
9. BH507-D: London Clay encountered 3.4m bgl (16.09m AOD) to 24.45m bgl and underlain by Lambeth Group (Reading Formation) to 36.0m bgl. Upnor Formation encountered from 36.0m bgl to 37.75m bgl with White Chalk subgroup underlying (possible Culver Chalk Formation) to base of hole 40.6m bgl (-21.11m AOD).

Groundwater-surface water interactions (springs, sinks, karst, groundwater dependent terrestrial ecosystems)

4.2.390 As discussed in paragraph 4.2.349, the River Itchen is a groundwater dependent SSSI and SAC designated chalk stream and is designated as a GWDTE by the EA.

4.2.391 Springs and seepages are likely to be present below and in the banks of local surface watercourses. Known potential and ground-truthed springs within the area have been identified and plotted in ES Figure 19.2 Groundwater features, Volume III (Document reference 6.3, DCO Volume 6), based on OS mapping, data provided by Portsmouth Water and site surveys.

4.2.392 Non-designated GWDTE have been identified from priority habitat, NVC and UKHab data as summarised in ES Appendix 8.2 Habitats, Volume II (Document reference 6.2, DCO Volume 6) and ES Figure 8.8 UK Habitat classification for potential groundwater dependent terrestrial ecosystems within the field survey area that have potential to be impacted by the Proposed Development, Volume III (Document reference 6.3, DCO Volume 6).

4.2.393 No karst features have been mapped from data provided by third parties, with the majority of mapped potential karst features to the north of the Proposed Development (within the chalk bedrock of the South Downs). However rapid flow is detected at Otterbourne which supports the presence of karst in the area.

Groundwater levels

4.2.394 Multiple active EA groundwater monitoring boreholes are located in the wider area around Section M of the Pipeline.

4.2.395 Twyford Moors is located east of Otterbourne WSW. The borehole has a datum of 37.07m AOD, extends to 29m bgl and is screened in the Newhaven Chalk Member. The borehole has been manually dipped monthly since 1988, with levels varying from 21.18m AOD (2005) to 26.98m AOD (2014).

4.2.396 Oakwood Copse is located west of Otterbourne WSW. The borehole has a datum of 38.9m AOD, extends to 34.4m bgl and is screened in the Spetisbury Chalk Member. The borehole has been manually dipped monthly since 1988, with levels varying from 16.6m AOD to 24.62m AOD (2014). The deeper monitored levels are considered to likely be as a result of pumping from Otterbourne WSW, with water levels generally in the order of 20.0m AOD to 23.0m AOD.

4.2.397 Highways Road is located north-west of Otterbourne WSW. The borehole has a datum of 52.43m AOD, extends to 43.3m bgl and is screened in the Spetisbury Chalk Member. The borehole has been manually dipped since 1988, with levels varying from 24.14m AOD to 33.68m AOD, with the exception of December 2023 where a level of 40.27m AOD was measured.

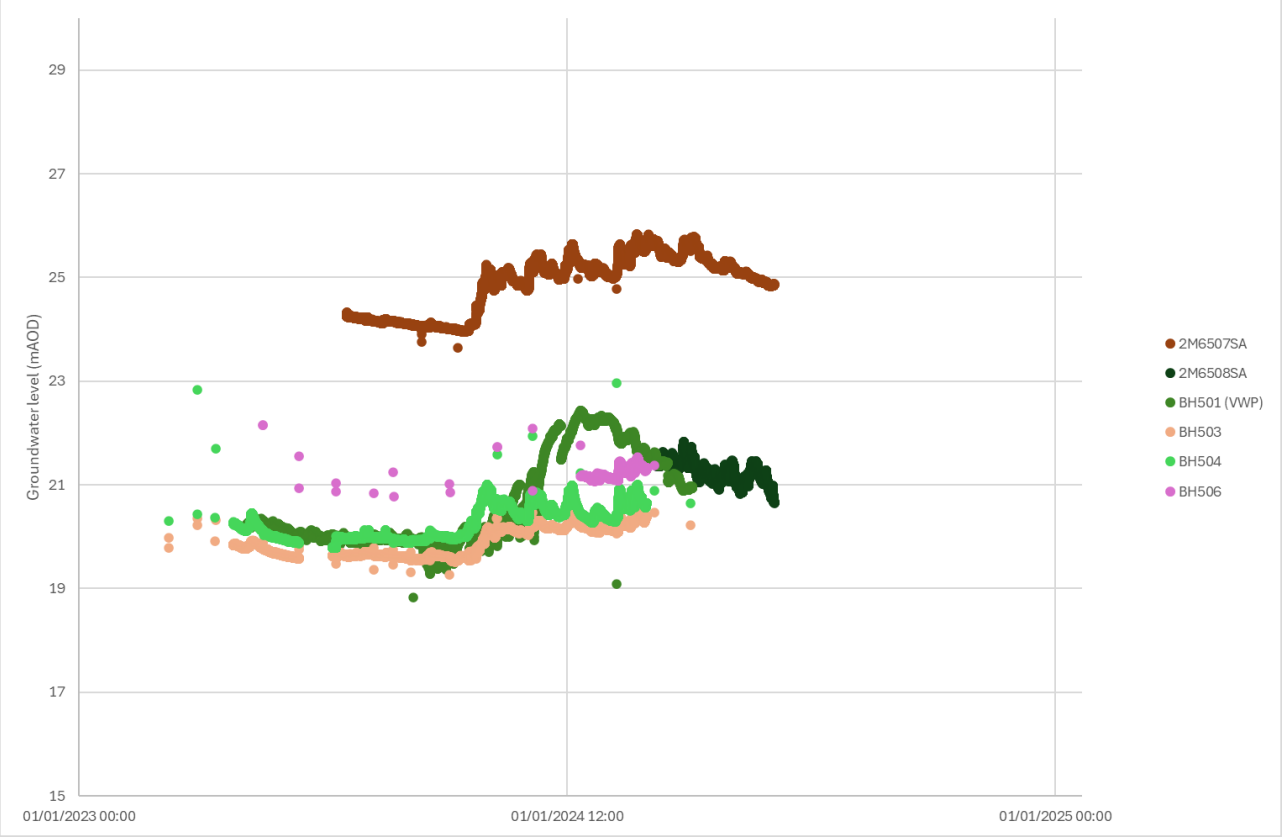
4.2.398 Site specific groundwater monitoring has been undertaken in a number of the Ground Investigation boreholes as summarised below:

1. BH501: Standpipe with response zone 1.0 to 2.1m bgl (screened in the River Terrace Deposits) and a vibrating wire piezometer installed to 32m bgl (within the Lambeth Group). Standpipe manually dipped monthly.
2. BH502: Standpipe installed 0.9 to 3.0m bgl (screened in the River Terrace Deposits). Standpipe manually dipped monthly.
3. BH503: Two standpipes with response zone 1.0 to 2.1m bgl (screened in the Alluvium) and 30.0 to 35.6m bgl (screened in the Lambeth Group). Data logger installed in deeper standpipe with shallower standpipe manually dipped monthly.
4. BH504: Two standpipes with response zones 0.9 to 3.0m bgl (screened in the River Terrace Deposits) and 12.0 to 17.6m bgl (screened in the London Clay – Bognor Sand Member). Data logger installed in deeper standpipe with shallower standpipe manually dipped monthly.

5. 2M6507SA: Two standpipes with response zones 1.0 to 4.0m bgl (screened in the River Terrace Deposits) and 9.7 to 10.0m bgl (screened in the Lambeth Group). Data logger installed in shallower standpipe with deeper standpipe manually dipped monthly.
6. 2M6508SA: One standpipe with response zone 7.0 to 20.0m bgl (screened in the Culver Chalk Formation. Data logger installed in standpipe.
7. BH505: One standpipe with response zone 1.3 to 3.6m bgl (screened in the River Terrace Deposits). Standpipe manually dipped monthly.
8. BH506: Two standpipes with response zones 1.5 to 4.0m bgl (screened in London Clay Formation) and 20.5 to 26.0m bgl (screened in London Clay Formation). Data logger installed in deeper standpipe with shallower standpipe manually dipped monthly.
9. BH507-D: Two standpipes with response zones 12.0 to 17.6m bgl (screened in London Clay Formation) and 26.0 to 31.6m bgl (screened in Lambeth Group; Reading Formation). Standpipes manually dipped monthly.

4.2.399 The monthly hand dips indicate generally shallow groundwater levels, at or close to ground level. Datalogger data from the boreholes in Section M of the Pipeline is illustrated in Graphic 4-7.

Graphic 4-7 Datalogger Groundwater Monitoring – Section M: Brambridge to Otterbourne Water Supply Works



4.2.400 Perched groundwater may be encountered within the overlying superficial deposits where present (assumed to be present when considering potential impacts).

Groundwater quality

4.2.401 The geo-environmental interpretative report for Phase 1 and 3A Ground Investigation (Shafts and Tunnels) and the geotechnical and geo-environmental interpretative report for Ground Investigation in Section M (Phase 2 and Phase 3B/3C) (see ES Appendix 11.2 Ground investigation reports, Volume II (Document reference 6.2, DCO Volume 6)) discusses the groundwater sampling undertaken in Section M and provide an assessment of the groundwater quality against Environmental Quality Standards. ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6), discusses water quality impacts from land contamination, which are not duplicated in this HIA.

4.2.402 Regionally the vast majority of unconfined groundwaters within the Wessex Basin Chalk are of the Ca-HCO_3 type [9]. The groundwater quality of the superficial deposits and other bedrock strata are likely to be more variable, with shallower groundwaters in the superficial deposits more susceptible to anthropogenic activities.

Groundwater flooding

4.2.403 Hampshire has a known history of groundwater flooding as discussed in paragraphs 4.2.33 and 4.2.34.

4.2.404 ES Figure 19.12 Groundwater flooding susceptibility, Volume III (Document reference 6.3, DCO Volume 6) shows the susceptibility to groundwater flooding dataset, which identifies areas where further consideration of groundwater flood risk may need to be considered.

4.2.405 The figure indicates that the majority of the Pipeline in Section M is susceptible to clearwater groundwater flooding.

4.2.406 Flooding is discussed in further detail in ES Appendix 19.1 Flood Risk Assessment, Volume II (Document reference 6.2, DCO Volume 6).

Abstractions

4.2.407 Nine licensed groundwater abstractions are mapped within the study area, as documented in Table 4-49.

4.2.408 It is noted that the EA point names do not always correlate to the Southern Water site operational names for the wells and boreholes, and that the grid references for the points provided by the EA do not correlate with the actual locations of the infrastructure (for security reasons) which have been ground-truthed during surveys.

Table 4-49 Licensed groundwater abstractions – Section M: Brambridge to Otterbourne Water Supply Works

Licence holder	Licence No.	Use	Point name
Southern Water Services	11/42/22.7/94	Environmental – Make-up or top up water	Otterbourne PS Point E
Southern Water Services	11/42/22.7/94	Environmental – Make-up or top up water	Otterbourne PS Point F

Licence holder	Licence No.	Use	Point name
Southern Water Services	11/42/22.7/94	PWS	Otterbourne PS Point G
Southern Water Services	11/42/22.7/94	PWS	Otterbourne PS Point H
Southern Water Services	11/42/22.7/94	PWS	Otterbourne PS Point A
Southern Water Services	11/42/22.7/94	PWS	Otterbourne PS Point B
Southern Water Services	11/42/22.7/94	PWS	Otterbourne PS Point C
Southern Water Services	11/42/22.7/94	Environmental – Make-up or top up water	Otterbourne PS Point K
Southern Water Services	11/42/22.7/94	Environmental – Make-up or top up water	Otterbourne PS Point D

4.2.409 During the groundwater feature surveys, the Otterbourne WSW site was visited with the location of abstraction boreholes (referenced operationally A to H) and abstraction wells (referenced operationally A to F) identified on-site. No boreholes/wells are within the Order Limits with the exception of Otterbourne Borehole D (Point D), which is understood to have been out of service for over ten years. Several of the boreholes and wells are within the study area. With agreement from the Applicant's operational team, Borehole D could potentially be utilised for future monitoring, as well as other assets on the Otterbourne WSW site (such as access shafts).

4.2.410 A borehole is marked on the OS map south of Kiln Lane and west of the Pipeline, which it has not been possible to locate during site surveys. There is no data available on the decommissioning of this borehole, and as such it is assumed to not have been decommissioned in line with relevant guidance at the time.

4.2.411 A number of licensed surface water abstractions are also located within the study area for Section M of the Pipeline, as follows:

1. Licence SO/042/0031/023: East Lodge Fisheries – Itchen Navigation at Brambridge - Environmental: Remedial River/Wetland Support (Transfer between sources).
2. Licence 11/42/22.6/93: Southern Water Services – River Itchen at the Otterbourne Intake - PWS.
3. Licence SO/042/0031/020: Malms House Ltd – Lower Itchen Navigation at Shawford – Environmental: Non-remedial water/wetland support, Transfer between sources.

4.2.412 WCC and EBC provided details on a number of licensed and unlicensed abstractions (less than 20m^3/d) within their administrative areas.

4.2.413 No EBC unlicensed abstractions were identified within the study area of Section M of the Pipeline. A WCC unlicensed abstraction is located within the study area, as summarised below:

1. Qing Ya Xi (formerly Kingfisher Lodge) private water supply approximately 400m east/south-east of the Pipeline.

4.2.414 Abstractions within the study area are illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

Discharges

4.2.415 Discharge consents located within the study area are summarised in Annex B and illustrated in ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

4.3 Hydrogeological conceptualisation

4.3.1 Based on the regional and local understanding of the study area as outlined in sections 3 and 4.2, Table 4-50 to Table 4-61 summarise the hydrogeological conceptualisation of each section of the Proposed Development.

Table 4-50 Conceptual model for the Water Recycling Plant site and associated pumping stations

Model element	Study area description
Surface topography	The WRP site has elevation in the order of 5-15m AOD. Langstone Harbour located to the south of the study area at an elevation in the order of 2m AOD (submerged at high tide). General increase in topography to north towards the chalk South Downs and steep increase to north-west towards Portsdown Hill chalk ridge.
WER groundwater catchment	Underlain by East Hants Chalk (GB40701G502700) – Poor overall status.
Main groundwater bodies	Superficial deposits: WRP site underlain primarily by Raised Marine Deposits (Secondary undifferentiated aquifer) with some River Terrace Deposits (Secondary A aquifer) mapped towards the north. Made ground/land fill encountered on site. Landfill considered in ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6). Bedrock: WRP site underlain by chalk bedrock (Principal aquifer).
Groundwater flow direction	Main groundwater table generally flowing south towards the sea. Some localised south-easterly groundwater flow from the Portsdown Hill possible. Localised flow in the superficial deposits is likely to be controlled by tidal interaction and surface watercourses.
Approximate groundwater level in Proposed Development study area	Due to elevation compared to surrounding area, groundwater levels greater than 10.0m bgl where elevations are highest. Tidal behaviour observed in groundwater monitoring data due to proximity to the sea.
Regional faults	No significant regional faults identified.
Surface water bodies	To the south of WRP site lies the Langstone Harbour Transitional Water Body. Langstone Harbour designated as a SSSI, SPA, Ramsar and SAC. Hermitage Stream flows towards the sea on the eastern edge of the WRP site.

Model element	Study area description
Groundwater Abstractions Licenses (within 1km)	Portsmouth Water PWS abstractions from the Bedhampton-Havant springs to the north of the WRP site.
SPZs	SPZ 1 located approximately 350m north, associated with the Bedhampton-Havant abstractions.
Groundwater - surface water Interactions (GWSWI)	Numerous springs to the north of the WRP site; the Bedhampton-Havant springs are utilised for PWS and feed some of the minor watercourses in the area. Langstone Harbour to the south is designated as a GWDTE.
Karsts	Karstic systems likely feed Bedhampton Springs, and potentially supports, or interacts with, the Hermitage Stream. Extensive karstic features provide conduits for groundwater to rise from greater depths to the surface or to near-surface high permeability superficial deposits. Vertical and horizontal extent and interconnectivity of karstic system is not fully understood. Some karstic features thought to be linked to a fold axis, and so likely to extend/repeat along this axis. Other karstic features do not align with known fold axes but can be assumed to have similar characteristics.
Recharge	Low permeability Palaeogene and urbanisation retard recharge in the area. Aquifer recharge predominantly anticipated to occur to north in the South Downs.

Table 4-51 Conceptual model for Pipelines between Budds Farm Wastewater Treatment Works and the Water Recycling Plant site (including the Budds Farm Wastewater Treatment Works site)

Model element	Study area description
Surface topography	Relatively shallow topography (4-9m AOD), with higher elevations to the north-west of the alignment (around the WRP site).
WER groundwater catchment	Underlain by East Hants Chalk (GB40701G502700) – Poor overall status.
Main groundwater bodies	Superficial deposits: Underlain by Raised Marine Deposits (Secondary undifferentiated aquifer), beach and tidal flat deposits (Secondary undifferentiated aquifer) and alluvium (Secondary A aquifer). Made Ground/landfill encountered in initial site investigation boreholes. Landfill considered in ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6). Bedrock: Section underlain by chalk bedrock (Principal aquifer).
Groundwater flow direction	Main groundwater table generally flowing south towards the sea. Localised flow in the superficial deposits is likely to be controlled by tidal interaction and surface watercourses.
Approximate groundwater level in Proposed Development study area	Groundwater level in the chalk anticipated to be shallow or potentially flowing artesian in the area, due to the numerous springs. Exception is the WRP site which sits at a higher elevation (groundwater levels greater than 10m bgl at highest elevations). Tidal groundwater behaviour observed in monitoring data, due to proximity to the sea.
Regional faults	No significant regional faults identified.

Model element	Study area description
Surface water bodies	The Pipelines pass beneath the Langstone Harbour transitional water body. The Pipelines cross beneath the Hermitage Stream, which flows south into Langstone Harbour.
Groundwater Abstractions Licences (within 1km)	Portsmouth Water PWS abstractions from the Bedhampton-Havant springs to the north of the WRP site.
SPZs	SPZ 1 located approximately 550m north, associated with the Bedhampton-Havant abstractions.
GWSWI	Numerous springs to the north of the Pipelines between Budds Farm WTW and the WRP site section; the Bedhampton-Havant springs, are utilised for PWS and feed some of the minor watercourses in the area. Langstone Harbour to the south is designated as a GWDTE. Study area partly overlaps the designated site where the Hermitage Stream is crossed.
Recharge	Low permeability Palaeogene and urbanisation retard recharge in the area. Aquifer recharge predominantly anticipated to occur to north in the South Downs.

Table 4-52 Conceptual model for the Pipelines between the Water Recycling Plant site and Havant Thicket Reservoir

Model element	Study area description
Surface topography	Fall in topography from approximately 14m AOD at the WRP site to approximately 4m AOD. Topography then remains relatively level (between 4m AOD and 6.5m AOD) as it travels north into the Bedhampton Springs complex.
WER groundwater catchment	Underlain by East Hants Chalk (GB40701G502700) – Poor overall status.
Main groundwater bodies	Superficial deposits: Pipelines are underlain by River Terrace Deposits (Secondary A aquifer), Alluvium (Secondary A aquifer) and Raised Marine Deposits (Secondary undifferentiated). Made Ground/landfill encountered in initial site investigation boreholes at WRP site. Landfill considered in ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6). Bedrock: Pipelines are underlain by chalk bedrock (Principal aquifer).
Groundwater flow direction	Main groundwater table generally flowing south towards the sea. Localised flow in the superficial deposits likely to be controlled by tidal interaction and surface watercourses.
Approximate groundwater level in Proposed Development study area	Groundwater level in the chalk anticipated to be shallow or potentially flowing artesian in the majority of the area in and around Bedhampton. Exception is the WRP site which sits at a higher elevation. Variable groundwater levels are anticipated in the superficial deposits, with a general trend of higher groundwater levels towards the north away from the sea. Tidal behaviour observed in groundwater monitoring data towards the south due to proximity to the sea.
Regional faults	No significant regional faults identified.

Model element	Study area description
Surface water bodies	Pipelines travel parallel to the Hermitage Stream, crossing a tributary of the Hermitage Stream and Old Mill Dam as it enters the Portsmouth Water Bedhampton site.
Groundwater Abstractions Licenses (within 1km)	Pipeline terminates within the Portsmouth Water Bedhampton PWS site where it connects to the Portsmouth Water pipelines.
SPZs	The north of the Pipelines is situated within a SPZ1, associated with the Portsmouth Water Bedhampton PWS (where the Pipelines connects to the Portsmouth Water pipelines). The Pipelines are anticipated to be above-ground in the location of the SPZ1.
GWSWI	Numerous springs in the Bedhampton-Havant area, including at the Portsmouth Water Bedhampton PWS site, where the Pipelines connects to the Portsmouth Water pipelines. Majority of water courses in the area anticipated to be spring fed in part. Langstone Harbour to the south is designated as a GWDTE.
Recharge	Low permeability Palaeogene and urbanisation retard recharge in the area. Aquifer recharge predominantly anticipated to occur in the north in the South Downs.

Table 4-53 Conceptual model for Section D of the Pipeline between the Water Recycling Plant site and Otterbourne Water Supply Works

Model element	Study area description
Surface topography	From the WRP site the ground elevation increases from approximately 20m AOD to 50m AOD over a relatively short distance, before a more gradual increase to 90m AOD. The topography then falls to approximately 50m AOD at the northern end. The higher topography corresponds to Portsdown Hill.
WER groundwater catchment	South-east of Pipeline within East Hants Chalk (GB40701G502700) – Poor overall status. North-west of Pipeline within South Hants Lambeth Group (GB40702G503700) – Good overall status. London Clay not designated a WER groundwater catchment.
Main groundwater bodies	Superficial deposits: Pipeline underlain by Head (Secondary undifferentiated aquifer), River Terrace Deposits (Secondary A aquifer), and Raised Marine Deposits (Secondary undifferentiated), as well as large areas with no superficial cover (predominantly in the north of the study area and most of the Pipeline). Bedrock: Pipeline underlain by chalk bedrock (Principal aquifer) in the south. Moving north the southern pipeline section is underlain by Lambeth Group (Secondary A) and London Clay (predominantly unproductive, with some granular bands designated Secondary A). The Pipeline anticipated to be predominantly within the chalk.
Groundwater flow direction	Main groundwater table generally flowing south towards the sea. Localised flow in the superficial deposits likely to be controlled by tidal interaction (in the south) and surface watercourses. Infiltration into the Portsdown Hill chalk may locally influence groundwater flow directions, particularly during wetter periods (e.g. radially away from the hill).
Approximate groundwater level	Groundwater level in the chalk anticipated to be shallow or potentially flowing artesian in the southern part of the alignment, due to the numerous

Model element	Study area description
in Proposed Development study area	springs in the area. Groundwater levels in the chalk in the Portsdown Hill area seasonally fluctuate but generally at depth, due to the topography. Variable groundwater levels are anticipated in the superficial deposits, as well as the Lambeth Group and London Clay deposits, with a general trend of higher groundwater levels towards the north.
Regional faults	No significant regional faults identified.
Surface water bodies	The Pipeline alignment is within the catchment of Potwell Tributary and the coast. No surface water bodies are crossed by the Pipelines.
Groundwater Abstractions Licenses	Portsmouth Water PWS abstractions from the Bedhampton-Havant springs to the north-east of the WRP site at the south-eastern end of the Order Limits for Section D.
SPZs	The Pipeline avoids the SPZ1 in the north of the study area, which is associated with the chalk springs at Bedhampton (a Portsmouth Water PWS).
GWSWI	Numerous springs in the Bedhampton-Havant area, north-east of the WRP site at the south-eastern end of the Order Limits for Section D. Langstone Harbour to the south of the eastern end of the Order Limits is designated as a GWDTE. Portsdown SSSI is approximately 400m south-west of the Pipeline where it diverts northwards near the A3. The site is a chalk grassland habitat, although not designated a GWDTE.
Recharge	Low permeability Palaeogene and urbanisation retard recharge in the area. Aquifer recharge predominantly anticipated to occur to north in the South Downs, although some localised recharge of the chalk may occur on Portsdown Hill.

Table 4-54 Conceptual model for Section E of the Pipeline between the Water Recycling Plant site and Otterbourne Water Supply Works

Model element	Study area description
Surface topography	The Pipeline is located on the northern flank of Portsdown Hill. The topography undulates between 50m AOD and 70m AOD.
WER groundwater catchment	Pipeline generally underlain by East Hants Chalk (GB40701G502700) – Poor overall status. Close to Chalk-Lambeth boundary, with a small area of the Pipeline underlain by South Hants Lambeth Group (GB40702G503700) – Good overall status.
Main groundwater bodies	Superficial deposits: Pipeline underlain by Head (Secondary undifferentiated aquifer) in places. Large areas with no superficial deposits mapped. Bedrock: Pipeline underlain by chalk bedrock (Principal aquifer) and Lambeth Group (Secondary A).
Groundwater flow direction	Main groundwater table generally flowing south towards the sea. Localised flow in the superficial deposits and bedrock likely to be controlled by topography.
Approximate groundwater level in Proposed Development study area	Variable groundwater levels are anticipated in the superficial deposits and bedrock locally influenced by the topography of the hill. General trend of higher groundwater levels anticipated towards the north.

Model element	Study area description
Regional faults	No significant regional faults identified.
Surface water bodies	The Pipeline lies within the catchment of Potwell Tributary and the catchment of Wallington below Southwick
Groundwater Abstractions Licenses (within 1km)	A licensed abstraction is located at Offwell Farm, Southwick approximately 150m north of the Order Limits.
SPZs	No SPZ crossed by the Pipeline in this section. SPZ2 and SPZ3 associated with the Maindell PWS abstraction in the west of the study area, and the SPZ associated with the Bedhampton springs PWS in the north-east of the study area.
GWSWI	A number of springs are anticipated in the study area. Hook Heath Meadows SSSI is located to the north of the Pipeline, adjacent to Potwell Tributary. The site is designated a GWDTE. Portsdown SSSI is approximately 400m south of the Pipeline where it diverts northwards near the A3. The site is a chalk grassland habitat, although not designated a GWDTE.
Recharge	Low permeability Palaeogene and urbanisation retard recharge in the study area. Aquifer recharge predominantly anticipated to occur to the north in the South Downs, although some may occur on Portsdown Hill in vegetated areas with limited or no superficial cover.

Table 4-55 Conceptual model for Section F of the Pipeline between the Water Recycling Plant site and Otterbourne Water Supply Works

Model element	Study area description
Surface topography	From east to west, the topography initially falls as the Pipeline descends the western flank of Portsdown Hill and crosses the River Wallington. The topography subsequently rises again to the west, away from the valley containing the River Wallington.
WER groundwater catchment	Pipeline generally underlain by East Hants Chalk (GB40701G502700) – Poor overall status. As Pipeline travels north becomes underlain by South Hants Lambeth Group (GB40702G503700) – Good overall status.
Main groundwater bodies	Superficial deposits: Corridor underlain by Head (Secondary undifferentiated aquifer), River Terrace Deposits (Secondary A aquifer) and Alluvium (Secondary A aquifer), as well as large areas with no superficial cover. Bedrock: Pipeline underlain by chalk bedrock (Principal aquifer), Lambeth Group (Secondary A) and London Clay (predominantly unproductive, with some granular bands designated Secondary A).
Groundwater flow direction	Main groundwater table generally flowing south towards the sea. Localised flow in the superficial deposits likely to be controlled by topography and surface watercourses (e.g. flow towards the Wallington).
Approximate groundwater level in Proposed Development study area	Variable groundwater levels are anticipated in the superficial deposits and bedrock, with a general trend of higher groundwater levels towards the north. Groundwater levels at the location of the River Wallington assumed to be at or close to ground level.
Regional faults	No significant regional faults identified.

