11. Ground Conditions and Contamination

Introduction

11.1. Prepared by Waterman Infrastructure & Environment Limited (Waterman) presents an assessment of the likely significant effects of the Development with respect to ground conditions and contamination. Particular consideration is given to the likely significant effects of any existing ground contamination on human health, controlled waters and other aspects of the environment.

11.2. This Chapter provides a description of the relevant baseline conditions of the Site and surrounding area, and an assessment of the likely significant effects of the Development during the demolition, alteration, refurbishment and construction works (the Works) and once the Development is completed and operational. Mitigation measures are identified, where appropriate to avoid, reduce or offset any likely adverse effects identified and / or enhance likely beneficial effects. Taking account of the mitigation measures, the nature and significance of the residual effects are described.

11.3. A Preliminary Risk Assessment (PRA) prepared by Waterman in January 2022, and ground investigation report prepared by Waterman for the eastern part of the Site in February 2018 supports this Chapter. Such work is presented within **Appendix 11.1** and **Appendix 11.2** respectively.

Assessment Methodology and Significance Criteria

Assessment Methodology

Preliminary Environmental Risk Assessment

11.4. As noted above, a desk-based qualitative PRA (**Appendix 11.1**) for the Site was completed by Waterman in January 2022. This follows on from a previous PRA prepared for the Site in August 2016 and updated in February 2018. This report was undertaken to establish the potential for significant ground contamination to exist and the likely risk posed to a range of sensitive receptors, including human health, property, controlled waters and flora.

11.5. The PRA was undertaken in general accordance with the Environment Agency Land Contamination Risk Management guidance (LCRM)[1] and was informed by:

- a Groundsure Enviro Insight report for the project boundary[2] which contains historical Ordnance Survey (OS) extracts, environmental data sheets and sensitivity plans;
- previous environmental assessments and reports prepared for the Site:
  - Stag Brewery: Phase 1 Environmental Site Assessment, Aecom, July 2015;
  - Stag Brewery: Phase 2 Environmental Site Assessment Report, Aecom, September 2015;
  - Stag Brewery, Mortlake: Groundwater Sampling Point decommissioning Report, Aecom, February 2016; and
  - Environmental Risk Assessment: The Former Stag Brewery East Site, Mortlake, London, Waterman, February 2018.
- tank decommissioning certificates for works by Bale Group between December 2015 to January 2016;

- inspections of the Stag Brewery and wider project boundary undertaken by Waterman in July 2016, July 2019 and December 2021;
- a review of publicly available and relevant historical, geological and hydrogeological information sources;
- British Geological Survey (BGS) 1:50,000 Map Sheet 270 (South London, Solid and Drift Edition), BGS borehole records TQ27/NW-596 and TQ27/NW-597, and the BGS website;
- review of World War II ordnance impact mapping[3];
- information obtained from the London Borough of Richmond upon Thames (LBRuT) Environmental Health Officer (EHO) relating to potential historical sources of contamination at the Site; and
- Information from the Environment Agency relating to recorded historical pollution incidents at the Stag Brewery.

11.6. The PRA includes a Conceptual Site Model (CSM) which identifies the likely significant potential pollutant linkages. Consideration is given in the CSM to the potential contamination sources, migration pathways and sensitive receptors. The likely effects of ground contamination upon human health, property, controlled waters and flora were assessed as part of the PRA using this source-pathway-receptor approach.

11.7. The findings of the PRA have been used to inform the qualitative assessment presented in this Chapter of likely effects to, and from, any potential ground contamination likely to exist at the Site. Using information obtained from the above sources, an appraisal of the means by which sources might affect receptors (the pathways) was carried out.

Ground Investigation Report

11.8. Ship Lane runs from north to south, bisecting the Site into a western area (Development Area 2 and the school) and an eastern area (Development Area 1). The Applicant commissioned a preliminary ground investigation of the eastern part of the Site (Development Area 1, refer to **Appendix 11.2**), as this was identified as the area with the greatest potential for contamination to be present on the Site. Whilst the ground investigation undertaken by Waterman only covers Development Area 1, this report includes previous ground investigations which covered both Development Area 1 and 2. Historic ground investigation work has therefore informed the potential contamination for the Site as a whole.

11.9. The investigation targeted potential contamination sources and pathways identified by the PRA. The investigation involved drilling 10 window sample holes to depths between 0.5 m bgl (below ground level) and 5.5 m bgl, and two cable percussion boreholes to 30 m bgl. Soil samples were collected from all shallow strata encountered. Monitoring wells were installed for follow-up groundwater sampling, and ground gas / vapour monitoring. A single round of groundwater sampling and ground gas / vapour monitoring was completed.

11.10. Soil and groundwater samples collected were analysed for a range of inorganic and hydrocarbon contaminants including metals, total petroleum hydrocarbons (TPH), polyaromatic hydrocarbons (PAHs) volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs).

11.11. The ground investigation results were compared to Waterman Generic Assessment Criteria (GAC) for land with a residential end-use without plant uptake, and 1% soil organic matter. Results from the Aecom 2015 Ground Investigation within the eastern part of the Site were also considered within the Ground Investigation Report. The findings informed an assessment of the

potential for all receptors to be affected by ground conditions at the Site. In turn, the CSM developed in the PRA was updated with the new assessment findings.

11.12. In respect of the assessment of the outline component of the Development, the assessment set out within this Chapter has considered the maximum allowable spatial parameters sought for approval. This would give rise to the most intrusive ground works and so can be considered to reflect a 'worst-case' assessment. That said, based on professional and expert judgement, it is unlikely that the minimum allowable spatial parameters sought for approval would give rise to materially different ground contamination effects. This is because the scale of Works that would be required for both the maximum and minimum allowable parameters would be similar and the sensitive receptors likely to be affected by ground contamination would be the same.

Significance Criteria

11.13. There are no published criteria for assessing the significance of effects from ground conditions and contamination. Significance criteria have therefore been developed using the criteria outlined in **Chapter 2: EIA Methodology**, contaminated land guidance, and professional expert judgement.

