CEMEX UK Materials Limited

Datchet Quarry

Environmental Permit Application

Environmental Setting and Site Design

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1.0 Introduction

1.1 Report Context

1.1.1 This section of the Environmental Permit application corresponds to Question 1, Appendix 4 of Part B4 of the EP application forms, which requires the provision of an Environmental Setting and Site Design (ESSD) report.

1.1.2 The aim of this report is to describe the regulated facility in relation to the environmental setting, identifying the source terms, pathways and receptors that will be used as the basis for the risk assessments, including:-

- Hydrogeological Risk Assessment;
- Landfill Gas Screen Report; and
- Environmental Risk Assessment.

1.1.3 The above risk assessments will include more specific conceptual models.

1.1.4 This Environmental Permit application has been prepared on behalf of the operator, CEMEX UK Materials Limited (CEMEX), by WYG.

1.2 Regulated Facility Details

Site Location

1.2.1 Datchet Quarry is located approximately 900m to the south east of Slough in Berkshire. It is located to the north of the M4 motorway and separated from it by Riding Court Road. The site is centred at National Grid Reference (NGR) SU 98900 77900. The application site is detailed on Drawing Number A097237/LOC/01.

1.2.2 Current access to the site for agricultural purposes is via the Riding Court farmyard, which is accessed from a private road off Riding Court Road.

Landfill Classification

1.2.3 The regulated facility is an inert landfill.

Application Boundary and Site Security

1.2.4 The proposed application boundary is shown on Drawing Number A097237/LOC/01, which includes the site boundary and Riding Court Road. The boundary is formed by trees and vegetation and a drainage ditch, which runs along Riding Court Road between the road and the site boundary. This will act as a barrier to prevent unauthorised access from the road.

1.2.5 The access road to the Riding Court Farm business complex is fenced, as are its boundaries. An electronic gate at the bottom of this access road prevents ingress to the site via the farm track.

1.2.6 The site will be secure from public access by lockable gates at the site entrance. Security lights and CCTV cameras will also be installed on site.

Site Context

1.2.7 To the east of the site is the M25 motorway with Heathrow Airport located approximately 5.5km from the site. To the north are open fields and the residential area of south west Langley. The nearest residential dwelling to the site is 'Tree Tops', located approximately 10m from the site boundary on the north side of the M4.

1.2.8 A stream, Datchet Common Brook runs in a west – east direction to the north of the application site and then flows into the site on the northern boundary, where it then flows south eastwards across the north eastern part of the site.

1.2.9 A 'Nature and Heritage Conservation Screen' (EPR/EB3402MU/A001) was requested from the Environment Agency. This screen determines the presence of any sites of nature and heritage conservation, or protected species or habitats that may be impacted by the proposal.

1.2.10 The results of the screen identified multiple areas of deciduous woodland within 1km of the site to be protected habitats. The nearest is located to the north of the application site and runs along the northern boundary in a west – east direction.

Compliance with Environment Agency position statement on location of landfills

1.2.11 With reference to the Environment Agency's mapping website 'What's in my backyard', there is a section of land located to the south and west of the site that are situated within a Flood

Zone 2 area which is land assessed as having less than 1 in 1,000 annual probability of flooding from the river or sea. The north of the site and where the Datchet Common Brook runs across the north east part of the site is situated within a Flood Zone 3 which is land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or in a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

1.2.12 According to the Environment Agency's mapping website 'What's in my backyard', the majority of the site is located within a Total Catchment Zone which is defined as an area around a source within which all groundwater recharge is presumed to be discharged at the source. The map also indicates that a small area of land to the west of the site is located within an Outer Zone of the groundwater source protection zone.

1.2.13 The Environmental Risk Assessment (Appendix D of the main application) that has been undertaken for the proposed application shows that Datchet Quarry does not pose a potential hazard to groundwater quality.

1.2.14 The Environmental Risk Assessment also demonstrates that long-term site management will not be required due to the environmental protection measures and waste acceptance protocols proposed for the development.

2.0 Source Term Characterisation

2.1 Development of the Installation

Historical Development

2.1.1 The application site was shown in the original adopted Berkshire Minerals Plan as a 'Restricted Area' for mineral extraction due to its agricultural quality but this designation as an over-riding constraint against mineral extraction subsequently removed.

2.1.2 Following the removal of this constraint. the site was allocated for extraction in the Replacement Minerals Local Plan for Berkshire in 1995 as Preferred Area 11.

2.1.3 This allocation was re-confirmed in the current adopted Berkshire Replacement Minerals Local Plan (BRMLP) 2001, where it remains as Preferred Area 11.

2.1.4 As stipulated in the BRMLP, access to the site should be via Riding Court Road and Ditton Road to the A4 and M4 (Junction 5), with a new vehicular access to the site provided along Riding Court Road.

2.1.5 Planning Permission for such an access was granted in July 1997, subject to the separate granting of permission for mineral extraction. This permission has not expired.

2.1.6 Subsequent to that permission, there have been no other planning applications or permissions for the application site.

2.1.7 In September 2015, The Royal Borough Windsor and Maidenhead granted Planning Permission for the extraction of minerals at Datchet Quarry. Following mineral extraction, Planning Permission Reference No. 13/01667 also requires the site to be restored in accordance with the restoration scheme as approved. As a function of this planning permission, no dewatering of the site is permitted.

Proposed Development

2.1.8 The proposal entails the importation of inert waste for infilling of the quarry void that will be created following the mineral extraction activities. The works will be completed in accordance with the final ground contours and restoration scheme (Drawing Number P1/869/8A) as approved under Planning Permission reference 13/01667.

Waste Types and Quantities

2.1.9 It is proposed that Datchet Quarry will accept only inert waste as stipulated in the Planning Permission.

2.1.10 Permitted wastes accepted at the site will be strictly inert as classified under the Landfill Directive (1999/31/EC) and Council Decision (2003/33/EC) of 19 December 2002 'establishing criteria and procedures for the acceptance of waste landfills'.

2.1.11 Details regarding the proposed waste types including restrictions are provided in the Operating Techniques (Appendix B in the Environmental Permit Application).

2.1.12 The restoration of the site will require approximately 1,120,850m^3 (2,241,700 tonnes) of inert material.

Proposed Operational Phasing

2.1.13 Extraction and progressive restoration will commence in the western part of the site in Area 2, and will proceed progressively from west to east in the sequence detailed in Drawing No. P1/869/5. The areas shown are indicative of how the site will be worked and the timing of the completion of extraction and restoration for each area will be dependent on the depth of mineral.

2.1.14 The overall extraction operations will last for approximately 6 years, with restoration taking place concurrently and taking a total of 11 years.

Final Landform and After Use

2.1.15 Drawing Number P1/869/8A details the proposed final restoration contours for the site.

2.1.16 The majority of the site to the western and central areas will be restored to agriculture at original ground levels; the remainder of the east will be restored to parkland and two small open water areas at levels slightly lower than the existing ground levels, as shown on plan P1/869/8A.

2.2 Engineering

Groundwater Management

2.2.1 As a function of the planning permission no dewatering of the site is permitted. Due to the inert nature of the wastes deposited, no groundwater management system will be employed at the site.

Geological Barrier

2.2.2 The site will benefit from a natural geological barrier at the base of the sand and gravel excavation which is underlain by London Clay. It is considered that this natural barrier provides the requisite depth and impermeable characteristics in order to satisfy the requirements of the landfill directive.

2.2.3 An artificial sidewall geological barrier will be provided around the perimeter of the site in each phase, working in a west to east direction, with construction at least 25m ahead of landfilling. Consideration has been given to the excavation of the underlying London Clay in order to form the geological barrier, however, to utilise the London Clay at the base of the site would require dewatering which is not permitted under the planning permission and as such it is anticipated that there will be isolated pockets of standing groundwater within the excavation void. In addition, the site configuration does not allow access to excavate into the London Clay due to operational safety reasons.

2.2.4 The sidewall geological barrier will be constructed from selected imported wastes, which will have sufficient clay content capable of achieving the required properties for the geological barrier. The physical suitability of the material will be assessed by the Site Manager in accordance with the flow chart provided in the Environment Agency's 'Standards and Measures for the Deposit of Inert Waste on Land'. A copy of the flow chart is detailed in Appendix A.

2.2.5 Materials selected for incorporation in the geological barrier above water will be capable of being spread in thin layers using earthmoving plant and tracked in, without heavy compaction, to form a barrier at least 15m wide with a permeability of 1 x 10^{-6}m/s or less to achieve equivalence with the Landfill Directive requirements.

2.2.6 Barrier material for disposal below water will initially be deposited on a plateau at approximately the original ground level to allow inspection, and will then be bulldozed over an advancing face into the water. If any unacceptable barrier material is discovered, and is suitable as inert fill, it would be stockpiled or placed in accordance with waste placement procedures. Barrier slopes below the water table will form at a natural angle of repose and will be allowed to consolidate under gravity alone. Vehicles delivering material to the site will not be permitted to travel within

10m of the face to ensure that the slope is not surcharged.

2.2.7 Once the level of the barrier is above groundwater level, the material can be compacted by multiple passes of earthmoving equipment.

2.2.8 The geological barrier will be a minimum of 20m wide at the base and will sit directly on top of the London Clay (as the gravel reserve will have been fully excavated). At CEMEX's Coldharbour Lane landfill (permit reference EPR/CP334LF), the Environment Agency has accepted a 20-40m wide overburden mound as a geological barrier which had been placed directly on top of London Clay. The overburden separated the landfill waste from the adjacent natural ground (principal aquifer).

2.2.9 The geological barrier deposited below the water table will be compacted under self-weight and as additional waste is placed on top. An estimate of the time for 90% consolidation has been made assuming that the Coefficient of Consolidation (cv) of the waste is equivalent to $25m^2$/year. This is a typical value adopted for London Clay (from which it is likely much of the waste will be derived). The assumption is therefore considered to be very conservative as the permeability of the waste will be higher than undisturbed London Clay allowing more rapid consolidation. The calculation indicates that 90% settlement will occur within 1 year of completion, which is within the aftercare period for the landfill. Any settlement hollows that appear as a result of consolidation of the waste mass can therefore be remediated by local filling and/or grading during the aftercare period.

2.2.10 CQA of the barrier will be achieved through a combination of the following:

- Chemical suitability - review of site investigation information and Waste Information Form provided by the customer;
- Physical suitability (prior to import) using Chart 1 - review of site investigation information and Waste Information Form provided by the customer;
- Physical suitability (on arrival at site) using Chart 1 - visual inspection including a field strength and plasticity test as per Chart 1;
- Visual inspection of each load on tipping, prior to incorporation into the geological barrier;
- Area completed each week recorded via a GPS coordinate and source of material identified and mapped on a barrier location plan;

- Topographic surveys in accordance with the environmental permit;
- Periodic independent CQA visual inspection and site record check throughout construction period;
- In-situ permeability testing to demonstrate equivalence;
- Identification of works or procedures that do not comply with the requirements of the CQA Plan – 'Non Conformances';
- Recording of remedial works undertaken to rectify 'Non Conformances'; and
- Provision of CQA Completion Reports including full records of all inspections, checks and testing carried out including records demonstrating the compliance of the works and records of any or outstanding 'non-conformances' as appropriate.

2.2.11 It is considered that the CQA method described above in combination with the following processes is sufficient for CQA of the geological barrier, above and below the water table:

- Minimum 15m thickness of the geological barrier;
- Source evaluation;
- Waste acceptance procedures;
- Duty of care testing; and
- HRA (modelled without a barrier).

Capping

2.2.12 In accordance with the requirements of the Landfill Directive, an engineered cap (clay or plastic) is not required. On completion of filling to final levels, the agricultural areas proposed in the restoration plan will be capped with 1m of restoration soils comprising not less than 0.3m of topsoil.

Restoration

2.2.14 As detailed in the approved restoration plan (Drawing No. P1/869/8A), the scheme comprises a combination of agricultural land restored to the western sector of the site and two small lakes restored to the east.

2.2.15 The scheme provides for the reinstatement of approximately 22.2ha of agricultural land restored back to original ground levels to the western and central parts of the site. Significant

areas of native broadleaved woodland and wet woodland will be established within the remainder of the area. These will complement the advanced, now maturing, planting that has taken place around the site.

2.2.16 The lakes that will be restored in the eastern sector of the site will be steep sided with margins sown with Common Reed and goose proof fencing erected in the initial stages until the vegetation becomes established. The lakes will be situated within a framework of woodland

2.2.17 The silt pond system within the south-eastern part of the site will be restored to wetland at approximately former ground level. The wetland will extend around the restored lakes to minimise the attractiveness of the water bodies for potential birdstrike species due to the proximity of Heathrow.

Aftercare

2.2.18 All planting and grass seeded areas will be subject to a comprehensive five-year aftercare scheme, following completion of the restoration, covering annual maintenance and weed control, and replacement of dead or dying trees.

2.2.19 Details of the aftercare scheme will be agreed with the Mineral Planning Authority.

2.3 Leachate Management and Monitoring

Leachate Generation

2.3.1 Leachate is generated by rainfall infiltrating through areas of open waste and also through areas of capped and restored waste. Due to the inert nature of the waste, there will be no leachate generated at the site and therefore no leachate management or monitoring is proposed.