Model element	Study area description
Surface water bodies	The Pipeline lies within the catchment of Wallington below Southwick, with the Wallington River crossed in the middle of the section.
Groundwater Abstractions Licenses (within 1km)	No licensed abstractions have been mapped within the study area of Section F. The Portsmouth Water PWS abstraction Maindell PS is located to the south of the Pipeline outside the study area, but with the SPZ1 within the study area. A private water supply, 1 and 2 The Cottage, is located approximately 600m north-east of the Order Limits.
SPZs	The Pipeline crosses the SPZ2 and SPZ3 associated with the Maindell PWS abstraction, which is located to the south of the Order Limits. The abstraction is not currently active, although Portsmouth Water are looking to recommence abstraction in the future.
GWSWI	Springs and seepages are likely below and in the banks of the River Wallington and its tributaries.
Recharge	Low permeability Palaeogene and urbanisation retard recharge in areas. Aquifer recharge predominantly anticipated to occur to north in the South Downs.

Table 4-56 Conceptual model for Section G of the Pipeline between the Water Recycling Plant site and Otterbourne Water Supply Works

Model element	Study area description
Surface topography	From east to west, the topography undulates before falling towards the River Meon in the centre of the section. West of the River Meon the topography gradually rises.
WER groundwater catchment	South-east of Pipeline underlain by London Clay (no WER groundwater catchment). Majority of northern half of Pipeline underlain by South East Hants Bracklesham Group (GB40702G503000) – Poor overall status.
Main groundwater bodies	Superficial deposits: Pipeline underlain by Head (Secondary undifferentiated aquifer), River Terrace Deposits (Secondary A aquifer) and Alluvium (Secondary A aquifer), as well as large areas with no superficial cover. Bedrock: Pipeline underlain by formations of the Bracklesham Group (Secondary A) and London Clay (predominantly unproductive, with some granular bands designated Secondary A).
Groundwater flow direction	Main groundwater table generally flowing south towards the sea. Localised flow in the superficial deposits and bedrock likely to be controlled by topography and surface watercourses (e.g. flow towards the River Meon).
Approximate groundwater level in Proposed Development study area	Variable groundwater levels are anticipated in the superficial deposits and low permeability bedrock, with a general trend of higher groundwater levels towards the north but local variations influenced by topography and surface water interactions.
Regional faults	No significant regional faults identified.
Surface water bodies	This section of the Pipeline lies within the River Meon catchment. South-west of Wickham, the Pipeline crosses the River Meon; a chalk stream which flows south-westerly towards the sea.

Model element	Study area description
Groundwater Abstractions Licenses (within 1km)	A licensed abstraction borehole is located at Wickham Park Golf Club which is utilised for irrigation. The abstraction is within the Order Limits. Two unlicensed abstractions (1 and 2 The Cottage and The Bungalow) are located within the study area, but outside the Order Limits.
SPZs	The south-east of the study area intercepts the SPZ2 and SPZ3 associated with the Maindell PWS abstraction.
GWSWI	The River Meon is a chalk stream (although the River Meon is anticipated to be underlain by London Clay where the Pipeline crosses), with springs and seepages anticipated to be present below and in the banks of the River Meon and its associated tributaries.
Recharge	Low permeability Palaeogene and urbanisation retard recharge in the area. Aquifer recharge predominantly anticipated to occur to north in the South Downs.

Table 4-57 Conceptual model for Section H of the Pipeline between the Water Recycling Plant site and Otterbourne Water Supply Works

Model element	Study area description
Surface topography	From east to west, the topography along the Pipeline remains relatively level until it reaches a river valley (upper reach of the River Hamble) south-east of Shedfield. After the river valley, the topography steadily rises again to the north towards Shirrell Heath High Street before gradually falling.
WER groundwater catchment	Majority of Pipeline underlain by South East Hants Bracklesham Group (GB40702G503000) – Poor overall status. London Clay (no WER groundwater catchment) underlies the Pipeline in the centre of the section.
Main groundwater bodies	Superficial deposits: Pipeline underlain by Head (Secondary undifferentiated aquifer) and River Terrace Deposits (Secondary A aquifer), as well as large areas with no superficial cover. Bedrock: Pipeline underlain by Bracklesham Group (Secondary A) and London Clay (predominantly unproductive, with some granular bands designated Secondary A).
Groundwater flow direction	Main groundwater table generally flowing south towards the sea. Localised flow in the superficial deposits and bedrock likely to be controlled by topography and surface watercourses (e.g. flow towards the River Meon).
Approximate groundwater level in Proposed Development study area	Variable groundwater levels are anticipated in the superficial deposits and low permeability bedrock, with a general trend of higher groundwater levels towards the north and away from surface water courses.
Regional faults	No significant regional faults identified.
Surface water bodies	This section of the Pipeline lies within the River Meon catchment and a non-designated catchment. South-east of Shirrel Heath the Pipeline will cross an upper reach of the River Hamble (not designated a main river at this point but is immediately downstream).
Groundwater Abstractions Licenses (within 1km)	The licensed abstraction borehole at Wickham Park Golf Club is located within the study area of Section H. A single unlicensed abstraction (The Bungalow) is located approximately 50m west of the Pipeline within the section.

Model element	Study area description
SPZs	No SPZs within the study area.
GWSWI	Springs and seepages are likely to be present below and in the banks of local minor surface watercourses. Waltham Chase Meadows is 900m north of the Order Limits, with the SSSI designated as a GWDTE. There is limited hydraulic continuity between the section and the site.
Recharge	Low permeability Palaeogene and urbanisation retard recharge in the area. Aquifer recharge predominantly anticipated to occur to north in the South Downs.

Table 4-58 Conceptual model for Section J of the Pipeline between the Water Recycling Plant site and Otterbourne Water Supply Works

Model element	Study area description
Surface topography	From east to west, gradual fall in topography towards the valley associated with the Shawfords Lake tributary of the River Hamble before steadily rising again towards Curdridge Lane. Topography steadily falls again towards the River Hamble to the north.
WER groundwater catchment	Pipeline underlain by London Clay (non-designated WER groundwater body) and South East Hants Bracklesham Group (GB40702G503000) – Poor overall status.
Main groundwater bodies	Superficial deposits: Pipeline underlain by Head (Secondary undifferentiated aquifer), River Terrace Deposits (Secondary A aquifer) and Alluvium (Secondary A aquifer), as well as large areas with no superficial cover. Bedrock: Pipeline underlain by Bracklesham Group (Secondary A) and London Clay (predominantly unproductive, with some granular bands designated Secondary A).
Groundwater flow direction	Main groundwater table generally flowing south towards the sea. Localised flow in the superficial deposits and bedrock likely to be controlled by topography and surface watercourses (e.g. flow towards the River Hamble).
Approximate groundwater level in Proposed Development study area	Variable groundwater levels are anticipated in the superficial deposits and low permeability bedrock, with a general trend of higher groundwater levels towards the north.
Regional faults	No significant regional faults identified.
Surface water bodies	The Pipeline crosses a number of surface water catchments including the Main River Hamble, Moors Stream and an undesignated catchment. Minor watercourses may be crossed south-west of Waltham Chase.
Groundwater Abstractions Licenses (within 1km)	No licensed abstractions are mapped within the study area. Three unlicensed abstractions (Yewtree Cottage, The Granary and Woodman's Farmhouse) are located within the study area, but outside the Order Limits. Woodman's Farmhouse is the closest private water supply; located approximately 80m south-west of the Pipeline.
SPZs	None in this part of the study area.
GWSWI	Springs and seepages likely to be present in the area, particularly below and in the bank of local surface watercourses. Waltham Chase Meadows SSSI is located approximately 450m north-east of the Pipeline and is designated as a GWDTE.

Model element	Study area description
Recharge	Low permeability Palaeogene and urbanisation retard recharge in the area. Aquifer recharge predominantly anticipated to occur to north in the South Downs.

Table 4-59 Conceptual model for Section K of the Pipeline between the Water Recycling Plant site and Otterbourne Water Supply Works

Model element	Study area description
Surface topography	From east to west, the Pipeline crosses the River Hamble at an elevation of approximately 15m AOD before rising steadily (with some undulation) towards Winters Hill. The topography then falls slowly towards where the Pipeline crosses the B3037.
WER groundwater catchment	Pipeline in Section K underlain by London Clay (no WER groundwater catchment).
Main groundwater bodies	Superficial deposits: Pipeline underlain by Head (Secondary undifferentiated aquifer), River Terrace Deposits (Secondary A aquifer) and Alluvium (Secondary A aquifer). Large areas with no superficial cover mapped. Bedrock: Pipeline underlain by London Clay (predominantly unproductive, with some granular bands designated Secondary A).
Groundwater flow direction	Main groundwater table generally flowing south towards the sea. Localised flow in the superficial deposits and bedrock likely to be controlled by topography, abstractions, and surface watercourses.
Approximate groundwater level in Proposed Development study area	Variable groundwater levels are anticipated in the superficial deposits and low permeability bedrock, with a general trend of higher groundwater levels towards the north. Groundwater levels in are anticipated to be locally influenced by topography and surface water courses.
Regional faults	No significant regional faults identified.
Surface water bodies	This section of the Pipeline crosses a number of surface water catchments including the Main River Hamble, Horton Heath Stream and Upper Hamble. This section of the Pipeline crosses the Main River Hamble in the south-east of the Order Limits. The upper reaches of the Horton Heath Stream may also be crossed in the north-west of the Order Limits (south-west of Lower Upham).
Groundwater Abstractions Licenses (within 1km)	One licensed groundwater abstraction is located within the study area for this section; the Portsmouth Water Lower Upham PWS. A single unlicensed private water supply abstraction is mapped in the study area at approximately 900m distance.
SPZs	The Pipeline crosses the SPZ1c and SPZ2c associated with the Lower Upham PWS abstraction east of Horton Heath stream. The SPZ1 is located within the study area to the south-west of the Pipeline, with the SPZ2 present in the north-east of the study area.
GWSWI	Springs and seepages likely to be present below and in the banks of local surface watercourses (such as the Main River Hamble and Horton Heath stream).
Recharge	Low permeability Palaeogene and urbanisation retard recharge in the area. Aquifer recharge predominantly anticipated to occur to the north in the South Downs

Table 4-60 Conceptual model for Section L of the Pipeline between the Water Recycling Plant site and Otterbourne Water Supply Works

Model element	Study area description
Surface topography	From east to west, the topography undulates and gradually falls from approximately 45m AOD to 30m AOD. The elevation rises relatively rapidly at Crowdhill before falling to where the Pipeline crosses Bow Lake.
WER groundwater catchment	Majority of Pipeline underlain by London Clay (not designated WER groundwater body). Small section underlain by East Hants Lambeth Group (GB40702G500800) – Good overall status.
Main groundwater bodies	Superficial deposits: Pipeline underlain by River Terrace Deposits (Secondary A aquifer) and Alluvium (Secondary A aquifer) in parts. Majority of the section mapped with no superficial cover. Bedrock: Pipeline underlain by Lambeth Group (Secondary A) and London Clay (predominantly unproductive, with some granular bands designated Secondary A).
Groundwater flow direction	Main groundwater table generally flowing south towards the sea. Localised flow in the superficial deposits and bedrock likely to be controlled by topography, abstractions, and surface watercourses.
Approximate groundwater level in Proposed Development study area	Variable groundwater levels are anticipated in the superficial deposits and low permeability bedrock, with a general trend of higher groundwater levels towards the north. Groundwater levels in the superficial deposits are anticipated to be shallow and influenced by the local groundwater abstractions and surface watercourses.
Regional faults	No significant regional faults identified.
Surface water bodies	This section of the Pipeline crosses a number of surface water catchments including the Horton Heath Stream, Bow Lake (for the majority of the section) and River Itchen. This section of the Pipeline crosses a number of watercourses including Bow Lake and minor tributaries of the River Itchen.
Groundwater Abstractions Licenses (within 1km)	Six licensed abstractions are located within the study area including two Southern Water abstractions associated with the Otterbourne WSW (Points E and F) and a number of agricultural abstractions (Fisher's Pond Point A, Fisher's Pond Swifts Farm, Fisher's Pond Borehole C and Bowlake Fish Farm Borehole at Point A). Three unlicensed abstractions are also noted within the study area including Lowhill Farmhouse, Marwell Manor and Stoke Park Farm. Lowhill Farmhouse is the closest to the Order Limits approximately 60m south.
SPZs	No SPZs directly underlie the Order Limits, although the majority of the north of the study area is within SPZs associated with the Otterbourne PWS and Fisher's Pond licensed abstractions. The SPZ associated with the Lower Upham PWS is also in the east of the study area.
GWSWI	Springs and seepages likely to be present below and in the banks of local surface watercourses (such as Bow Lake and towards the River Itchen). The River Itchen is located in the west of the study area and is a SSSI and SAC designated chalk river and GWDTE.
Recharge	Low permeability Palaeogene and urbanisation retard recharge in the area. Aquifer recharge predominantly anticipated to occur to the north in the South Downs.

Table 4-61 Conceptual model for Section M of the Pipeline between the Water Recycling Plant site and Otterbourne Water Supply Works

Model element	Study area description
Surface topography	The topography undulates as the Pipeline crosses the River Itchen and heads north towards Otterbourne WSW.
WER groundwater catchment	Majority of Pipeline underlain by London Clay (not designated WER groundwater body). As Pipeline travel north towards Otterbourne, underlain by Central Hants Lambeth Group (GB40702G503800 – Good overall status) and River Itchen Chalk (GB40701G505000 – Poor overall status).
Main groundwater bodies	Superficial deposits: Pipeline underlain by River Terrace Deposits (Secondary A aquifer) and Alluvium (Secondary A aquifer) associated with the River Itchen, as well as large areas with no superficial cover. Head (Secondary undifferentiated aquifer) and Clay with Flints (unproductive aquifer) are mapped underlying the north of Otterbourne WSW. Bedrock: Pipeline underlain by Chalk (Principal aquifer), Lambeth Group (Secondary A) and London Clay (predominantly unproductive, with some granular bands designated Secondary A).
Groundwater flow direction	Main groundwater table generally flowing south towards the sea. Localised flow in the superficial deposits and bedrock likely to be controlled by topography, abstractions (flow towards Otterbourne WSW), and surface watercourses such as the River Itchen.
Approximate groundwater level in Proposed Development study area	Variable groundwater levels are anticipated in the superficial deposits and low permeability bedrock, with a general trend of higher groundwater levels towards the north. Groundwater levels in the chalk are anticipated to be shallow and influenced by the local groundwater abstractions and surface watercourses.
Regional faults	No significant regional faults identified.
Surface water bodies	This section of the Pipeline is entirely within the River Itchen surface water catchment. This section of the Pipeline crosses the River Itchen and Itchen Navigation, together with a tributary of the River Itchen south of Otterbourne WSW.
Groundwater Abstractions Licenses (within 1km)	Nine licensed groundwater abstractions are mapped within the study area all associated with the Otterbourne PWS. A private water supply, Qing Ya Xi, is located approximately 400m south-east/east of the Order Limits.
SPZs	Section M of the Pipeline is almost entirely within the SPZ associated with the Otterbourne WSW. The SPZ is confined by the overlying London Clay (SPZ1c) south of Kiln Lane, and unconfined (SPZ1) to the north of Kiln Lane around Otterbourne WSW.
GWSWI	The River Itchen is a SSSI and SAC designated chalk river and GWDTE, although the River Itchen is mapped as being underlain by London Clay at the crossing location which would limit baseflow. The tributary of the River Itchen south of Otterbourne WSW is mapped within chalk and as such some groundwater-surface water interaction is anticipated. Springs and seepages likely to be present below and in the banks of local surface watercourses.
Karsts	No karst features are mapped at Otterbourne. However, rapid flow has been detected at Otterbourne which supports the presence of karstic features.

Model element	Study area description
Recharge	Low permeability Palaeogene and urbanisation retard recharge in the area. Aquifer recharge predominantly anticipated to occur to the north in the South Downs.

5 Assessment of impacts

5.1 Introduction

5.1.1 This section identifies flow, drawdown and quality impacts that could occur as a result of construction and operational activities. Decommissioning impacts are considered to be no greater than those identified for construction. The section identifies which groundwater receptors are susceptible to those impacts, and in section 6 control measures to eliminate or reduce impacts are presented. The assessment of likely significant effects of these impacts is presented in ES Chapter 19 Water environment, Volume I (Document reference 6.1, DCO Volume 6).

5.1.2 The majority of the assessment of impacts has been undertaken qualitatively, on the basis that embedded mitigation and tertiary mitigation measures (as outlined in section 6) can be implemented to mitigate potential impacts without a detailed quantitative assessment being required.

5.1.3 Impacts that have the potential to result in likely significant effects, which may not be able to be mitigated by standard control measures (and may require secondary mitigation measures) have been assessed quantitatively. This primarily relates to deeper structures (such as shafts and pits) within the Chalk Principal aquifer.

5.2 General impacts of the Proposed Development

Construction impacts

5.2.1 The construction of the Proposed Development may locally alter the groundwater levels and flows.

5.2.2 Groundwater levels could be temporarily reduced by excavation below the water table which may occur along the Pipeline; particularly in lower topography areas around river crossings or at the eastern and western areas of Proposed Development towards the Bedhampton and Havant Spring complex and Otterbourne WSW respectively. Conversely, the installation of below-ground infrastructure can locally increase the water table due to mounding effects.

5.2.3 Altered recharge to the ground from temporary or permanent works could also locally impact groundwater levels; where stripping of low permeability materials could increase local recharge whilst installation of low permeability material could reduce local recharge and increase runoff.

5.2.4 Groundwater flows in the saturated and unsaturated zone could be locally altered during construction through modified near surface drainage (e.g. associated with the AGP), excavation below the water table or the installation of retaining structures or permeable pipe bedding.

5.2.5 Due to the scale and temporary nature of the works, the localised impact of the general construction works on groundwater levels and flows is considered likely to generally be minor but may be more significant where proximal to sensitive receptors (such as within the chalk, close to water courses or abstractions) or the temporary works are more extensive (trenchless crossings with drive and reception shafts). Where previously unidentified receptors (assumed to be or low value, if

not previously recorded) are encountered these will be managed via measures set out in the Outline Construction Environmental Management Plan (CEMP) (Document reference 7.1, DCO Volume 7).

5.2.6 Groundwater quality impacts could occur from general construction activities (such as the use of plant and machinery and drilling/piling), pollution incidents, mobilisation of existing contaminants or silt/fines mobilisation (including increased turbidity). The magnitude of the impacts would vary dependent on the hydraulic parameters of the underlying aquifer (pathway potential) and sensitivity of receptors in proximity to the works.

Operational impacts

5.2.7 Following construction of the Proposed Development, groundwater quality could be impacted by localised maintenance work, leakage from or into the pipeline or emergency washouts. The magnitude of any leakage or washout impact would be dependent on the location, quality, frequency of occurrence, flow and duration.

5.2.8 Maintenance works are anticipated to be of smaller scale and duration relative to the construction works, and as such of less magnitude. Maintenance works are to be undertaken in accordance with the Outline Operational Management Plan (OMP) (Document reference 7.7, DCO Volume 7) .

5.2.9 Emergency washouts or significant leakages from the Pipeline are considered within ES Chapter 14 Major accidents and disasters, Volume I (Document reference 6.1, DCO Volume 6).

Decommissioning impacts

5.2.10 Decommissioning impacts are considered to be no greater than the impacts identified and assessed during construction, and as such have not been assessed separately within the report. Decommissioning impacts are considered to be comparable to those described for construction.

5.3 Water Recycling Plant site and associated pumping stations

Construction impacts

5.3.1 The WRP site and associated pumping stations lie on a historical landfill (see ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6) for further details), which in turn lies on the chalk bedrock, and is within 200m of the coastline.

5.3.2 It is assumed that excavation works on the WRP site would be relatively shallow (excluding drive and/or reception shafts located within the WRP site which are covered in the respective pipeline sections). Excavations on the WRP site below the water table would require temporary dewatering to maintain the water table below excavation or a wet construction methodology; for the purpose of assessment it is assumed that dewatering would be implemented which would have wider drawdown impacts than wet construction (and thus considered worst case). Due to the driving heads from the north, impacts on receptors to the north

of the WRP site (such as the Bedhampton-Havant spring complex) are likely to be limited. However, any drawdown could have an impact on baseflow to the adjacent Hermitage Stream or Langstone Harbour, although the magnitude of this impact is likely to be negligible due to the Harbour's connectivity to the Solent. The negligible impacts on the adjacent surface water bodies will be verified by the Water Monitoring Plan.

5.3.3 Piling is anticipated to be extensive at the WRP site, with a potential pathway for impact on the quality of the groundwater underlying the WRP or the water quality of adjacent receptors through mobilisation of existing contaminants within the landfill, creation of preferential pathways through the landfill to the chalk, turbidity or saline intrusion. Contaminated land impacts are assessed in ES Chapter 11 Land quality and ground conditions, Volume I (Document reference 6.1, DCO Volume 6).

5.3.4 Groundwater features identified as being susceptible to impacts are summarised in Table 5-1.

Operational impacts

5.3.5 The installation of the WRP site (assuming impermeable hardstanding) may locally reduce recharge to ground. However, this is considered unlikely to have a meaningful impact on the chalk groundwater levels as limited recharge is anticipated to occur in the baseline scenario. This is due to the size of the site, overlying geology and the location of the site adjacent to the sea. This change in recharge could have a beneficial impact on leachate generation in the underlying landfill.

5.3.6 Leakage from the WRP site during operation could result in dissolution of the underlying aquifer. In addition, leakage could locally alter the groundwater or surface water quality and lead to localised drawdown or mounding, dependent on leakage rates.

5.3.7 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

5.4 Pipelines between Budds Farm Wastewater Treatment Works and the Water Recycling Plant

Construction impacts

5.4.1 The primary receptors that could be impacted by this section are the underlying chalk aquifer (and hydraulically linked superficial deposits), the Hermitage Stream and Langstone Harbour.

5.4.2 Any excavations required for the Pipelines (such as drive and reception shafts) would likely require temporary dewatering to maintain the water table below excavation or a wet shaft construction methodology utilised. Due to the driving heads from the north, impacts on receptors to the north are likely to be limited. However, any drawdown could have an impact on baseflow to the adjacent Hermitage Stream or Langstone Harbour, although the magnitude of this impact is likely to be relatively negligible due to the Harbour's connectivity to the Solent.

5.4.3 The trenchless crossing of the Hermitage Stream has the potential to locally alter groundwater levels and flow paths. This could be through inflows into the crossing during construction, creation of new preferential pathways or barrier effects (such as if the pipeline blocks a karstic flow path).

5.4.4 Drilling fluid breakout (where drilling fluid escapes into the surrounding aquifer, and potentially to surface) and increased turbidity from the trenchless operation could have an impact on the Hermitage Stream and/or Langstone Harbour.

5.4.5 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Operational impacts

5.4.6 Leakage from or into the pipelines during operation could result in dissolution of the underlying aquifer.

5.4.7 In addition, leakage could locally alter the groundwater or surface water quality and lead to localised drawdown or mounding, dependent on leakage rates.

5.4.8 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

5.5 Pipelines between the Water Recycling Plant site and Havant Thicket Reservoir

Construction impacts

5.5.1 The primary receptors that could be impacted by this section are the underlying chalk aquifer, Bedhampton Springs, the Hermitage Stream and Langstone Harbour.

5.5.2 The Pipelines between the Water Recycling Plant site and Havant Thicket Reservoir (being constructed as part of the Proposed Development) would be constructed using a combination of trenchless and above-ground methods of construction. The Pipelines would be a distance of approximately 750m. The Pipelines would commence at the site of the WRP and pass underneath the A27 and Mill Lane. East of Mill Lane the Pipelines would consist of a section of above-ground pipelines within Bedhampton Springs over a distance of approximately 200m. The above-ground pipelines are being used at this location due to the proximity to groundwater abstraction at Bedhampton Springs and location within SPZ1.

5.5.3 Any excavations required for the Pipelines (such as drive and reception shafts) would likely require temporary dewatering to maintain the water table below excavation or a wet shaft construction methodology utilised. Due to the driving heads from the north, impacts on receptors to the north are likely to be limited, although the impacts from drawdown at the southern end of the route (Mill Lane and Bedhampton Springs) need to be considered. Any drawdown at the southern end of the route could have an impact on baseflow to the adjacent Hermitage Stream or Langstone Harbour, although the magnitude of any impact to Langstone Harbour is likely to be relatively negligible due to the Harbour's connectivity to the Solent.

5.5.4 The trenchless section (which is anticipated to be within the chalk aquifer) has the potential to locally alter groundwater levels and flow paths. This could be through creation of new preferential pathways or barrier effects (such as if the pipeline blocks a karstic flow path).

5.5.5 Drilling fluid breakout (where drilling fluid escapes into the surrounding aquifer, and potentially to surface) from the trenchless operation could have an impact on the springs, Hermitage Stream and/or Langstone Harbour.

5.5.6 Any drilling or excavations undertaken where there are possible karstic systems within the chalk (currently known to extend from north of the A27 to immediately north of Bedhampton Road) could have impacts – including significant turbidity impacts – on the Bedhampton Springs, and possible impacts on the Hermitage Stream.

5.5.7 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Operational impacts

5.5.8 Leakage from or into the pipelines during operation could result in dissolution of the underlying aquifer.

5.5.9 In addition, leakage could locally alter the groundwater or surface water quality and lead to localised drawdown or mounding, dependent on leakage rates.

5.5.10 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

5.6 Pipeline between the Water Recycling Plant site and Otterbourne Water Supply Works

Section D: The Water Recycling Plant site to Portsdown Hill

Construction impacts

5.6.1 Section D of the Pipeline would be installed using a tunnelling technique, launched from the WRP site construction compound, and would not require any surface works. However, the use of below-ground plant and drilling fluids would be required.

5.6.2 The Pipeline in Section D has been located to avoid the SPZ to the north, however, the Pipeline remains within the Principal chalk aquifer. Any tunnelling operations or shaft operations within the chalk have the potential to impact the sensitive groundwater body, together with groundwater dependent receptors in the area. Due to the elevated topography, there are limited groundwater dependent receptors at surface in the immediate area.

5.6.3 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Operational impacts

5.6.4 Leakage from or into the pipeline during operation could result in dissolution of the underlying aquifer.

5.6.5 In addition, leakage could locally alter the groundwater or surface water quality and lead to localised drawdown or mounding, dependent on leakage rates.

5.6.6 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Section E: Portsdown Hill to Boarhunt

Construction impacts

5.6.7 Section E of the Pipeline would be installed using a trenched open-cut construction technique, except where particular features (e.g. rivers, roads) require the use of alternative construction techniques as a result of any environmental sensitivities.

5.6.8 The Pipeline in Section E is on the northern slope of a chalk ridge (Portsdown Hill). The Proposed Development in Section E is almost entirely overlying the Principal chalk aquifer, which could be impacted by any construction below the water table or pollution impacts.

5.6.9 Limited groundwater dependent receptors have been identified in the east of the section. In the centre, approximately 150m downgradient (north), Offwell Farm licensed abstraction is located which has the potential to be impacted by any localised dewatering or quality impacts upgradient.

5.6.10 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Operational impacts

5.6.11 Leakage from or into the pipeline during operation could result in dissolution of the underlying aquifer.

5.6.12 In addition, leakage could locally alter the groundwater or surface water quality and lead to localised drawdown or mounding, dependent on leakage rates.

5.6.13 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Section F: Boarhunt to Crockerhill

Construction impacts

5.6.14 Section F of the Pipeline would be installed using a trenched open-cut construction technique, except where particular features (e.g. rivers, roads) require the use of alternative construction techniques as a result of any environmental sensitivities.

5.6.15 The Pipeline in Section F traverses down the western flank of the Portsdown Hill before crossing the River Wallington. The trenchless crossing of the Wallington within the Principal chalk aquifer has the potential for adverse impacts both on the aquifer and River Wallington without appropriate mitigation measures in place. The

Portsmouth Water Maindell abstraction (which is not currently operational) is also located to the south of the Pipeline, with the SPZ2 and SPZ3 of the abstraction partly within the Order Limits. Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Operational impacts

5.6.16 Leakage from or into the Pipeline during operation could result in dissolution of the underlying aquifer when within the chalk.