11.14. An adverse effect in respect of ground contamination relies on the presence of a source, pathway and receptor pollutant linkage. The significance of the effect depends on the value of the resource, the sensitivity of the receptor and the ways in which the Works and the Development can provide a pathway to the receptor. The significance of an effect partly depends on the timescales involved, i.e. short, medium or long term and the extent of the area affected.

11.15. The assessment of the likely significant effects and residual effects used in this assessment are set out in **Table 11.1**.

Table 11.1: Significance Criteria for Ground Conditions and Contamination Assessment

Significance Criteria	Description
Adverse effect of major significance	High risk site classification and acute or severe chronic effects to human health and / or animal / plant populations predicted. Effect to a potable groundwater or surface water resource of regional importance e.g. Principal aquifer, public water reservoir or inner Source Protection Zone (SPZ) of a public supply borehole.
Adverse effect of moderate significance	Medium risk site classification and proven pollutant linkages with human health and / or animal / plant populations, with harm from long-term exposure. Effect to a potable groundwater or surface water resource at a local level e.g. effect to an outer groundwater SPZ or Principal aquifer, which is not abstracted locally. Temporary alteration to the regional hydrological or hydrogeological regime or permanent alteration to the local regime.
Adverse effect of minor significance	Low risk site classification and potential pollutant linkages with human health and / or animal / plant populations identified. Reversible, localised reduction in the quality of groundwater or surface water resources used for commercial or industrial abstractions, Secondary A Aquifer.
Insignificant	Low risk site classification and no appreciable effects to human, animal or plant health, potable groundwater or surface water resources.
Beneficial effect of minor significance	Risks to human, animal or plant health are reduced to acceptable levels. Minor local scale improvement to the quality of groundwater or surface water resources used for commercial or industrial abstraction.
Beneficial effect of moderate significance	Risks to human, animal or plant health are reduced to acceptable levels. Moderate local improvement to the quality of potable groundwater or surface

Significance Criteria	Description
	water resources. Significant improvement to the quality of groundwater or surface water resources used for public water supply.
Beneficial effect of major significance	Major reduction in risks to human, animal or plant health. Regional scale improvement to the quality of potable groundwater or surface water resources.

11.16. **Chapter 2: EIA Methodology** also sets out the general approach to temporal and geographical extent of effects, reproduced below.

- 'short' to 'medium-term' effects are considered to be those associated with the Site preparation and construction works;
- 'long-term' effects are those associated with the completed and operational Development;
- 'local' effects are those affecting neighbouring receptors;
- 'district' effects are those which are likely to occur to receptors within the wider Borough of the London Borough of Richmond upon Thames (LBRuT);
- 'sub-regional' effects are those affecting Boroughs adjacent to LBRuT;
- 'regional' effects are those affecting receptors across Greater London; and
- 'national' effects are those that affecting receptors within the UK.

Baseline Conditions

Historical Land Uses on-Site and in the Surrounding Area

11.17. A review of historical maps indicates the eastern part of the Site was in brewery use since the 15th Century. The brewery expanded to occupy the majority of the eastern part of the Site by 1868. Circa 1933, further brewery structures were constructed within the western part of the Site, and in 1961 these buildings were reshaped to the current layout. The Stag Brewery occupied the entire Site with exception of the playing fields by 1974 (as well as the highway land included as part of the Applications for the S278 Works). The Stag Brewery ceased operations in late 2015 and decommissioning of brewery infrastructure was undertaken following cessation of brewery activities. Works on-Site were undertaken in 2017 to remove the brewery fixtures and fittings.

11.18. Historical contamination sources at the Site include an engine room, pump room, paint shop, garages, silos and large storage tanks. Historically, the area surrounding the Site has primarily been residential. However, some industrial uses including a coal wharf, smithy, works and garages, incinerator and electrical substations have also been noted.

Existing Land Uses on-Site and in the Surrounding Area

11.19. The Site comprises land mostly occupied by the former brewery, with sixteen predominantly industrial buildings surrounded largely by hardstanding. The majority of former brewery infrastructure including tanks, brewery vats, pipework and electrical cabinets have been removed from the Site, with partial demolition of the external walls of some structures in the west of the Site to facilitate the removal. The majority of these buildings remain in place. Numerous electrical substations and tanks remain located throughout the Site, however all remaining tanks with potentially contaminative contents such as oil, diesel, caustic soda, hydrochloric acid or effluent have been decommissioned and certified clean and gas-free.

11.20. Watney's Sports Ground clubhouse and playing fields are located within the south west of the Site.

11.21. The River Thames and River Thames towpath are located immediately to the north of the Site. Residential properties are also located immediately to the north, west and east of the Site. The predominant land uses to the south of the Site are retail and residential.

11.22. The wider Site Boundary includes highway and associated landscaping of Sheen Lane (B351), and Mortlake High Street and Lower Richmond Road (A3003) extending to the junction with Clifford Avenue (A316) and South Circular (A205). This includes a small informal car park and landscaping on the south-west corner of Lower Richmond Road. The part of the Site is surrounded by residential uses with Fulham (North Sheen) Cemetery located immediately to the north.

11.23. Further information relating to the existing land uses on and off the Site are provided in **Chapter 3: Existing Land Uses and Activities**.

11.24. The Groundsure Enviro Insight dataset (refer to **Appendix 11.1**) identified the following potentially contaminative uses within 500m of the Site Boundary set out in **Table 11.2**.

Table 11.2: Potentially Contaminative Land Uses within 500m of the Site

Location	Summary Description
To the north of the Site	• Five historical landfills, the closest is 126m north-west, named Duke's Meadow and accepted waste between 1945 and 1950. The other three landfills are between 233m and 419m north, and where recorded accepted inert and industrial waste. These landfills closed between 1934 and 1935. • Single Environmental Permit for a crematorium 234m north.
To the east of the Site	• Single Environmental Permit 44m east and registered to a dry cleaners.
To the south of the Site	• Four Environmental Permits, the closest 59m south and registered to a petrol filling station. Further entries are for another petrol filling station 491m south and two dry cleaners 374m south and 496m south-east.
To the west of the Site	• Single Environmental Permit for a petrol filling station 433m west.