2.4 Landfill Gas Management and Monitoring

Landfill Gas Generation

2.4.1 A Landfill Gas Risk Assessment (GRA) has not been prepared for Datchet Quarry, as the Landfill Technical Guidance Note LFTGN03 indicates that new inert landfills do not pose a landfill gas hazard. Nevertheless, a landfill gas screening report has been prepared which has been submitted with the Environmental Permit application as Appendix G.

Landfill Gas Management and Monitoring Infrastructure

2.4.2 As above, a landfill gas screening report has been prepared to confirm that landfill gas management will not be required. In waste gas monitoring infrastructure will be installed following the completion of each landfill cell in order to monitor the levels of gas produced by waste mass in accordance with the requirements of Environment Agency's Technical Guidance Note LFTGN03 and the Landfill Directive. Monitoring of these wells will be undertaken on a monthly basis during the operational phase and on a six monthly basis during the aftercare period.

2.4.3 Further details with regards to the monitoring of landfill gas is provided in the Landfill Gas Screening Report.

2.5 Surface Water Management System

2.5.1 As the level of the waste rises above the water table, the working area will be kept free from surface water by grading the surface of the waste to falls, to facilitate runoff. Rainwater falling on unfilled areas of the Site will collect in low areas where it will be allowed to soak away naturally.

2.5.2 On completion, the gradient of the final landform will control surface water drainage across the installation. Surface water will drain to Datchet Common Brook and the unnamed surface water stream to the north of the Site. Surface water is also likely to discharge to the planned amenity lake located in the south-eastern corner of the Site.

2.6 Post Closure Controls

2.6.1 The post closure controls will ensure the long-term management and monitoring of the regulated facility.

2.6.2 The Environmental Management and Monitoring Plan (Appendix H of the Environmental Permit Application) provides details regarding the monitoring schedule of the aftercare phase.

2.6.3 The Closure and Aftercare Plan (Appendix I of the Environmental Permit Application) provides details of the measures to be taken upon and after the closure of the landfill to avoid pollution risk.

3.0 Pathway and Receptor Term Characterisation

3.1 Climate

3.1.1 Environment Agency (2004) reports that the Thames region receives an average rainfall of 690 mm/a with an average effective rainfall (HER) of 250 mm/a.

3.1.2 Rainfall data is available from a rain gauge at Heathrow Airport 5 km to the east of the Site (NGR: 507800, 176700) shown on the Met Office website (Met Office, 2016) from 1948 to 2016 with average monthly rainfall summarised in Table 1 below, with an average total rainfall of 607mm/a. The rainfall for 2014 was considerable above average at 864mm/a, whilst conversely rainfall for 2015 was slightly below average at 562mm/a.

Table 1: Monthly rainfall data from Heathrow (1948-2016)

Month	Average Rainfall mm (1948-2016)	2014 rainfall (mm)	2015 rainfall (mm)
January	54.5	162.4	63.4
February	39.9	89.8	38.6
March	40.8	27.8	24
April	42.2	58	16.2
May	48.4	84.6	41.6
June	47.9	40.8	12.2
July	48.6	50	71.8
August	55.0	97.6	116.8
September	50.9	10.8	50
October	62.3	76	39.8
November	61.1	128.4	48.2
December	55.6	37.8	39.4
Total	607.2	864.0	562

3.1.3 Rainfall statistics from the Centre of Ecology and Hydrology (CEH) (2014) for the catchment area upstream of gauging station 39111 on the Thames at Staines (about 5 km to the south east of the Site), give average rainfall values of 840mm/a for the period between 1941 and 1970 and 696mm/a for the period between 1961 and 1990. For the area over the Site the rainfall average is shown as being between 600 and 625mm/a which is consistent with the Average Met Office rainfall value of 607.2mm/a rather than the higher Environment Agency

average of 690mm/a.

3.1.4 Effective precipitation was estimated from CEH (2014) using catchment area and mean flow data from a gauging station at Staines. Based on a catchment area of 8,120km^2 and a mean flow at the gauge of 54.99m^3/s, an effective precipitation of 214mm was estimated. However, this only provides an approximation of the recharge rate as the calculation of effective precipitation assumes that there is no net anthropogenic influence on the flows.

3.1.5 Long term average rainfall data (1971 to 2000) was obtained from the Met Office Rainfall and Evaporation Calculation System (MORECS) and is presented in Table 2.

Table 2: Long-term average hydrometric data for MORECS square 161

Month	Average rainfall (mm)	Average PE (mm)	Average HER (mm)
Jan	54.80	19.49	22.92
Feb	35.46	22.88	13.24
Mar	42.86	42.85	7.83
Apr	45.46	65.34	6.41
May	52.56	97.11	2.55
Jun	54.66	100.99	1.70
Jul	42.29	110.03	0.00
Aug	48.53	96.55	0.00
Sep	55.95	64.49	0.00
Oct	67.22	41.69	4.23
Nov	55.38	24.01	12.25
Dec	58.33	18.39	14.10
Yearly total	613.49	703.82	85.23

PE = Potential Evapotranspiration; HER = Hydrologically Effective Rainfall

3.1.6 The MORECS data shows the long-term average rainfall to be 613 mm per year and the long-term average potential evapotranspiration to be 704 mm per year with HER values of 87.5 mm/a. The level of rainfall is consistent with that reported by the Met Office and the CEH, rather than the Environment Agency.

3.1.7 The MORECS HER value of 85.23 mm/a is also much lower than the Environment Agency value of 250 mm/a. However, the MORECS HER value, at only 14% of MORECS rainfall figure, appears low and the Environment Agency HER value is considered more appropriate.

3.1.8 Data for the months from February 2013 to January 2014 (12 months) for the Thames region Natural Environment Research Council (NERC) (CEH) 2014 showed a rainfall level of 845 mm/a, 122% the 1971-2000 average. This exceeds the average rainfall levels stated above by 200 mm/a and provided the best indicator of wet condition rainfall values.

3.2 Geology

Regional Geology

3.2.1 The geology of the Site and the surrounding area is shown on the 1:50,000 scale geological map 269 (BGS, 1999) and is explained in the geological memoir (Ellison & Williamson, 1999). The typical geological succession observed in the region is presented in Table 3 below and is shown on Figure 3.1 and **Error! Reference source not found.**.

3.2.2 The geological map shows that the Shepperton Gravel (River Terrace Deposits) is present beneath the Site above the London Clay, with the Lambeth Group and Chalk beneath the London Clay. According to the geological map, the London Clay is absent about 300 m to the south-west of the Site. The geological map does not show any evidence that the Thanet Sand is present between the London Clay and the Chalk.

Table 3: Summary of regional geology

Stratigraphy	Unit	Lithology	Estimated thickness
Quaternary	Alluvium	Mainly sand, silty and clay	
Pleistocene and Holocene River Terrace Deposits	River Terrace Deposits	Sand and Gravel	0 to 10 m
Eocene Thames Group	London Clay Formation	Claygate Member: silty and clayey sand	0 to 10 m
		Undivided: Brown to dark grey clay with fine grained sands and pebbles beds in places	87 to 111 m
Lambeth Group	Harwich Formation	Green to brown pebbly sand	0-6 m
	Reading Formation	Mottled clay with beds of sand and shelly clay	18-25 m
	Upnor Formation	Fine grained sand	0-5 m

	Thanet Sand Formation	Fine to medium grained sand	0-4 m
Unconformity			
Upper Cretaceous Chalk	Upper Chalk	Chalk, white, with flints; nodular chalk at base.	200 m

Local geology

3.2.3 Entec Ltd (in reports dated 1999 and 2001) reviewed BGS borehole records in the vicinity of the Site which suggested the Sand and Gravel beneath the Site is underlain by up to about 6m of London Clay which is underlain by the clay-dominated Reading Beds. Other boreholes suggested that the London Clay may be absent, although it was noted that it is difficult to differentiate between London Clay and the Reading Beds.

3.2.4 An intrusive site investigation was undertaken by Entec in March 2000 (as reported in Entec (2001) in Appendix B) as follows:

- seven boreholes (BH1A to BH7A) were drilled in the Sand and Gravel with a piezometer installed in each borehole; and
- five boreholes (BH1B to BH5B), located adjacent to five of the seven Sand and Gravel piezometers, were drilled across the Lambeth Group and into the Chalk and installed with two piezometers; one installed in the Reading Beds (referred to as P1) and one installed in the Chalk (referred to as P2).

3.2.5 Borehole locations are shown in **Error! Reference source not found.** and the geology is summarised in Table 4; borehole logs are presented in Appendix E. A north to south geological cross sections is shown in **Error! Reference source not found.** and an east to west cross section is shown in **Error! Reference source not found.** (both from the Entec (2001) report). A summary of the local geology is given in Entec (2001) as summarised below:

- A thin cover of alluvium is present above the Sand and Gravel.
- The Sand and Gravel is typically 5 to 10 m in thickness across the Site.
- The London Clay was encountered at each deep borehole location and ranged in thickness from 1.6 to 9.8 m, thinning out towards the west and south at estimated distances of about 500m.

- Between the London Clay and Chalk, is reported to be entirely Reading Beds with no report of the Harwich, Upnor or Thanet Sand Formations being present. The Reading Beds typically constituted the following:-
  - An upper silty clay of 5.6 to 13.8 m in thickness;
  - A 4 to 13 m thick zone ranging between a silty clay and a sand;
  - A lower silty clay of between 6.2 to 7.9 m.
- Chalk with a maximum proven thickness of 5.4 m at an elevation between -18 and -26 m AOD.

3.2.6 A summary of the local geology and hydrogeology is included in Table 4. Selected site investigation boreholes from 1995 have also been included.

Man-made deposits

3.2.7 A search of the Environment Agency website (Environment Agency, 2016) shows there are three records of historical landfill sites within 1 km of the Site. These are presented on **Error! Reference source not found.** and summarised below:-

- Upton Court Farm landfill, located directly adjacent to the Site to the west, received waste between 1960 and 1969 (inert, industrial, commercial and household waste);
- Slough Road, Eton, about 200 m to the south west, received waste between 1950 and 1959 (inert, industrial, commercial and household waste); and
- Mill Place, Datchet, about 800 m to the south, received waste in 1970 (inert and industrial waste).

3.2.8 Entec (2010) reported that Slough Borough Council recently designated the western area of the Upton Court Farm landfill as contaminated land on the basis of risk to site users from ingestion of soils and soil derived dust contaminated with lead. However, little groundwater contamination was found apart from elevated nitrate (240 mg/l) and sulphate (290 mg/l) in one of three boreholes.

3.3 Man-made subsurface pathways

3.3.1 The quarry will be quarried to the top of the London Clay, which is estimated to be between 1.6 and 9.8 m thick. The London Clay will not be excavated, which means that the potential for any man-made subsurface pathways to the underlying Chalk to exist, are considered to be minimal. The underlying Reading Bed strata also have low permeability in the upper horizons.

3.3.2 A number of the Entec boreholes drilled in 2000 feature dual installations, with one piezometer monitoring the Reading Formation and a deeper piezometer installed in the Chalk. The boreholes have been constructed using substantial bentonite seals and downward migration of water in the borehole annulus is considered to be highly unlikely (logs are presented in Appendix E). The boreholes are unlikely to act as a subsurface pathway for water or contaminant migration into the Chalk.