5.6.17 In addition, leakage could locally alter the groundwater or surface water quality and lead to localised drawdown or mounding, dependent on leakage rates.

5.6.18 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Section G: Crockerhill to Wickham

Construction impacts

5.6.19 Section G of the Pipeline would be installed using a trenched open-cut construction technique, except where particular features (e.g. rivers, roads) require the use of alternative construction techniques as a result of any environmental sensitivities.

5.6.20 The Pipeline travels through the Bracklesham Group and London Clay bedrock formations.

5.6.21 South-west of Wickham, the River Meon would be crossed by a trenchless methodology, within London Clay bedrock. Permeable superficial deposits or bedrock may be present, which could locally impact baseflows to receptors within the area (including the River Meon).

5.6.22 As the Pipeline travels north, the Wickham Park Golf Club licensed abstraction is located within the Order Limits and as such could be directly impacted by the construction works, although it is assumed that the abstraction would be avoided by micrositing within the Order Limits. Any indirect impacts on the abstraction would be temporary and subject to appropriate mitigation, where required.

5.6.23 Groundwater features identified as being susceptible to change in groundwater conditions to impacts are summarised in Table 5-1.

Operational impacts

5.6.24 Leakage could locally alter the groundwater or surface water quality and lead to localised drawdown or mounding, dependent on leakage rates.

5.6.25 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Section H: Wickham to Shedfield

Construction impacts

5.6.26 Section H of the Pipeline would be installed using a trenched open-cut construction technique, except where particular features (e.g. rivers, roads) require the use of alternative construction techniques as a result of any environmental sensitivities.

5.6.27 The Pipeline traverses across land underlain by the Bracklesham Group and London Clay bedrock formations. Permeable superficial deposits or bedrock may be present, which could locally impact baseflows to receptors within the area.

5.6.28 Few groundwater dependent receptors have been mapped in proximity to the Order Limits in Section H, except for an unlicensed private water supply which is within 100m of the Order Limits and could be susceptible to drawdown impacts or pollution incidents.

5.6.29 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Operational impacts

5.6.30 Leakage could locally alter the groundwater or surface water quality and lead to localised drawdown or mounding, dependent on leakage rates.

5.6.31 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Section J: Shedfield to the River Hamble

Construction impacts

5.6.32 Section J of the Pipeline would be installed using a trenched open-cut construction technique, except where particular features (e.g. rivers, roads) require the use of alternative construction techniques as a result of any environmental sensitivities.

5.6.33 Section J of the Pipeline is underlain by the Bracklesham Group or London Clay Formation. Permeable superficial deposits or bedrock may be present, which could locally impact baseflows to receptors within the area.

5.6.34 Few groundwater dependent receptors are mapped in proximity to the Order Limits, except for a number of small unlicensed private water supplies (with the closest being less than 100m distance) which could be impacted by drawdown impacts or pollution incidents.

5.6.35 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Operational impacts

5.6.36 Leakage could locally alter the groundwater or surface water quality and lead to localised drawdown or mounding, dependent on the underlying geology and leakage rates.

5.6.37 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Section K: The River Hamble to Lower Upham

Construction impacts

5.6.38 Section K of the would be installed using a trenched open-cut construction technique, except where particular features (e.g. rivers, roads) require the use of alternative construction techniques as a result of any environmental sensitivities.

5.6.39 Section K of the Pipeline is mapped as being underlain by the London Clay Formation. Permeable superficial deposits or bedrock may be present, which could locally impact baseflows to receptors within the area.

5.6.40 South-west of Bishop's Waltham, the Order Limits crosses the Main River Hamble. This trenchless crossing is anticipated to be within the London Clay, although permeable superficial deposits or sand bands in the area of the trenchless crossing, could enable continuity between the construction works and the River Hamble.

5.6.41 The Portsmouth Water Lower Upham abstraction is located south of the western end of Section K, with the Pipeline crossing SPZ1c and SPZ2c. The chalk at this location is considered to be greater than 50m bgl and as such is unlikely to be impacted by shallow excavations.

5.6.42 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Operational impacts

5.6.43 Leakage could locally alter the groundwater or surface water quality and lead to localised drawdown or mounding, dependent on the underlying geology and leakage rates.

5.6.44 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Section L: Lower Upham to Brambridge

Construction impacts

5.6.45 Section L of the Pipeline would be installed using a trenched open-cut construction technique, except where particular features (e.g. rivers, roads) require the use of alternative construction techniques as a result of any environmental sensitivities.

5.6.46 Section L of the Pipeline is almost entirely underlain by London Clay.

5.6.47 Fisher's Pond BH C is located within 50m of the Order Limits, adjacent to Winchester Road (B3354) and could be impacted by localised drawdown (such as the Bow Lake crossing) or water quality impacts. A private water supply at Lowhill Farm is also approximately 50m from the Order Limits which could be impacted by localised drawdown or water quality impacts.

5.6.48 The majority of other groundwater dependent receptors are further north in the South Downs, with limited hydraulic continuity to the construction works.

5.6.49 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Operational impacts

5.6.50 Leakage from or into the pipeline during operation could locally alter the groundwater or surface water quality and lead to localised drawdown or mounding, dependent on leakage rates.

5.6.51 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Section M: Brambridge to Otterbourne Water Supply Works

Construction impacts

5.6.52 In order to avoid operational impacts to the railway, Highbridge Road (B3335) and to avoid direct impact on the River Itchen and the Itchen Navigation and adjacent tributaries, the Pipeline construction would be undertaken using a trenchless method of drilling over an approximately 800m distance. West of the river and railway, Section M of the Pipeline would be installed using a trenched open-cut construction technique, except where particular barriers (e.g. rivers, roads) require the use of a trenchless alternative.

5.6.53 The trenchless crossing of the River Itchen and Itchen Navigation is anticipated to be within London Clay deposits, which would reduce the risk of the crossing and associated works on the overlying sensitive chalk stream. After the trenchless crossing, the Pipeline route diverts northwards towards Otterbourne, with the underlying geology changes to Lambeth Group and subsequently chalk.

5.6.54 South-west of Otterbourne WSW a trenchless crossing of a tributary of the River Itchen (Poles Lane Stream) would be required, which would be partly within the Principal chalk aquifer and the SPZ1 associated with the Otterbourne abstractions.

5.6.55 The construction risks within the chalk at Otterbourne are considered to be similar to those at Bedhampton and Havant, with the PWS susceptible to quality impacts from any tunnelling works (such as turbidity spikes).

5.6.56 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

Operational impacts

5.6.57 Leakage from or into the Pipeline between the WRP site and Otterbourne WSW during operation could result in dissolution of the underlying chalk aquifer where present.

5.6.58 In addition, leakage could locally alter the groundwater or surface water quality and lead to localised drawdown or mounding, dependent on leakage rates.

5.6.59 Groundwater features identified as being susceptible to change in groundwater conditions are summarised in Table 5-1.

5.7 Receptors susceptible to impacts

5.7.1 Based on the developed hydrogeological conceptualisation of the Proposed Development, Table 5-1 summarises the groundwater features within the study area and identifies whether they are considered to be susceptible to change in groundwater conditions.

Table 5-1 Receptors susceptible to change in groundwater conditions

Receptor	Susceptible to potential impacts
Aquifer - Principal Bedrock (White Chalk Subgroup)	Yes
Aquifer - Secondary A Bedrock Aquifer (Bracklesham Group)	Yes
Aquifer - Secondary A Bedrock Aquifer (Lambeth Group)	Yes
Aquifer - Secondary A Bedrock Aquifer (London Clay Sand Members)	Yes
Aquifer - Secondary A Superficial Deposits Aquifer (Alluvium)	Yes
Aquifer - Secondary A Superficial Deposits Aquifer (River Terrace Deposits)	Yes
Aquifer - Secondary Undifferentiated Superficial Deposits Aquifer (Beach and Tidal Flat Deposits)	Yes
Aquifer - Secondary Undifferentiated Superficial Deposits Aquifer (Head)	Yes
Aquifer - Secondary Undifferentiated Superficial Deposits Aquifer (Raised Marine Deposits)	Yes
Aquifer – Unproductive Bedrock Aquifer (London Clay)	No – Negligible pathway to effect due to hydrogeological characteristics
Aquifer – Unproductive Superficial Deposits Aquifer (Clay with Flints)	No - Negligible pathway to effect due to hydrogeological characteristics
Consented Discharges outside Order Limits (more than 25m)	No – Negligible dependence on groundwater. Receiving waterbodies considered separately
Consented Discharge A00751: Southern Water Services – Budds Farm WTW – To the Solent/Langstone Harbour	Yes
Designated Site – Hook Heath Meadows SSSI (GWDTE)	No – limited hydraulic continuity between Proposed Development and site
Designated Site – Portsdown SSSI (Not GWDTE)	No – not groundwater dependent
Designated Site – Waltham Chase Meadows SSSI (GWDTE)	No – limited hydraulic continuity between

Receptor	Susceptible to potential impacts
	Proposed Development and site
GWSWI - Bedhampton and Havant Springs (locally important PWS)	Yes
GWSWI - Potential Sinks	Yes
GWSWI - Potential Springs	Yes
GWSWI - Potential non-designated GWDTE	Yes
Licensed GW Abstraction – Southwick Estate – Offwell Farm, Southwick (Private Water Supply)	Yes
Licensed GW Abstraction – Golfpartners International Limited – Borehole at Wickham Park Golf Club (Spray Irrigation)	Yes
Licensed GW Abstraction - Fisher's Pond Ltd - Fisher's Pond Point A (Agriculture - Fish Farm/Cress Pond Throughflow)	No – limited hydraulic continuity between Proposed Development and abstraction
Licensed GW Abstraction – Fisher's Pond Ltd – Swifts Farm, Fisher's Pond (Agriculture – Fish Farm/Cress Pond Throughflow)	No – limited hydraulic continuity between Proposed Development and abstraction
Licensed GW Abstraction - Fisher's Pond Ltd - Fisher Pond Borehole C (Agriculture - Fish Farm/Cress Pond Throughflow)	Yes
Licensed GW Abstraction – Hampshire Carp Hatcheries - Bowlake Fish Farm Borehole at Point A (Agriculture - Fish Farm/Cress Pond Throughflow)	No – limited hydraulic continuity between Proposed Development and abstraction
Licensed GW Abstraction - Portsmouth Water - Bedhampton PS Spring No 1 (PWS)	Yes
Licensed GW Abstraction - Portsmouth Water - Bedhampton PS Spring No 2 (PWS)	Yes
Licensed GW Abstraction - Portsmouth Water - Havant PS (PWS)	Yes
Licensed GW Abstraction - Portsmouth Water - Maindell PS (PWS)	Yes
Licensed GW Abstraction - Portsmouth Water - Lower Upham (PWS)	No – limited hydraulic continuity due to unproductive strata between Pipeline and abstraction
Licensed GW Abstraction - Southern Water Services - Otterbourne PS Point E (Environmental Make-up or top-up water)	Yes
Licensed GW Abstraction - Southern Water Services - Otterbourne PS Point F (Environmental Make-up or top-up water)	Yes
Licensed GW Abstraction - Southern Water Services - Otterbourne PS Point G (PWS)	Yes

Receptor	Susceptible to potential impacts
Licensed GW Abstraction - Southern Water Services - Otterbourne PS Point H (Environmental Make-up or top-up water)	Yes
Licensed GW Abstraction - Southern Water Services - Otterbourne PS Point A (Environmental Make-up or top-up water)	Yes
Licensed GW Abstraction - Southern Water Services - Otterbourne PS Point B (Environmental Make-up or top-up water)	Yes
Licensed GW Abstraction - Southern Water Services - Otterbourne PS Point C (Environmental Make-up or top-up water)	Yes
Licensed GW Abstraction - Southern Water Services - Otterbourne PS Point K (Environmental Make-up or top-up water)	Yes
Licensed GW Abstraction - Southern Water Services - Otterbourne PS Point D (Environmental Make-up or top-up water)	Yes
Licensed Surface Water Abstraction – 11/42/33.5/23: Southwick Park Naval Recreational Centre Management Committee - Southwick Lake on the River Wallington (Spray Irrigation)	No – limited hydraulic continuity between Proposed Development and abstraction.
Licensed Surface Water Abstraction – 11/42/25.2/54: River Hamble at Durley (Agriculture/Irrigation)	Yes
Licensed Surface Water Abstraction – SO/042/0031/007: Fisher's Pond Ltd – Point A, Marwell Manor Farm, Fisher's Pond (Agriculture – Fish Farm/Cress Pond Throughflow)	No – limited hydraulic continuity between Proposed Development and abstraction
Licensed Surface Water Abstraction – 11/42/22.9/159: Fisher's Pond Ltd - Trib of Bow Lake Stream at Fisher's Pond (Agriculture - Fish Farm/Cress Pond Throughflow)	No – limited hydraulic continuity between Proposed Development and abstraction
Licensed Surface Water Abstraction – 31/090: Fisher's Pond Ltd - Thompson Lane, Fisher's Pond (Points A and B) (Agriculture - Fish Farm/Cress Pond Throughflow)	No – limited hydraulic continuity between Proposed Development and abstraction
Licensed Surface Water Abstraction - 11/42/22.9/163: Hampshire Carp Hatcheries - Bow Lake Stream at Soke Common (Agriculture - Fish Farm/Cress Pond Throughflow)	Yes
Licensed Surface Water Abstraction – 31/110: Black Dyke, Point A (Environmental - Transfer between sources)	Yes
Licensed Surface Water Abstraction – SO/042/0031/023: East Lodge Fisheries - Itchen Navigation at Brambridge (Environmental - Remedial River/Wetland Support [Transfer between sources])	Yes
Licensed Surface Water Abstraction – SO/042/0031/020: Malms House Ltd - Lower Itchen Navigation at Shawford (Environmental - Non-remedial water/wetland support [Transfer between sources])	Yes

Receptor	Susceptible to potential impacts
Licensed Surface Water Abstraction – 11/42/22.6/93: Southern Water Services - River Itchen at the Otterbourne Intake (PWS)	Yes
SPZ1 and SPZ1c related to Bedhampton-Havant Springs PWS	Yes
SPZ1 and SPZ1c related to Maindell PWS	Yes
SPZ1 and SPZ1c related to Lower Upham PWS	No – limited hydraulic continuity due to unproductive strata between Pipeline and abstraction
SPZ1 and SPZ1c related to Fisher Pond Commercial Abstraction	No – limited hydraulic continuity. Surface water abstraction upgradient
SPZ1 and SPZ1c related to Otterbourne PWS	Yes
SPZ2 and SPZ2c related to Maindell PWS	Yes
SPZ2 and SPZ2c related to Lower Upham PWS	No – limited hydraulic continuity due to unproductive strata between Pipeline and abstraction
SPZ2 and SPZ2c related to Otterbourne PWS	Yes
SPZ3 related to Maindell PWS	Yes
SPZ3 related to Otterbourne PWS	No – limited hydraulic continuity as upgradient of Proposed Development
Bow Lake WER Classified Watercourse.	Yes
Hermitage Stream WER Classified Watercourse	Yes
Horton Heath Stream WER Classified Watercourse.	Yes
Itchen Protected WER Classified Water Body - SAC, SSSI. Noted as GWDTE.	Yes
Langstone Harbour Protected WER Transitional Water Body - SSSI, SPA, Ramsar, SAC. Noted as GWDTE.	Yes
Lavant (Hants) WER Classified Watercourse	Yes
Main River Hamble WER Classified Watercourse.	Yes
Monks Brook WER Classified Watercourse	No – limited hydraulic continuity between Proposed Development and watercourse
Moors Stream WER Classified Watercourse.	Yes
Potwell Tributary WER Classified Watercourse	Yes

Receptor	Susceptible to potential impacts
River Meon WER Classified Watercourse.	Yes
Upper Hamble WER Classified Watercourse.	Yes
Upper Wallington WER Classified Watercourse	Yes
Wallington below Southwick WER Classified Watercourse	Yes
Unlicensed GW abstraction – Stoke Park Farm Private Water Supply	No – limited hydraulic continuity between Proposed Development and abstraction
Unlicensed GW abstraction - The Bungalow (now the Garden House) Private Water Supply	Yes
Unlicensed GW abstraction - Yewtree Cottage Private Water Supply	No – limited hydraulic continuity between Proposed Development and abstraction
Unlicensed GW abstraction - Woodman's Farmhouse Private Water Supply	Yes
Unlicensed GW abstraction - The Granary Private Water Supply	No – limited hydraulic continuity between Proposed Development and abstraction
Unlicensed GW abstraction - Lowhill Farmhouse Private Water Supply	Yes
Unlicensed GW abstraction - Marwell Manor Private Water Supply	No – limited hydraulic continuity between Proposed Development and abstraction
Unlicensed GW abstraction - 1 and 2 The Cottage Private Water Supply	Yes
Unlicensed GW abstraction – Qing Ya Xi (formerly Kingfisher Lodge)	No – limited hydraulic continuity between Proposed Development and abstraction
Other private water supplies	Yes, if within or very close to the Order Limits

6 Control measures

6.1 Introduction

6.1.1 Based on the conceptualisation, receptors susceptible to groundwater flow, drawdown or quality impacts have been identified. This section outlines a selection of the key embedded and tertiary control measures included within the design or management plans to eliminate or reduce the magnitude of impacts for different site activities.

6.2 Construction control measures

6.2.1 Key construction activity embedded and tertiary control measures to reduce impacts are outlined in Table 6-1.

Table 6-1 Construction mitigation measures

Activity	Mitigation
Construction dewatering for below-ground activities	Route selection to reduce potential impacts (as per Order Limits). Trenchless methodologies that exclude groundwater. Compliance with abstraction and discharge regulations (as per Outline CEMP (Document reference 7.1, DCO Volume 7)). Contractor will adhere to EAs approach to Groundwater Protection 2018 Framework (as per Outline CEMP (Document reference 7.1, DCO Volume 7)). Water Monitoring Plan to be developed by the Contractor, to ascertain the pre-construction baseline and verify predicted impacts to local surface water and groundwater receptors (as per Outline CEMP (Document reference 7.1, DCO Volume 7)). ES Appendix 19.9 Outline Water Monitoring Plan, Volume II (Document reference 6.2, DCO Volume 6) has been developed to form the basis of the Water Monitoring Plan and includes trigger levels and action plans. Pollution prevention measures (as per Outline CEMP (Document reference 7.1, DCO Volume 7)).
Piling and deep structures	Use of CFA piles in the WRP. Mitigation requirements as identified by the Foundation Works Risk Assessments undertaken in accordance with relevant EA published guidance. Outline Foundation Works Risk Assessments (FWRAs) issued with the DCO as appendices to the Outline CEMP (Document reference 7.1, DCO Volume 7)).
Tunnelling activities	Route selection to reduce potential impacts (such as routing Itchen crossing within London Clay). (as per Order Limits) Trenchless methodologies that exclude groundwater. Drilling Fluid Management Plan to be developed by Contractor (as per Outline CEMP (Document reference 7.1, DCO Volume 7)).
Temporary change in landuse (e.g. soil stripping, increased hardstanding)	Construction Drainage Plan (as per Outline CEMP (Document reference 7.1, DCO Volume 7)). Pollution prevention measures (as per Outline CEMP (Document reference 7.1, DCO Volume 7)).

Activity	Mitigation
Modified near surface drainage (e.g. preferential pathways, mounding)	Foundation Works Risk Assessment undertaken in accordance with relevant EA published guidance. Outline FWRAs issued with the DCO as appendices to the Outline CEMP (Document reference 7.1, DCO Volume 7)). Backfill material specification to prevent creation of preferential pathways or mounding (as per Design Principles Document (Document reference 5.11, DCO Volume 5)).
General construction activities	Contractor to produce an Emergency Management Plan (as per Outline CEMP (Document reference 7.1, DCO Volume 7)). Contractor to produce Water Monitoring Plan (as per Outline CEMP (Document reference 7.1, DCO Volume 7)). Contractor will adhere to EAs approach to Groundwater Protection 2018 Framework (as per Outline CEMP (Document reference 7.1, DCO Volume 7)). Pollution prevention measures (as per Outline CEMP (Document reference 7.1, DCO Volume 7)). Voids Treatment Protocol (as per Outline CEMP (Document reference 7.1, DCO Volume 7)). Bespoke measures agreed with stakeholders in event of unknown receptors (such as springs or private water supplies) being encountered (as per Outline Water Monitoring Plan) Micrositing during detailed design within LoD, following engagement with landowners/stakeholders, such as Wickham Park Golf Club who have a licence within the Order Limits and private water supplies close to the Order Limits.

6.3 Operational control measures

6.3.1 Key operational activity embedded and tertiary control measures to eliminate or reduce impacts are outlined in Table 6-2.

Table 6-2 Operational mitigation measures

Activity	Mitigation
Maintenance activities	• Measures as per Outline OMP (Document reference 7.7, DCO Volume 7).
Leakage into/from pipeline	• Tunnel design to reduce ingress rates. • Leak detection would be present on the pipeline transfer, either via flow and pressure monitoring or active acoustic monitoring. This has been designed to automatically shut the pipeline system down in the event a leak starts.

6.4 Water monitoring plan

6.4.1 Due to the inherent uncertainties and limitations in hydrogeological conceptualisation, particularly in karstic systems, monitoring plays a critical role in the mitigation strategy.

6.4.2 The Main Works Contractor will develop a Water Monitoring Plan in consultation with key stakeholders that builds upon the strategy outlined in ES Appendix 19.9

Outline Water Monitoring Plan, Volume II (Document reference 6.2, DCO Volume 6).

6.4.3 The Water Monitoring Plan will outline trigger levels and action plans to enable mitigation to be implemented based on observed conditions.

7 Conclusions

7.1.1 The hydrogeological baseline has been collated based on publicly available data, information provided by stakeholders, site surveys and Ground Investigation data.

7.1.2 Based on the baseline collated to date, a primarily qualitative HIA has been undertaken of the construction and operational impacts of the Proposed Development to receptors within the study area. This assessment, utilising the source-pathway-receptor conceptualisation, has identified receptors potentially susceptible to impacts and receptors that can be descoped from further assessment due to limited hydraulic continuity.

7.1.3 The findings of the HIA have informed the embedded and tertiary mitigation measures requirements including ES Appendix 19.9 Outline Water Monitoring Plan, Volume II (Document reference 6.2, DCO Volume 6).

7.1.4 The assessment findings and control measures have subsequently informed the magnitudes of impacts and likely significant effects reported in ES Chapter 19 Water environment, Volume I (Document reference 6.1, DCO Volume 6).

7.1.5 As the design develops and further baseline data is accessed, further assessment is likely to be required as part of the Environmental Permitting process (for abstractions and discharges). However, the assessment to date is considered sufficient to inform the identification of likely significant effects for the purposes of the EIA and DCO application.

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Annex A – Descoped tunnel option baseline information

A.1 Descoped Backup Option between the Water Recycling Plant site and Havant Thicket Reservoir

A.1.1.1 This section outlines the baseline for the descoped backup options for a connection between the WRP site and Havant Thicket Reservoir, which provides useful background data for the wider area around Bedhampton Springs.

A.1.2 Topography

A.1.2.1 The topography from the south-western end of the descoped Pipelines between the WRP site and Havant Thicket Reservoir (at the WRP site) falls from around 14m AOD to around 4m AOD. It then gradually rises up to around 20m AOD before falling into the valley of a tributary of the Hermitage Stream. It then follows along the eastern side of this valley, rising up at the north-eastern end towards Havant Thicket Reservoir.

A.1.3 Environmentally designated sites

A.1.3.1 The descoped Pipelines are situated within a SPZ for all but the most southern 500m of the alignment. This SPZ is associated with the chalk springs at Bedhampton, which are used for potable water supply by Portsmouth Water. The most southern area is an SPZ1 zone (inner zone), which indicates a zone where there is a 50-day travel time of pollutant to source. This SPZ1 zone is approximately 300m wide north to south, north of which is SPZ 1c – which refers to an area with a protective cover of low permeability sat above a unit of high permeability, which if mined or tunnelled into would be representative of SPZ1. In this case, London Clay provides much of the cover above chalk members.

A.1.3.2 Langstone Harbour is approximately 400m south of the southern end of the alignment and is an environmentally sensitive site and has a number of statutory environmental designations including:

1. SSSI – ‘Langstone Harbour’ (also noted as a GWDTE)
2. SPA – ‘Chichester and Langstone Harbour’
3. Ramsar site – ‘Chichester and Langstone Harbours’
4. SAC – ‘Solent Maritime’

A.1.3.3 Environmental designations along the Pipelines corridor are illustrated in ES Figure 8.1 Statutory designated sites within the Order Limits plus a 2km buffer, Volume III (Document reference 6.3, DCO Volume 6), with SPZs shown on ES Figure 19.8 Water resources, Volume III (Document reference 6.3, DCO Volume 6).

A.1.4 Surface watercourses

A.1.4.1 The descoped Pipelines study area includes three surface water catchment areas, as summarised in Table A-1. The Pipelines passes through the Hermitage Stream water body catchment in the northern half of the alignment, whilst the Langstone Harbour Transitional Water Body and Lavant (Hants) catchments are at distance (approximately 100m and 700m respectively at their closest).

Table A-1 Surface water catchments in study area - Pipelines between the Water Recycling Plant site and Havant Thicket Reservoir

	Langstone Harbour transitional water body	Hermitage Stream	Lavant (Hants) Catchment
Water Body ID	GB580705130000	GB107042016370	GB107042016420
River Basin District	South East	South East	South East
Hydromorphological Designation	Heavily Modified	Heavily Modified	Not designated artificial or heavily modified
Current Ecological	Moderate	Moderate	Poor
Current Chemical	Fail	Fail	Fail
Ecological Objective	Good	Good	Good
Chemical Objective	Good	Good	Good

A.1.4.2 Passing across the descoped Pipelines study area is the Hermitage Stream, an EA main river, which flows south towards the Langstone Harbour. The Hermitage Stream is fed by a number of smaller watercourses in the area, including Brockhampton Stream, which are anticipated to be primarily groundwater fed by chalk springs. The Pipelines alignment crosses the Hermitage Stream having been routed alongside one of its tributaries. At the eastern part of the study area, the Lavant (Hants) main river also flows south towards the Langstone Harbour.

A.1.4.3 Surface water catchments and main rivers are illustrated in ES Figure 19.1 Surface water features, Volume III (Document reference 6.3, DCO Volume 6).

A.1.5 Superficial deposits

A.1.5.1 The route of the descoped Pipelines from south-west to north-east is mapped as being underlain by Raised Marine Deposits, Beach, River Terrace Deposits and Alluvium in the south-west, much of the mid-section of the study area is underlain by Head deposits, with a 0.2km section of no superficial cover, the north-eastern end has no superficial cover whilst large parts of Havant Thicket Reservoir are also underlain by Head deposits. Table A-2 details the superficial geology mapped in the study area.