Geology

11.25. The Site's geology is summarised in **Table 11.3.** Geology has been established from previous ground investigations by Dames and Moore (1995), CRA (2003), Aecom (2015) and Soil Consultants (2016), alongside British Geological Survey 1:50,000 map sheet 270 (South London, Solid and Drift Edition) and BGS borehole records TQ27/NW-596 and TQ27/NW-597 (accessed online December 2021). Further details of the geology are described in **Appendix 11.1**.

Table 11.3: Geological Sequence Beneath the Site

Stratum	Area Covered	Estimated Thickness (m)	Typical Description
Hardstanding.	Entire Site (excluding the playing fields).	0.25 - 0.8	Tarmac or reinforced concrete floor slab at surface level. Encountered as two or three separate layers up to 0.5 m thick, each separated by up to 0.5 m Made Ground in eastern area.
Made Ground	Entire Site	0.4 – 4.6m, typically 1.0 – 3.0m across the main Site area	Predominantly coarse sand and gravel, including pieces of brick and minor amounts of black clinker.
Alluvium	Sporadic across entire Site area	0.35 – 1.5	Soft brown grey slightly gravelly clay with occasional roots
Kempton Park Gravel Member	Entire Site	1.2 – 5.9m, generally thicker towards the east	Clayey, silty sand with varying gravel content with areas of soft, brown, sandy clay.
London Clay Formation	Entire Site	73	Stiff grey to brown clay, with occasional pockets of silt and sand.
Lambeth Group	Entire Site	15 – 20	Light to dark brown clay, some silty or sandy, with bands of sands and gravels.
Thanet Formation	Entire Site	5 – 10	Fine grained sand that can be clayey and glauconitic. Flints at the base of the formation.
Chalk Group	Entire Site	Not proven	White chalk with occasional flints.

Hydrogeology

11.26. The Environment Agency's (EA) Aquifer Designation Map[4] indicates that the Alluvium and Kempton Park Gravel Formation underlying the Site are classified as a Secondary A Aquifer. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. Based on available information, it is anticipated shallow groundwater in the Alluvium and Kempton Park Gravel Formation is in hydraulic continuity with the River Thames directly adjacent to the Site. Previous ground investigation infers that groundwater flows in a westerly direction across the Site.

11.27. The London Clay Formation is an Unproductive Stratum. The Lambeth Group and Thanet Formation are both also classed as Secondary A Aquifers, with the Chalk Formation at depth a Principal Aquifer. According to the EA, the Site is not located within a groundwater SPZ.

11.28. There are two recorded historical groundwater abstractions within the Site boundary, references TQ27/NW-596 and TQ27/NW-597. These wells were drilled circa 1830, extended to 101 m bgl and 121 m bgl and drew groundwater from the Chalk Group Principal Aquifer. Details of abstraction volumes were not recorded.

11.29. Two groundwater abstractions are recorded within a 1km radius of the Site. The closest of these is located 219m north at Dukes Meadow Golf Club, drawing 8,000 litres of groundwater per year

from the Chalk Group aquifer for irrigation of the playing green. The further abstraction is located 643m north-east, also for irrigation purposes at Dukes Meadow Golf Club and drawing a further 5,000 litres per year.

11.30. There are no Environmental Permits for discharges to groundwater recorded within 1 km of the Site.

Hydrology

11.31. The nearest surface water to the Site is the River Thames, located directly to the north.

11.32. There are no surface water abstractions within 1km of the Site. The closest is 1.3 km north east, drawing water from the River Thames to supply a lake / pond.

11.33. There are no recorded active Environmental Permits for discharges to surface waters within 500m of the Site. The closest recorded discharge consent is located 763m north west, operated by Thames Water for discharge of public sewage overflow to the River Thames. The other four are also for sewage overflows. Sewer records on the Site indicate that some areas currently drain to the Thames Water surface water sewer network, ultimately discharging to the River Thames. Further details are set out within **Chapter 12: Surface Water Resources and Flood Risk**.

11.34. The Groundsure dataset identifies two pollution incidents within 500m of the Site, occurring in 2002 and 2003 respectively. The closest of these, occurring 252m north of the Site involved an unknown pollutant release with a Category 3 (minor) impact to controlled waters. The further incident is listed 482m north-west with no impact to waters. The EA records a single pollution incident to surface water from the Site, involving a spill of unknown chemicals. The spill was recorded as a Category 3 (minor incident). A further two Category 2 (significant incident) spills are recorded by the EA at Ship Lane, involving miscellaneous chemicals and unknown chemicals. Environmental Incident Reports for the Site by Aecom[5] identified 15 spill incidents during operation between 2009 and 2015. These included spills to drainage of brewing substances (wort, beer, grain, yeast and sugar) and mechanical fluids (lubricant, hydraulic oil, oxafoam, diesel and unidentified substances).

Unexploded Ordnance

11.35. There is a risk that unexploded bombs, anti-aircraft projectiles and / or incendiary bombs fell unnoticed and unrecorded within the Site during WWII. The Preliminary Unexploded Ordnance (UXO) Risk Assessment[6] produced by Groundsure (refer to **Appendix 11.1**) identifies an overall medium risk classification for the Site. Historical records indicate that during WWII LBRuT sustained a high density of bombing and bomb risk maps have identified several high explosive bombs as having fallen on parts of the Site.

11.36. As part of the October 2016 ground investigation works at the eastern part of the Site, a further preliminary UXO study was undertaken for the area by Soil Consultants Limited. This identified a significant UXO risk across the Site, and recommended a UXO specialist be present for any intrusive ground works undertaken. A UXO specialist attended Site throughout the works of Soil Consultants Limited.