Figure 3.1: Superficial geology, worked ground and surface water features

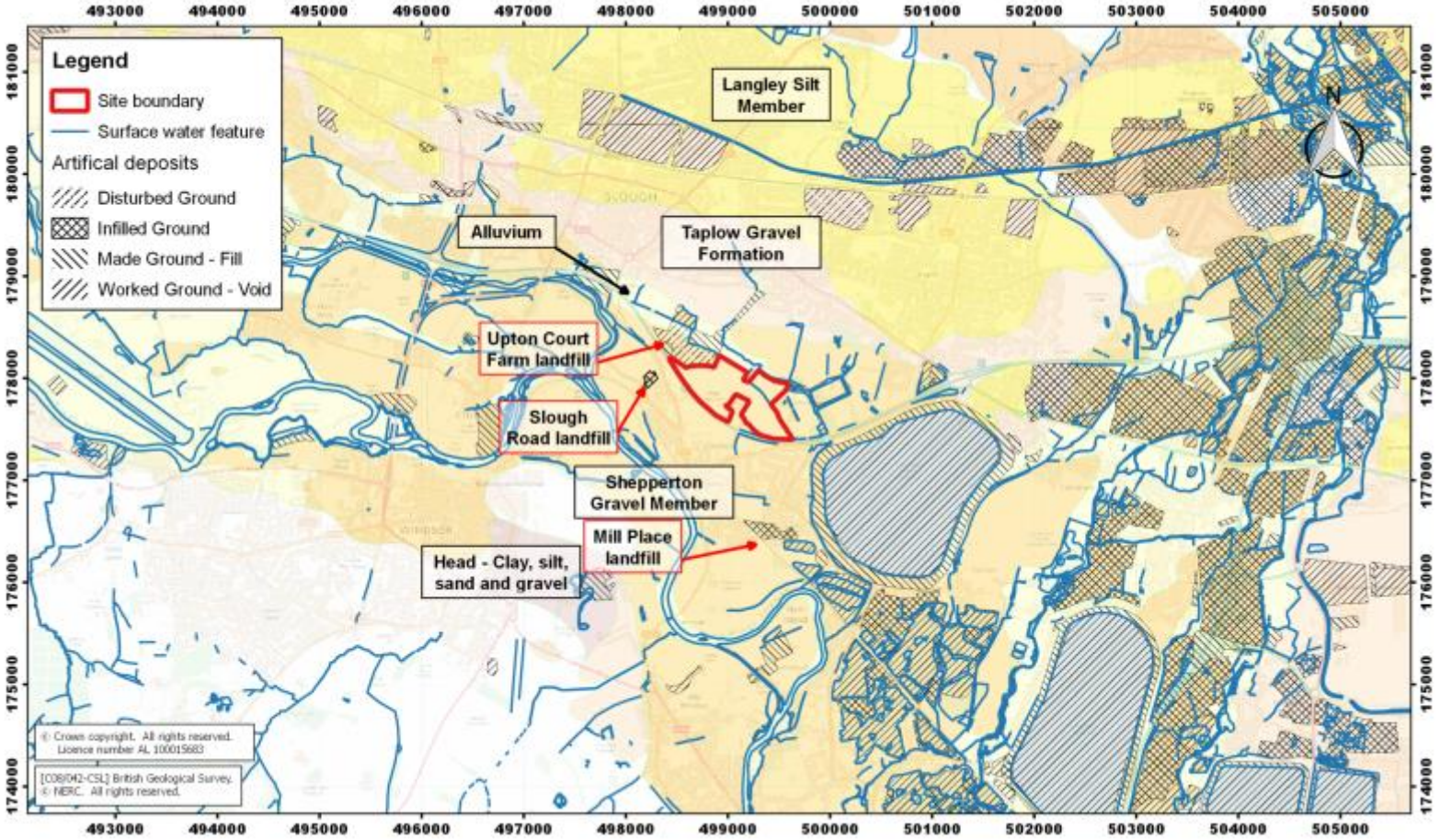


Figure 3.2: Bedrock geology and surface water features

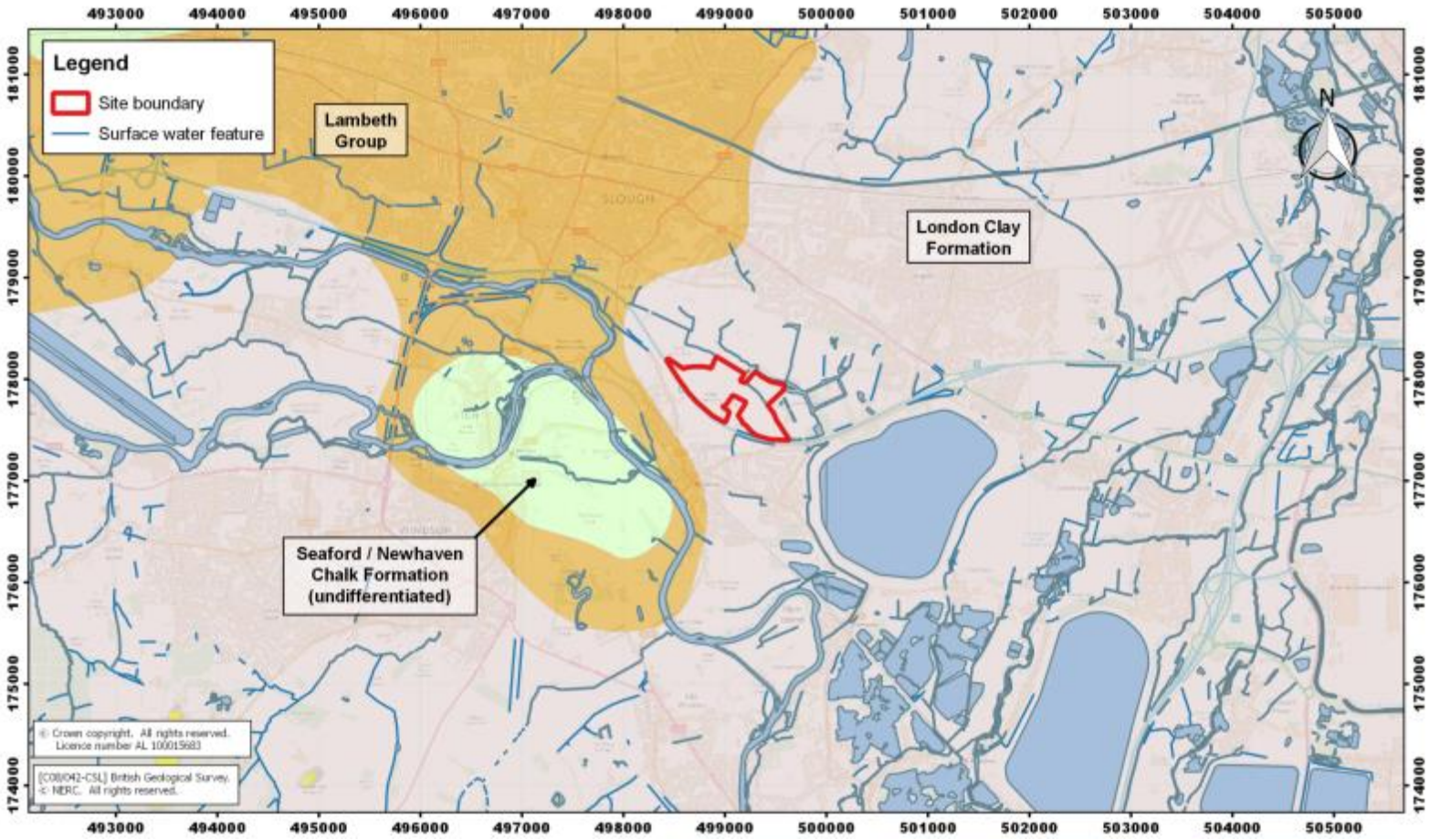


Figure 3.3: Monitoring locations in relation to superficial geology

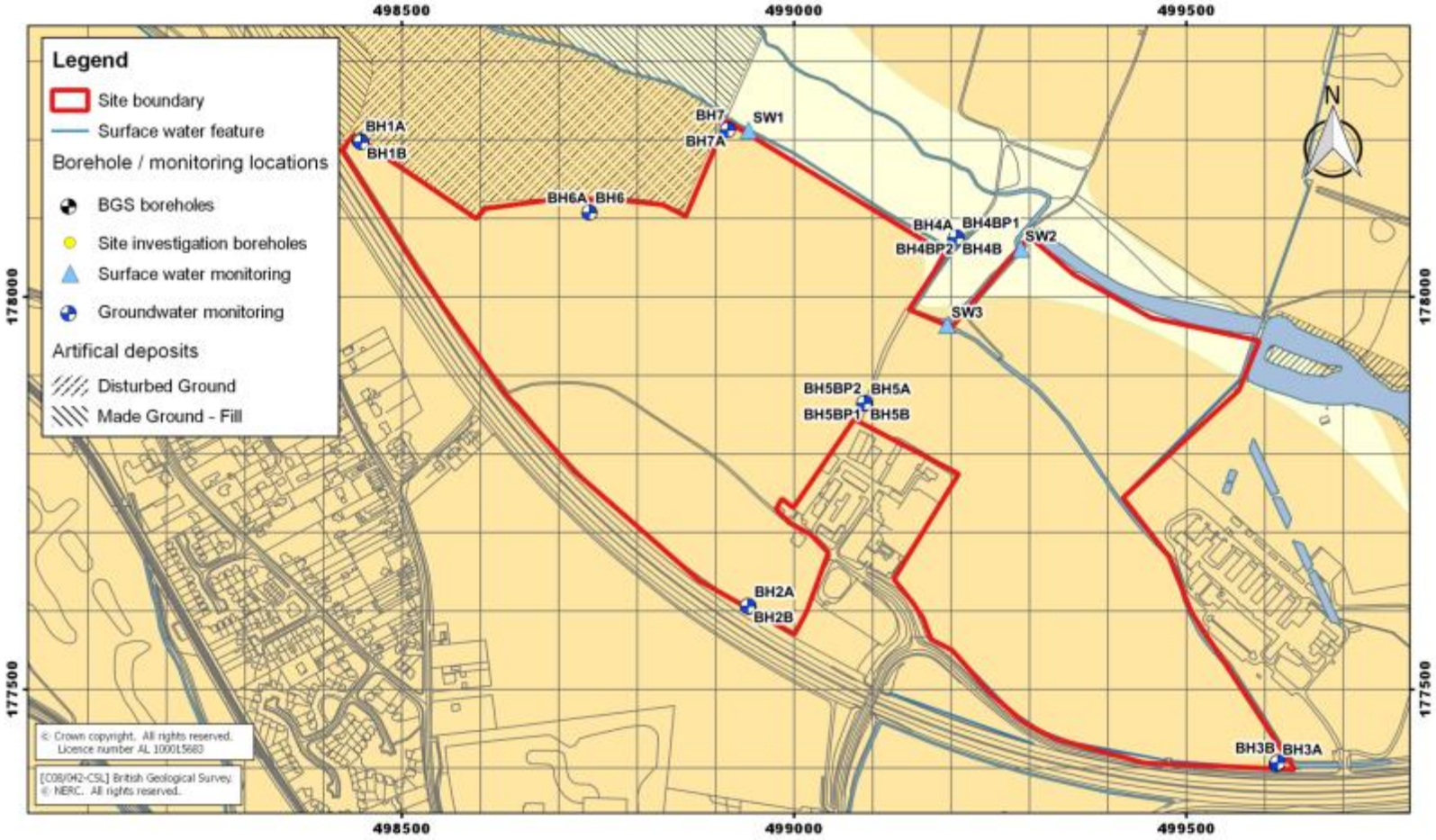


Figure 3.4: North-to-south geological cross section

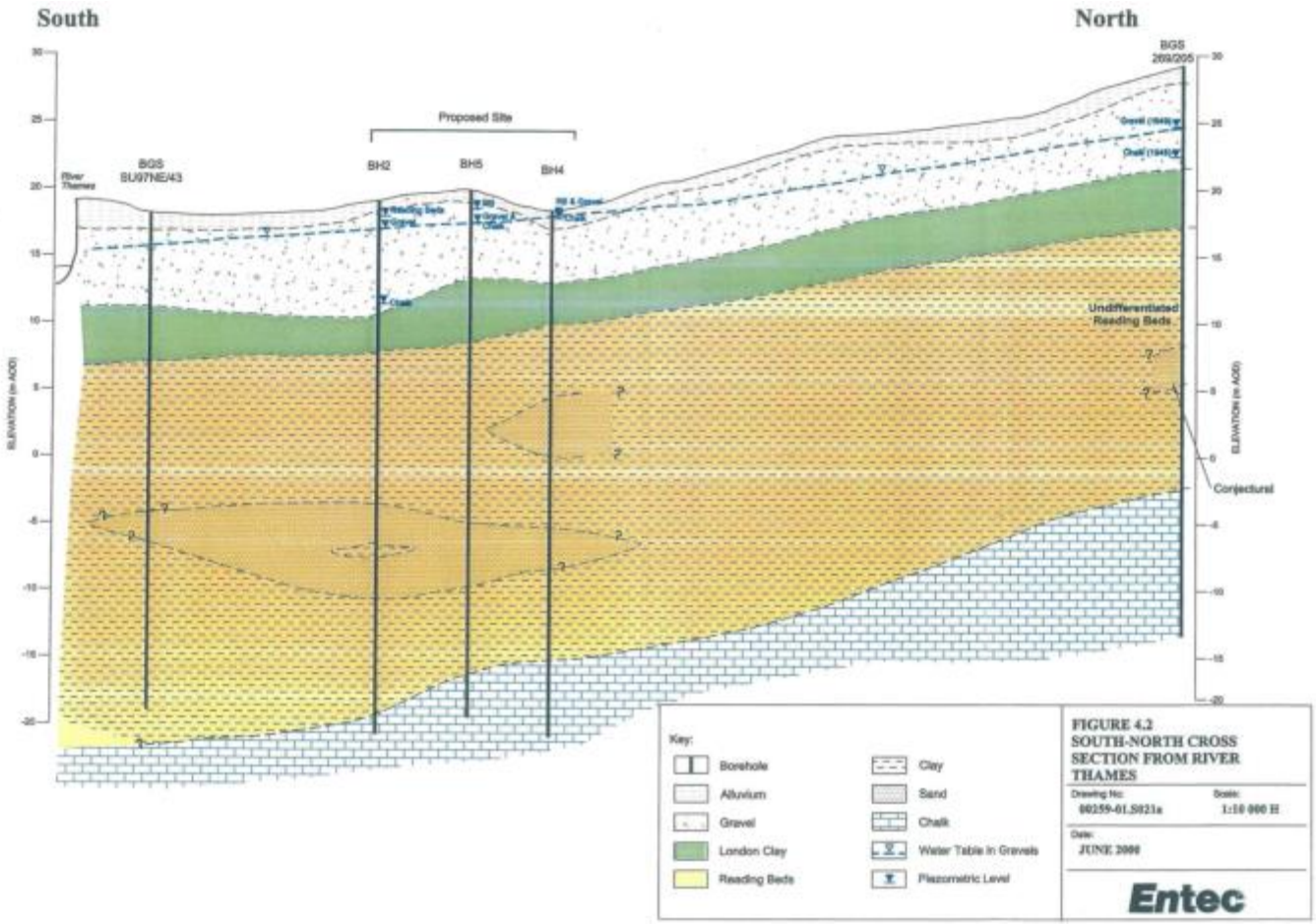


Figure 3.5: West-to-east geological cross section

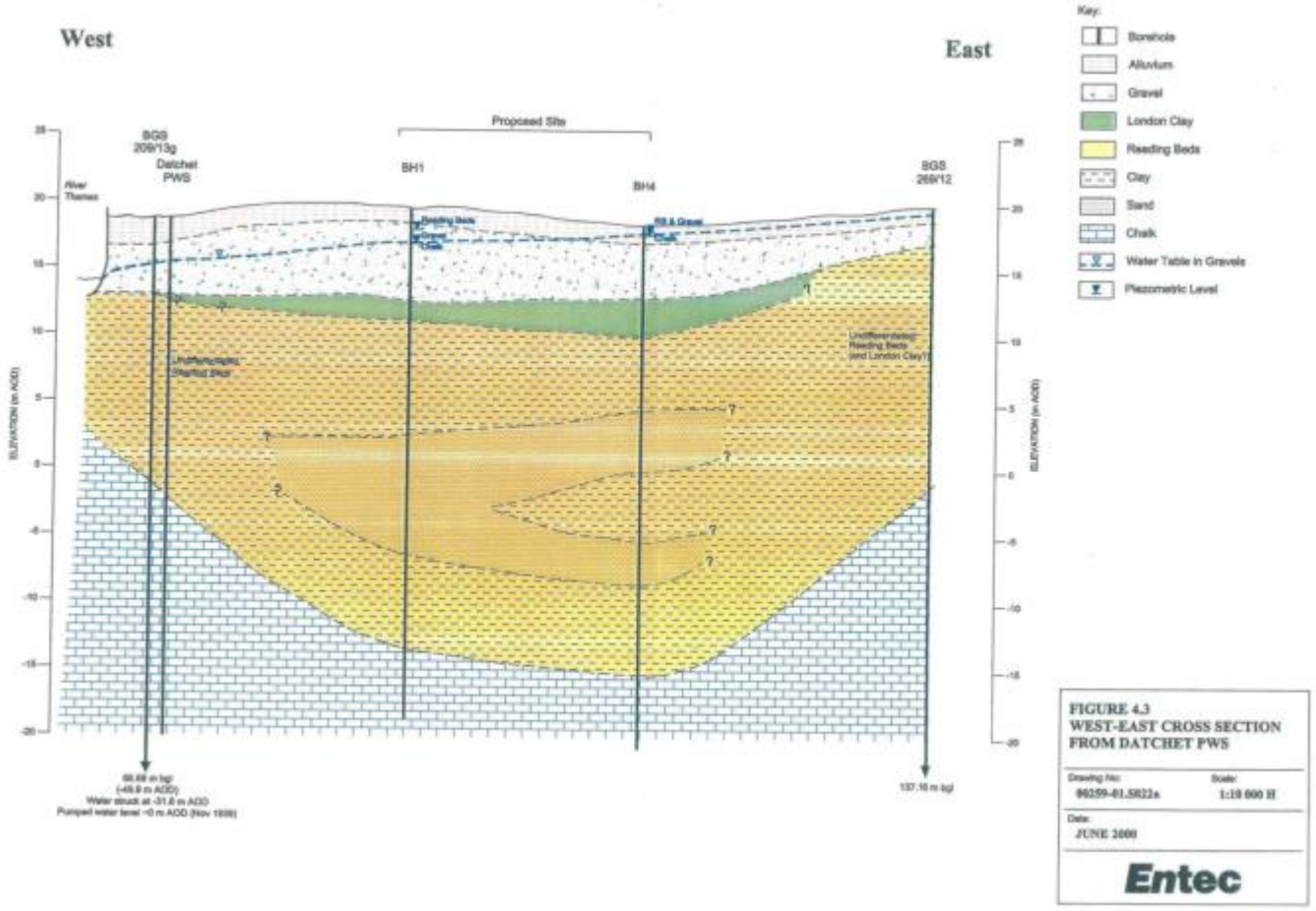


Table 4: Summary of local geology and hydrogeology (May 2000 - June 2016)

Borehole	BH1	BH2	BH3	BH4	BH5	BH1/95	BH11/95	BH25/95	BH35/95	BH37/95	BH46/95
Elevation of base of unit (mAOD)											
Ground level	19.54	19.14	18.48	18.36	19.85	18.59	18.78	18.56	18.67	19.01	18.84
Alluvium	18.34	18.34	17.28	17.36	18.95	18.09	18.28	17.66	17.77	18.01	17.64
Gravels	12.64	10.64	12.98	13.06	13.15	13.09	11.78	12.96	10.67	12.01	12.34
London Clay	11.04	7.84	3.18	10.16	8.45	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Reading Beds	-13.46	-16.86	-22.52	-15.24	-16.35	-	-	-	-	-	-
Chalk	n.d.[1]	-20.86	-25.52	-20.64	-19.45	-	-	-	-	-	-
Depth to base of unit (mAOD)											
Alluvium	1.2	0.8	1.2	1	0.9	0.5	0.5	0.9	0.9	1.0	1.2
Gravels	6.9	8.5	5.5	5.3	6.7	5.5	7.0	5.6	8.0	7.0	6.5
London Clay	8.5	11.3	15.3	8.2	11.4	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Reading Beds	33	36	41	33.6	36.2	-	-	-	-	-	-
Chalk	38	40	44	39	39.3	-	-	-	-	-	-
Thickness of each unit (mAOD)											
Alluvium	1.2	0.8	1.2	1	0.9	0.5	0.5	0.9	0.9	1.0	1.2
Gravels	5.7	7.7	4.3	4.3	5.8	5.0	6.5	4.7	7.1	6.0	5.3
London Clay	1.6	2.8	9.8	2.9	4.7	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Reading Beds	24.5	24.7	25.7	25.4	24.8	-	-	-	-	-	-
Chalk	5	4	3	5.4	3.1	-	-	-	-	-	-

River Terrace Gravels groundwater elevation (mAOD)											
Minimum	18.02	16.77	16.18	16.99	17.55	-	-	-	-	-	-
Average	19.27	18.41	17.74	18.15	19.58	2.5*	2.5*	2.0*	2.5*	2.5*	2.5*
Maximum	19.68	19.14	18.48	18.36	19.85	-	-	-	-	-	-
Chalk groundwater elevation (mAOD)											
Minimum	16.87	16.27	14.80	11.96	16.45	-	-	-	-	-	-
Average	19.15	18.01	16.66	16.63	17.31	-	-	-	-	-	-
Maximum	19.68	19.14	18.08	18.36	19.17	-	-	-	-	-	-

3.4 Hydrology

Drainage

3.4.1 The Site is underlain by superficial deposits associated with the nearby River Thames, and there are a number of drainage features in the vicinity associated with the river. Surface water features are highlighted on **Error! Reference source not found.**.

- The River Thames flows in a west to east direction, approximately 750 m to the south-west of the Site. The Jubilee River merges with the River Thames approximately 750 m to the west of the Site (both of these are to the south of the motorway;

- Datchet Common Brook lies immediately to the north of the Site, flowing in a north-to-south direction and ultimately into the River Thames, approximately 2.3 km to the south-east of the Site. The stream flows around the north-eastern corner of the Site (**Error! Reference source not found.**), but does not transect the Site. A smaller, unnamed tributary stream is noted to flow through the north-eastern corner of the Site for approximately 600 m;

- Ditton Park lies approximately 200 m east of the Site and has an associated moat;

- Immediately to the north-east of the Site, there is a fishing lake. This is not connected to the Ditton Park moat, but does have a connection to Datchet Common Brook at its western end;

- To the east of the Site, Datchet Common Brook flows east north-eastwards, immediately north of the M4 motorway. It then flows under the motorway and discharges into the River Thames, approximately 2.3 km to the south-east of the Site;

- The Queen Mother Reservoir is located approximately 400 m to the south east with Wraysbury reservoir approximately 3 km south east the other side of the motorway. The Reservoir is excavated into the London Clay and its sides are constructed from London Clay. Historical gravel pits are present between the Queen Mother reservoir and the Wraysbury reservoir to the south east which have been restored to open water, the closest being approximately 1 km from the Site; and

- The Grand Union Canal, orientated east to west, is located about 2 km to the north of the Site.

Surface Water Abstractions

3.4.2 Information regarding abstraction licences was obtained from the Environment Agency. There are four surface water abstractions, covered by three surface water abstraction licences, within 3 km of the Site. These are summarised in Table 5. Only the location of the non-water company licence is shown on **Error! Reference source not found.**, as the water company licences are not shown for security reasons.