Table A-2 Superficial deposits in study area - Pipelines between the Water Recycling Plant site and Havant Thicket Reservoir

Geology	Description	Location and prevalence	Mapped within the Order Limits
Head	Clay, Silt, Sand and Gravel	Much of the central part of study area (when viewing area as north to south) is underlain with Head deposits, with more sparse coverage in the north of the study area. Large parts of Havant Thicket Reservoir mapped as being underlain by Head	Yes
River Terrace Deposits (Undifferentiated)	Sand, Silt and Clay	A band extending from the south-west of the study area to midway up the eastern side of the study area	Yes
Alluvium	Clay, Silt, Sand and Gravel	Adjacent to the surface watercourses in the south of the study area	Yes
Raised Marine Deposits	Sand and Gravel	Narrow strip in the south of the study area	Yes
Beach and Tidal Flat Deposits (Undifferentiated)	Clay, Silt, Sand and Gravel	Covers all of the most southerly end of the study area	No - study area only
No superficial cover	-	Areas in south-west of study area, a small section directly on the Pipelines corridor halfway along and much of the northern end of the study area	Yes

A.1.5.2 Phase 1 ground investigation boreholes BH101 to BH109 have confirmed the superficial deposits at selected locations along the Pipelines route (from south to north):

1. BH101: 0.55m of Topsoil underlain by soft to very stiff clay to 2.1m bgl. Chalk Bedrock at 2.10m bgl (6.32m AOD).
2. BH102/102A: 0.3m of Topsoil and Made Ground underlain by firm to stiff clay. Lambeth Group bedrock encountered at 1.2m bgl (8.24m AOD).
3. BH103: 0.1m of Topsoil underlain by soft to stiff clay and sand deposits (Head Deposits). London Clay bedrock encountered at 3.35m bgl (9.62m AOD).
4. BH104: 0.35m of Topsoil underlain by soft to firm clay (Head Deposits). London Clay bedrock encountered at approximately 5.0m bgl (9.4m AOD).
5. BH105: 0.5m of Topsoil underlain by soft to stiff clay and sand (Head Deposits). London Clay bedrock (possibly Bognor Sand Formation) encountered at 3.6m bgl (13.06m AOD).
6. BH106: 0.5m of Made Ground underlain by soft to firm clay (Head Deposits). London Clay bedrock encountered at 4.8m bgl (7.79m AOD).
7. BH107: 0.2m of Topsoil underlain by soft clay, gravels and sands (head Deposits). London Clay (Bognor Sand Member) encountered at 3.7m bgl (12.67m AOD).

8. BH108: 0.28m of Topsoil underlain by soft clay and sands (Head Deposits). London Clay bedrock encountered at 1.2m bgl (23.77mm AOD).
9. BH109: 0.5m of Topsoil and Made Ground underlain by soft to firm clay (Head Deposits). London Clay bedrock encountered at 2.7m bgl (13.14m AOD).

A.1.6 Bedrock geology

A.1.6.1 The study area is underlain from south-west to north-east by Undifferentiated Chalk (Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation) at its south-western end, then a narrow band of Lambeth Group, before a larger area of London Clay Formation (Clay Silt and Sand). More granular members of the London Clay are mapped along the Pipelines such as Bognor Sand Member and London Clay Formation (Sand). Most of the north-eastern end of the study area is underlain by the Bognor Sand Member before returning to London Clay at the extreme northern end of the descoped Pipelines corridor. Table A-3 details the bedrock geology in the study area.

Table A-3 Bedrock geology in study area - Pipelines between the Water Recycling Plant site and Havant Thicket Reservoir

Geology	Description	Location and prevalence	Mapped within the Order Limits
Undifferentiated Chalk (Lewes Nodular, Seaford Chalk, Newhaven Chalk, Culver Chalk and Portsdown Chalk Formations)	Chalk	Majority of south-western third of study area	Yes
Lambeth Group	Clay, Silt and Sand	Narrow band directly north of Lewes Nodular, Seaford Chalk, Newhaven Chalk, Culver Chalk and Portsdown Chalk Formations Chalk	Yes
London Clay Formation	Clay, Silt and Sand	Much of the central area and part of the north-eastern end of the study area	Yes
London Clay Formation	Sand	Small area directly on Pipelines halfway along	Yes
Bognor Sand Member	Sand	Narrow band across study area a third of the way along the study area from the south-west heading north-east, and a larger area covering half of the north-eastern third of the study area	Yes
Newhaven Chalk Formation	Chalk	Narrow band on western edge of south-western end of study area	Study area only
Tarrant Chalk Member	Chalk	Narrow band on western edge of south-western end of study area	Study area only

Geology	Description	Location and prevalence	Mapped within the Order Limits
Spetisbury Chalk Member	Chalk	Narrow band on western edge of south-western end of study area	Study area only
Portsdown Chalk Member	Chalk	Narrow band on western edge of south-western end of study area	Study area only

A.1.6.2 Phase 1 ground Investigation boreholes BH101 to BH109 have confirmed the bedrock at selected locations along the descoped Pipelines route (from south to north):

1. BH101: White Chalk bedrock encountered at 2.10m bgl (6.32m AOD). Chalk bedrock extends to base of borehole at 30.3m bgl (-21.88m AOD).
2. BH102/102A: Lambeth Group bedrock encountered at 1.2m bgl (8.24m AOD). The Upnor Formation of the Lambeth Group was possibly encountered between 20.6 and 21.3m bgl (-11.2 to -11.9m AOD), which was subsequently underlain by the White Chalk (Culver Formation). The White Chalk (Culver and Newhaven Formations extended to the base of the borehole at 50.3m bgl (-40.9m AOD).
3. BH103: London Clay bedrock encountered at 3.35m bgl (9.62m AOD). London Clay underlain by Lambeth Group at 15.1m bgl (-2.13m AOD). Lambeth Group extends to the base of the borehole at 40.2m bgl (-27.23m AOD).
4. BH104: London Clay bedrock encountered at approximately 5.0m bgl (9.4m AOD). London Clay underlain by Harwich Formation at approximately 1.5m bgl (-1.1m AOD). Underlying the Harwich Formation at approximately 17.0m bgl (-2.6m AOD) is the Lambeth Group which extends to the base of the borehole at 55.0m bgl (-40.6m AOD).
5. BH105: London Clay bedrock (possibly Bognor Sand Formation) encountered at 3.6m bgl (13.06m AOD). Bognor Sand Formation underlain by London Clay at 6.8m bgl (9.86m AOD), which is subsequently underlain by the Harwich Formation at 22.83m bgl (-6.17m AOD). Lambeth Group encountered at 23.5m bgl (-7.09m AOD), which extends to the base of the borehole at 35.0m bgl (-18.34m AOD).
6. BH106: London Clay bedrock encountered at 4.8m bgl (7.79m AOD). London Clay underlain by the Harwich Formation (0.3m thick). Underlying the Harwich Formation at 13.0m bgl (-0.41m AOD) is the Lambeth Group, which extends to the base of the borehole at 30.0m bgl (-17.41m AOD).
7. BH107: London Clay (Bognor Sand Member) encountered at 3.7m bgl (12.67m AOD). London Clay underlain by Lambeth Group (possible Reading Formation at 7.51m bgl (8.86m AOD). The Lambeth Group (Reading and Woolwich Formations) extends to the base of the borehole at 30.5m bgl (-14.13m AOD).
8. BH108: London Clay bedrock encountered at 1.2m bgl (23.77mm AOD). London Clay underlain by Harwich Formation (possible Oldhaven Member) at 24.7m bgl (0.27m AOD) which in turn is underlain by the Lambeth Group (possible Woolwhich Formation) at 26.8m bgl (-1.83m AOD). The Reading Formation of the Lambeth Group was encountered at 27.7m bgl (-2.73m AOD) which extended to the base of the borehole 60m bgl (-35.03m AOD).

9. BH109: London Clay bedrock encountered at 2.7m bgl (13.14m AOD). London Clay underlain by Lambeth Group (possible Reading Formation) at 17.4m bgl (-1.56m AOD). Borehole terminated at 18.5m bgl within Lambeth Group.

A.1.7 Groundwater-surface water interactions (springs, sinks, karst and groundwater dependent terrestrial ecosystems)

A.1.7.1 The Bedhampton and Havant springs, as detailed in paragraph 4.1.45 are karst-fed chalk springs, with a number of the springs being used for potable water supply as documented in the abstractions section below.

A.1.7.2 It is anticipated that additional springs are present within the area around Bedhampton and Havant which have not been identified by available data or site surveys. Springs and seepages are likely to be present below and in the banks of local surface watercourses.

A.1.7.3 Potential and ground-truthed springs within the area have been plotted in ES Figure 19.2 Groundwater features, Volume III (Document reference 6.3, DCO Volume 6), based on OS mapping, data provided by Portsmouth Water and site surveys.

A.1.7.4 Non-designated GWDTE have been identified from priority habitat, NVC and UKHab data as summarised in ES Appendix 8.2 Habitats, Volume II (Document reference 6.2, DCO Volume 6) and ES Figure 8.8 UK Habitat classification for potential groundwater dependent terrestrial ecosystems within the field survey area that have potential to be impacted by the Proposed Development, Volume III (Document reference 6.3, DCO Volume 6).

A.1.7.5 No karst features have been mapped from data provided by third parties, with the majority of mapped potential Karst features to the north of the Proposed Development (within the chalk bedrock of the South Downs). However, the chalk is known to be karstic.

A.1.7.6 Geophysical surveys were undertaken as part of the third Phase of Ground Investigations in the area. This included 13 electrical resistivity tomography (ERT) transects; ten parallel with the proposal and a further three roughly perpendicular to the proposal. Downhole geophysical surveys were also undertaken.

A.1.7.7 These surveys have shown a number of large areas of low resistivity, and other areas of high resistivity. Low resistivity can indicate the potential for karstic systems.

A.1.7.8 These features tend to be bell-shaped, tapering towards the surface, proven to be at least 20m across (but likely to be wider at greater depths), and proven to depths of -15mAOD (but likely to extend much deeper). Some of these features are located close to mapped geological fold axes.

A.1.7.9 The low resistivity features show variable potential to be connected with the surface or with shallow, low permeability superficial deposits. One large feature extends to the surface proximal to the Hermitage Stream, and several others extend to at/near surface along the Bedhampton Spring line.

A.1.7.10 Given that the full extent, geometry and interconnectivity of these features is not fully known from the current geophysical surveying, and the proximity of these

features to the tunnel alignment, it is very likely that, during the drilling process, these low resistivity features will be encountered.

A.1.7.11 Downhole geophysical surveys undertaken in BH101 and BH102A are relevant to this section of the proposal. This can highlight discontinuities in the chalk, which can indicate fracturing. This, in turn, can indicate preferential flow paths and, where large enough, karstic features.

A.1.7.12 Several discontinuities were recorded in each. BH101 showed repeated discontinuities between approximately 11 and 16mbgl, and a single discontinuity at 27mbgl. BH102A showed discontinuities between approximately 28 and 46mbgl. Given the tunnel depth in this area is around 18 to 24mbgl, these discontinuities are unlikely to be encountered while drilling.

A.1.8 Groundwater levels

A.1.8.1 The closest EA groundwater monitoring locations to the Pipelines are the Portsdown groundwater monitoring location (discussed in paragraph 4.2.64), which is 3-4km to the west and the Pyle Farm Cottages groundwater monitoring location about 1km north of Havant Thicket Reservoir.

A.1.8.2 Pyle Farm Cottages borehole has a datum of 56.36m AOD and is screened within the Tarrant Chalk Member. The borehole is generally dipped twice annually in spring and autumn and shows a clear seasonal variation with higher groundwater levels generally observed in early Spring. Groundwater levels generally fluctuate between approximately 22m AOD and 35m AOD but is occasionally monitored at higher levels during wet periods (e.g. monitored at 43.48m AOD in March 2014).

A.1.8.3 Site specific groundwater monitoring was undertaken in a number of the ground investigation boreholes as summarised below:

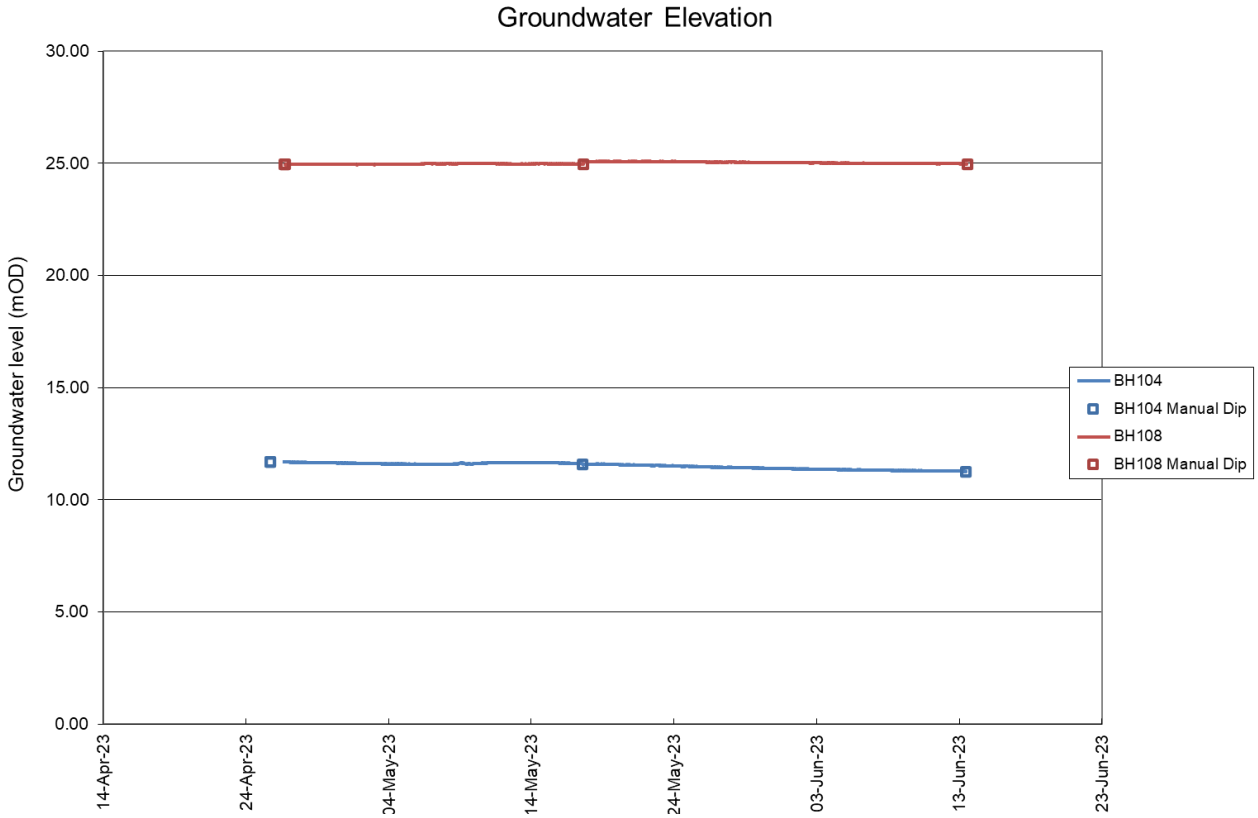
1. BH101: Standpipe with response zone 17.5 to 30.0m bgl (screened in the chalk bedrock). Awaiting monitoring data but assumed to be artesian.
2. BH102A: Standpipe with response zone 24.0 to 29.1m bgl (screened in the chalk bedrock). Awaiting monitoring data but assumed to be artesian.
3. BH103: Standpipe with response zone 21.5 to 28.0m bgl (screened in the Lambeth Group). Manually dipped monthly.
4. BH104: Two standpipes with response zones 16.5 to 20.1m bgl (screened in the Harwich Formation and the upper Lambeth Group) and 26.0 to 32.6m bgl (screened in the Lambeth Group). Data logger installed in deeper standpipe with shallower standpipe manually dipped monthly.
5. BH105: Two standpipes with response zones 15.0 to 20.0m bgl (screened in the London Clay) and 24.0 to 28.5m bgl (screened in the Lambeth Group). Manually dipped monthly.
6. BH106: Two standpipes with response zones 15.9 to 18.5m bgl (screened in the Lambeth Group – Reading Formation) and 22.0 to 26.0m bgl (screened in the Lambeth Group – Woolwich Formation). Manually dipped monthly.
7. BH107: Standpipe with response zone 19.5 to 26.0m bgl (screened in the Lambeth Group – Woolwich Formation). Manually dipped monthly.
8. BH108: Two standpipes with response zones 1.2 to 4.3m bgl (screened in the London Clay) and 28.0 to 33.6m bgl (screened in the Lambeth Group). Data

logger installed in deeper standpipe with shallower standpipe manually dipped monthly. Both standpipes recording artesian groundwater at surface.

9. BH109: No installations.

A.1.8.4 Available datalogger data from the Phase 1 boreholes between the WRP site and Havant Thicket Reservoir is illustrated in Graphic A-1.

Graphic A-1 Phase 1 Datalogger groundwater monitoring (up to June 2023) - Pipelines between the Water Recycling Plant site and Havant Thicket Reservoir



A.1.8.5 Perched groundwater may be encountered within the overlying superficial deposits, where present (assumed to be present when considering potential impacts).

A.1.9 Groundwater quality

A.1.9.1 The groundwater within the chalk is not anticipated to be saline, due to the dominant flow paths and heads from the north. Regionally the vast majority of unconfined groundwaters within the Wessex Basin Chalk are of the Ca-HCO_3 type [9]. The groundwater quality of the superficial deposits and London Clay are likely to be more variable, with shallower groundwaters in the superficial deposits more susceptible to anthropogenic activities.

A.1.9.2 The proximity to the sea in the south, means that shallow groundwater within the superficial deposits is assumed to be brackish or saline towards the coast.

A.1.10 Groundwater flooding

A.1.10.1 Hampshire has a known history of groundwater flooding as discussed in paragraphs 4.2.33 and 4.2.34.

A.1.10.2 Groundwater flood risk varies from areas of limited potential for groundwater flooding (at the location of the WRP site and the north-east of the Order Limits) to areas with potential for groundwater flooding to occur at surface (in the area of Havant).

A.1.11 Abstractions

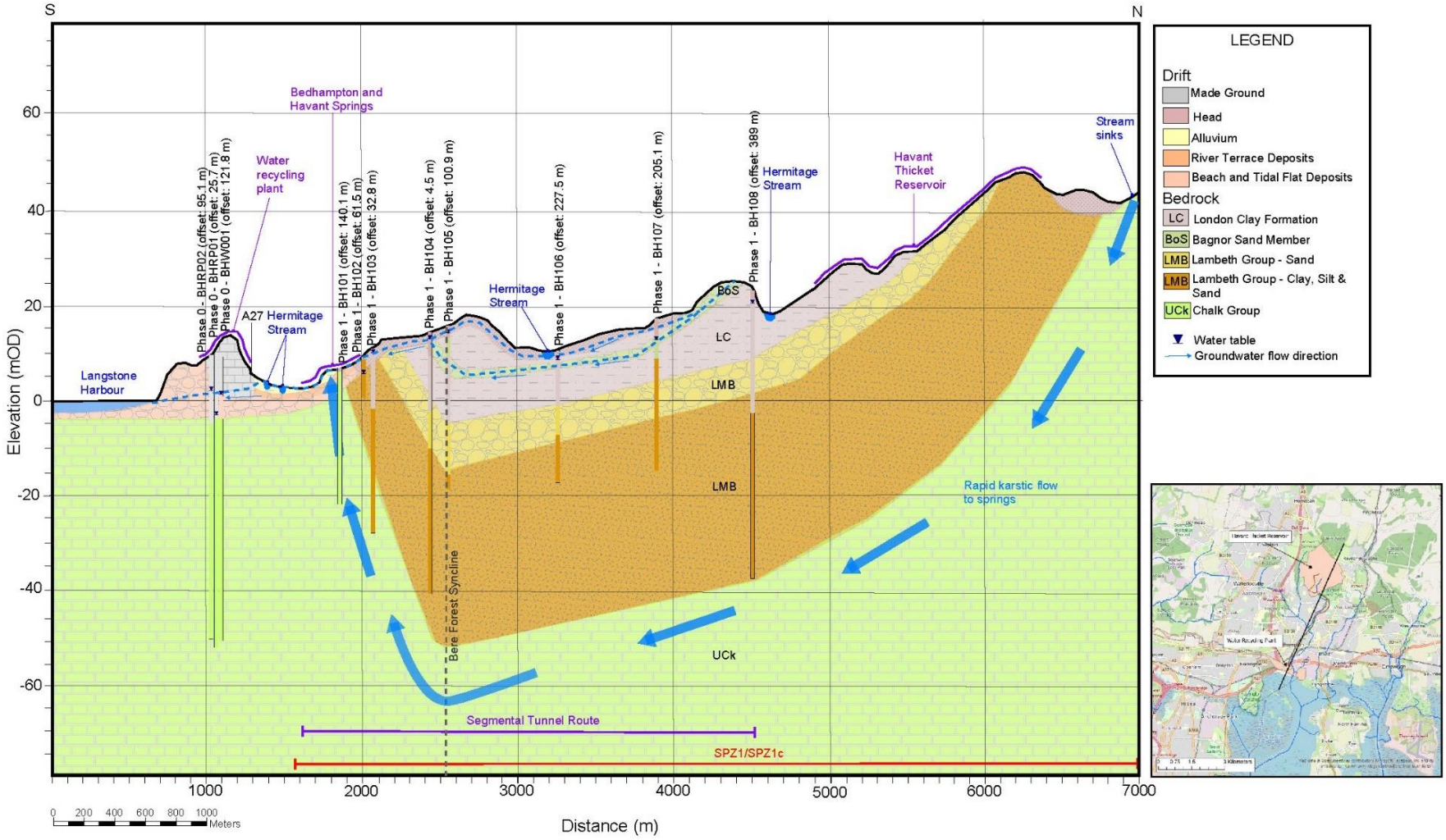
A.1.11.1 Three licensed groundwater abstraction are located in the study area of the Water Recycling Plant, as documented in Table A-4.

Table A-4 Licensed groundwater abstractions - Pipelines between the Water Recycling Plant site and Havant Thicket Reservoir

Licence Holder	Licence no.	Use	Point Name
Portsmouth Water	11/42/36.2/1	PWS	Bedhampton PS Spring No 1
Portsmouth Water	11/42/36.2/1	PWS	Bedhampton PS Spring No 2
Portsmouth Water	11/42/36.2/1	PWS	Havant PS

A.1.11.2 HBC and EHDC were both contacted in regard to unlicensed abstractions (less than 20m^3/day) within the area. HBC and EHDC responded that no sites were identified within the study area of the Water Recycling Plant.

Graphic A-2 Hydrogeological Cross Section N-S (Backup Tunnel Route now descoped)



Annex B – Discharge consents within Proposed Development study area

Consented discharge	Within Order Limits
A00751: Southern Water Services - Budds Farm WTW - To the Solent/Langstone Harbour	**Within Budds Farm WTW**
A00752: Southern Water Services - Budds Farm Havant CSO - To Brockhampton Creek	Outside Order Limits
A01016: Southern Water Services - Priorsdean Crescent Havant CSO - To Hermitage Stream	Outside Order Limits
A01308: Southern water services limited. - Newmans Bridge Southwick CSO - To River Wallington	Outside Order Limits
A01309: Southern Water Services Ltd - Fareham Road Wickham CSO - To River Meon	Outside Order Limits
A01399: Southern Water Services Ltd - Ashton Corner CSO - To tributary of the River Hamble	Outside Order Limits
EPRAB3296EX: Fisher's Pond Limited - Fish Farm at Marwell Pond - To tributary of Bow Lake Stream	Outside Order Limits
EPRDB3398EE: 7 Forest Lane - To groundwater via borehole	Outside Order Limits
EPRDB3999DM: The Chilterns - To infiltration field	Outside Order Limits
EPRDP3325XB: Jardini - To tributary of Colden Common	Outside Order Limits
EPREB3096RR: Hazardous Waste Management Ltd - Otterbourne Farm - To groundwater	Outside Order Limits
EPREB3193DB: Malmsmead - To ground	Outside Order Limits
EPREB3198VU: The Summerhouse - To groundwater	Outside Order Limits
EPREB3199AH: Crantock – To groundwater	Outside Order Limits
EPREB3299WH: Calvi - To groundwater	Outside Order Limits
EPREB3592NW: Greenlaw - To groundwater	Outside Order Limits
EPREB3594RB: Torbay Farm - To unnamed tributary of Ford Lake	Outside Order Limits
EPREB3899DL: Chinook Lodge - To groundwater	Outside Order Limits
EPRFB3091NX: Bridle Way - To groundwater	Outside Order Limits
EPRFB3390AY: Yi Shui Ge - Tributary of Itchen Navigation	Outside Order Limits
EPRFB3390DP: Qing Ya Xi - To Kingfisher Stream	Outside Order Limits
EPRGP3929XP: Marling - To groundwater via borehole	Outside Order Limits
EPRHB3994NK: Malms Farm - To River Itchen	Outside Order Limits
EPRJB3694NM: Nythfa - To tributary of Ford Lake River	Outside Order Limits
EPRJP3726GP: SGC Projects Ltd – 2 The Cottages – To ditch tributary of River Wallington	Outside Order Limits
EPRJP3924XW: Knightsgate (UK) limited - Plot 1 Former Hoads Hill Service St - To tributary of River Wallington	Outside Order Limits
EPRLB3797RA: Great Pecks STP - To ditch leading to River Hamble	Outside Order Limits

Consented discharge	Within Order Limits
EPRLP3125GC: Spencer place - To unnamed tributary of Shawfords lake	Outside Order Limits
EPRLP3225XG: Knightsgate (UK) Ltd - Plot 2 Former Hoads Hill Services St - To Tributary of River Wallington	Outside Order Limits
EPRLP3226GV: Knightsgate (UK) Ltd - Plot 4 Former Hoads Hill Service St - To tributary of River Wallington	Outside Order Limits
EPRLP3226XT: Knightsgate (UK) Ltd - Plot 3 Former Hoads Hill Service St - To tributary of River Wallington	Outside Order Limits
EPRLP3422GC: Moat Cottage - Unnamed tributary of River Itchen	Outside Order Limits
EPRNB3235AG: Bowlakes Fish Farm - To Bow Lake and tributary of Bow Lake	Outside Order Limits
EPRNP3621XT: Knightsgate UK Ltd. - Whitethorn - To River Meon	Outside Order Limits
EPRSB3690WN: 1 Lyons Cottage - To ditch tributary of Shawfords Lake	Outside Order Limits
EPRTB3392VC: Sandy Acres Girl Guide Group - Sandy Acres Girl Guide Group STP - To tributary of Shawfords Lake	Outside Order Limits
EPRTB3393VN: Black Horse Farm - To tributary of Shawfords Lake	Outside Order Limits
EPRUB3697NY: Middle Barn The Tree Nursery - To tributary of Shawfords Lake	Outside Order Limits
EPRYP3825GE: Birchfrith - To groundwater via borehole	Outside Order Limits
EPRZP3929XR: Laurel Cottage - To tributary of River Hamble	Outside Order Limits
G00388: C Morgan and Sons (Motors and Spares) Ltd - C Morgan and Sons Ltd - To Shawford Lake tributary of Hamble	Outside Order Limits
G01169: Veolia es Hampshire ltd - Warren Farm Waste Transfer Station - To groundwater via soakaway	Outside Order Limits
G01170: Veolia es Hampshire limited - Warren Farm Waste Transfer Station - To groundwater via soakaway	Outside Order Limits
G01171: Veolia es Hampshire limited - Warren Farm Waste Transfer Station - To groundwater via soakaway	Outside Order Limits
G01172: Veolia es Hampshire ltd - Warren Farm Waste Transfer Station - To groundwater via soakaway	Outside Order Limits
H01073: Southern Water services ltd - Sewage Pumping Station - To freshwater river	Outside Order Limits
H01351: Mayles Lodge - To freshwater river	Outside Order Limits
H01467: Rose Tree Cottage - To freshwater river	Outside Order Limits
H01471: Arbour Cottage - To freshwater river	Outside Order Limits
H01543: Tudor Cottage - To Freshwater River	Outside Order Limits
H01605: Potwell House - To freshwater river	Outside Order Limits
H01608: The Southwick Estate - To Freshwater River	Outside Order Limits
H01657: Gravel Hill House - To freshwater river	Outside Order Limits
H01692: Conifers - To freshwater river	Outside Order Limits
H01697: Hook heath farm - To freshwater river	Outside Order Limits