Potential Contamination Sources

11.37. The PRA (refer to **Appendix 11.1**) has identified historical land uses that could result in potential ground contamination within the Site, including the former Stag Brewery itself, and nearby off-Site

features such as landfills, a smithy, a coal depot and electrical substations. Based upon an appraisal of historical and current land uses, contaminants of concern are identified in **Table 11.4**.

Table 11.4: Contaminants of Concern

Source	Associated Contaminants
On-Site (current)	
Electrical substations	Metals, PCBs, transformer oils
Diesel tanks and generators	Diesel fuel
On-Site (historic)	
Brewery	Diesel fuel, waste oil, lubricant oils, hydrochloric acid, caustic soda, slurry, asbestos
Off-Site (current within 250m)	
Garages and petrol filling stations	Metals and metalloids, fuels, TPH, PAH, organic solvents, asbestos
Off-Site (historic within 250m)	
Smithy	Metals and metalloids, organic solvents, asbestos
Railway station and railway lines	Metals and metalloids, TPH, PAH
Coal wharf	Metals and metalloids, sulphates, sulphides, cyanides
Electricity works and electrical substations	Metals and metalloids, PCBs, bitumen, detergents, organic solvents, TPH, mineral oil, asbestos

11.38. Ground investigation by Aecom in 2015 and Waterman in 2016 identified the following elevated contaminants in the soil:

- petroleum hydrocarbons;
- arsenic; and
- asbestos.

11.39. Elevated contaminants in the groundwater included:

- chromium;
- copper;
- iron;
- vanadium;
- nickel;
- zinc; and
- sulphate.

11.40. Whilst contaminants were recorded in the soil and groundwater, they were not consistently found to be above assessment criteria across the eastern part of the Stag Brewery. As such, the results summarised above are considered likely to represent contamination hotspots rather than gross contamination at the Site.

Potential Contamination Pathways

11.41. During the Works, in absence of mitigation, the potential pollutant linkages would be as follows:

- construction workers, visitors and off-site residents contacting contaminated soils and groundwater via dermal contact, ingestion, runoff from stockpiled soils and dust inhalation;
- remobilisation of contamination in soils by rainfall infiltration following removal of hardstanding during the Works, with leaching to lower soils and the shallow Secondary A aquifer in the Alluvium and Kempton Park Gravel Formation;
- potential contamination of shallow groundwater and impacts to water quality and ecological receptors at the River Thames from the release of existing contamination (for example, via surface run-off from stockpiled materials, via the drainage system discharging to the River Thames, or mobilisation of ground contamination by rainfall infiltration after removal of hardstanding during demolition);
- potential risks to exposed shallow soils and groundwater from introduction of new potential sources of contamination such as construction materials, fuels and other chemicals during the works; and
- potential to encounter UXO.

11.42. Once the Development is completed and operational, in the absence of mitigation, the potential pollutant linkages would be as follows:

- new structures contacting ground contamination via direct contact and chemical attack, and potential for ground gas and vapour ingress from Made Ground, Alluvium and hydrocarbon contamination within shallow groundwater;
- plants in soft landscaping and private gardens contacting contamination in Made Ground, shallow soils, and shallow groundwater via root uptake;
- potential exposure of future residents and visitors of the Site to residual ground contamination via exposed soils in soft landscaping, and plant uptake from private gardens; and
- potential mobilisation of contamination via historical abstraction wells to the deep Secondary A aquifers in the Lambeth Group and Thanet Formation, and Principal Aquifer in the Chalk Group (should abstraction wells not be decommissioned during the Works and not mitigated).

Potential Contamination Receptors

11.43. During the Works, potential receptors in the absence of mitigation include;

- construction workers and visitors;
- off-site residents;
- occupants of completed Development phases, including staff and students of the new school;
- fauna and flora associated with the River Thames;
- Secondary A Aquifer in the Alluvium and Kempton Park Gravel Formation; and
- the River Thames.

11.44. In the absence of any mitigation, potential receptors of the completed and operational Development include;

- future Site residents, workers and occupiers (i.e. commercial occupiers and nursing staff), school students and staff and visitors;
- plants and vegetation in soft landscaping and private gardens;
- fauna and flora associated with the River Thames
- Secondary A Aquifer in the Lambeth Group, and Thanet Formation;

- Principal Aquifer in the Chalk Group; and
- the River Thames.

Likely Significant Effects

The Works

Effects to Human Health from Ground Contamination, Ground Gas, and Vapour

11.45. During the Works, workers on the Site would be more likely to be exposed to sources of contamination, as the demolition and construction areas would not be accessible to the public. However, members of the public could still be impacted by potentially contaminated dust and surface run-off.

11.46. The Works, which would include the demolition of buildings, removal of hardstanding, excavation of soils, basement excavation and piling could expose Site workers to sources of contamination via plausible pollutant linkages including dermal contact, inhalation and / or ingestion. However, workers on the Site would be subject to mandatory health and safety requirements under the Construction (Design and Management) Regulations 2015[7], the Control of Substances Hazardous to Health (COSHH) Regulations 2002[8] and the Control of Asbestos Regulations (CAR) 2012[9]. In addition, Site workers and visitors would be required to use Personal Protective Equipment (PPE) and Respiratory Protective Equipment (RPE) as required, thereby minimising the risk of exposure to potential contamination from soils, dust, ground gas and other potential contamination sources.

11.47. Adherence to the legislative requirements described above would significantly reduce the risk to the demolition and construction workers, such that the likely effect is considered to be **insignificant**.

11.48. Dust may be generated by the Works, particularly during dry and windy weather. Under these conditions, the public in areas adjacent to the Site and residents occupying the earlier phases of the Development could be temporarily exposed to contamination via the inhalation of potentially contaminated dust. Members of the public and occupants of the early phases of the Development would not be wearing PPE or RPE. As such, the likely significant effects to the public and early occupants of the Development in the absence of mitigation are considered to be **short** to **medium-term**, **local**, **adverse** and of **minor significance**.