Table 5: Licenced surface water abstractions within 3km

Licence	Distance from Site (m)	Holder	Source	Use	Max Daily Volume (m^3/d)
Non-water company abstraction licenses					
28/39/28/0301	2957	J Raynor & Sons Ltd.	Surface water	Spray Irrigation	1273
Water company abstraction licenses					
28/39/M/0002	1089	Thames Water	Surface water	Public water supply	2273000
28/39/27/0064	1718	Veolia Water	Surface water	Public water supply	227300

Private Water Supplies

3.4.3 The Site is located within the Royal Borough of Windsor & Maidenhead but is on the boundary with Slough Borough Council to the north. Each local authority was contacted to establish if there were any private water supplies within 2 km of the Site with the following responses. Locations are shown on **Error! Reference source not found.**.

- Slough Borough Council identifies only two private water supplies on their website which are located at a distance of 2.3 and 4 km from the Site; and

- Royal Borough of Windsor & Maidenhead reported that the closest private water supply to the Site within their borough is located about 2.2 km to the south, with a total of four private water supplies at a distance of between 2 km and 3 km from the Site.

Discharge consents

3.4.4 There are ten discharge consents located within a 1km radius of the Site and these are shown on **Error! Reference source not found.**. These are also summarised in Table 6 below. It is noted that consent number CNTW.0921 is located at the Site for soakaway to the Sand and Gravel in relation to quarrying activities. Four discharges are to the River Thames, whilst three are to Datchet Common Brook to the north of the Site.

Table 6: Discharge consents within 3 km of the Site

Licence no.	Easting	Northing	Distance from Site	Type	Receiving water
CNTW.0921	499050	177720	0	Domestic Property	Flood plain – gravel
TEMP.1385	498900	178400	24	Sewerage Network - Pumping Station -	Datchet Common Brook
TEMP.1050	498500	177602	282	Sewerage Network - Pumping Station -	River Thames
TEMP.1917	498500	177601	282	Sewerage Network - Pumping Station -	River Thames
TEMP.1737	498900	178800	394	Sewerage Network - Pumping Station -	Datchet Common Brook
TEMP.1555	497800	178600	617	Sewerage Network - Pumping Station -	Myrke Ditch
TEMP.0818	499300	178900	644	Sewerage Network - Pumping Station -	Datchet Common Brook
CNTM.1739	497640	178130	732	Water Treatment Works	Myrke Ditch
CATM.2901	497450	178110	921	Education	River Thames
TEMP.1511	499600	176400	999	Sewerage Network - Pumping Station - water company	River Thames

Flood Risk

3.4.5 The Site is situated within both a Flood Zone 3 and a Flood Zone 2 (Environment Agency, 2016). The areas prone to flooding lie around the perimeter of the Site, with the area in the centre not listed as being susceptible to flooding as it lies at a higher elevation.

3.4.6 Areas that lie within a Flood Zone 3 have a 1 in 100 or greater chance of flooding each year, whilst areas in a Flood Zone 2 have up to a 1 in 1,000 chance of flooding each year.

3.4.7 The Site is located approximately. 750m from the River Thames at its closest point.

Surface water quality

3.4.8 CEMEX monitor surface water quality data local to the site and surrounding area using three different locations. SW1 monitors the drainage ditch which runs along the northern site boundary, SW2 monitors the point where Datchet Common Brook meets the northern site boundary, whilst SW3 monitors the stream south-east of the sewage pumping station. All three surface water monitoring locations are along the northern boundary of the Site and are shown on **Error! Reference source not found.**. Time-series charts of surface water quality are presented in Appendix C.

3.4.9 Table 7 displays a statistical summary of surface water quality from the three monitoring locations (although SW3 was only monitored once, in December 2000) for the period from December 2000 to July 2016.

3.4.10 Surface water quality is generally good, with no major contaminants of concern identified. Major ions show concentrations within their respective Environmental Quality Standards (EQS) range, with no exceedances reported. For example, average chloride concentrations are just 31 mg/l, when compared to an EQS value of 250 mg/l.

3.4.11 Cadmium was the only metal noted to be frequently in excess of its relevant EQS limit, with 95.5 % of all samples (42/44) above the limit, although it is noted that only five results were detected above the limit of detection.