Consented discharge	Within Order Limits
H01886: H L Gamblin and Sons - Little Tapnage Farm - To freshwater river	Outside Order Limits
H01896: Oak Tree Cottage - To saline estuary	Outside Order Limits
H01925: Brooklands Farm House - To saline estuary	Outside Order Limits
H01928: Deer Lodge - To freshwater river	Outside Order Limits
H01930: Double Lodge - To Freshwater River	Outside Order Limits
H01931: Northfields Farm House - To freshwater river	Outside Order Limits
H01958: Underwath - To saline estuary	Outside Order Limits
H01960: Ashley Down Farm House - To freshwater river	Outside Order Limits
H02003: Premises at Curdridge Lane - To freshwater River	Outside Order Limits
H02836: Marwell Manor - To freshwater river	Outside Order Limits
N01162: Fasset Limited - Langstone Road - To Freshwater River	Outside Order Limits
N01228: HBC – Bus Station at Elm Road – To Saline Estuary	Outside Order Limits
N01265: North Shore Yacht Yards Ltd - Boshampton Lane - To Saline Estuary	Outside Order Limits
N01642: R B Dunford and Son - Stoke Park Farmhouse - To underground strata	Outside Order Limits
N02579: Southwick and Roche Court Estate co - 1 and 2 Ashley Down Cottages - To land	Outside Order Limits
N03056: Timbers - Into land	Outside Order Limits
N03057: Septic tank serving Mallards Point - Into land	Outside Order Limits
N03092: Mayles House - To land	Outside Order Limits
N03260: Dell Copse - Into land	Outside Order Limits
NPSWQD003411: Lambs Hill - To soakaway	Outside Order Limits
NPSWQD005981: Fisher's Pond Ltd - Fisher's Pond Fishery - To a tributary of Bow Lake	Outside Order Limits
P00174: De La Rue Systems - High Technology Campus - To Freshwater River	Outside Order Limits
P010526: New Deeps Farm - New Deeps Farm - Into land	Outside Order Limits
P01097: Brendoncare Foundation - The Old Parsonage - To freshwater river	Outside Order Limits
P01146: Swimming Pool at Iolanda - Into land	Outside Order Limits
P02737: Royal armouries - Hampshire c.c. - To land	Outside Order Limits
P02918: Otterbourne Grange - Into land	Outside Order Limits
P03199: Leylands Farm - Into land	Outside Order Limits
P04382: Priory CC 101 Ltd - The Queens Head - To freshwater river	Outside Order Limits
P05514: Scottish and Southern Energy PLC - Land East of Southmoor Lane - To unnamed Tributary of Lavant Stream	Outside Order Limits
P06216: The Meadows (Upham) Management Ltd - Upham Street STW - To underground strata	Outside Order Limits
P06856: WCC - Field Adj to No 1 Widley Walk - To Freshwater River	Outside Order Limits
P10535: Lift and Shift Skip Hire Ltd - Farlington Redoubt - To Land	Outside Order Limits

Consented discharge	Within Order Limits
W00006: Southern Water Services Ltd – Bishop's Waltham WTW - To River Hamble	Outside Order Limits
W00248: Southern Water services ltd - Southwick WTW - To River Wallington	Outside Order Limits

Annex C – Groundwater monitoring installations

GI Phase	Borehole ID	2022					2023											2024											
		01-Aug-22	01-Sep-22	01-Oct-22	01-Nov-22	01-Dec-22	01-Jan-23	01-Feb-23	01-Mar-23	01-Apr-23	01-May-23	01-Jun-23	01-Jul-23	01-Aug-23	01-Sep-23	01-Oct-23	01-Nov-23	01-Dec-23	01-Jan-24	01-Feb-24	01-Mar-24	01-Apr-24	01-May-24	01-Jun-24	01-Jul-24	01-Aug-24	01-Sep-24	01-Oct-24	01-Nov-24	01-Dec-24
Phase 0	BHRP01																												
Phase 0	BHRP01																												
Phase 0	BHRP02																												
Phase 0	BHRP02																												
Phase 0	BHW001																												
Phase 0	BHW001																												
Phase 0	BHW002																												
Phase 0	BHW002																												
Phase 0	BHW003																												
Phase 0	BHW003																												
Phase 0	BHW004																												
Phase 0	BHW004																												
Phase 0	BHW005																												
Phase 0	BHW005																												
Phase 0	WSW001																												
Phase 0	WSW002																												
Phase 0	WSW003																												
Phase 1	BH101																												
Phase 1	BH102A																												
Phase 1	BH103																												
Phase 1	BH104																												
Phase 1	BH105																												
Phase 1	BH106																												
Phase 1	BH107																												
Phase 1	BH108																												
Phase 1	BH202																												
Phase 1	BH301A																												
Phase 1	BH302																												
Phase 1	BH303-D																												
Phase 1	BH303-S																												
Phase 1	BH501																												
Phase 1	BH502																												
Phase 1	BH503																												
Phase 1	BH504																												
Phase 2	2B1500SA (1)																												
Phase 2	2D2500SA (1)																												
Phase 2	2E3000RC (1)																												
Phase 2	2E3002RC (1)																												
Phase 2	2F3500DS (1)																												
Phase 2	2F3501DS																												
Phase 2	2F3502SA																												
Phase 2	2F3503SA																												
Phase 2	2F3504DS																												
Phase 2	2F3512RC																												
Phase 2	2F3513DS																												
Phase 2	2F3515DS																												
Phase 2	2G4000SA																												
Phase 2	2G4001SA																												
Phase 2	2G4003DS																												
Phase 2	2H4500DR																												
Phase 2	2H4501DR																												
Phase 2	2H4502DS																												
Phase 2	2H4503DS																												
Phase 2	2K5500SR																												
Phase 2	2K5501SR																												
Phase 2	2L6002SA																												
Phase 2	2L6003SA																												
Phase 2	2L6005SA																												
Phase 2	2L6007DR																												

GI Phase	Borehole ID	01-Aug-22	01-Sep-22	01-Oct-22	01-Nov-22	01-Dec-22	01-Jan-23	01-Feb-23	01-Mar-23	01-Apr-23	01-May-23	01-Jun-23	01-Jul-23	01-Aug-23	01-Sep-23	01-Oct-23	01-Nov-23	01-Dec-23	01-Jan-24	01-Feb-24	01-Mar-24	01-Apr-24	01-May-24	01-Jun-24	01-Jul-24	01-Aug-24	01-Sep-24	01-Oct-24	01-Nov-24	01-Dec-24
		2022					2023												2024											
Phase 2	2L6008DR (1)																													
Phase 2	2L6008DR (2)																													
Phase 2	2L6009DR (1)																													
Phase 2	2L6009DR (2)																													
Phase 2	2L6010DR																													
Phase 2	2L6011SR (1)																													
Phase 2	2L6011SR (2)																													
Phase 2	2L6012SR																													
Phase 2	2M6507SA (1)																													
Phase 2	2M6507SA (2)																													
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Phase 2	2M6508SA (2)																													
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Phase 3A	BHP02																													
Phase 3A	BHP05																													
Phase 3A	BHP06																													
Phase 3B	3E3019DS																													
Phase 3B	3H4517SA																													
Phase 3B	3J5002SA																													
Phase 3B	3J5004DS																													
Phase 3B	3J5028DS																													
Phase 3B	3K5525DR																													
Phase 3B	3K5606SA																													
Phase 3B	3L6106DS																													
Phase 3C	3E3035DS																													
Phase 3C	3E3115DS																													
Phase 3C	3F3523DR																													
Phase 3C	3F3524DR																													
Phase 3C	3G4022DS																													
Phase 3C	3G4037DS																													
Phase 3C	3G4038DS																													
Phase 3C	3G4102SA																													
Phase 3C	3G4105SA																													
Phase 3C	3G4106SA																													
Phase 3C	3H4600SA																													
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Phase 3C	3W8539DS																													
Phase 3C	3W8553DS																													
Phase 3C	3W8554DS																													
Phase 3C	3W8558SA																													
Phase 3C	3W8567SA																													

Legend	
	Manual Dip Data
	Datalogger Data

Annex D– Quantitative assessment of dewatering impacts

D.1 Introduction

D.1.1.1 For the majority of the Proposed Development, a conservative qualitative assessment (based on the hydrogeological conceptualisation and professional judgement) has been undertaken to identify receptors considered likely to be impacted by drawdown of groundwater levels.

D.1.1.2 To ensure that likely significant effects have been identified, a more detailed conceptualisation and conservative quantitative analytical assessment has been undertaken of dewatering impacts for deeper structures within the chalk; to determine the potential abstraction rates, Zone of Influence and consequently magnitude of drawdown effects without any mitigation measures in place.

D.1.1.3 The results have informed the potential mitigation and monitoring measures that have been set out in the Outline CEMP (Document reference 7.1, DCO Volume 7) and may be required as part of the abstraction licence and discharge permit processes (post Development Consent Order). The exact requirements will be confirmed following further site investigation works, detailed design (including confirmation of shaft construction methodologies and depths) and during the abstraction and discharge consenting processes.

D.1.1.4 The ten elements that have been reviewed in more detail are:

1. WRP East Shaft (to Bedhampton Springs)
2. WRP West Shaft (Purbrook Tunnel)
3. WRP South Shaft (to Budds Farm)
4. Budds Farm Shaft
5. Mill Lane East (Bedhampton Pipe-Jack)
6. Mill Lane West (Bedhampton Pipe-Jack)
7. Portsdown Hill Shaft
8. Purbrook Shaft
9. River Wallington Launch and Reception Shafts
10. Poles Lane Stream Launch and Reception Shafts

D.1.1.5 The conservative quantitative assessment undertakes a staged approach:

1. Conceptualisation to identify dewatering requirements based on indicative structure dimensions.
2. Tier 1 analytical equations to conservatively assess anticipated flow rates and drawdown at distance.
3. Tier 2 testing of conceptualisation with conservative analytical or numerical models to confirm flow rates and drawdown at distance, and sensitivity to hydrogeological parameters.

D.1.1.6 As noted in paragraph D.1.1.3, these activities would ultimately be subject to abstraction licences and environmental permits, and a more detailed assessment is required during the application process which will verify the mitigation and monitoring requirements. These mitigation requirements will be secured as part of the application process of the relevant abstraction licences and discharge permits.

D.1.1.7 The annex does not repeat general hydrogeological impacts and mitigation measures outlined in the main report which are relevant to all works (such as pollution prevention measures).

D.2 WRP East Shaft

D.2.1 Conceptualisation

D.2.1.1 The WRP East Shaft is located in the north-east of the WRP and will act as the launch shaft for the pipeline towards Bedhampton Springs.

D.2.1.2 The approximate shaft location and main surface water and groundwater receptors in relation to the shaft are illustrated in Graphic D 11. The most proximal surface water receptors are the Hermitage Stream to the east at approximately 135m distance and Langstone Harbour to the south at approximately 400m distance.

D.2.1.3 The ground conditions at the shaft location are anticipated to comprise a approximately 2m of Made Ground underlain by Landfill deposits to approximately 16.65m bgl (-3.25m OD). The landfill in this area is anticipated to be directly underlain by chalk bedrock (proven to 65.25m bgl in the most proximal borehole).

D.2.1.4 Perched groundwater is anticipated within the Made Ground and landfill deposits. Due to the landfills presence this perched groundwater may be contaminated.

D.2.1.5 Groundwater levels in the underlying chalk are tidally influenced and have been monitored between 0.75m AOD and 3.5m AOD on the WRP site (see Graphic 4-2). The groundwater levels show a clear tidal response, with up to 2.0m tidal variation observed in some boreholes between low and high tide. The groundwater head in the chalk generally increases to the north, and subsequently the dominant flow is from the north towards the south.

D.2.1.6 As noted in paragraph 4.1.37, the transmissivity of the chalk in the Hampshire area is highly variable with a geometric mean of 1,600m^2/d. Packer testing within boreholes in the Phase 0 ground investigation (ES Appendix 11.2 Ground investigation report, Volume III (Document reference 6.3, DCO Volume 6) indicating permeability values between $8x10^{-8}$ m/s and $2.8x10^{-5}$ m/s, although these tests may not have picked up the most significant fracture flow horizons. There is no documented evidence of karst in the area of the WRP, unlike evidenced in the north, although karstic features may be present and will be monitored during the works.

D.2.1.7 The design of the shaft will be finalised during detailed design, but for the purpose of this assessment is considered to have an internal diameter of 12.5m and invert of 16.8m bgl (formation located within the chalk beneath the landfill), as per the Outline FWRA – Proposed Water Recycling Plant (Document reference 7.4, DCO Volume 7).

D.2.2 Abstraction Rates

D.2.2.1 Equivalent well analysis (assumes the shaft is a large well/borehole) has been utilised to estimate potential steady state flows to the shaft from the chalk bedrock, conservatively assuming no measures to limit inflows (such as cut-off walls or grouting).

D.2.2.2 To calculate indicative abstraction rates, the Thiem equation for steady state flow to a well in confined conditions has been used:

$$Q = \frac{2\pi kD(H - h_w)}{\ln [{}^{R_0}/_{r_e}]}$$

Where:

k = permeability

D = thickness of confined aquifer

H = initial water table in the aquifer

h_w = water level in the equivalent well

R_0 = radius of influence

r_e = equivalent well radius (shaft radius)

D.2.2.3 The parameters utilised for the initial assessment of flows are as follows:

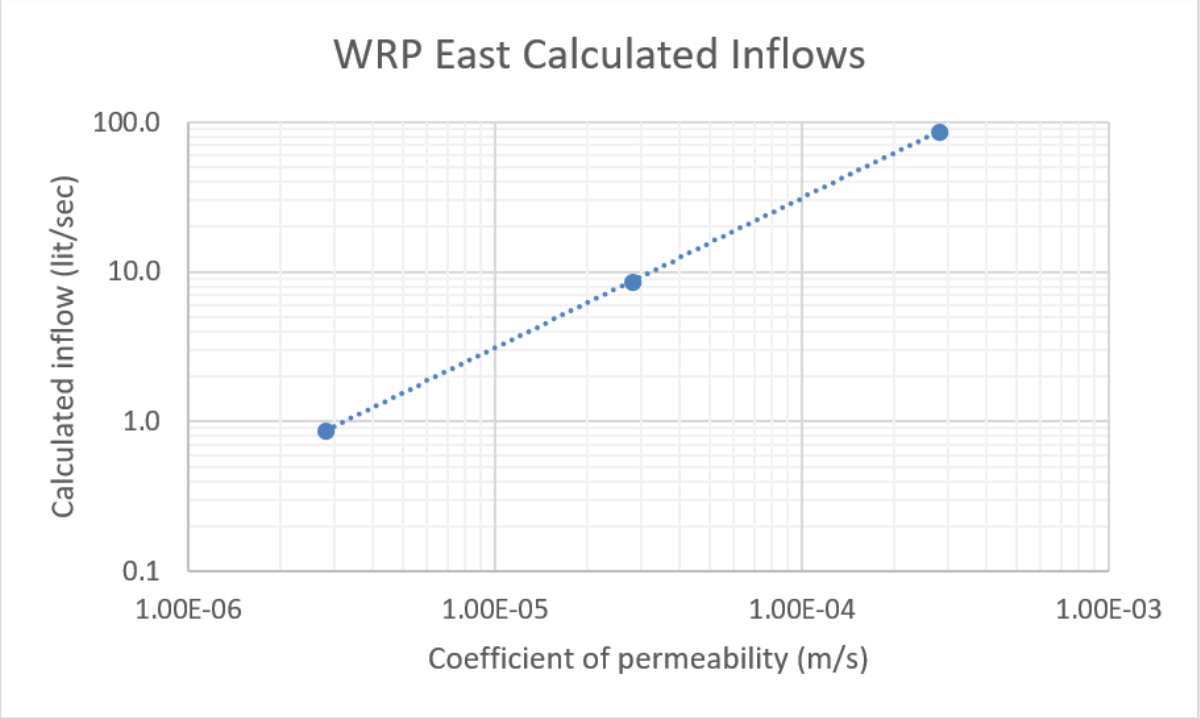
1. Permeability of 2.8×10^{-5} m/s from site investigation results.
2. Thickness of confined aquifer taken as 20m (base of aquifer at -23.25m AOD for purpose of calculation). It is known that the aquifer extends deeper, however any dewatering wells required for the shaft are anticipated to only partially penetrate into the chalk and the chalk is anticipated to generally reduce in permeability with depth.
3. Initial water table taken as 3.5m AOD.
4. Water level in equivalent well taken as -4.1m AOD (approximately 1.0m below indicative shaft depth).
5. Radius of influence of 135m (see below).
6. Equivalent well radius taken as 6.25m; internal shaft radius.

D.2.2.4 A smaller radius of influence results in higher flows and as such, for the purpose of calculating flows only, the radius of influence has been taken as 135m distance; which correspond to the closest potential head boundary (the Hermitage Stream).

D.2.2.5 For the parameters listed in paragraph D.2.2.3, a steady state abstraction rate of 8.7 lit/sec is calculated.

Sensitivity analysis has been undertaken to ascertain abstraction rates for a range of permeabilities which are illustrated in Graphic D 1.

Graphic D 1 WRP East Shaft. Abstraction Rate Inflow Sensitivity Analysis



D.2.3 Zone of Influence

D.2.3.1 A 'recharge circle' is an analytical assessment to show what surface area is required to support an abstraction – in this case the calculated temporary dewatering rates. A recharge circle is similar to a radius of influence calculation, and informs what might be within a theoretical radius of influence of a dewatering abstraction, including surface water bodies and other dependent receptors.

D.2.3.2 The radius of a recharge circle (R) is calculated using the following equation and the variables of abstraction (A), precipitation (P) and potential evapotranspiration (PET):

$$R = \sqrt{\frac{A}{\pi(P_{eff})}}$$

Where Effectuve Precipitation (P_{eff}) = P – PET [9]

D.2.3.3 The abstraction value has been taken as the total abstraction volume over a year, at the calculated inflow rate. Effective precipitation has been calculated as the sum of daily P_{eff} for the year 2011 (a drought year, with below average annual rainfall in this area). The P and PET values have been taken from the HadUK 1km Gridded and Environment Agency PET dataset. [19] [20]

D.2.3.4 Based on an average inflow rate of 8.7 lit/sec over a year, and effective annual precipitation of 417mm, the calculated radius of the recharge circle is 457.8m.

[9] Where potential evapotranspiration exceeds precipitation on any given day, the effective precipitation for that day is measured as 0.

D.2.3.5 Due to the dominant hydraulic boundaries in the vicinity of the WRP site, such as the Langstone Harbour and Hermitage Stream surface water bodies and the karstic chalk network to the north, the actual Zone of Influence is likely to be significantly smaller; constrained by the dominant head boundaries.

D.2.4 Hydrogeological Impacts

D.2.4.1 Dewatering activities are considered likely to be non-consumptive with abstracted groundwater released back to the water environment, where the water quality allows (as the WRP is a historic landfill treatment prior to release may be required or alternatively the abstracted water may need to be disposed off appropriately). Where feasible (subject to water quality constraints and discharge constraints), net abstraction from the local water environment would be minimal.

D.2.4.2 Without appropriate measures in place, drawdown and flow impacts could be observed at proximal receptors; such as the adjacent Hermitage Stream and Langstone Harbour which could see a temporary reduction in baseflow and reversal in hydraulic gradients. Due to the dominant karstic flowpaths feeding the springs, the likelihood of impacts to the Bedhampton and Havant springs are considered to be low, although this will need to be verified by monitoring.

D.2.4.3 Water quality impacts could include contaminant mobilisation from the historic landfill and saline intrusion through reversal of hydraulic gradients, without appropriate measures in place.

D.2.5 Mitigation and Monitoring

D.2.5.1 The mitigation requirements will ultimately be confirmed as part of the abstraction licence and environmental permit processes, whilst monitoring requirements will be confirmed through the consenting processes and within the Water Monitoring Plan (to be produced substantially in accordance with the Outline Water Monitoring Plan).

D.2.5.2 The shaft designs will be confirmed during the detailed design process, but are likely to require measures to reduce inflows and the Zone of Influence (such as cut-off of shallow deposits and potential grouting of the chalk) as detailed in the Outline FWRA – Proposed Water Recycling Plant (Document reference 7.4, DCO Volume 7). The requirement for additional groundwater control mitigation measures as detailed in the Outline CEMP (Document reference 7.1, DCO Volume 7) would be reviewed, during the detailed design and licensing processes, as required.

D.2.5.3 In general, the intention would be for abstractions to be non-consumptive and released back to the local water environment. This would be subject to the abstracted water quality being suitable (non-polluting).

D.3 WRP West Shaft

D.3.1 Conceptualisation

D.3.1.1 The WRP West Shaft is located in the north/north-east of the WRP and will act as the launch shaft for the tunnel towards Purbrook.

D.3.1.2 The approximate shaft location and main surface water and groundwater receptors in relation to the shaft are illustrated in Graphic D 11. The most proximal surface water receptors are the Hermitage Stream to the east at approximately 200m distance and Langstone Harbour to the south at approximately 380m distance.

D.3.1.3 The ground conditions at the shaft location are anticipated to comprise approximately 2m of Made Ground underlain by Landfill deposits to approximately 17.0m bgl (-6.73m AOD). The landfill in this area is anticipated to be directly underlain by chalk bedrock (proven to 60.7m bgl in the most proximal borehole).

D.3.1.4 Perched groundwater is anticipated within the Made Ground and landfill deposits. Due to the landfills presence this perched groundwater may be contaminated.

D.3.1.5 Groundwater levels in the underlying chalk are tidally influenced and have been monitored between 0.75m AOD and 3.5m AOD on the WRP site (see Graphic 4-2). The groundwater levels show a clear tidal response, with up to 2.0m tidal variation observed in some boreholes between low and high tide. The groundwater head in the chalk generally increases to the north, and subsequently the dominant flow is from the north towards the south.

D.3.1.6 As noted in paragraph 4.1.37, the transmissivity of the chalk in the Hampshire area is highly variable with a geometric mean of 1,600m^2/d. Packer testing within boreholes in the Phase 0 ground investigation (ES Appendix 11.2 Ground investigation reports, Volume II (Document reference 6.2, DCO Volume 6) indicating permeability values between $8x10^{-8}$ m/s and $2.8x10^{-5}$ m/s, although these tests may not have picked up the most significant fracture flow horizons. There is no evidence of extensive karst in the area of the WRP, unlike evidenced in the north, although karstic features may be present and will be monitored during the works.

D.3.1.7 The design of the shaft will be finalised during detailed design, but for the purpose of this assessment is considered to have an internal diameter of 15.0m and invert of 24.6m bgl (formation located within the chalk beneath the landfill), as per the Outline FWRA – Proposed Water Recycling Plant (Document reference 7.4, DCO Volume 7).

D.3.2 Abstraction Rates

D.3.2.1 Equivalent well analysis (assumes the shaft is a large well/borehole) has been utilised to estimate potential steady state flows to the shaft from the chalk bedrock, conservatively assuming no measures to limit inflows (such as cut-off walls or grouting). To calculate indicative abstraction rates, the Thiem equation for steady state flow to a well in confined conditions has been used:

$$Q = \frac{2\pi kD(H - h_w)}{\ln [R_0/r_e]}$$

Where:

k = permeability

D = thickness of confined aquifer

H = initial water table in the aquifer

h_w = water level in the equivalent well

R_0 = radius of influence

r_e = equivalent well radius (shaft radius)

D.3.2.2 The parameters utilised for the initial assessment of flows are as follows:

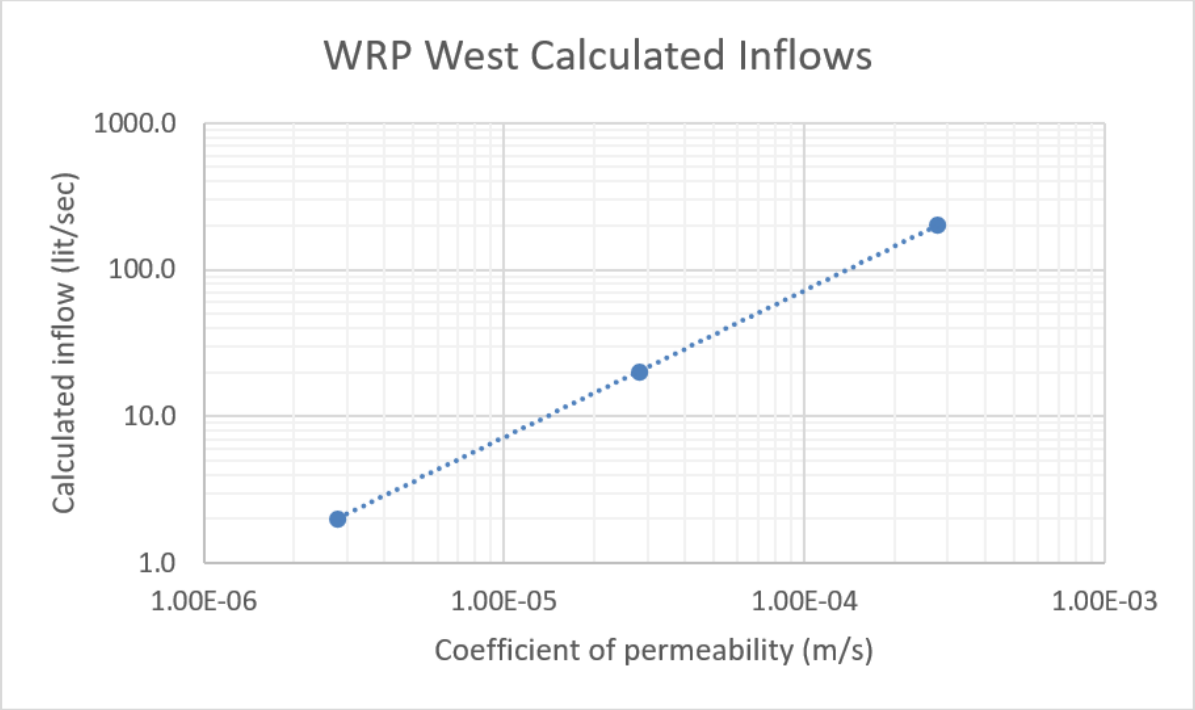
1. Permeability of 2.8×10^{-5} m/s from site investigation results.
2. Thickness of confined aquifer taken as 20m (base of aquifer at -26.73m AOD for purpose of calculation). It is known that the aquifer extends deeper, however any dewatering wells required for the shaft are anticipated to only partially penetrate into the chalk and the chalk is anticipated to generally reduce in permeability with depth.
3. Initial water table taken as 3.5m AOD.
4. Water level in equivalent well taken as -15.33m AOD (approximately 1.0m below indicative shaft depth).
5. Radius of influence of 200m (see below).
6. Equivalent well radius taken as 7.5m; internal shaft radius.

D.3.2.3 A smaller radius of influence results in higher flows and as such, for the purpose of calculating flows only, the radius of influence has been taken as 200m distance; which correspond to the closest potential head boundary (the Hermitage Stream).

D.3.2.4 For the parameters assessed in paragraph D.3.2.2, a steady state abstraction rate of 20.2 lit/sec is calculated.

D.3.2.5 Sensitivity analysis has been undertaken to ascertain abstraction rates for a range of permeabilities which are illustrated in Graphic D 2.

Graphic D 2 WRP West Shaft. Abstraction Rate Inflow Sensitivity Analysis



D.3.3 Zone of Influence

D.3.3.1 Recharge circles have been assessed to provide an indication of the theoretical radius of influence of a dewatering abstraction, as discussed in section D.2.3.

D.3.3.2 Based on an average inflow rate of 20.2 lit/sec over a year, and effective annual precipitation of 417mm, the calculated radius of the recharge circle is 697.6m.

D.3.3.3 Due to the dominant hydraulic boundaries in the vicinity of the WRP site, such as the Langstone Harbour and Hermitage Stream surface water bodies and the karstic chalk network to the north, the actual Zone of Influence is likely to be significantly smaller; constrained by the dominant head boundaries.

D.3.4 Hydrogeological Impacts

D.3.4.1 The potential hydrogeological impacts from dewatering the WRP West shaft are likely to be similar to those identified for the WRP East shaft (see D.2.4).