Effects to Controlled Waters from Ground Contamination

11.49. With reference to **Chapter 5: The Proposed Development** and **Chapter 6: Development Programme, Demolition, Alteration, Refurbishment and Construction**, the bottom of the proposed basement slab within the east part of the Site (east of Ship Lane) would be set at +0.76m OD. The maximum extent of the proposed basement within the west part of the Site (west of Ship Lane), would be set at +2.45m OD.

11.50. The proposed foundation design for all buildings within the detailed element of the Site would comprise a 1m deep piled raft, with the exception of the proposed cinema area which would be founded in 1m deep local pile caps with 1m deep ground beams. Below the foundations, all buildings would have an expanse of piles (3 to 5 per column) that would be 600mm in diameter and extending down to an estimated maximum 25m in length.

11.51. The piles would be formed using Continuous Flight Augur (CFA) cast in-situ methodologies. This is a non-displacement method, with soils being brought to the surface. Contaminants in the Made

Ground would therefore not be driven down into the Secondary A Aquifer in the Kempton Park Gravel Member. Furthermore, given the thickness of the London Clay Formation (73 m thick), the pile toes would not penetrate the base and, therefore, a preferential pathway for contaminants in the Made Ground to migrate to and affect the underlying sensitive aquifers would not be created. As such, the intrusive groundwork associated with the works are likely to give rise to **insignificant** contamination effects to the Secondary A Aquifer beneath the Site.

11.52. In addition to the above, a new flood defence wall would be constructed within the north of the Site. This would comprise a sheet pile wall with an in-situ reinforced concrete capping beam. The toe level of the sheet pile wall would be set at -1m Above Ordnance Datum (AOD). Such intrusive works may mobilise contamination in the Made Ground and create a pollutant pathway for contaminants to migrate to and impact the River Thames. Given the flood defence wall piling works would be undertaken immediately next to the River Thames, there is no potential for contaminants to attenuate, disperse, or dilute within the groundwater. The risk to the River Thames is, therefore, increased for the piling flood defence wall works in comparison to activities undertaken within the wider Site. In the absence of mitigation measures the likely effect on the River Thames would be **temporary**, **short** to **medium-term**, **local**, **adverse** and of **moderate significance**.

11.53. During the Works, areas of existing hardstanding would be broken out. Such works would temporarily increase the permeable cover allowing increased rainwater and surface water infiltration to the ground and potentially to the underlying aquifer. Given that the shallow groundwater is in hydraulic continuity with the River Thames, there is a potential for ground contamination mobilised by rainwater to reach this water course. In the absence of mitigation, the likely effect to the River Thames is considered to be **temporary**, **short** to **medium-term**, **local**, **adverse** and of **minor significance**.

11.54. Two historical abstractions wells are recorded on the Site. The wells abstract from the Principal Aquifer in the Chalk Group at recorded depths of 101m bgl and 121m bgl. The exact location and status of these wells is not known. However, taking a precautionary and 'worst-case' approach, if these wells are still present and active, a preferential pathway may be present allowing shallow ground contamination mobilised by rainwater to reach the Principal Aquifer. The likely effects, in the absence of mitigation, would be **temporary**, **short** to **medium-term**, **local, adverse** and of **moderate significance**.

11.55. During the Works, it is likely that new sources of contamination would be introduced and stored on the Site (for example, diesel fuel, oils, chemicals and other construction materials). As a result, there would be a risk of leaks and spills to occur directly or indirectly to the ground (Secondary A aquifer in the Alluvium and Kempton Park Gravel Formation) and the River Thames. Potential pathways include surface water drains, preferential pathways created by existing wells, surface water run-off, and migration within the groundwater.

11.56. Despite the above, at a minimum the Works would be undertaken in accordance with legislative requirements for construction activities such as the Control of Substances Hazardous to Human Health (COSHH) Regulations 2002[8], and in-line with best practice methods. This would act to reduce the potential for contamination leaks or spills. As such, the likely effect is considered to be **temporary**, **short** to **medium-term**, **local, adverse** and of **minor significance**.

Effects to Ecological Receptors from Ground Contamination

11.57. Similar to the likely effects to human health, ecological receptors adjacent to the Site and associated with the River Thames may temporarily expose to contamination via the inhalation or

ingestion of potentially contaminated dust. This effect would likely give rise to **temporary**, **short** to **medium-term**, **local**, **adverse effects** of **minor significance**.

11.58. As previously noted, the physical Works would temporarily increase the permeable cover allowing increased rainwater and surface water infiltration to the ground and potentially to the underlying aquifer. Given that the shallow groundwater is in hydraulic continuity with the River Thames, there is a potential for ground contamination mobilised by rainwater to reach the River Thames. In addition, new sources of contamination would be introduced and stored on the Site (for example, diesel fuel, oils, chemicals and other construction materials). As a result, there would be a risk of leaks and spills to occur directly or indirectly to the ground and the River Thames. Potential pathways include via surface water drains, preferential pathways created by existing wells, surface water run-off, and migration within the groundwater.

11.59. Despite the above, the Works would be undertaken in accordance with the Control of Substances Hazardous to Human Health (COSHH) Regulations 2002, and in-line with best practice methods. This would act to reduce the potential for contamination leaks or spills. As such, the likely effect to ecological receptors surrounding the Site is considered to be **temporary**, **short** to **medium-term**, **local, adverse** and of **minor significance**.

Unexploded Ordnance

11.60. Bomb risk maps (refer to **Appendix 11.1**) have identified several high explosive bombs as having fallen on parts of the Site. In addition, a risk exists for unnoticed or unrecorded bombs to have fallen within the Site. There is therefore a risk of potential UXO underneath the Site to detonate during the Works if disturbed, with possible severe consequences.

11.61. In the absence of mitigation, any encountered UXO retains the potential to detonate if disturbed during the Works. The likely effect would be **short-term**, **local**, **adverse** and of **major significance**.

Completed Development

Effects to Human Health from Ground Contamination

11.62. As described within **Chapter 6: Development Programme, Demolition, Alteration, Refurbishment and Construction**, it is proposed that the Development would be implemented in phases, with each phase being occupied as it is completed.