Figure 3.6: Surface water features within the vicinity of the Site

Figure 3.7: Discharge consents, surface water abstraction licences and private water supplies

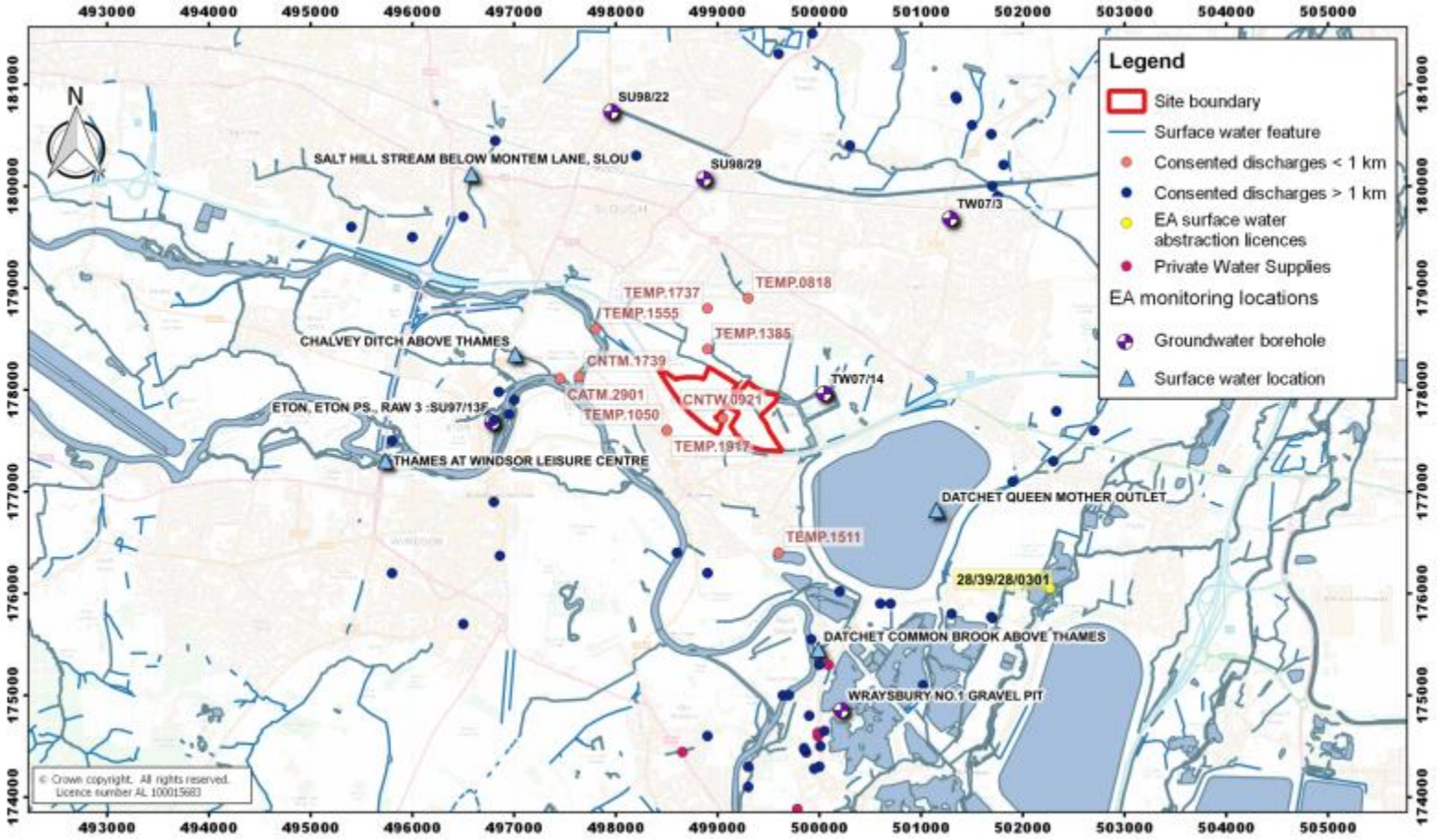


Table 7: Statistical summary of surface water quality (SW1, SW2 and SW3*, Dec 2000 – July 2016)

Determinand	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	EQS FW		
												No. Exceeding	% Exceeding	Action Level
Field / lab parameters														
Conductivity- Electrical (Field)	50	µS/cm	17	1034	700	715	217	393	976	50	100	0	0	-
Conductivity- Electrical 20deg	140	µS/cm	154	1130	768	779	141	580	957	140	100	0	0	-
D.O. concentration	133	mg/l	<0.5	12.5	4.29	3.7	2.24	1.4	8.64	130	97.7	0	0	-
Dissolved Oxygen Unfixed	3	mg/l	6.9	8.8	7.73	7.5	0.971	6.96	8.67	3	100	0	0	-
pH	140	pH	6.9	8.5	7.81	7.8	0.333	7.3	8.4	140	100	0	0	-
pH (Field)	64	pH	4.09	8.8	7.66	7.6	0.611	6.93	8.3	64	100	0	0	-
Major ions														
Alkalinity as CaCO3	140	mg/l	43.1	406	299	312	60.5	188	366	140	100	0	0	-
Calcium	140	mg/l	18	223	151	154	34.8	96.8	196	140	100	0	0	-
Chloride	140	mg/l	11	98	31	29.5	9.38	20.7	42.5	140	100	0	0	250
Magnesium	140	mg/l	2.06	23.1	15.4	16	4.07	8.86	22	140	100	0	0	-
Nitrate as N	140	mg/l	<0.7	21.8	1.3	0.8	2.16	n.d.	3.41	83	59.3	0	0	-
Potassium	140	mg/l	2.5	13	5.51	5.3	1.4	3.82	8.1	140	100	0	0	-
Sodium	140	mg/l	6.8	45	22.6	22	5.05	15	30.1	140	100	0	0	170
Sulphate as SO4	140	mg/l	<5	395	118	117	58.7	7.2	211	134	95.7	0	0	400
Metals														
Cadmium	44	µg/l	<0.6	1.1	n.d.	n.d.	n.d.	n.d.	1	5	11.4	42	95.5	0.25
Chromium	44	µg/l	<2	11	n.d.	n.d.	n.d.	n.d.	n.d.	2	4.55	2	4.55	5
Copper	44	µg/l	<9	30	6.56	n.d.	5.9	n.d.	13.4	12	27.3	2	4.55	28

Determinand	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	EQS FW		
												No. Exceeding	% Exceeding	Action Level
Iron	44	µg/l	<230	7510	307	n.d.	1128	n.d.	490	20	45.5	2	4.55	1000
Lead	44	µg/l	<6	10	4.27	n.d.	2.08	n.d.	9.85	8	18.2	4	9.09	7.2
Manganese	44	µg/l	<7	2920	314	140	536	49.3	1523	43	97.7	0	0	-
Nickel	44	µg/l	<3	39	5.38	4	6.83	n.d.	15.8	22	50	10	22.7	4
Zinc	44	µg/l	<18	80	19.4	19	14.8	n.d.	39.7	22	50	0	0	125
Nitrogen species														
Ammoniacal Nitrogen as N	140	mg/l	<0.06	1.58	0.166	0.12	0.208	n.d.	0.433	107	76.4	0	0	-
Nitrite as N	140	mg/l	<0.006	0.201	0.0261	0.0155	0.0308	n.d.	0.0771	112	80	0	0	-
Other parameters														
BOD + ATU (5 day)	140	mg/l	<1	22	2.93	2	3.85	n.d.	12.1	89	63.6	0	0	-
COD (Total)	140	mg/l	<20	92	34.3	33	14.4	n.d.	53.1	127	90.7	0	0	-

Note: if significant number of results exceed action limit row is coloured as follows: 10 - 25% pale red, 25 - 50% darker red, >50% dark red. n.d. statistic not determinable. Mean statistics for non-detects are calculated at half the limit of detection.

** SW3 only monitored in December 2000.*

3.5 Hydrogeology

Aquifer characteristics

3.5.1 The River Terrace Gravels of the River Thames form the aquifer within the superficial deposits and represents the resource worked at the quarry. The gravels are underlain by the London Clay Formation, which acts as the base of the aquifer. Groundwater levels within the sand and gravels typically vary from being very shallow in BH1B P1 in the far west of the Site to around 2 mbgl in BH7 in the north of the Site. The records of extensive borehole drilling at the Site in 1995 show that the thickness of the aquifer will be between 3.3 m and 9.7 m prior to quarrying taking place, with the aquifer being thinnest in borehole 29/95 in the north of the Site and thickest in borehole 34/95 in the south of the Site.

3.5.2 Entec (2001) report the hydraulic conductivity of the gravels to be between 2.5 to 25 m/d. This estimate was calculated from the particle size distribution of the gravels (PSD) which are characterised as poorly graded, sandy gravel.

3.5.3 However additional sources present hydraulic conductivity values for the gravels which significantly from those presented by Entec:

- Kingsmead groundwater flow model (ESI, 2014b) used pumping test data which indicates a hydraulic conductivity of between 200 - 300 m/d with an average of 250 m/d used;
- Analysed site samples taken from another nearby Sand and Gravel Quarry show a hydraulic conductivity ranging from between 62 to 324 m/d with 150 m/d used as an average value; and
- Younger (1990) provides a table of hydraulic conductivities taken from additional sources. The table is presented in Table 8:

Table 8: Hydraulic conductivities taken from Younger (1990)

Author	Range	Mean	Unit
Naylor (1974)	14 - 2000		m/d
Morgan – Jones et al (1984)	21 - 7200		m/d
Ridings et al (1977)	1500		m/d

3.5.4 Entec (2001) reported on some triaxial permeability testing carried out on the Lower Reading Beds with hydraulic conductivity results from clay samples ranging from 8.64 x 10^{-7} m/d to 3.27x10^{-4} m/d.

3.5.5 The London Clay is known to have a low permeability and hydraulic conductivities are expected to be in the range of 8.64 x 10^{-5} to 8.64 x 10^{-7} m/d (Entec, 2001).

Aquifer vulnerability

3.5.6 The River Terrace Deposits are classified as a Principal Aquifer of intermediate vulnerability (see **Error! Reference source not found.**). This means that the superficial deposits have high intergranular permeability and are capable of providing a high level of water storage. They may support water supply and / or river base flow on a strategic scale.

Groundwater abstractions

3.5.7 The Site lies predominantly within a (Zone 3) Source Protection Zone (SPZ), as shown on **Error! Reference source not found.**, although the westernmost extent of the Site is situated within an 'Outer Zone' (Zone 2) SPZ. This relates to an abstraction borehole which is located at Datchet Pumping Station (28/39/27/0003) around 400 m to the west of the Site.

3.5.8 It is noted that groundwater is being abstracted from the Chalk, which is protected by the overlying London Clay and Reading Formation. The Site is an excavation only into the superficial deposits, with a considerable thickness of the London Clay and Reading Formation beneath before the Chalk is encountered.

Groundwater levels and flow

3.5.9 During the 2000 site investigation, a total of seven boreholes were installed in the Sand and Gravels (BH1A to BH7A), five boreholes were installed in the Reading Formation (BH1B P1 to BH5B P1) and five boreholes were installed in the Chalk (BH1B P2 to BH5B P2). A summary of the units monitored and the respective groundwater levels is given in Table 9.

3.5.10 The data shows that the saturated thickness of the Sand and Gravel aquifer is typically between three and six metres, with the greatest saturated thickness being in BH2A. Groundwater levels within the Sand and Gravel of the Shepperton Formation (**Error! Reference source not found.**) are highest in BH7A in the north of the Site and lowest in BH2A in the south of the Site, indicating that groundwater flow is to the south to south-west towards the River Thames. **Error! Reference source not found.** shows indicative groundwater flow contours within each geological strata beneath the Site.

3.5.11 Within the Reading Formation (**Error! Reference source not found.**), groundwater levels are typically higher than those in the overlying Sand and Gravel aquifer, indicating an upwards hydraulic gradient. The highest groundwater levels within this stratum are typically within BH5B, which is located in the centre of the Site. However, there is no clear groundwater flow direction discernible from the available data.

3.5.12 Within the Chalk (**Error! Reference source not found.**), groundwater levels are occasionally higher than those in the Sand and Gravel aquifer, with an upwards hydraulic gradient most evident in BH1, where groundwater levels in the Chalk are around 18 mAOD, compared to between 16 and 17 mAOD in the Shepperton Gravels. An upwards hydraulic gradient is also evident in BH2, but not in any of the other locations, as shown by the data summary in Table 10.

3.5.13 Average groundwater levels in the Chalk range from 16.63 mAOD in BH4B P2 in the north of the Site to 19.15 mAOD in BH1B P2 in the far west of the Site, indicating that groundwater flow is generally in an easterly direction. This is consistent with groundwater flow directions reported in Environment Agency (2013b).

3.5.14 The Chalk groundwater level in BH4BP2 shows a drop in level from March to November 2015.This pattern is not shown by any of the other Chalk monitoring wells. Since February 2016 the level has suddenly returned to higher, more normal, levels. It is not clear as to the reason for this behaviour.

3.5.15 Irregularities in the groundwater flow dataset may arise due to the presence of the Queen Mother reservoir to the south-east of the Site. It is understood that the reservoir has a clay-cored bund around the perimeter that extends through the gravels to the London Clay and thus diverts a significant amount of groundwater flow from the north around the reservoir.