D.3.5 Mitigation and Monitoring

D.3.5.1 The mitigation and monitoring requirements for the WRP West shaft are likely to be similar to those identified for the WRP East shaft (see D.2.5).

D.4 WRP South Shaft

D.4.1 Conceptualisation

D.4.1.1 The WRP South Shaft is located in the south-west of the WRP and will act as the launch shaft for the trenchless crossing towards Budds Farm.

D.4.1.2 The approximate shaft location and main surface water and groundwater receptors in relation to the shaft are illustrated in Graphic D 11. The most proximal surface water receptors are the Hermitage Stream to the east at approximately 350m distance and Langstone Harbour to the south at approximately 200m distance.

D.4.1.3 The ground conditions at the shaft location are anticipated to comprise approximately 2m of Made Ground underlain by Landfill deposits to approximately 9.6m bgl (1.14m OD). In this area, the landfill is anticipated to be underlain by superficial deposits (Alluvium and River Terrace Deposits) to approximately 12.2m bgl. Chalk bedrock is anticipated below the superficial deposits to significant depth (proven to 29.3m bgl in proximal boreholes, and to greater than 65.0m bgl in wider boreholes within the WRP).

D.4.1.4 Perched groundwater is anticipated within the Made Ground and landfill deposits. Due to the landfills presence this perched groundwater may be contaminated.

D.4.1.5 Groundwater levels in the underlying chalk are tidally influenced and have been monitored between 0.75m AOD and 3.5m AOD on the WRP site (see Graphic 4-2). The groundwater levels show a clear tidal response, with up to 2.0m tidal variation observed in some boreholes between low and high tide. The groundwater head in the chalk generally increases to the north, and subsequently the dominant flow is from the north towards the south.

D.4.1.6 As noted in paragraph 4.1.37, the transmissivity of the chalk in the Hampshire area is highly variable with a geometric mean of 1,600m^2/d. Packer testing within boreholes in the Phase 0 ground investigation (ES Appendix 11.2 Ground investigation reports, Volume III (Document reference 6.2, DCO Volume 6)) indicating permeability values between $8x10^{-8}$ m/s and $2.8x10^{-5}$ m/s, although these tests may not have picked up the most significant fracture flow horizons. There is no evidence of extensive karst in the area of the WRP, unlike evidenced in the north, although karstic features may be present and will be monitored during the works.

D.4.1.7 The design of the shaft will be finalised during detailed design, but for the purpose of this assessment is considered to have an internal diameter of 9.0m and invert of 20.4m bgl (formation located within the chalk beneath the landfill), as per the Outline FWRA – Proposed Water Recycling Plant (Document reference 7.4, DCO Volume 7).

D.4.2 Abstraction Rates

D.4.2.1 Equivalent well analysis (assumes the shaft is a large well/borehole) has been utilised to estimate potential steady state flows to the shaft from the chalk bedrock, conservatively assuming no measures to limit inflows within the chalk (such as cut-off walls or grouting).

D.4.2.2 To calculate indicative abstraction rates, the Thiem equation for steady state flow to a well in confined conditions has been used:

$$Q = \frac{2\pi kD(H - h_w)}{\ln\left[{}^{R_0}/_{r_e}\right]}$$

Where:

k = permeability

D = thickness of confined aquifer

H = initial water table in the aquifer

h_w = water level in the equivalent well

R_0 = radius of influence

r_e = equivalent well radius (shaft radius)

D.4.2.3 The parameters utilised for the initial assessment of flows are as follows:

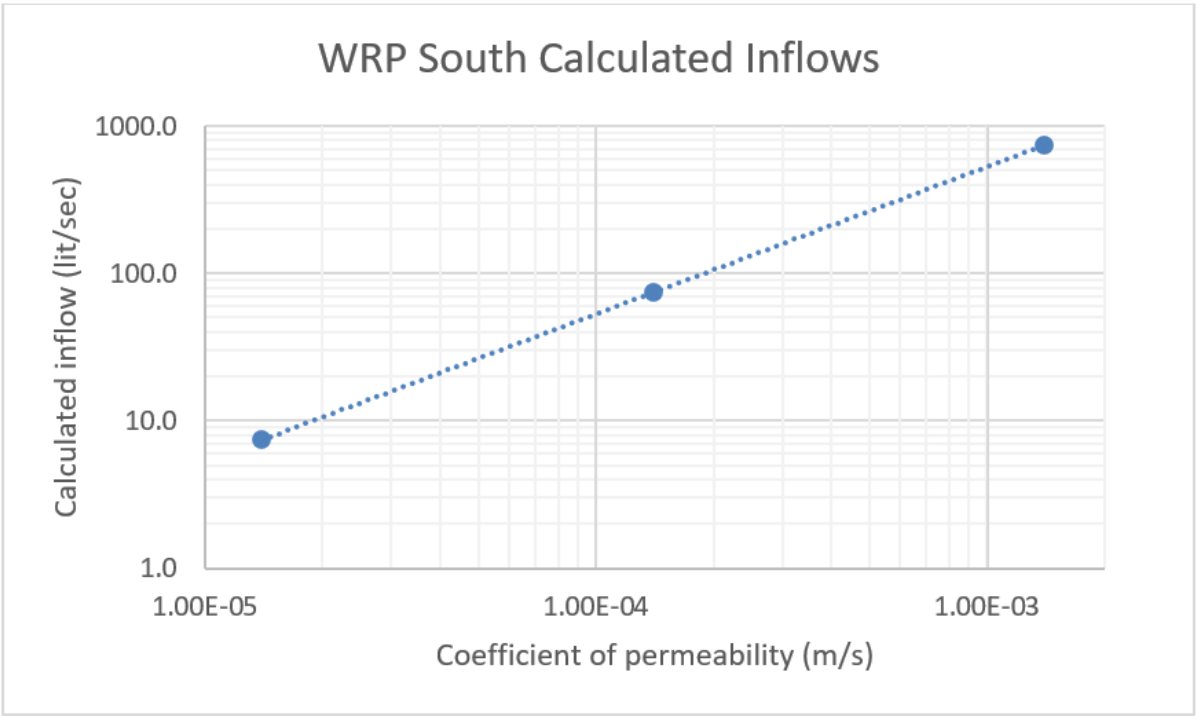
1. Weighted permeability of 1.4 x10^{-4} m/s (based on chalk permeability of 2.8x10^{-5} m/s from site investigation results and assumed superficial deposits permeability of 1.0x10^{-3} m/s).
2. Thickness of confined aquifer taken as 22.6m (2.6m thick superficial deposits and 20m thick chalk bedrock with base of aquifer at -21.46m AOD for purpose of calculation). It is known that the aquifer extends deeper, however the wells are anticipated to only partially penetrate into the chalk and the chalk is anticipated to generally reduce in permeability with depth.
3. Initial water table taken as 3.5m AOD.
4. Water level in equivalent well taken as -10.66m AOD (approximately 1.0m below indicative shaft depth).
5. Radius of influence of 200m (see below).
6. Equivalent well radius taken as 4.5m; internal shaft radius.

D.4.2.4 A smaller radius of influence results in higher flows and as such, for the purpose of calculating flows only, the radius of influence has been taken as 200m distance; which correspond to the closest potential head boundary (Langstone Harbour).

D.4.2.5 For the parameters assessed in paragraph D.4.2.3, a steady state abstraction rate of 74.2 lit/sec is calculated.

D.4.2.6 Sensitivity analysis has been undertaken to ascertain abstraction rates for a range of permeabilities which are illustrated in Graphic D 3.

Graphic D 3 WRP South Shaft. Abstraction Rate Inflow Sensitivity Analysis



D.4.3 Zone of Influence

D.4.3.1 Recharge circles have been assessed to provide an indication of the theoretical radius of influence of a dewatering abstraction (without taking into consideration cut-off or grouting measures), as discussed in section D.2.3.

D.4.3.2 Based on an average inflow rate of 74.2 lit/sec over a year, and effective annual precipitation of 417mm, the calculated radius of the recharge circle is 1336.9m.

D.4.3.3 Due to the dominant hydraulic boundaries in the vicinity of the WRP site, such as the Langstone Harbour and Hermitage Stream surface water bodies and the karstic chalk network to the north, the actual Zone of Influence is likely to be significantly smaller; constrained by the dominant head boundaries (with no impacts envisioned outside the study area).

D.4.4 Hydrogeological Impacts

D.4.4.1 The potential hydrogeological impacts from dewatering the WRP South shaft are likely to be similar to those identified for the WRP East shaft (see D.2.4).

D.4.5 Mitigation and Monitoring

D.4.5.1 The mitigation and monitoring requirements for the WRP South shaft are likely to be similar to those identified for the WRP East shaft (see D.2.5).

D.5 Budds Farm Shaft

D.5.1 Conceptualisation

D.5.1.1 The Budds Farm Shaft is located in the south-west of the Budds Farm WTW site and will act as the reception shaft for the tunnel from the WRP.

D.5.1.2 The approximate shaft location and main surface water and groundwater receptors in relation to the shaft are illustrated in Graphic D 11. The most proximal surface water receptor is Langstone Harbour to the south-west at approximately 50m distance.

D.5.1.3 The ground conditions at the shaft location are anticipated to comprise approximately 2m of Made Ground underlain by Alluvium and Raised Marine deposits to approximately 7.2m bgl (-3.78m OD). The chalk bedrock was proven to 45.8m bgl in the most proximal borehole.

D.5.1.4 Groundwater levels in the underlying chalk are tidally influenced and have been monitored between 0.75m AOD and 3.5m AOD on the WRP site using dataloggers (see Graphic 4-2). Spot sampling in site investigation at the Budds Farm site proximal to the shaft indicated a range of 0.84m AOD to 2.30m AOD. The groundwater levels show a clear tidal response, with up to 2.0m tidal variation observed in some boreholes between low and high tide. The groundwater head in the chalk generally increases to the north, and subsequently the dominant flow is from the north towards the south. The chalk is anticipated to be in hydraulic continuity with the overlying superficial deposits due to their granular nature in this area.

D.5.1.5 As noted in paragraph 4.1.37, the transmissivity of the chalk in the Hampshire area is highly variable with a geometric mean of 1,600m^2/d. Packer testing within boreholes in the Phase 0 ground investigation indicating permeability values between 8x10^{-8} m/s and 2.8x10^{-5} m/s, although these tests may not have picked up the most significant fracture flow horizons. There is no evidence of extensive karst in the area of Budds Farm, unlike evidenced in the north, although karstic features may be present and will be monitored during the works.

D.5.1.6 The design of the shaft will be finalised during detailed design, but for the purpose of this assessment is considered to have an internal diameter of 5.5m and invert of 17.6m bgl (formation located within the chalk beneath the landfill), as per the Outline FWRA – Proposed Water Recycling Plant (Document reference 7.4, DCO Volume 7).

D.5.2 Abstraction Rates

D.5.2.1 Equivalent well analysis (assumes the shaft is a large well/borehole) has been utilised to estimate potential steady state flows to the shaft from the chalk bedrock and overlying superficial deposits, conservatively assuming no measures to limit inflows (such as cut-off walls or grouting).

D.5.2.2 To calculate indicative abstraction rates, the Dupuit-Forcheimer equation for steady state flow to a well in an unconfined conditions has been used:

$$Q = \frac{\pi k(H^2 - h_w^2)}{\ln\left[{}^{R_0}/_{r_e}\right]}$$

Where:

k = permeability

H = initial water table in the aquifer

h_w = water level in the equivalent well

R_0 = radius of influence

r_e = equivalent well radius (shaft radius)

D.5.2.3 The parameters utilised for the initial assessment of flows are as follows:

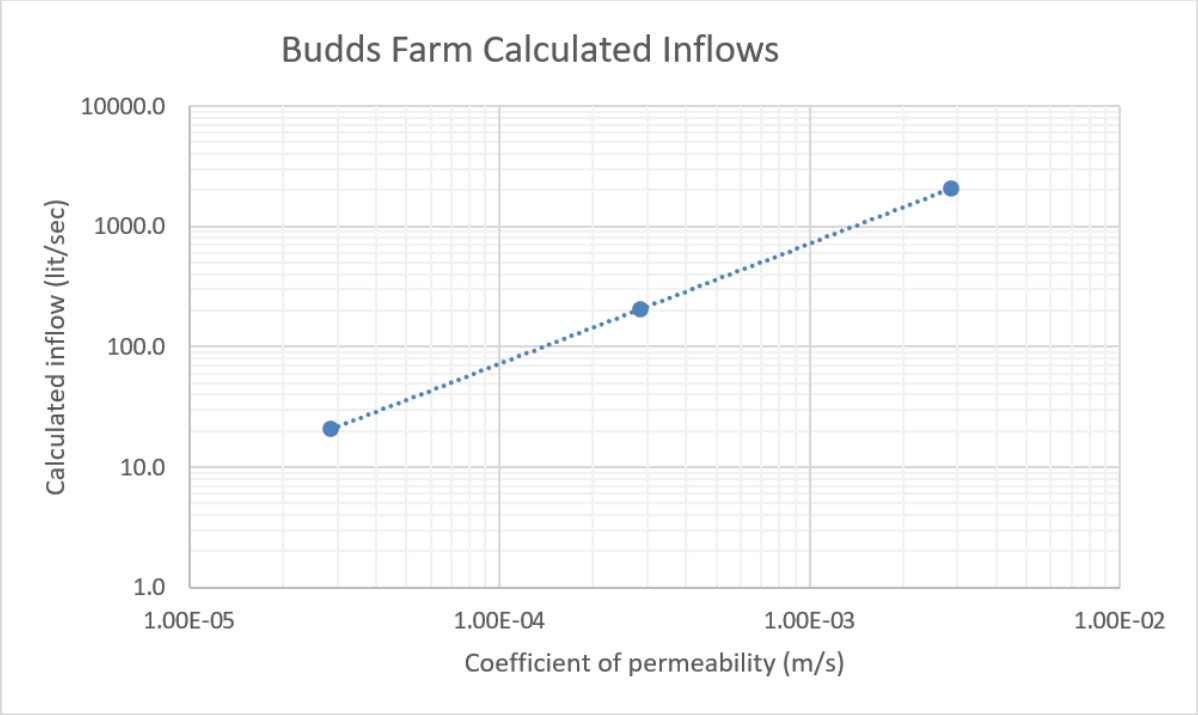
1. Weighted permeability of 2.85 x10^{-4} m/s (based on chalk permeability of 2.8x10^{-5} m/s from site investigation results and assumed superficial deposits permeability of 1.0x10^{-3} m/s).
2. Thickness of aquifer taken as 27.2m (7.2m thick superficial deposits and 20m thick chalk bedrock with base of aquifer at -23.78m AOD for purpose of calculation). It is known that the aquifer extends deeper, however any dewatering wells required for the shaft are anticipated to only partially penetrate into the chalk and the chalk is anticipated to generally reduce in permeability with depth.
3. Initial water table taken as 3.42m AOD (Ground Level).
4. Water level in equivalent well taken as -15.18m AOD (approximately 1.0m below indicative shaft depth).
5. Radius of influence of 50m (see below).
6. Equivalent well radius taken as 2.75m; internal shaft radius.

D.5.2.4 A smaller radius of influence results in higher flows and as such, for the purpose of calculating flows only, the radius of influence has been taken as 50m distance; which correspond to the closest potential head boundary (the Langstone Harbour).

D.5.2.5 For the parameters assessed above, a steady state abstraction rate of 205.6 lit/sec is calculated.

D.5.2.6 Sensitivity analysis has been undertaken to ascertain abstraction rates for a range of permeabilities which are illustrated in Graphic D 4.

Graphic D 4 Budds Farm Shaft. Abstraction Rate Inflow Sensitivity Analysis



D.5.3 Zone of Influence

D.5.3.1 Recharge circles have been assessed to provide an indication of the theoretical radius of influence of a dewatering abstraction (without taking into consideration cut-off or grouting measures), as discussed in section D.2.3.

D.5.3.2 Based on an average inflow rate of 205.6 lit/sec over a year, and effective annual precipitation of 417mm, the calculated radius of the recharge circle is 2225.4m.

D.5.3.3 Due to the dominant hydraulic boundaries in the vicinity of the Budds Farm site, in particular the Langstone Harbour and Hermitage Stream surface water bodies, together with the karstic chalk network to the north, the actual Zone of Influence is likely to be significantly smaller and constrained to the local area; constrained by the dominant head boundaries (with no impacts envisioned outside the study area).

D.5.4 Hydrogeological Impacts

D.5.4.1 The potential hydrogeological impacts from dewatering the Budds Farm shaft are likely to be similar to those identified for the WRP East shaft (see D.2.4).

D.5.5 Mitigation and Monitoring

D.5.5.1 The mitigation and monitoring requirements for the Budds Farm shaft are likely to be similar to those identified for the WRP East shaft (see D.2.5).

D.6 Mill Lane West Shaft

D.6.1 Conceptualisation

D.6.1.1 The Mill Lane West Shaft is located to the north of the WRP and south-west of Bedhampton Springs. The shaft will act as the reception shaft for the pipeline from the WRP (WRP East shaft) and launch shaft for the trenchless crossing of Mill Lane (towards Bedhampton Springs).

D.6.1.2 The approximate shaft location and main surface water and groundwater receptors in relation to the shaft are illustrated in Graphic D 11. The most proximal surface water receptor is the Hermitage Stream to the east at approximately 75m distance. The SPZ1 associated with the Bedhampton Springs is approximately 125m to the north-east.

D.6.1.3 The ground conditions at the shaft location are anticipated to comprise River Terrace Deposits underlain by chalk bedrock (possibly unstructured Newhaven Chalk Formation). Chalk bedrock is anticipated at approximately 3.4m bgl.

D.6.1.4 Perched groundwater is possible within the River Terrace Deposits.

D.6.1.5 Groundwater levels in the underlying chalk show some tidal influence and have been monitored close to ground level (approximately 1.0m below ground level) which aligns with the groundwater level (in m AOD) at the proximal Bedhampton and Havant chalk springs which are at a slightly reduced elevation. The groundwater head generally increases to the north, and subsequently the dominant flow is from the north towards the south. Manual dips in the River Terrace Deposits indicate slightly higher groundwater levels in the overlying superficial deposits at the shaft location.

D.6.1.6 As noted in paragraph 4.1.37, the transmissivity of the chalk in the Hampshire area is highly variable with a geometric mean of 1,600m^2/d. Permeability testing in the borehole closest to the shaft indicated permeabilities in the order of 10^{-5} (up to $7.5x10^{-5}$) but may not have picked up the most significant fracture flow horizons where permeabilities could be higher. The Mill Lane West shaft is not too distant to the Bedhampton and Havant Springs source protection zone, and as such has a higher likelihood of encountering karstic chalk than the shafts further south.

D.6.1.7 The design of the shaft will be finalised during detailed design, but for the purpose of this assessment is considered to have an internal diameter of 10.5m and invert of c11.0m bgl (formation located within the chalk bedrock), as per the Outline FWRA – Tunnels and Shafts (Document reference 7.4, DCO Volume 7).

D.6.2 Abstraction Rates

D.6.2.1 Equivalent well analysis (assumes the shaft is a large well/borehole) has been utilised to estimate potential steady state flows to the shaft from the superficial deposits and chalk bedrock, conservatively assuming no measures to limit inflows (such as cut-off walls or grouting).

D.6.2.2 To calculate indicative abstraction rates, the Dupuit-Forcheimer equation for steady state flow to a well in unconfined conditions has been used, as per D.5.2.2.

D.6.2.3 The parameters utilised for the initial assessment of flows are as follows:

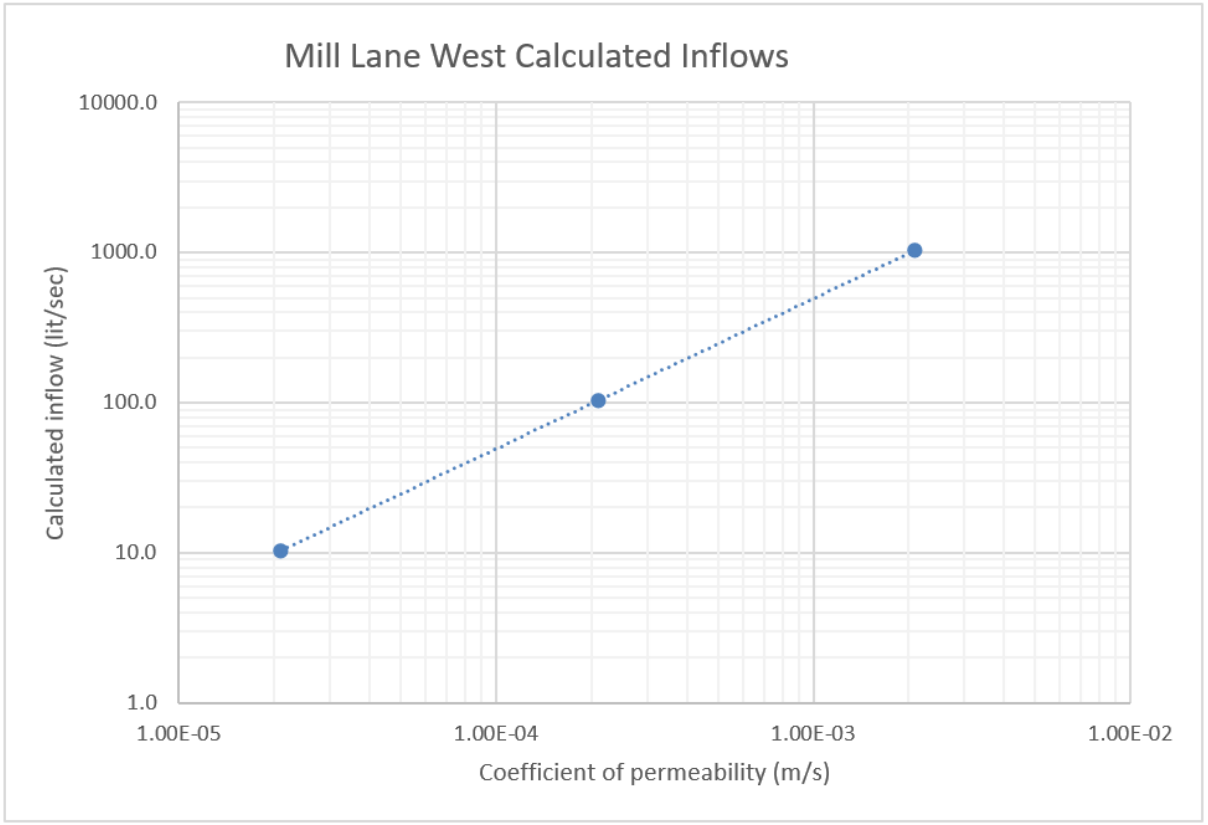
1. Weighted permeability of 2.09 x10^{-4} m/s (based on a chalk permeability of 7.5x10^{-5} m/s from site investigation results at the shaft location and assumed superficial deposits permeability of 1.0x10^{-3} m/s).
2. Thickness of aquifer taken as 23.4m (3.4m thick superficial deposits and 20m thick chalk bedrock with base of aquifer at -18.04m AOD for purpose of calculation). It is known that the aquifer extends deeper, however any dewatering wells required for the shaft are anticipated to only partially penetrate into the chalk and the chalk is anticipated to generally reduce in permeability with depth.
3. Initial water table taken as 5.36m AOD (Ground Level).
4. Water level in equivalent well taken as -6.64m AOD (approximately 1.0m below indicative shaft depth).
5. Radius of influence of 75m (see below).
6. Equivalent well radius taken as 5.25m; internal shaft radius.

D.6.2.4 A smaller radius of influence results in higher flows and as such, for the purpose of calculating flows only, the radius of influence has been taken as 75m distance; which correspond to the closest potential head boundary (the Hermitage Stream).

D.6.2.5 For the parameters assessed above, a steady state abstraction rate of 103.1 lit/sec is calculated.

D.6.2.6 Sensitivity analysis has been undertaken to ascertain abstraction rates for a range of permeabilities which are illustrated in Graphic D-5.

Graphic D 5 Mill Lane West Shaft. Abstraction Rate Inflow Sensitivity Analysis



D.6.3 Zone of Influence

D.6.3.1 Recharge circles have been assessed to provide an indication of the theoretical radius of influence of a dewatering abstraction (without taking into consideration cut-off or grouting measures), as discussed in section D.2.3.

D.6.3.2 Based on an average inflow rate of 103.1 lit/sec over a year, and effective annual precipitation of 436mm, the calculated radius of the recharge circle is 1540.6m.

D.6.3.3 Due to the dominant hydraulic boundaries in the vicinity of the Mill Lane West shaft site, such as the Bedhampton and Havant Springs and Hermitage Stream, the actual Zone of Influence is likely to be significantly smaller and constrained to the local area (negligible drawdown anticipated outside the study area).

D.6.4 Hydrogeological Impacts

D.6.4.1 Dewatering activities are considered likely to be non-consumptive with abstracted groundwater released back to the water environment (recharged to ground or released to the proximal Hermitage Stream or Brookside Road Stream), where the water quality allows. As such, net abstraction from the local water environment would be minimal.

D.6.4.2 Without appropriate measures in place, drawdown and flow impacts could be observed at proximal receptors; such as the Hermitage and Brookside Road streams less than 35m distance (reduction in baseflow) or the SPZ 35m to the north (interception/reduction in karstic flows).

D.6.4.3 Water quality impacts could include mobilisation of historic contamination, without appropriate measures in place.

D.6.5 Mitigation and Monitoring

D.6.5.1 The mitigation requirements will ultimately be confirmed as part of the abstraction licence and environmental permit processes, whilst monitoring requirements will be confirmed through the consenting processes and within the Water Monitoring Plan (to be produced substantially in accordance with the Outline Water Monitoring Plan). Particular monitoring requirements, trigger levels and contingency and action plans will be required for works in proximity to the Bedhampton and Havant Springs.

D.6.5.2 The shaft designs will be confirmed during the detailed design process, but may require measures to reduce inflows and the Zone of Influence (such as potential grouting of the chalk) as detailed in the Outline FWRA – Tunnels and Shafts (Document reference 7.4, DCO Volume 7). The requirement for additional groundwater control mitigation measures (to reduce impacts on identified receptors) as detailed in the Outline CEMP (Document reference 7.1, DCO Volume 7) such as a recharge system would be reviewed, during the detailed design and licensing processes, as required.

D.6.5.3 In general, the intention would be for abstractions to be non-consumptive and released back to the local water environment. This would be subject to the abstracted water quality being suitable (non-polluting) for release. Careful management of discharges/recharges will be required to maintain the local water

balance (such as compensation flows into the watercourses within the Order Limits).

D.7 Mill Lane East Shaft

D.7.1 Conceptualisation

D.7.1.1 The Mill Lane East Shaft is located to the south-west of the Bedhampton Springs site and is the reception shaft for the trenchless crossing below Mill Lane.

D.7.1.2 The approximate shaft location and main surface water and groundwater receptors in relation to the shaft are illustrated in Graphic D 11. The most proximal surface water receptor is the Hermitage Stream (Old Mill Dam) to the east at approximately 30m distance. The SPZ1 associated with the Bedhampton Springs is approximately 30m to the north-east.

D.7.1.3 The ground conditions at the shaft location are anticipated to comprise less than 1m of Made Ground underlain by Superficial Deposits comprising Head Deposits and River Terrace Deposits. Bedrock is anticipated at approximately 6.2m bgl, and comprises chalk (possibly unstructured Newhaven Chalk Formation).

D.7.1.4 Perched groundwater is anticipated within the Made Ground and Superficial Deposits.

D.7.1.5 Groundwater levels in the underlying chalk show some tidal influence and have been monitored close to ground level (occasionally at or slightly above ground level) which aligns with the proximal Bedhampton and Havant chalk springs. The groundwater head generally increases to the north, and subsequently the dominant flow is from the north towards the south.