11.63. The basement excavation at the Site would remove a volume of Made Ground beneath the Development, reducing the hotspots of contamination associated with the Site. However, any residual Made Ground beneath the Site could contain organic material that could represent a potential source of ground gas. In such instances, in the absence of mitigation, and taking a precautionary 'worst-case' approach, the likely effect to human health would be **long-term**, **local**, **adverse** and of **moderate significance**.

11.64. The majority of soft-landscaped areas associated with the Development in the Site would be constructed over the proposed basement and so would be removed from any residual ground contamination and require the use of clean, inert imported soil. In such areas, the effects to human health would be **insignificant**.

11.65. Where soft-landscaping and private gardens are proposed outside the footprint of the basement areas (for example, the private gardens associated with Buildings 20 and 21 within the north west of the Site), residents of the Development, together with visitors and users of these areas could

come into contact with ground contamination via dermal contact with contaminated soils, and by plant uptake in private garden areas. Again, in the absence of mitigation, and taking a precautionary 'worst-case' approach, the likely effect to human health would be **long-term**, **local**, **adverse** and of **moderate significance**.

Effects to Controlled Waters from Ground Contamination

11.66. Made Ground present in the footprint of the proposed basements would be removed from the Site, thereby removing a potential source of contamination. The Development would change the land use of the Site from a former industrial use to a primarily residential land use with the comparatively minimal storage of hazardous materials. The reduction in the storage of hazardous materials in the Development would reduce the relative risk of spillages or leakages of hazardous material occurring.

11.67. Any hazardous materials kept on the Site would be stored and maintained in accordance with relevant legislation, which aims to reduce contamination risks. Whilst accidental spillages cannot be ruled out, chemicals would be appropriately stored and spill kits provided where necessary. The Development would include managed drainage inset in the hardstanding areas, which would prevent the majority of rainwater and surface water runoff infiltrating into the ground. Furthermore, the drainage system would be designed to incorporate drainage solutions such as interceptors, filters or silt traps to avoid the discharge or any fuels of oils. This would be particularly important for the three proposed drainage outfalls to the River Thames (refer to **Chapter 12: Water Resources and Flood Risk**). The incorporation of green roofs, and the potential inclusion of rainwater harvesting and permeable paving would further improve surface water quality before it is discharged. If required, a biomat filtration system, downstream defender or other hard engineered solution could also be incorporated to ensure discharge is appropriately treated. Such inherent design features of the Development would likely reduce the silt and oil deposition into the River Thames when compared to the existing situation.

11.68. The Development includes for soft landscaping and private gardens across the Site. There is the potential for rainwater infiltration to soils beneath the Site via this landscaping at the completed development. As the majority of the Site will be covered by buildings and hardstanding with managed drainage, there are unlikely to be significant impacts from any mobilisation with infiltration limited to these landscaping areas.

11.69. In view of the above, the likely effect of the completed and operational Development upon controlled waters is likely to be **long-term**, **local**, **beneficial** and of **minor significance**.

Effects to Building Structures and Services from Ground Contamination

11.70. Below ground Development infrastructure would be inherently suitably designed and specified for the ground conditions at the Site to withstand the potential adverse effects from any residual contamination which could give rise to chemical attack. This would be informed by investigation works necessary to inform foundations design. Therefore, the likely effect is therefore considered to be **insignificant**.

Effects to Ecological Receptors from Ground Contamination

11.71. As noted earlier in this Chapter, soft-landscaped areas and private gardens associated with the Development in the Site would need to be constructed using imported, certified clean topsoil, as soils suitable for this purpose are not present at the existing Site. However, if not installed to an appropriate thickness, future ecological receptors could come into contact with ground

contamination via either root contact or by dermal contact with contaminated soils, and by plant uptake in private garden areas. Again, in the absence of mitigation, and taking a precautionary 'worst-case' approach, the likely effect to ecological receptors on the Site would be **long-term**, **local**, **adverse** and of **minor significance.**

11.72. In respect of any ecological receptors surrounding the Site, including those associated with the River Thames, the likely effect in respect of contamination would likely range from **insignificant** to **long-term**, **local**, **beneficial** and of **minor significance**. The latter would be representative of the likely reduction of silt and oil deposition into the River Thames.

Mitigation Measures and Likely Residual Effects

Intrusive Ground Investigation

11.73. Ground investigation was undertaken across the Site by Aecom in 2015, and within the eastern part of the Site by Waterman in 2016 (refer to **Appendix 11.2**). Further and more detailed ground investigations are due to be undertaken on the western area of the Site, which would also inform a Remediation Strategy. This Remediation Strategy would detail how all potential contamination risks to future receptors would be broken, and the measures necessary to achieve this.

11.74. As part of the detailed construction plans to be developed post-determination, geotechnical investigation would be required. As part of this geotechnical ground investigation, the following works would be undertaken in relation to the contaminated land risk at areas of the Stag Brewery not covered by the 2016 investigation works:

- sampling of soils for contamination identified by previous ground investigations, and for preliminary waste classification purposes;
- installation of ground gas and vapour monitoring wells on the western part of the Site to screen the Made Ground, Alluvium and Kempton Park Gravel Formation;
- sampling and testing of shallow groundwater at the new wells for contamination identified by previous ground investigations, and to assess the risk of chemical attack to buried structures;
- six ground gas and vapour monitoring visits over a period of three months at the new wells, and also at the wells installed as part of the 2016 Waterman ground investigation (refer to **Appendix 11.2**) within the eastern part of the Site to confirm the ground gas and vapour regime; and
- preparation of a Generic Quantitative Risk Assessment (GQRA) report based on the results of the ground investigation to further assess the potential pollutant linkages identified in the PRA.

11.75. The findings of the GQRA would inform a Remediation Strategy, the scope of which would be agreed with the EA and LBRuT. The Remediation Strategy would outline the measures necessary to break potential pollutant linkages across the Site. The purpose of the Remediation Strategy would be to ensure the Site would be 'suitable for the end use' (i.e. the completed and operational Development) and that no unacceptable contamination risk would remain. Remedial measures may include, but would not be limited to, the following:

- removal of contaminated material;
- treatment of soil prior to reuse or disposal;
- appropriate reuse of material beneath paved areas or cover systems;
- importation of clean soils for areas of soft landscaping;

- the use of ground gas / vapour membranes in basements; and
- appropriately designed buried concrete and service pipes.