Table 9: Summary of groundwater elevation data

Location	Unit	Ground level (mAOD)	No. of data points	Groundwater level (mAOD)		
				Min	Mean	Max
BH1A	Sand & Gravel	19.53	180	14.11	16.68	18.79
BH1B P1	Reading Beds	19.54	133	18.02	19.27	19.68
BH1B P2	Chalk	19.54	133	16.87	19.15	19.68

BH2A	Sand & Gravel	19.11	179	15.93	16.55	18.20
BH2B P1	Reading Beds	19.14	141	16.77	18.41	19.14
BH2B P2	Chalk	19.14	140	16.27	18.01	19.14
BH3A	Sand & Gravel	18.39	176	15.12	16.74	17.98
BH3B P1	Reading Beds	18.48	141	16.18	17.74	18.48
BH3B P2	Chalk	18.48	141	14.80	16.66	18.08
BH4A	Sand & Gravel	18.42	171	15.93	17.59	18.42
BH4B P1	Reading Beds	18.36	123	16.99	18.15	18.36
BH4B P2	Chalk	18.36	123	11.96	16.63	18.36
BH5A	Sand & Gravel	19.86	177	16.41	17.08	18.75
BH5B P1	Reading Beds	19.85	117	17.55	19.58	19.85
BH5B P2	Chalk	19.85	4	16.05	17.69	19.73
BH6	Sand & Gravel	18.62	179	16.45	17.31	19.17
BH7	Sand & Gravel	18.85	180	17.05	17.69	18.59

Table 10: Vertical hydraulic gradient calculations

Location	Difference between average Chalk and Sand & Gravel groundwater levels	Difference between average Reading Formation and Sand & Gravel groundwater levels	Difference between average Chalk and Reading Formation groundwater levels
BH1	2.47	2.60	-0.13
BH2	1.47	1.87	-0.40
BH3	-0.09	1.00	-1.09
BH4	-0.96	0.56	-1.52
BH5	~~0.61*~~	2.51	~~-1.89*~~

3.5.16 Tables 11, 12 and 13 present a statistical summary of groundwater quality over the past seventeen years in the Shepperton Sand and Gravels, the Reading Formation and the Chalk respectively. Only data for determinands where there was at least one positive detection have been included.

3.5.17 Time-series charts of groundwater chemistry for Ammoniacal Nitrogen, Calcium, Chloride and Sulphate are presented in Appendix D.

3.5.18 For comparative purposes only, the data have been compared to the UK Drinking Water Standards (DWS) to give an indication of whether the groundwater is of a good quality or not.

3.5.19 Groundwater ammoniacal nitrogen concentrations are notably elevated surrounding the Site, with an average concentration in the boreholes in the Sand and Gravel for the past seventeen years of 3.04 mg/l, compared to the DWS of 0.39 mg/l. This means that 745 of the 1,271 samples in the superficial deposits are above the DWS, representing 58.6 % of these samples. Ammoniacal nitrogen concentrations are also elevated in the Reading Formation, albeit at a lower average concentration of 0.44 mg/l. Even so, 60.7% of samples were above the DWS. In the Chalk, ammoniacal nitrogen concentrations are lower still, with an average concentration of 0.31 mg/l and 37.2 % of samples above the DWS. It is notable that the 95th percentile ammoniacal nitrogen concentration in the Sand and Gravel is 10.1 mg/l, compared to a concentration of 0.7 and 0.6 mg/l for the Reading and Chalk Formations respectively. This suggests that water quality, with respect to ammoniacal nitrogen, is significantly poorer in the Sand and Gravel compared to the Reading and Chalk formations.

3.5.20 Time-series chemistry charts are presented in Appendix D, which show that ammoniacal nitrogen concentrations are particularly elevated in BH1A, BH7 and BH6, which are screened in the Shepperton Sand and Gravel.

3.5.21 It is noted that the Site lies down-gradient of a number of historical landfills which may be having an impact on the prevailing groundwater quality at the Site. In particular, BH1A, BH6 and BH7 are all situated along the north-western boundary of the Site, adjacent to Upton Court Farm Landfill (Environment Agency, 2016). Similarly, nitrite concentrations have also been detected at elevated concentrations and dissolved oxygen concentrations are relatively low, which imply that there are reducing conditions dominating in this part of the aquifer.

3.5.22 The only other determinands to show a notable number of exceedances of the DWS were calcium, sulphate and iron. These were predominantly in the Sand and Gravel, as there were no exceedances for calcium or sulphate in the Reading Formation or Upper Chalk, and few exceedances for iron.

3.5.23 As with ammoniacal nitrogen, the highest calcium concentrations are found in boreholes BH1A, BH6 and BH7, within the Sand and Gravel, along the north-western site boundary, adjacent to the historical landfill (Appendix D). In BH1A concentrations reached a high of 465 mg/l in 2009, which is over double the DWS, and concentrations have typically always exceeded the DWS in both BH1A and BH7.

3.5.24 Groundwater sulphate concentrations are again elevated in the Sand and Gravel, in the same three boreholes, BH1A, BH6 and BH7, with the majority of samples in these locations being above the 250 mg/l DWS. The maximum concentrations are this time found in BH7, with a high of 667 mg/l in 2001. There has been no notable decline in concentrations since monitoring commenced.

3.5.25 In terms of metals, there have been no exceedances of the DWS for arsenic, cadmium, chromium, copper or zinc in any strata since monitoring began. Manganese was found to be in excess of the DWS in 79.6 % of samples in the Sand and Gravel, although it is acknowledged that manganese is often found to be elevated in background groundwater concentrations throughout the UK, especially in superficial strata. Iron was above the DWS in 36% of samples obtained from the superficial strata, with the majority of exceedances in BH7. Exceedances decreased to 14.3 % of samples in the Reading Formation, and just 6.6 % of samples in the Chalk.