D.7.1.6 As noted in paragraph 4.1.37, the transmissivity of the chalk in the Hampshire area is highly variable with a geometric mean of 1,600m^2/d. Permeability testing in the borehole closest to the shaft indicated permeabilities in the order of 10^{-5} (up to $2.7x10^{-5}$) but may not have picked up the most significant fracture flow horizons where permeabilities could be higher. The Mill Lane East shaft is the closest shaft to the Bedhampton and Havant Springs source protection zone, and as such has a higher likelihood of encountering karstic chalk.

D.7.1.7 The design of the shaft will be finalised during detailed design, but for the purpose of this assessment is considered to have an internal diameter of 8.2m and invert of c9.5m bgl (formation located within the chalk bedrock), as per the Outline FWRA – Tunnels and Shafts (Document reference 7.4, DCO Volume 7).

D.7.2 Abstraction Rates

D.7.2.1 Equivalent well analysis (assumes the shaft is a large well/borehole) has been utilised to estimate potential steady state flows to the shaft from the chalk bedrock and overlying superficial deposits, conservatively assuming no measures to limit inflows (such as cut-off walls or grouting).

D.7.2.2 To calculate indicative abstraction rates, the Dupuit-Forcheimer equation for steady state flow to a well in unconfined conditions has been used, as per D.5.2.2.

D.7.2.3 The parameters utilised for the initial assessment of flows are as follows:

1. Weighted permeability of 2.57 $x10^{-4}$ m/s (based on a chalk permeability of $2.7x10^{-5}$ m/s from site investigation results at the shaft location and assumed superficial deposits permeability of $1.0x10^{-3}$ m/s).

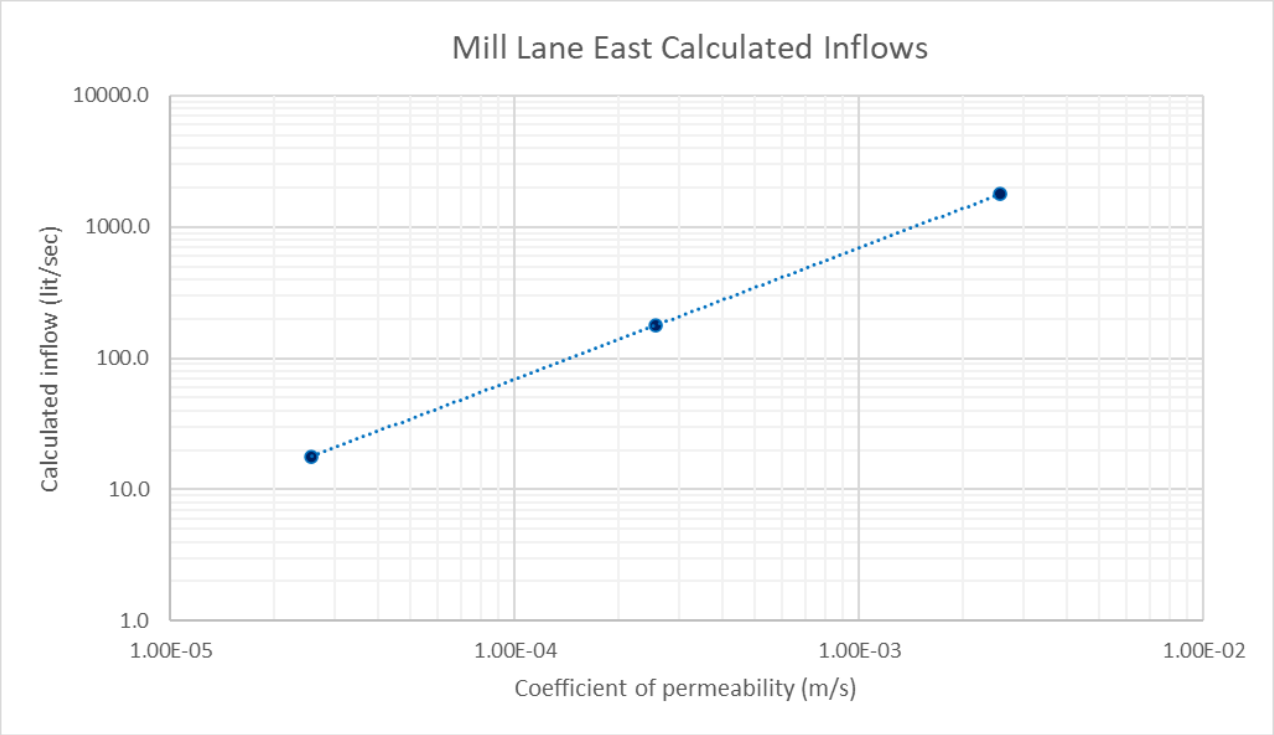
2. Thickness of aquifer taken as 26.2m (6.2m thick superficial deposits and 20m thick chalk bedrock with base of aquifer at -22.29m AOD for purpose of calculation). It is known that the aquifer extends deeper, however any dewatering wells required for the shaft are anticipated to only partially penetrate into the chalk and the chalk is anticipated to generally reduce in permeability with depth.
3. Initial water table taken as 3.91m AOD (Ground Level).
4. Water level in equivalent well taken as -6.59m AOD (approximately 1.0m below indicative shaft depth).
5. Radius of influence of 30m (see below).
6. Equivalent well radius taken as 4.1m; internal shaft radius.

D.7.2.4 A smaller radius of influence results in higher flows and as such, for the purpose of calculating flows only, the radius of influence has been taken as 30m distance; which correspond to the closest potential head boundary (the Hermitage Stream).

D.7.2.5 For the parameters assessed above, a steady state abstraction rate of 178.5 lit/sec is calculated.

D.7.2.6 Sensitivity analysis has been undertaken to ascertain abstraction rates for a range of permeabilities which are illustrated in Graphic D 6.

Graphic D 6: Mill Lane East Shaft. Abstraction Rate Inflow Sensitivity Analysis



D.7.3 Zone of Influence

D.7.3.1 Recharge circles have been assessed to provide an indication of the theoretical radius of influence of a dewatering abstraction (without taking into consideration cut-off or grouting measures), as discussed in section D.2.3.

D.7.3.2 Based on an average inflow rate of 178.5 lit/sec over a year, and effective annual precipitation of 436mm, the calculated radius of the recharge circle is 2027.1m.

D.7.3.3 Due to the dominant hydraulic boundaries in the vicinity of the Mill Lane East shaft site, such as the Bedhampton and Havant Springs and Hermitage Stream, the actual Zone of Influence is likely to be significantly smaller and constrained to the local area (negligible drawdown anticipated outside the study area).

D.7.4 Hydrogeological Impacts

D.7.4.1 Due to its location, the hydrogeological impacts from the Mill Lane East shaft are anticipated to be similar to those identified for the Mill Lane West shaft, as per D.6.4.

D.7.5 Mitigation and Monitoring

D.7.5.1 Due to its location, the mitigation and monitoring measures for the Mill Lane East shaft are anticipated to be similar to those identified for the Mill Lane West shaft, as per D.6.5.

D.8 Portsdown Hill Shaft

D.8.1 Conceptualisation

D.8.1.1 The Portsdown Hill Shaft is an intermediate shaft to support tunnel construction along the Purbrook Tunnel, located to the south of the Crookhorn Lane and Portsdown Hill Road junction.

D.8.1.2 The approximate shaft location and main surface water and groundwater receptors in relation to the shaft are illustrated in Graphic D 12. The most proximal significant surface water receptor is Langstone Harbour at approximately 1.3km distance to the south-east. A small drainage feature, that potentially drains into the Hermitage, is located approximately 400m north-east. The SPZ1 associated with the Bedhampton Springs is approximately 1km to the north-east.

D.8.1.3 The ground conditions at the shaft location are anticipated to comprise a thin layer (less than 1m) of Head Deposits, underlain by chalk (encountered as unstructured Culver Chalk, structured Chalk, structured Newhaven Chalk and Seaford Chalk during ground investigation proximal to the shaft location, with the depth of chalk not proven).

D.8.1.4 Perched groundwater may be encountered within the Head Deposits of within more permeable zones of the chalk bedrock.

D.8.1.5 Groundwater levels in the underlying chalk show a seasonal fluctuation (rising in the wetter months). At the shaft location, groundwater monitoring showed a relatively deep groundwater level, with the highest groundwater level monitored in the site investigation borehole (installed approximately 40m from the shaft location) at 9.66m AOD (approximately 55m bgl) and relatively limited seasonal fluctuation (less than 10m over a year). The closest EA groundwater monitoring borehole at Portsdown (1.8km west) which has been monitored since 1994 shows much larger seasonal variations in groundwater level and at higher elevation; ranging from approximately 10m AOD in drier months to greater than 45m AOD in wetter periods (49.06m AOD in December 2000, but generally 20m AOD to 30m AOD in average winters).

D.8.1.6 As noted in paragraph 4.1.37, the transmissivity of the chalk in the Hampshire area is highly variable with a geometric mean of 1,600m^2/d. Packer Testing in the closest site investigation borehole indicated relatively low permeabilities in order of 10^{-6} but may not have picked up the most significant fracture flow horizons where permeabilities could be higher. There is no evidence of extensive karst in the Portsdown Hill area, as evidenced further north and east, although karstic features may be present and will be monitored during the works.

D.8.1.7 If the shaft is required, the design of the shaft will be finalised during detailed design, but for the purpose of this assessment is considered to have an internal diameter of 12.5m and invert of 64.5m bgl (formation located within the chalk bedrock), as per the Outline FWRA – Tunnels and Shafts (Document reference 7.4, DCO Volume 7).

D.8.2 Abstraction Rates

D.8.2.1 Equivalent well analysis (assumes the shaft is a large well/borehole) has been utilised to estimate potential steady state flows to the shaft from the chalk bedrock, conservatively assuming no measures to limit inflows (such as cut-off walls or grouting).

D.8.2.2 To calculate indicative abstraction rates, the Dupuit-Forcheimer equation for steady state flow to a well in unconfined conditions has been used, as per D.5.2.2.

D.8.2.3 The parameters utilised for the initial assessment of flows are as follows:

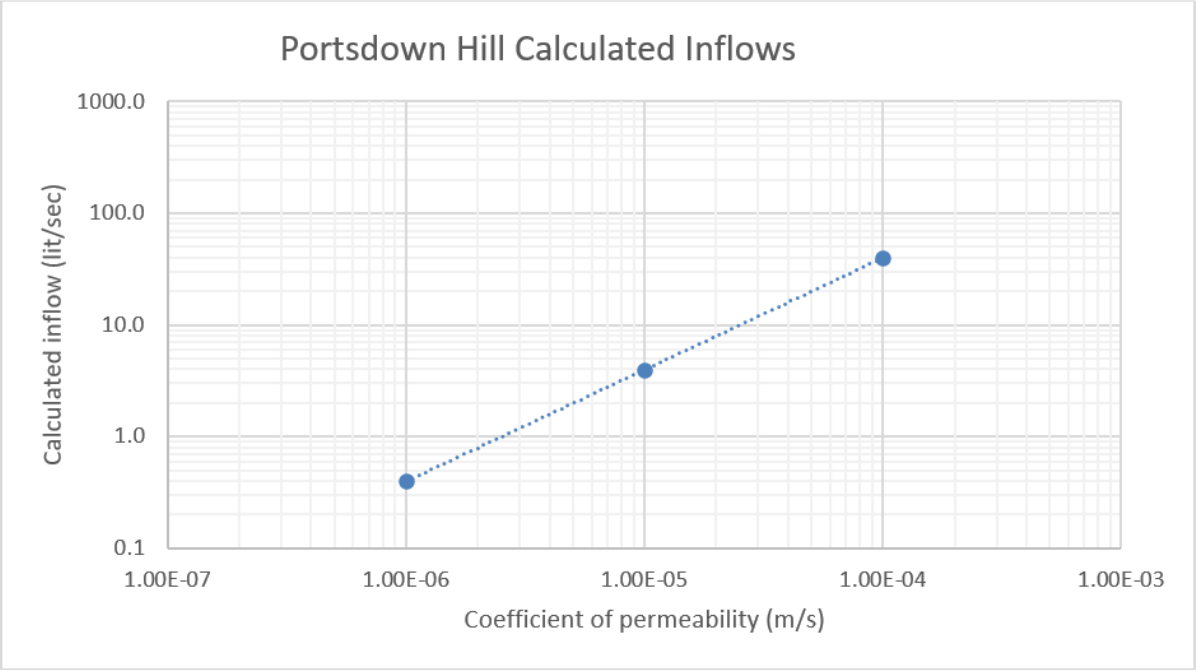
1. Permeability of 1.00 x 10^{-5} m/s (packer testing in closest site investigation borehole indicated a chalk permeability in the order of 1 x 10^{-6} m/s which is relatively low compared to other areas of chalk).
2. Base of aquifer at -20.12m AOD for purpose of calculation (20m deeper than proposed shaft depth). It is known that the aquifer extends deeper, however any dewatering wells required for the shaft are anticipated to only partially penetrate into the chalk and the chalk is anticipated to generally reduce in permeability with depth.
3. Initial water table taken as 9.66m AOD (highest monitored groundwater level in closest site investigation borehole).
4. Water level in equivalent well taken as -1.12m AOD (approximately 1.0m below indicative shaft depth).
5. Radius of influence of 400m (see paragraph D.8.2.4).
6. Equivalent well radius taken as 6.25m; internal shaft radius.

D.8.2.4 A smaller radius of influence results in higher flows and as such, for the purpose of calculating flows only, the radius of influence has been taken as 400m distance; which correspond to the closest potential head boundary (the minor drainage feature). The hydrogeology is anticipated to be partly controlled by the topography with seasonal springs anticipated in the slopes of the hill.

D.8.2.5 For the parameters assessed above, a steady state abstraction rate of 4.0 lit/sec is calculated. For a groundwater level of 49.06m AOD, the steady state abstraction rate is 33.4 lit/sec.

D.8.2.6 Sensitivity analysis has been undertaken to ascertain abstraction rates for a range of permeabilities which are illustrated in Graphic D 7.

Graphic D 7 Portsdown Hill shaft. Abstraction Rate Inflow Sensitivity Analysis (Groundwater level at 9.66m AOD)



D.8.3 Zone of Influence

D.8.3.1 Recharge circles have been assessed to provide an indication of the theoretical radius of influence of a dewatering abstraction (without taking into consideration cut-off or grouting measures), as discussed in section D.2.3.

D.8.3.2 Based on an average inflow rate of 4.0 lit/sec over a year, and effective annual precipitation of 523mm, the calculated radius of the recharge circle is 277.0m. If an abstraction rate of 33.4 lit/sec is utilised, the radius is 800.5m.

D.8.4 Hydrogeological Impacts

D.8.4.1 Dewatering activities are considered likely to be non-consumptive with abstracted groundwater released back to the water environment (such as recharged back to ground or local watercourses), where the water quality allows. As such, net abstraction from the local water environment would be minimal.

D.8.4.2 Without appropriate measures in place, drawdown and flow impacts could be observed at proximal receptors; such as unmapped springs on the slopes of the hill.

D.8.4.3 Water quality impacts could include mobilisation of historic contamination, without appropriate measures in place.

D.8.5 Mitigation and Monitoring

D.8.5.1 The mitigation requirements will ultimately be confirmed as part of the abstraction licence and environmental permit processes, whilst monitoring requirements will be confirmed through the consenting processes and within the Water Monitoring Plan (to be produced substantially in accordance with the Outline Water Monitoring Plan).

D.8.5.2 The shaft designs will be confirmed during the detailed design process, but may require measures to reduce inflows and the Zone of Influence (such as potential grouting of the chalk) as detailed in the Outline FWRA – Tunnels and Shafts (Document reference 7.4, DCO Volume 7). The requirement for additional groundwater control mitigation measures (to reduce impacts on identified receptors) as detailed in the Outline CEMP (Document reference 7.1, DCO Volume 7) such as a recharge system would be reviewed, during the detailed design and licensing processes, as required.

D.8.5.3 In general, the intention would be for abstractions to be non-consumptive and released back to the local water environment. This would be subject to the abstracted water quality being suitable (non-polluting) for release. Careful management of discharges/recharges will be required to maintain the local water balance.

D.9 Purbrook Shaft

D.9.1 Conceptualisation

D.9.1.1 The Purbrook Shaft is the reception shaft for the tunnel from the WRP, located 230m north-west of the Portsdown Hill Rd-London Road intersection.

D.9.1.2 The approximate shaft location and main surface water and groundwater receptors in relation to the shaft are illustrated in Graphic D 12. The most proximal surface water receptors are tributaries of Potwell tributary approximately 500m north-west of the shaft.

D.9.1.3 The ground conditions at the shaft location are anticipated to comprise approximately 3m of Head Deposits underlain by chalk (encountered as unstructured Culver Chalk, structured Portsdown/Culver Chalk and structured Newhaven Chalk to shaft base during ground investigation proximal to the shaft location; depth of chalk not proven).

D.9.1.4 Perched groundwater may be encountered within the Head Deposits of within more permeable zones of the chalk bedrock.

D.9.1.5 Groundwater levels in the underlying chalk show a seasonal fluctuation. At the shaft location, groundwater monitoring showed a range of approximately 15m (approximately 25m bgl in March 2023 to approximately 40m bgl in July to October 2023). The highest groundwater level monitored in the site investigation borehole (installed approximately 16m from the shaft location) was 44.28m AOD (24.85m bgl). The closest EA groundwater monitoring borehole at Portsdown (within 200m of the site; exact location unknown) which has been monitored since 1994 shows groundwater levels ranging from approximately 10m AOD in drier months to greater than 45m AOD in wetter periods (49.06m AOD in December 2000, but generally 20m AOD to 30m AOD in average winters).

D.9.1.6 As noted in paragraph 4.1.37, the transmissivity of the chalk in the Hampshire area is highly variable with a geometric mean of 1,600m^2/d. Packer Testing in the closest site investigation borehole indicated relatively low permeabilities in order of 10^{-6} but may not have picked up the most significant fracture flow horizons where permeabilities could be higher. There is no evidence of extensive karst in the Portsdown Hill area, as evidenced further north and east, although karstic features may be present and will be monitored during the works.

D.9.1.7 The design of the shaft will be finalised during detailed design, but for the purpose of this assessment is considered to have an internal diameter of 12.5m and invert of 64.8m bgl (formation located within the chalk), as per the Outline FWRA – Tunnels and Shafts (Document reference 7.4, DCO Volume 7).

D.9.2 Abstraction Rates

D.9.2.1 Equivalent well analysis (assumes the shaft is a large well/borehole) has been utilised to estimate potential steady state flows to the shaft from the chalk bedrock, conservatively assuming no measures to limit inflows (such as cut-off walls or grouting).

D.9.2.2 To calculate indicative abstraction rates, the Dupuit-Forcheimer equation for steady state flow to a well in unconfined conditions has been used, as per D.5.2.2.

D.9.2.3 The parameters utilised for the initial assessment of flows are as follows:

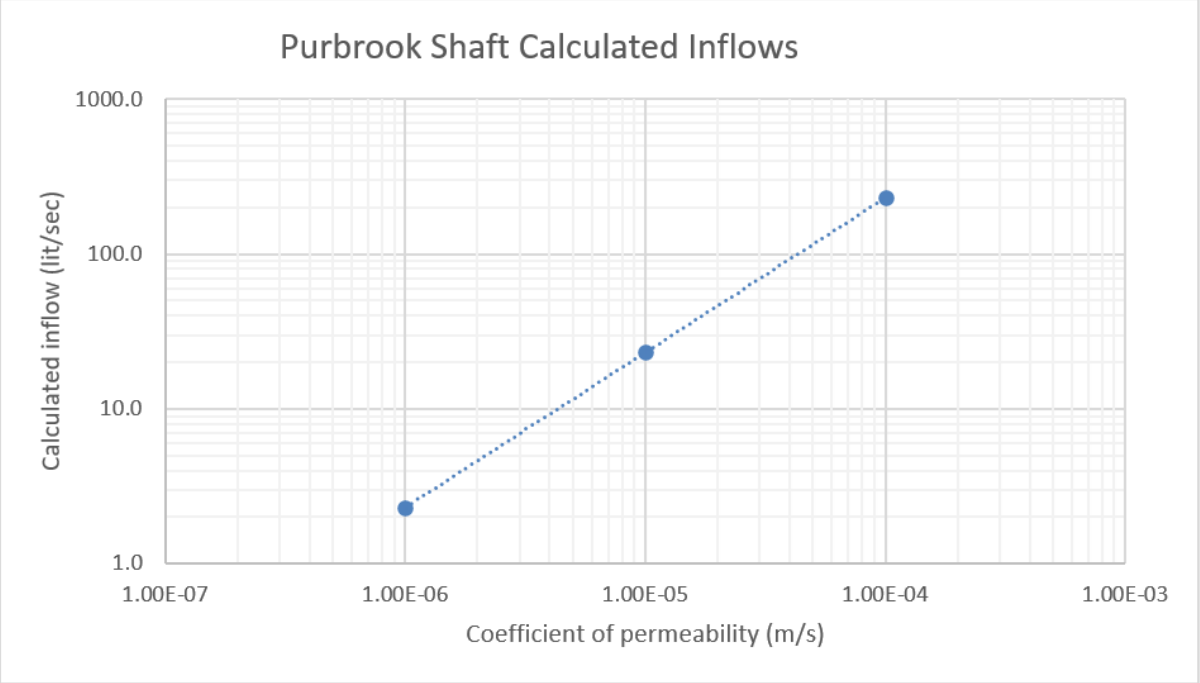
1. Permeability of 1.00 x10^{-5} m/s (packer testing in closest site investigation borehole indicated a chalk permeability in the order of 1 x 10^{-6} m/s which is relatively low compared to other areas of chalk).
2. Base of aquifer at -15.63m AOD for purpose of calculation (20m deeper than proposed shaft depth). It is known that the aquifer extends deeper, however any dewatering wells required for the shaft are anticipated to only partially penetrate into the chalk and the chalk is anticipated to generally reduce in permeability with depth.
3. Initial water table taken as 44.28m AOD (highest monitored groundwater level in closest site investigation borehole).
4. Water level in equivalent well taken as 3.37m AOD (approximately 1.0m below indicative shaft depth).
5. Radius of influence of 500m (see paragraph D.9.2.4).
6. Equivalent well radius taken as 6.25m; internal shaft radius.

D.9.2.4 The radius of influence has been taken as 500m distance; which correspond to the closest potential head boundary (the minor drainage feature). The hydrogeology is anticipated to be partly controlled by the topography with seasonal springs anticipated in the slopes of the hill.

D.9.2.5 For the parameters assessed above, a steady state abstraction rate of 23.1 lit/sec is calculated.

D.9.2.6 Sensitivity analysis has been undertaken to ascertain abstraction rates for a range of permeabilities which are illustrated in Graphic D 7.

Graphic D 8 Purbrook shaft. Abstraction Rate Inflow Sensitivity Analysis



D.9.3 Zone of Influence

D.9.3.1 Recharge circles have been assessed to provide an indication of the theoretical radius of influence of a dewatering abstraction (without taking into consideration cut-off or grouting measures), as discussed in section D.2.3.

D.9.3.2 Based on an average inflow rate of 23.1 lit/sec over a year, and effective annual precipitation of 513mm, the calculated radius of the recharge circle is 672.1m.

D.9.4 Hydrogeological Impacts

D.9.4.1 Dewatering activities are considered likely to be non-consumptive with abstracted groundwater released back to the water environment (such as recharged back to ground or local watercourses), where the water quality allows. As such, net abstraction from the local water environment would be minimal.

D.9.4.2 Without appropriate measures in place, drawdown and flow impacts could be observed at proximal receptors; such as unmapped springs on the slopes of the hill providing baseflow to tributaries. The EA monitoring borehole at Purbrook is likely to show a response to any dewatering activities at the shaft location.

D.9.4.3 Water quality impacts could include mobilisation of historic contamination, without appropriate measures in place.

D.9.5 Mitigation and Monitoring

D.9.5.1 The mitigation requirements will ultimately be confirmed as part of the abstraction licence and environmental permit processes, whilst monitoring requirements will be confirmed through the consenting processes and within the Water Monitoring Plan (to be produced substantially in accordance with the Outline Water Monitoring Plan).

D.9.5.2 The shaft designs will be confirmed during the detailed design process, but may require measures to reduce inflows and the Zone of Influence (such as potential grouting of the chalk) as detailed in the Outline FWRA – Tunnels and Shafts (Document reference 7.4, DCO Volume 7). The requirement for additional groundwater control mitigation measures (to reduce impacts on identified receptors) as detailed in the Outline CEMP (Document reference 7.1, DCO Volume 7) such as a recharge system would be reviewed, during the detailed design and licensing processes, as required.

D.9.5.3 In general, the intention would be for abstractions to be non-consumptive and released back to the local water environment. This would be subject to the abstracted water quality being suitable (non-polluting) for discharge. Careful management of discharges/recharges will be required to maintain the local water balance.

D.10 River Wallington Launch and Reception Shaft

D.10.1 Conceptualisation

D.10.1.1 Based on the Outline FWRA – Above Ground Plant and Trenchless Crossings (Document reference 7.4, DCO Volume 7), the River Wallington is anticipated to be crossed by a pipejack, or similar. For the purpose of this assessment, it is assumed the pipejack will launch from a launch shaft/pit approximately 9.4m deep and be received by a reception shaft/pit approximately 11.1m deep. The diameter of the launch and reception shafts have not yet been confirmed, but are assumed to be in the order of 5.0m diameter, based on previous project experience of pipejacks.

D.10.1.2 The approximate shaft location and main surface water and groundwater receptors in relation to the shaft are illustrated in Graphic D 13. The most proximal surface water receptor is the River Wallington which is between the shafts (potentially 40m distance to the closest shaft). The crossing lies within the SPZ2 for the Portsmouth Water Maindell abstraction. The abstraction is approximately 1.4km to the south.

D.10.1.3 The ground conditions at the shaft locations are anticipated to comprise a thin layer of Topsoil underlain by Head Deposits and Alluvium. Chalk bedrock is anticipated from 2.5 to 3.5m bgl (proven to at least 20.0m bgl at the shaft locations).

D.10.1.4 Perched groundwater may be encountered within the more permeable superficial deposits (such as the Head Deposits).

D.10.1.5 Groundwater levels monitored at the crossing location show a flashy response, with a highest groundwater level monitored at 6.95m AOD. Groundwater levels are expected to have some continuity with the River Wallington.

D.10.1.6 As noted in paragraph 4.1.37, the transmissivity of the chalk in the Hampshire area is highly variable with a geometric mean of 1,600m^2/d. There is no evidence of extensive karst in the area of the Wallington crossing, although karstic features may be present and will be monitored during the works.

D.10.2 Abstraction Rates

D.10.2.1 Equivalent well analysis (assumes the shaft is a large well/borehole) has been utilised to estimate potential steady state flows to the deeper reception shaft from the chalk bedrock, conservatively assuming no measures to limit inflows (such as cut-off walls or grouting).

D.10.2.2 To calculate indicative abstraction rates, the Dupuit-Forcheimer equation for steady state flow to a well in unconfined conditions has been used, as per D.5.2.2.

D.10.2.3 The parameters utilised for the initial assessment of flows are as follows:

1. Permeability of 1.00 x10^{-5} m/s (based on regional understanding, and higher than observed from variable head testing at the crossing location).
2. Base of aquifer at -21.98m AOD for purpose of calculation (20m deeper than the reception shaft depth). It is anticipated that the aquifer extends deeper, however any dewatering wells required for the shaft are anticipated to only partially penetrate into the chalk and the chalk is anticipated to generally reduce in permeability with depth.