11.76. Following the completion of any remedial works required, a Verification Report would be produced. This would detail the results of testing, audits, as-built plans and duty of care documents to demonstrate identified linkages have been broken. If any unforeseen contamination is encountered during the Works, a strategy would be devised to ensure that any identified potential effects to receptors would be mitigated. This may include removal of the material from the Development or appropriate reuse of the material on the Development in such a way that the source-pathway-receptor linkage is broken. Further investigative works, the remediation strategy and the verification report will be secured by planning condition.

The Works

Effects to Human Health from Ground Contamination, Ground Gas, and Vapour

11.77. The remediation of the Site (as necessary and informed by previous ground investigations and the proposed further ground investigation) would break all pathway linkages between any residual contamination and identified receptors not already broken by the presence of the Development. In addition, during the Works, precautions would be taken to minimise the exposure of Site workers and the public to potentially harmful substances.

11.78. Specific protection would be developed and implemented in accordance with a Construction Environmental Management Plan (CEMP) for the Development. As detailed within **Chapter 6: Development Programme, Demolition, Alteration, Refurbishment and Construction**, such protective measures would include:

- monitoring and preventive measures to control dust, which could include water spraying in dry weather, wheel washing facilities for vehicles leaving the Works;
- handling and storage of any potential hazardous liquids / materials not only in accordance with relevant legislation, but also in line with best practice including EA pollution prevention guidance;
- the use of appropriately tanked and bunded storage areas for fuels, oils and other chemicals;
- measures for preventing runoff from stockpiled soils reaching surface drainage, or the River Thames; and
- procedures for the management of construction materials, spillage response, use of best practice construction methods and monitoring.

11.79. Providing the above mitigation measures are implemented, the likely residual effect on human health during the Works for on-Site workers, visitors, occupants in the surrounding area, and occupants of the early phases of the Development would be **insignificant**.

Effects to Controlled Waters from Ground Contamination

11.80. The CEMP would include measures to minimise the potential risk to controlled waters during the Works. These would include:

- surface drainage would pass via settlement and oil interceptor facilities, within the proposed basements and where required, and discharge arrangements would be agreed with the EA and Thames Water;

- the provision of adequate drainage to manage surface water run-off and minimise contaminated water reaching the groundwater;
- stockpiling of contaminated materials would be avoided, wherever possible. Stockpiles would be located on areas of hardstanding or on plastic sheeting to prevent mobile contaminants infiltrating into the underlying ground and located away from the Thames and drains; and
- potentially hazardous liquids on the Site such as fuels and chemicals would be managed and stored in accordance with best practice guidance, such as that published by the EA. Storage tank and container facilities would be appropriately bunded with designated areas and located away from surface water drains. All drums and barrels would be fitted with flow control taps and would be properly labelled.

11.81. Post-demolition of the buildings on-Site, the work should be carried out to locate and decommission the historic abstraction wells in-line with best practices and EA guidance, to prevent them acting as preferential pathways to the Principal Aquifer in the Chalk Formation.

11.82. Following the implementation and adherence to the above measures, the contamination risk to the underlying aquifers and surface water features surrounding the Site would be mitigated, and thus the likely residual effect would be **insignificant**.

Effects to Ecological Receptors from Ground Contamination

11.83. During the Works, as noted earlier in this Chapter dust suppression methods would be implemented to minimise the dispersion of dust and associated contaminants. Furthermore, the measures summarised earlier in this Chapter to mitigate against the contamination of controlled waters such as measures detailed in the CEMP would also serve to provide mitigation to ecological receptors associated with the River Thames.

11.84. Accounting for the above, the likely residual contamination effects of the Works to ecological receptors would be **insignificant**.

Unexploded Ordnance

11.85. UXO assessments completed for the Site have identified the risk for encountering ordnance during below-ground works. Specialist UXO supervision would therefore be required during all works down to maximum bomb penetration depth. With the implementation of these mitigation measures, the likely residual effect from UXO would be **insignificant**.

Completed Development

Effects to Human Health from Ground Contamination

11.86. As previously detailed, a Remediation Strategy would be formulated, including measures necessary to ensure that no unacceptable contamination risk would remain at the completed development, particularly with respect to human health.

11.87. Findings of ground gas and vapour monitoring undertaken as part of previous investigations indicate there is not a significant potential for risks to future receptors at the eastern part of the Site. Further investigations at the western part of the Site will fully confirm the gas and vapour regime in this area. Depending on the results, gas and vapour protection measures would be integrated into new buildings to mitigate any gas or vapour accumulation risks.

11.88. In all areas of soft landscaping and private gardens, a suitable thickness of imported, certified clean and inert topsoil would be installed with a marker layer at base, to break any pollutant linkages between residual contamination and vegetation.

11.89. In consideration of the above, all relevant contamination receptor linages would be broken as part of the Development works, or by mitigation measures implemented as part of the Remediation Strategy. Furthermore, the operation of the Development would not give rise to any additional potential pollutant pathways to future occupants, users and visitors to the Site. Accordingly, the likely residual effect to such receptors would be **insignificant**.

Effects to Controlled Waters from Ground Contamination

11.90. As previously highlighted, a Remediation Strategy would be prepared for the Site to ensure that no unacceptable contamination risks to controlled waters would remain on completion of the Development.

11.91. In addition to the above, the assessment of likely significant effects identified that the completed and operational Development would likely give rise to long-term, local, beneficial effects of minor significance. This would be a result of the inherent design of the Development (including green roofs, interceptors and silt traps) which would reduce silt and oil deposition into the River Thames. The likely residual effect would therefore remain as the likely effect. That is, **long-term**, **local**, **beneficial** and of **minor significance**.