Figure 3.8: Groundwater vulnerability

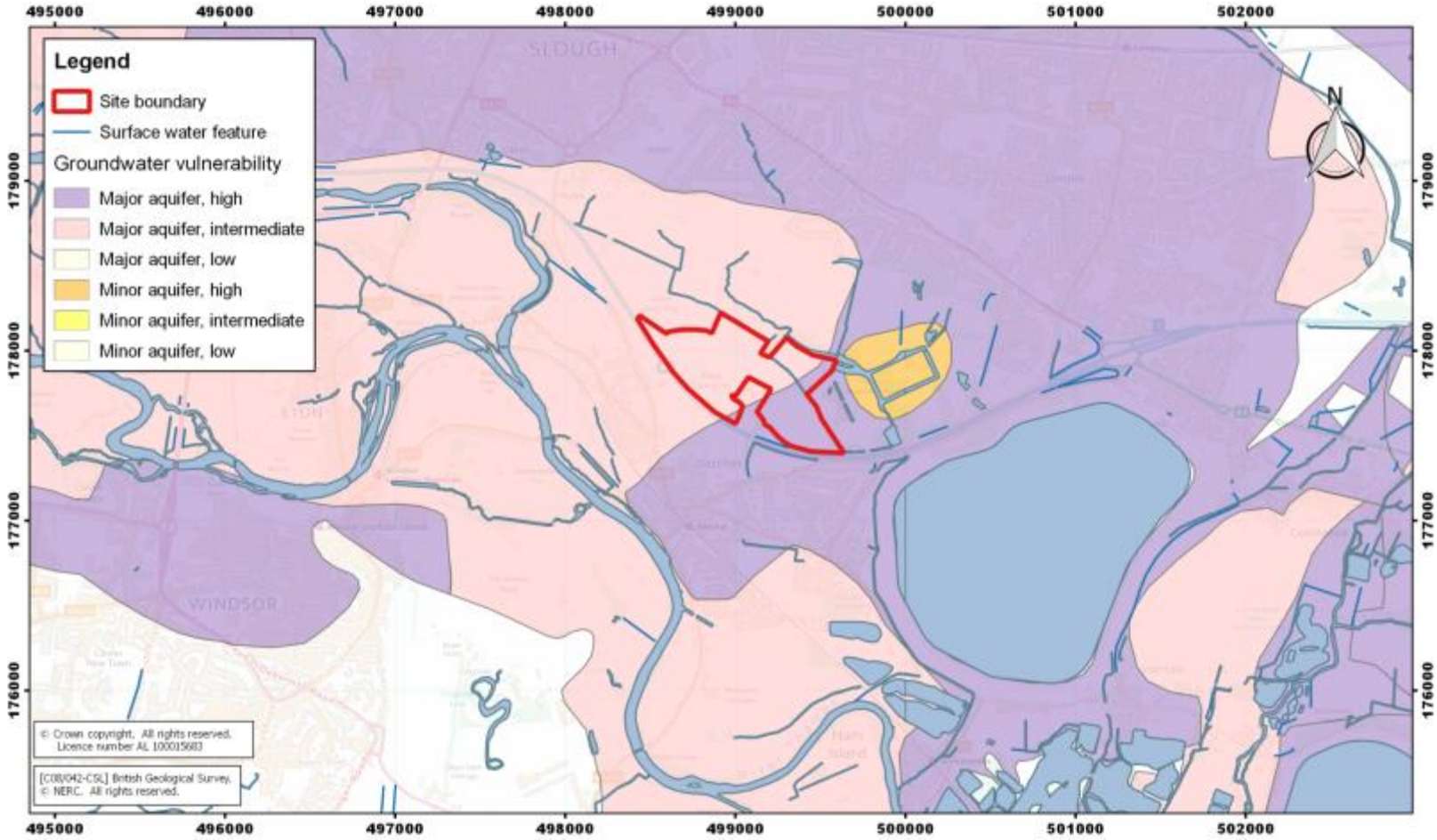


Figure 3.9: Groundwater source protection zones

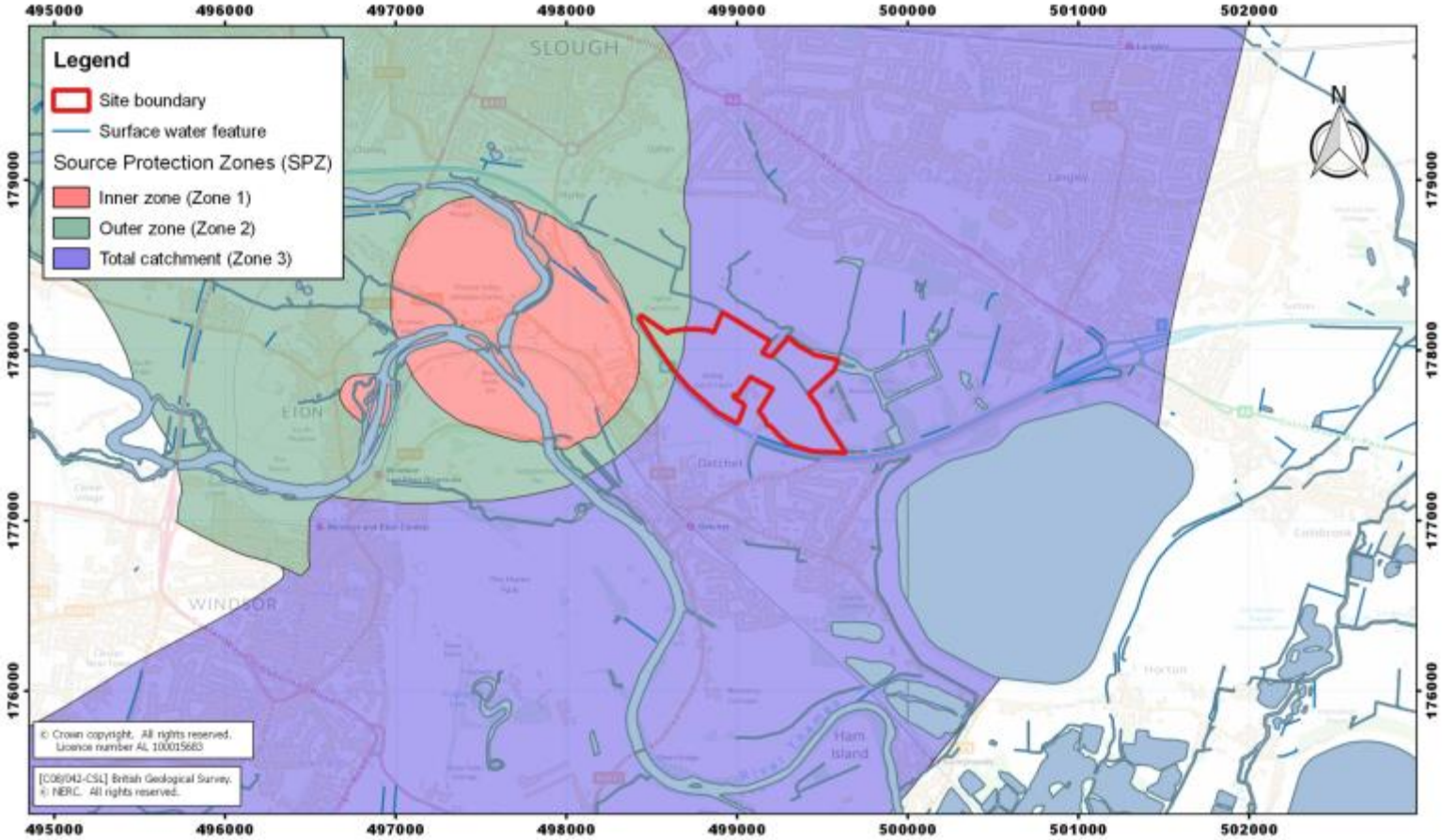


Figure 3.10: Historical sand and gravel groundwater elevation

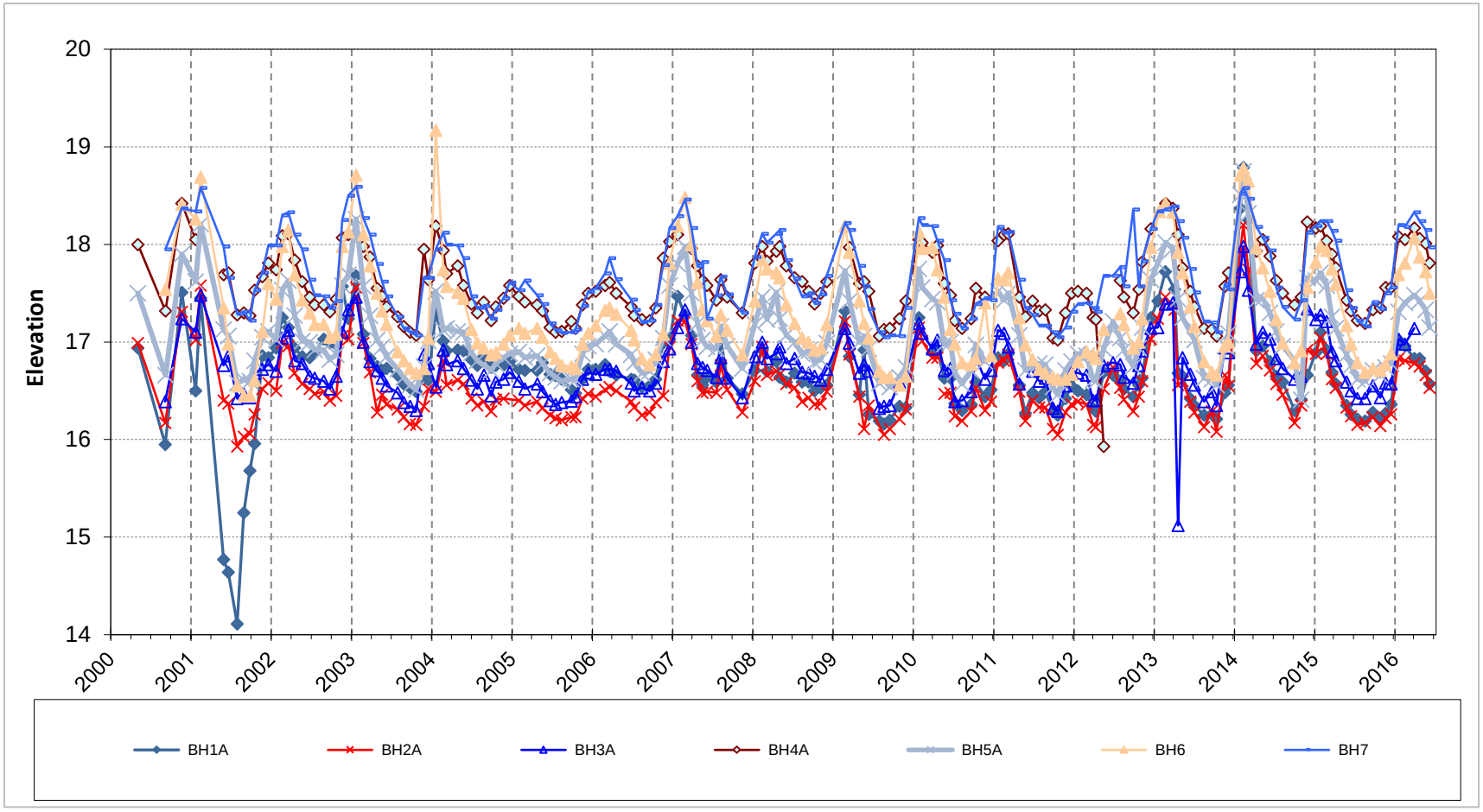


Figure 3.11: Historical groundwater elevation within the Reading Formation

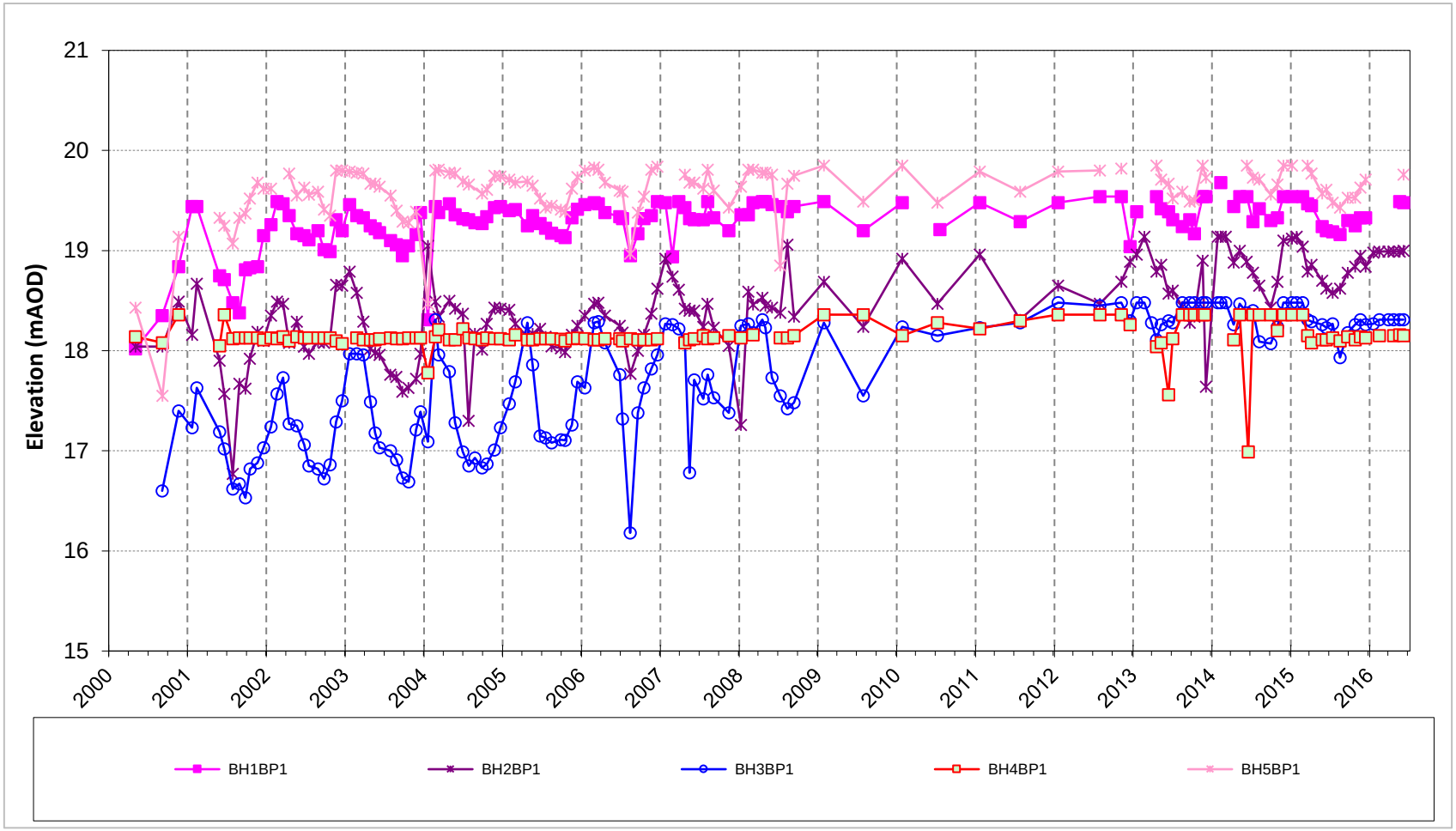


Figure 3.12: Historical groundwater elevation within the Chalk

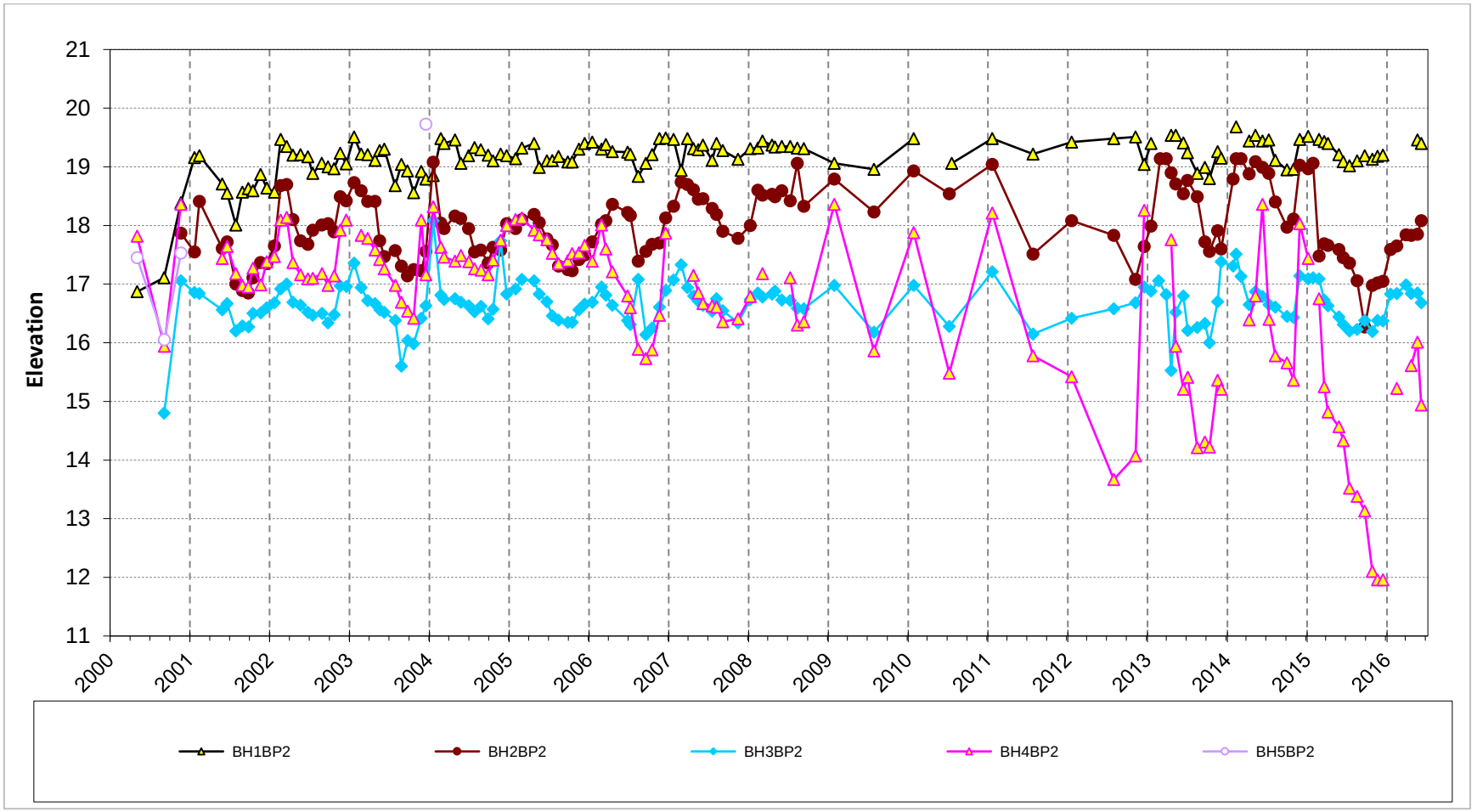


Table 11: Statistical summary of detected parameters in groundwater (2000 – 2016) in Sand and Gravel

Determinand	No. of Results	Unit	Min	Max	Mean	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS		
											No. Exceeding	% Exceeding	Action Level
Field / lab parameters													
Conductivity- Electrical (Field)	344	µS/cm	12.2	2064	851	391	411	1597	344	100	0	0	-
Conductivity- Electrical 20deg	1272	µS/cm	243	7030	952	469	478	1620	1272	100	0	0	-
D.O. concentration	1234	mg/l	<0.5	14.2	1.32	1.3	n.d.	3.5	843	68.3	0	0	-
Dissolved Oxygen Field (mg/l)	12	mg/l	0	6.8	3.29	1.95	0.825	6.75	12	100	0	0	-
Dissolved Oxygen Unfixed	18	mg/l	4	8.52	6.53	1.38	4.09	8.38	18	100	0	0	-
pH	1272	pH	6.4	8.8	7.52	0.394	7	8.3	1272	100	0	0	-
pH (Field)	626	pH	4.1	9.7	7.56	0.742	6.59	8.63	626	100	0	0	-
Major ions													
Alkalinity as CaCO3	1272	mg/l	87.3	7610	338	228	206	535	1272	100	0	0	-
Calcium	1272	mg/l	<0.09	468	176	105	20	354	1271	99.9	339	26.7	250
Chloride	1272	mg/l	10	175	32.6	13.6	19	52.9	1272	100	0	0	250