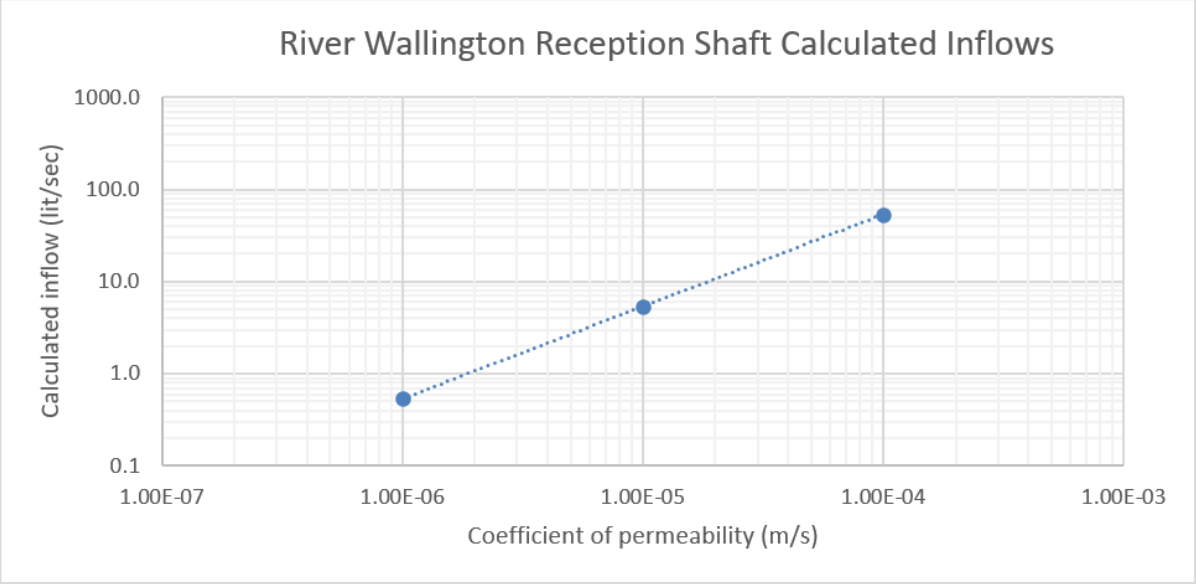
3. Initial water table taken as 6.95m AOD (highest monitored groundwater level in closest site investigation borehole).
4. Water level in equivalent well taken as -2.98m AOD (approximately 1.0m below indicative shaft depth).
5. Radius of influence of 40m (see paragraph D.10.2.4).
6. Equivalent well radius taken as 2.5m; internal shaft radius.

D.10.2.4 The radius of influence has been taken as 40m distance; which correspond to the closest potential head boundary (the river).

D.10.2.5 For the parameters assessed above, a steady state abstraction rate of 5.4 lit/sec is calculated.

D.10.2.6 Sensitivity analysis has been undertaken to ascertain abstraction rates for a range of permeabilities which are illustrated in Graphic D 7.

Graphic D 9 River Wallington Reception Shaft. Abstraction Rate Inflow Sensitivity Analysis



D.10.3 Zone of Influence

D.10.3.1 Recharge circles have been assessed to provide an indication of the theoretical radius of influence of a dewatering abstraction (without taking into consideration cut-off or grouting measures), as discussed in section D.2.3.

D.10.3.2 Based on an average inflow rate of 5.4 lit/sec over a year, and effective annual precipitation of 471mm, the calculated radius of the recharge circle is 339.3m.

D.10.4 Hydrogeological Impacts

D.10.4.1 Dewatering activities are considered likely to be non-consumptive with abstracted groundwater released back to the water environment (such as recharged back to ground or local watercourses), where the water quality allows. As such, net abstraction from the local water environment would be minimal.

D.10.4.2 Without appropriate measures in place, drawdown and flow impacts could be observed at proximal receptors; in particular reduced baseflow to the River Wallington.

D.10.4.3 Water quality impacts could include mobilisation of historic contamination, without appropriate measures in place.

D.10.5 Mitigation and Monitoring

D.10.5.1 The mitigation requirements will ultimately be confirmed as part of the abstraction licence and environmental permit processes, whilst monitoring requirements will be confirmed through the consenting processes and within the Water Monitoring Plan (to be produced substantially in accordance with the Outline Water Monitoring Plan).

D.10.5.2 The shaft designs will be confirmed during the detailed design process. The requirement for groundwater control mitigation measures (to reduce impacts on identified receptors) as detailed in the Outline CEMP (Document reference 7.1, DCO Volume 7) such as a recharge system would be reviewed, during the detailed design and licensing processes, as required.

D.10.5.3 In general, the intention would be for abstractions to be non-consumptive and released back to the local water environment. This would be subject to the abstracted water quality being suitable (non-polluting) for discharge. Careful management of discharges/recharges will be required to maintain the local water balance.

D.11 Poles Lane Stream Launch and Reception Shaft

D.11.1 Conceptualisation

D.11.1.1 Based on the Outline FWRA – Above Ground Plant and Trenchless Crossings (Document reference 7.4, DCO Volume 7), Poles Lane Stream is anticipated to be crossed by a pipejack. The pipejack is anticipated to be launched from a launch shaft/pit approximately 10.0m deep and be received by a reception shaft/pit approximately 13.0m deep. The diameter of the launch and reception shafts have not been confirmed, but are assumed to be in the order of 5.0m diameter, based on previous project experience of pipejacks.

D.11.1.2 The approximate shaft locations and main surface water and groundwater receptors in relation to the shaft are illustrated in Graphic D 14. The most proximal surface water receptors are Poles Lane Stream that is being crossed between the shafts, and the Itchen that the stream eventually flows into approximately 550m south-east. The crossing is located in close proximity to Otterbourne WSW and lies within the SPZ1 of the Otterbourne groundwater abstractions.

D.11.1.3 The ground conditions on the south of the stream at the shaft location are anticipated to comprise a thin layer of topsoil underlain by River Terrace Deposits to approximately 5.7m bgl (20.45m AOD). The River Terrace Deposits are anticipated to be underlain by Lambeth Group bedrock (Clay) to approximately 14.1m bgl (12.05m AOD) where chalk bedrock is encountered.

D.11.1.4 The ground conditions on the north of the stream at the shaft location are anticipated to comprise a thin layer of topsoil underlain by Alluvium (to approximately 2.55m bgl (20.70m AOD)) and River Terrace Deposits (to approximately 4.5m bgl (18.75m AOD)). The River Terrace Deposits are anticipated to be underlain by chalk bedrock. The tunnel is anticipated to transition from chalk to Lambeth Group bedrock along its alignment.

D.11.1.5 Perched groundwater may be encountered in more permeable bands within the superficial deposits.

D.11.1.6 Groundwater levels in the underlying chalk show seasonal variation as well as shorter term fluctuations which are considered likely to be related to both climatic conditions and potentially abstraction operations at Otterbourne.

D.11.1.7 As noted in paragraph 4.1.37, the transmissivity of the chalk in the Hampshire area is highly variable with a geometric mean of 1,600m^2/d. The Lambeth Group in the crossing area has been encountered as a clay and as such is considered likely to be of low transmissivity.

D.11.2 Abstraction Rates

D.11.2.1 Equivalent well analysis (assumes the shaft is a large well/borehole) has been utilised to estimate potential steady state flows to the launch shaft (north of the stream) from the chalk bedrock and overlying superficial deposits, conservatively assuming no measures to limit inflows (such as cut-off walls or grouting).

D.11.2.2 To calculate indicative abstraction rates, the Dupuit-Forcheimer equation for steady state flow to a well in unconfined conditions has been used, as per D.5.2.2.

D.11.2.3 The parameters utilised for the initial assessment of flows are as follows:

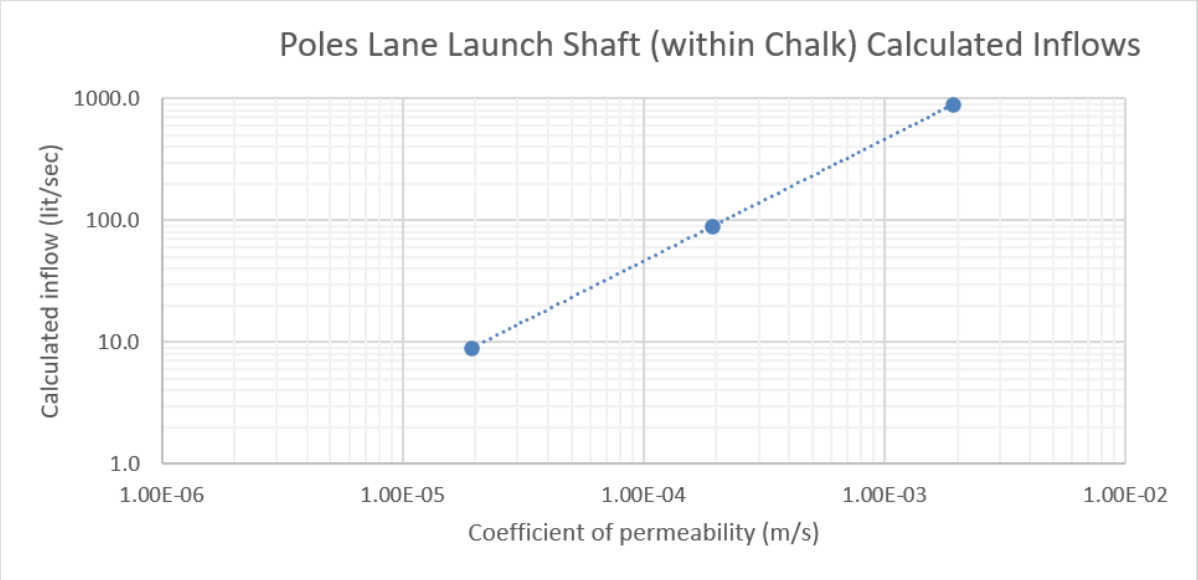
1. Weighted permeability of 1.9 x10^{-4} m/s (based on an assumed chalk permeability of 1.0x10^{-5} m/s and superficial deposits permeability of 1.0x10^{-3} m/s).
2. Thickness of aquifer taken as 24.5m (4.5m thick superficial deposits and 20m thick chalk bedrock with base of aquifer at -1.25m AOD for purpose of calculation. It is anticipated that the aquifer extends deeper, however any dewatering wells required for the shaft are anticipated to only partially penetrate into the chalk and the chalk is anticipated to generally reduce in permeability with depth.
3. Initial water table taken as 23.25m AOD (ground level in site investigation borehole at launch shaft location).
4. Water level in equivalent well taken as 13.25m AOD (approximately 1.0m below indicative shaft depth).
5. Radius of influence of 35m (see paragraph D.11.2.4).
6. Equivalent well radius taken as 2.5m; internal shaft radius.

D.11.2.4 The radius of influence has been taken as 35m distance; which correspond to the closest potential head boundary (Poles Lane Stream).

D.11.2.5 For the parameters assessed above, a steady state abstraction rate of 89.1 lit/sec is calculated.

D.11.2.6 Sensitivity analysis has been undertaken to ascertain abstraction rates for a range of permeabilities which are illustrated in Graphic D 10.

Graphic D 10 Poles Lane launch shaft. Abstraction Rate Inflow Sensitivity Analysis



D.11.3 Zone of Influence

D.11.3.1 Recharge circles have been assessed to provide an indication of the theoretical radius of influence of a dewatering abstraction (without taking into consideration cut-off or grouting measures), as discussed in section D.2.3.

D.11.3.2 Based on an average inflow rate of 89.1 lit/sec over a year, and effective annual precipitation of 561mm, the calculated radius of the recharge circle is 1262.1m.

D.11.4 Hydrogeological Impacts

D.11.4.1 Dewatering activities are considered likely to be non-consumptive with abstracted groundwater released back to the water environment (such as recharged back to ground or local watercourses), where the water quality allows. As such, net abstraction from the local water environment would be minimal.

D.11.4.2 Without appropriate measures in place, drawdown and flow impacts could be observed at proximal receptors; such as a reduction in baseflow to the Itchen and its tributaries or the Otterbourne abstractions.

D.11.4.3 Water quality impacts could include mobilisation of historic contamination, without appropriate measures in place.

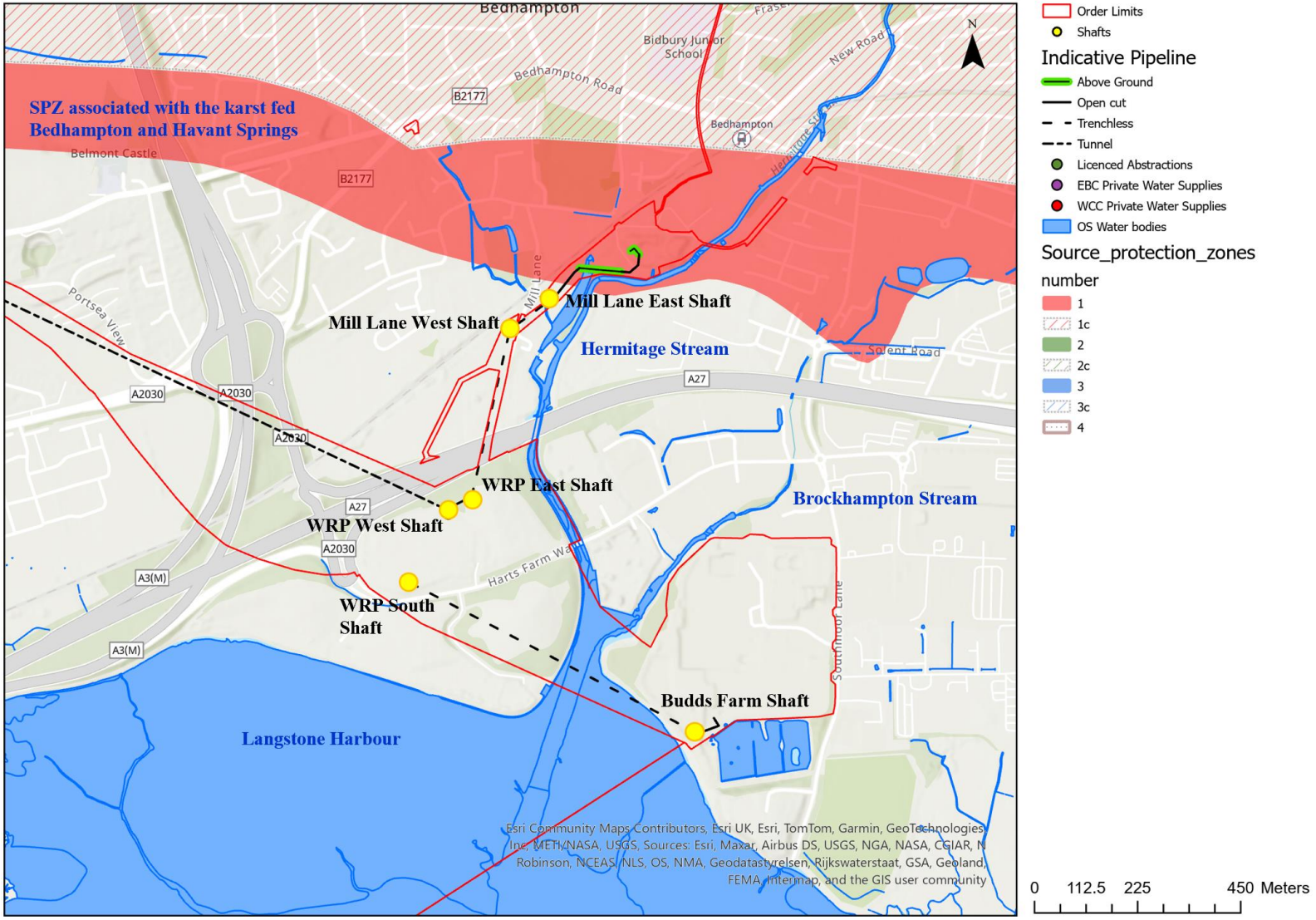
D.11.5 Mitigation and Monitoring

D.11.5.1 The mitigation and monitoring requirements will ultimately be confirmed as part of both the abstraction licence and environmental permit processes and during development of the Water Monitoring Plan trigger levels and action plan with the Otterbourne operational team (as per ES Appendix 19.9 Water Monitoring Strategy, Volume II (Document reference 6.2, DCO Volume 6)).

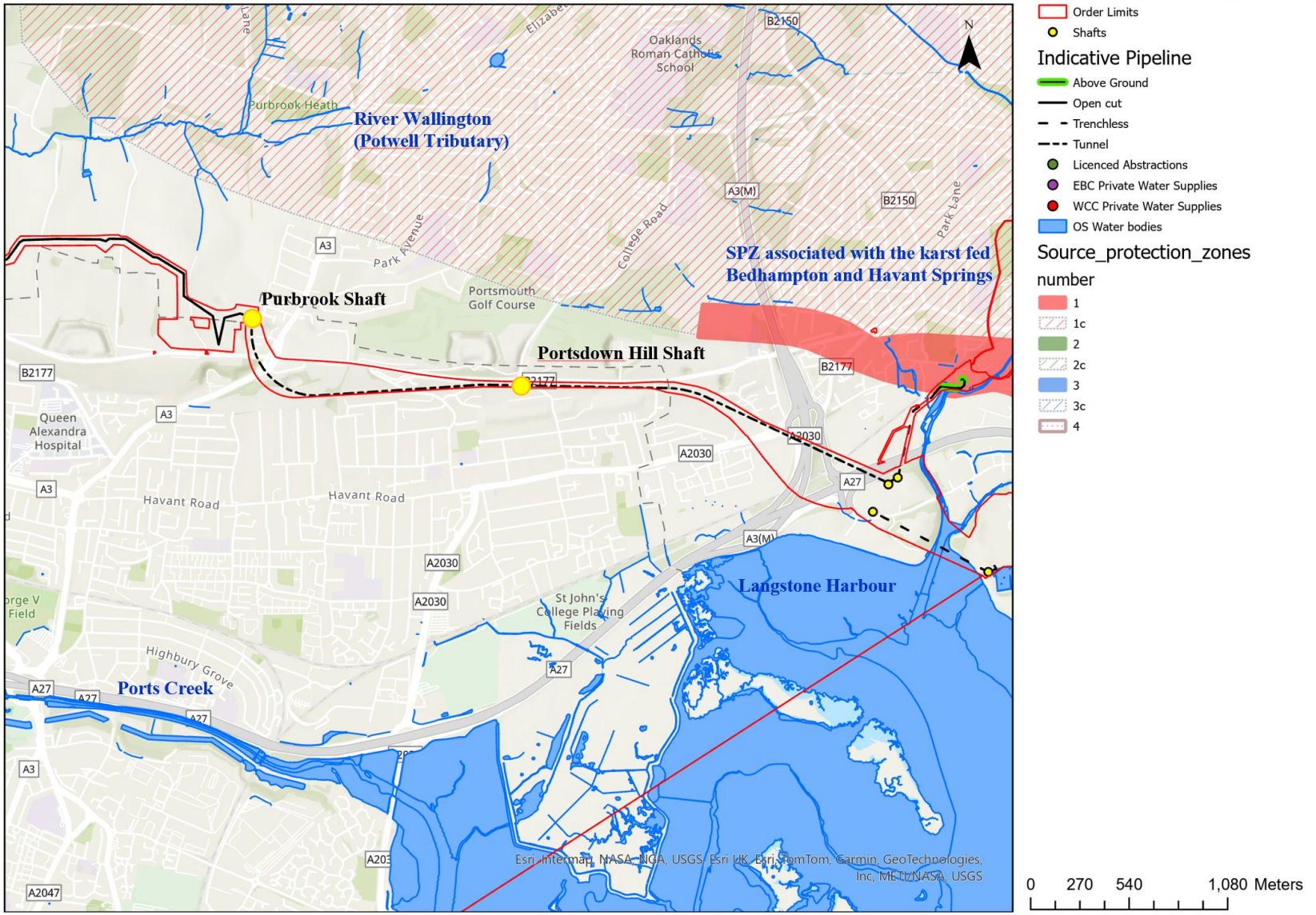
D.11.5.2 The shaft designs will be confirmed during the detailed design process. The requirement for groundwater control mitigation measures (to reduce impacts on identified receptors) as detailed in the Outline CEMP (Document reference 7.1, DCO Volume 7) such as a recharge system would be reviewed, during the detailed design and licensing processes, as required.

D.11.5.3 In general, the intention would be for abstractions to be non-consumptive and released back to the local water environment. This would be subject to the abstracted water quality being suitable (non-polluting) for discharge. Careful management of discharges/recharges will be required to maintain the local water balance.

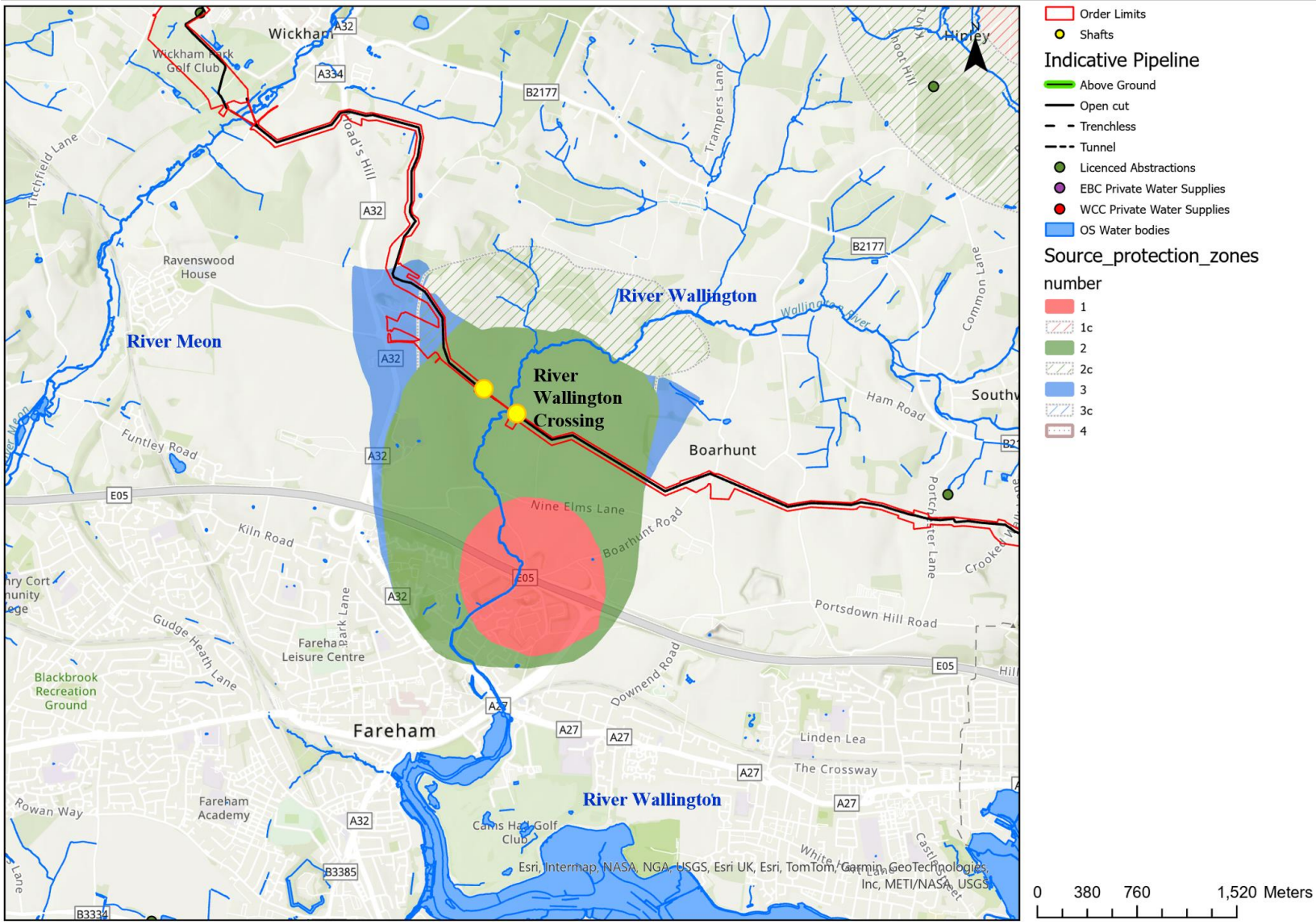
Graphic D 11 Conceptual Plan Water Recycling Plant, Budds Farm and Mill Lane crossing shafts



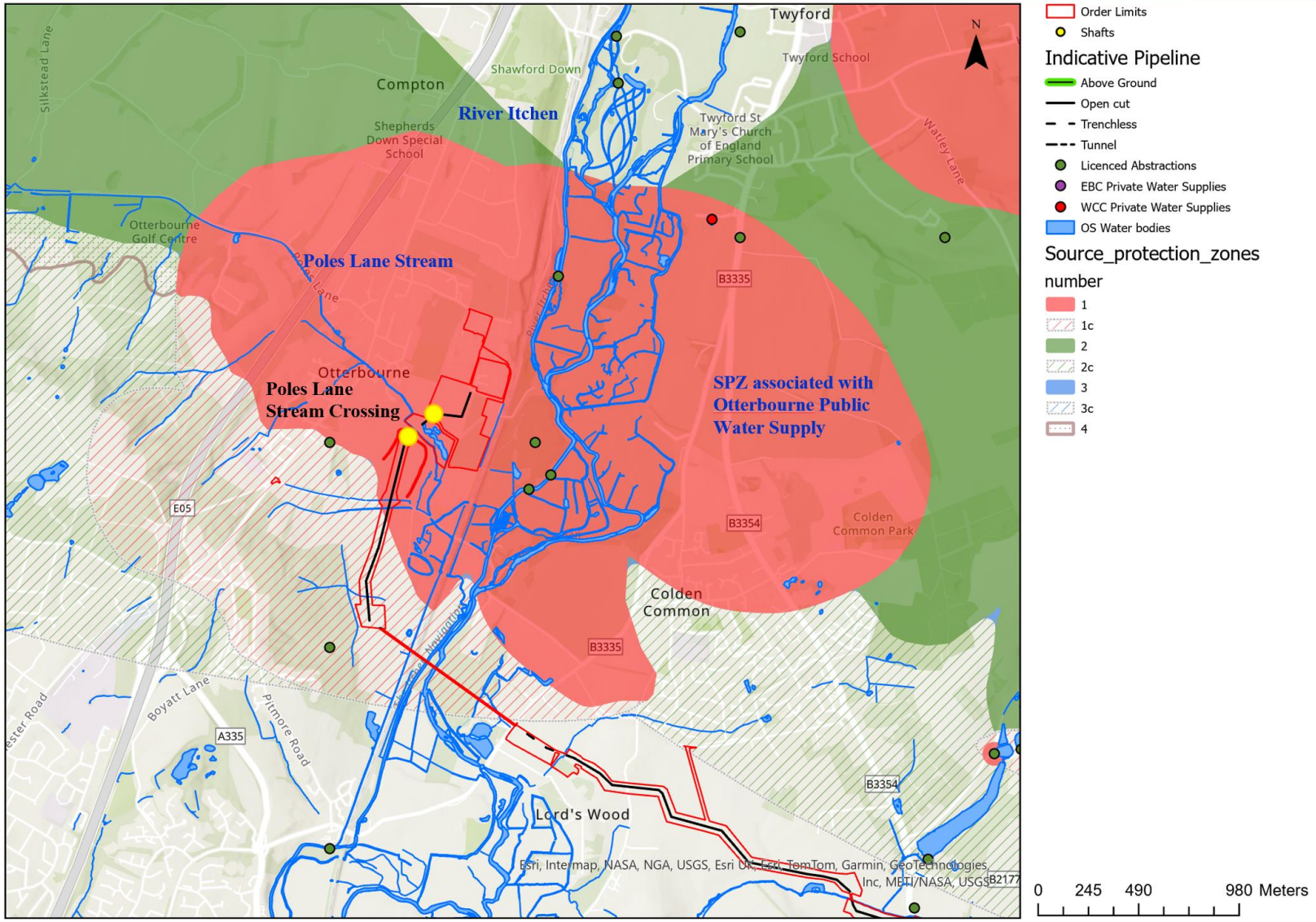
Graphic D 12 Conceptual Plan Purbrook and Portsdown Shafts



Graphic D 13 Conceptual Plan River Wallington Crossing



Graphic D 14 Conceptual Plan Poles Lane Stream Crossing

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