Effects to Building Structures and Services from Ground Contamination

11.92. Although the likely significant effect of ground contamination on buried infrastructure has been assessed as being insignificant, foundations, together with services would be selected and designed using the results of the ground investigation. Potable water supply pipes would be selected in accordance with relevant guidance and in consultation with Thames Water. Providing these measures are adhered to, the likely residual effect would remain as **insignificant**.

Effects to Ecological Receptors from Ground Contamination

11.93. In all areas of soft landscaping and private gardens, installation of an appropriate thickness of imported, clean and inert topsoil with marker layer at base would be utilised to break any contaminant linkages between residual contamination and vegetation.

11.94. In consideration of the above, all relevant contamination receptor linages would be broken as part of the Development or by mitigation measures. Furthermore, the operation of the Development would not give rise to any additional potential pollutant pathways to future occupants, users and visitors to the Site. Accordingly, the likely residual effect to ecological receptors on the Site would be **insignificant**.

11.95. In respect of any ecological receptors surrounding the Site, including those associated with the River Thames, the likely effect of the completed and operational Development in respect of contamination would likely range from insignificant to long-term, local, beneficial and of minor significance. The latter would be representative of the likely reduction of silt and oil deposition into the River Thames. The likely residual effect would therefore remain as the likely effect. That is, ranging from **insignificant** to **long-term**, **local**, **beneficial** and of **minor significance**.

Summary

11.96. **Table 11.5** summarises the likely significant effects, mitigation measures, and likely residual effects identified within this Chapter.

Table 11.5: Summary of Likely Significant Effects, Mitigation Measures and Likely Residual Effects

Issue	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
The Works			
Effects to the human health of construction workers from ground contamination and dust.	**Insignificant**.	Implementation of a CEMP to manage the Works to effectively minimise contamination risks.	**Insignificant**.
Effects to the human health of the public surrounding the Site, and early occupants of the Development from dust.	**Temporary**, **short** to **medium-term**, **local**, **adverse** and of **minor significance**.		**Insignificant**.
Installation of piles associated with the buildings of the Development, creating a pollutant pathway to the Secondary A Aquifer beneath the Site.	**Insignificant**.		**Insignificant**.
Installation of piles associated with the flood defence wall, creating a pollutant pathway to the River Thames.	**Temporary**, **short** to **medium-term**, **local**, **adverse** and of **moderate significance**.		**Insignificant**.
Removal of existing areas of hardstanding, thereby increasing the permeable cover of the Site, allowing for increased rainwater / surface water infiltration to the ground, underlying Secondary A Aquifer and River Thames.	**Temporary**, **short** to **medium-term**, **local**, **adverse** and of **minor significance**.		**Insignificant**.
Removal of existing areas of hardstanding, thereby increasing the permeable cover of the Site, allowing for increased rainwater / surface water infiltration to the ground, underlying Principal Aquifer.	**Temporary**, **short** to **medium-term**, **local**, **adverse** and of **moderate significance**.		**Insignificant**.

Issue	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Introduction of potential contaminants on the Site which could increase the risk of leakages and spillages to the ground (Secondary A Aquifer) and the River Thames.	**Temporary**, **short** to **medium-term**, **local**, **adverse** and of **minor significance**.		**Insignificant**.
Effects to ecological receptors on and off the Site from ground contamination and dust.	**Temporary**, **short** to **medium-term**, **local**, **adverse** and of **minor significance**.		**Insignificant**.
Effects associated with UXO.	**Short-term**, **local**, **adverse** and of **major significance**.	Undertaking of a detailed desk-based UXO assessment to identify and classify the actual on-Site risk posed by UXO and appropriate mitigation measures. This would include presence of a UXO specialist on-Site during the Works.	**Insignificant**.
Completed Development			
Effects to the human health of occupants, users and visitors of the Development from ground gas or vapour accumulation within buildings and hard-landscaped areas.	**Long-term**, **local**, **adverse** and of **moderate significance**.	In line with anticipated planning condition, further ground and geotechnical investigation to inform an appropriate Remediation Strategy for the Site, as required This may include the implementation of ground gas and vapour mitigation measures and the likely use of imported clean and inert soils within areas of proposed soft-landscaping.	**Insignificant**.
Effects to the human health of occupants, users and visitors of the Development from ground contamination within soft-landscaped areas.	**Insignificant** to **long-term**, **local**, **adverse** and of **moderate significance**.		**Insignificant**.
Effects to controlled waters (including the River Thames) from ground contamination.	**Long-term**, **local**, **beneficial** and of **minor significance**.		**Long-term**, **local**, **beneficial** and of **minor significance**.
Effects to buildings structures and services from ground contamination.	**Insignificant**.		**Insignificant**.
Effects to ecological receptors on the Site from ground contamination.	**Insignificant** to **long-term**, **local**, **adverse** and of **minor significance**.		**Insignificant**.
Effects to ecological receptors off-Site,	**Insignificant** to **long-term**, **local**, **beneficial**		**Insignificant** to **long-term**, **local**, **beneficial**

Issue	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
including those associated with the River Thames.	and of **minor significance**.		and of **minor significance**.

References

1 Environment Agency, Land Contamination Risk Management guidance (LCRM); April 2021.

2 Groundsure Enviro Insight information (ref. WTM_8385437_1_1); December 2021.

3 Bomb Sight: Mapping the WWII Bomb Census; www.bombsight.org; accessed online December 2021.

4 The Environment Agency Aquifer Designation Map; www.environment-agency.gov.uk; accessed online January 2022.

5 Aecom; Stag Brewery: Phase 1 Environmental Site Assessment, July 2015.

6 Groundsure 2017, Preliminary Unexploded Ordnance Risk Assessment (ref. SCL-3318495); 2017.

7 Health and Safety Executive, Construction (Design and Management) Regulations; 2015.

8 The Stationery Office, Control of Substances Hazardous to Health (COSHH) Regulations; 2002.

9 Health and Safety Executive; The Control of Asbestos Regulations (CAR); 2012.