Determinand	No. of Results	Unit	Min	Max	Mean	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS		
											No. Exceeding	% Exceeding	Action Level
Magnesium	1272	mg/l	<0.09	75	19.6	13.4	6.2	45	1271	99.9	25	1.97	50
Nitrate as N	1272	mg/l	<0.42	34.1	2.25	4.18	n.d.	11.2	721	56.7	66	5.19	11
Nitrogen (total oxidised) as N	123	mg/l	<0.42	14	1.44	2.76	n.d.	8.76	58	47.2	0	0	-
Potassium	1272	mg/l	<0.11	27	7.81	3.79	2.6	15.4	1270	99.8	0	0	-
Sodium	1272	mg/l	0.23	139	41.8	21.2	21.2	85.4	1272	100	0	0	200
Sulphate as SO4	1266	mg/l	<0.2	750	210	190	19	558	1264	99.8	482	38.1	250
Metals													
Arsenic	25	mg/l	<0.001	0.003	0.00078	0.000737	n.d.	0.0028	4	16	0	0	0.01
Cadmium	445	mg/l	<0.0006	0.0033	n.d.	n.d.	n.d.	0.001	47	10.6	0	0	0.005
Chromium	445	mg/l	<0.002	0.033	n.d.	n.d.	n.d.	0.0038	32	7.19	0	0	0.05
Copper	445	mg/l	<0.009	0.114	0.00643	0.00829	n.d.	0.014	124	27.9	0	0	2
Iron	445	mg/l	<0.23	121	2.29	8.19	n.d.	12.4	205	46.1	160	36	0.2
Lead	445	mg/l	<0.006	0.053	0.00494	0.00513	n.d.	0.015	72	16.2	6	1.35	0.025
Manganese	445	mg/l	<0.003	1.67	0.319	0.311	0.0192	0.94	427	96	354	79.6	0.05
Mercury	28	mg/l	<1E-05	0.0044	0.000308	0.000845	n.d.	0.00103	10	35.7	2	7.14	0.001
Nickel	438	mg/l	<0.003	0.14	0.00487	0.00817	n.d.	0.0132	170	38.8	6	1.37	0.02

Determinand	No. of Results	Unit	Min	Max	Mean	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS		
											No. Exceeding	% Exceeding	Action Level
Zinc	445	mg/l	<0.018	0.345	0.0135	0.0216	n.d.	0.0324	170	38.2	0	0	5
Nitrogen species													
Ammoniacal Nitrogen as N	1271	mg/l	<0.008	24.9	3.04	3.85	n.d.	10.1	1083	85.2	745	58.6	0.39
Nitrite as N	1271	mg/l	<0.006	5.8	0.0312	0.179	n.d.	0.106	684	53.8	231	18.2	0.03
Other parameters													
BOD + ATU (5 day)	1	mg/l	<1	<1	n.d.	n.d.	n.d.	n.d.	0	0	0	0	-
COD (Total)	1261	mg/l	<11	454	16.2	17.4	n.d.	35	571	45.3	0	0	-
Solids, Suspended	11	mg/l	142	22700	7945	7403	143	19500	11	100	0	0	-
TOC (filtered)	1272	mg/l	<0.7	61.5	5.12	3.58	1.2	9.25	1254	98.6	0	0	-

Table 12: Statistical summary of detected parameters in groundwater (2000 – 2016) in the Reading Formation

Determinand	No. of Results	Unit	Min	Max	Mean	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS		
											No. Exceeding	% Exceeding	Action Level
Field / lab parameter													
Conductivity- Electrical (Field)	34	µS/cm	326	835	550	115	386	731	34	100	0	0	-
Conductivity- Electrical 20deg	366	µS/cm	345	4697	566	241	446	677	366	100	0	0	-
D.O. concentration	351	mg/l	<0.5	11.5	1.81	1.52	n.d.	4.35	317	90.3	0	0	-
Dissolved Oxygen Field (mg/l)	9	mg/l	1.5	7	3.86	1.96	1.7	6.6	9	100	0	0	-
Dissolved Oxygen Unfixed	1	mg/l	6.9	6.9	6.9	-	6.9	6.9	1	100	0	0	-
pH	366	pH	6.9	8.8	8.08	0.327	7.5	8.6	366	100	0	0	-
pH (Field)	75	pH	0.44	9	7.59	1.96	1.65	8.89	75	100	0	0	-
Major ions													
Alkalinity as CaCO3	366	mg/l	136	462	215	31.3	175	243	366	100	0	0	-
Calcium	366	mg/l	4	181	35.4	34.1	12	105	366	100	0	0	250
Chloride	366	mg/l	15	56	29.1	11.1	17	48.3	366	100	0	0	250
Magnesium	366	mg/l	3	18	8.4	3.41	4.8	15	366	100	0	0	50
Nitrate as N	366	mg/l	<0.42	13.3	0.56	1.21	n.d.	1.1	163	44.5	3	0.82	11
Nitrogen (total oxidised) as N	15	mg/l	<0.42	0.94	0.403	0.246	n.d.	0.758	7	46.7	0	0	-

Determinand	No. of Results	Unit	Min	Max	Mean	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS		
											No. Exceeding	% Exceeding	Action Level
Potassium	366	mg/l	2.81	12	7.41	1.39	5	10	366	100	0	0	-
Sodium	366	mg/l	11	161	85.3	42.7	13	145	366	100	0	0	200
Sulphate as SO4	362	mg/l	<5	127	50.7	33.8	11.1	109	359	99.2	0	0	250
Metals													
Arsenic	14	mg/l	<0.001	0.003	n.d.	n.d.	n.d.	0.00235	2	14.3	0	0	0.01
Cadmium	91	mg/l	<0.0005	0.0007	n.d.	n.d.	n.d.	n.d.	2	2.2	0	0	0.005
Chromium	91	mg/l	<0.005	0.016	n.d.	n.d.	n.d.	n.d.	2	2.2	0	0	0.05
Copper	91	mg/l	<0.005	0.03	n.d.	n.d.	n.d.	0.013	11	12.1	0	0	2
Iron	91	mg/l	<0.05	3.59	0.185	0.543	n.d.	0.715	31	34.1	13	14.3	0.2
Lead	91	mg/l	<0.005	0.041	0.00745	0.00658	n.d.	0.02	16	17.6	2	2.2	0.025
Manganese	91	mg/l	<0.02	0.27	0.0604	0.0647	n.d.	0.18	64	70.3	26	28.6	0.05
Mercury	15	mg/l	<1E-05	0.001	n.d.	n.d.	n.d.	0.00037	2	13.3	0	0	0.001
Nickel	91	mg/l	<0.005	0.24	n.d.	n.d.	n.d.	0.02	12	13.2	3	3.3	0.02
Zinc	91	mg/l	<0.005	0.18	0.0215	0.0282	n.d.	0.048	29	31.9	0	0	5
Nitrogen species													
Ammoniacal Nitrogen as N	366	mg/l	<0.04	10	0.439	0.552	0.0625	0.7	351	95.9	222	60.7	0.39
Nitrite as N	366	mg/l	<0.003	0.44	0.0238	0.0578	n.d.	0.102	218	59.6	62	16.9	0.03

Determinand	No. of Results	Unit	Min	Max	Mean	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS		
											No. Exceeding	% Exceeding	Action Level
Other parameters													
BOD + ATU (5 day)	1	mg/l	<1	<1	n.d.	n.d.	n.d.	n.d.	0	0	0	0	-
COD (Total)	357	mg/l	<11	132	12.3	13.4	n.d.	33	58	16.2	0	0	-
Solids, Suspended	9	mg/l	176	84300	12143	27721	259	58180	9	100	0	0	-
TOC (filtered)	366	mg/l	<0.7	52	2.45	4.17	0.7	4.15	355	97	0	0	-

Table 13: Statistical summary of detected parameters in groundwater (2000 – 2016) in the Chalk

Determinand	No. of Results	Unit	Min	Max	Mean	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS		
											No. Exceeding	% Exceeding	Action Level
Field / lab parameters													
Conductivity- Electrical (Field)	31	µS/cm	327	1160	591	177	385	917	31	100	0	0	-
Conductivity- Electrical 20deg	301	µS/cm	240	1501	567	123	432	742	301	100	0	0	-
D.O. concentration	290	mg/l	<0.5	12.9	2.48	1.91	0.6	6.71	277	95.5	0	0	-
Dissolved Oxygen Field (mg/l)	9	mg/l	0.4	7.6	4.18	2.36	0.92	7.44	9	100	0	0	-
pH	301	pH	6.8	8.7	7.95	0.362	7.3	8.5	301	100	0	0	-
pH (Field)	61	pH	0.2	9	7.76	1.53	6.6	8.85	61	100	0	0	-
Major ions													
Alkalinity as CaCO3	301	mg/l	81.5	422	218	44.2	165	312	301	100	0	0	-
Calcium	301	mg/l	6	210	51.3	43.6	13	150	301	100	0	0	250
Chloride	301	mg/l	13	78	29.4	12.3	17	50	301	100	0	0	250
Magnesium	301	mg/l	3.9	23	8.93	3.36	4.8	14	301	100	0	0	50
Nitrate as N	301	mg/l	<0.3	7.2	0.498	0.592	n.d.	1.2	136	45.2	0	0	11

Determinand	No. of Results	Unit	Min	Max	Mean	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS		
											No. Exceeding	% Exceeding	Action Level
Nitrogen (total oxidised) as N	12	mg/l	<0.42	1.3	0.583	0.343	n.d.	1.14	8	66.7	0	0	-
Potassium	301	mg/l	2	13	6.71	1.96	3.1	10	301	100	0	0	-
Sodium	301	mg/l	8	171	73.1	45.7	12	141	301	100	0	0	200
Sulphate as SO4	297	mg/l	<5	247	52.8	29.9	16	95.3	294	99	0	0	250
Metals													
Arsenic	13	mg/l	<0.001	0.002	n.d.	n.d.	n.d.	0.0011	1	7.69	0	0	0.01
Cadmium	76	mg/l	<0.0005	0.001	n.d.	n.d.	n.d.	n.d.	3	3.95	0	0	0.005
Chromium	76	mg/l	<0.005	0.029	n.d.	n.d.	n.d.	n.d.	2	2.63	0	0	0.05
Copper	76	mg/l	<0.005	0.086	n.d.	n.d.	n.d.	0.03	7	9.21	0	0	2
Iron	76	mg/l	<0.05	0.506	0.0682	0.0964	n.d.	0.23	24	31.6	5	6.58	0.2
Lead	76	mg/l	<0.005	0.04	n.d.	n.d.	n.d.	0.02	8	10.5	2	2.63	0.025
Manganese	76	mg/l	<0.04	0.39	0.07	0.0759	n.d.	0.173	58	76.3	30	39.5	0.05
Mercury	12	mg/l	<1E-05	<1E-05	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.001
Nickel	76	mg/l	<0.005	0.027	n.d.	n.d.	n.d.	0.02	9	11.8	2	2.63	0.02
Zinc	76	mg/l	<0.005	0.06	0.0167	0.00944	n.d.	0.0272	22	28.9	0	0	5
Nitrogen species													

Determinand	No. of Results	Unit	Min	Max	Mean	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS		
											No. Exceeding	% Exceeding	Action Level
Ammoniacal Nitrogen as N	301	mg/l	<0.04	3.53	0.31	0.314	n.d.	0.62	268	89	112	37.2	0.39
Nitrite as N	301	mg/l	<0.006	0.543	0.0209	0.0464	n.d.	0.099	208	69.1	52	17.3	0.03
Other parameters													
COD (Total)	292	mg/l	<11	242	13.6	19.2	n.d.	37	56	19.2	0	0	-
Solids, Suspended	9	mg/l	396	76700	9836	25105	410	47508	9	100	0	0	-
TOC (filtered)	301	mg/l	<0.7	52	2.96	4.28	0.7	6.3	294	97.7	0	0	-

3.6 Off Site Landfill Gas Monitoring

3.6.1 A Landfill Gas Risk Assessment (GRA) has not been prepared for Datchet Quarry, as the Landfill Technical Guidance Note LFTGN03 indicates that new inert landfills do not pose a landfill gas hazard. Nevertheless, a Landfill Gas Risk Assessment Screening Exercise has been undertaken to assess the potential risks associated with Landfill Gas migration from the site and is provided within this Environmental Permit application.

3.6.2 The Landfill Gas Screening Report and the Environmental Management and Monitoring Plan details the perimeter gas monitoring requirements at the site.

3.7 Receptor and Compliance Points

Groundwater

3.7.1 The nature of the waste proposed to be accepted at the Site will ensure that no discernible concentrations of hazardous substances will enter groundwater.

3.7.2 Given that groundwater flow, as described in Section 0, is to the south / south-west towards the River Thames within the Sand and Gravel at the Site, the groundwater receptor is taken to be groundwater at the site installation boundary

Surface Water

3.7.3 The nearest surface water feature is the Datchet Common Brook, which runs in a west – east direction to the north of the application site and then flows into the site on the northern boundary, where it then flows south eastwards across the north east part of the site.

3.7.4 Surface water monitoring will be undertaken in accordance with the proposals in the HRA.

Landfill Gas Risk Assessment

3.7.5 A Landfill Gas Risk Assessment (GRA) has not been prepared for the silt lagoon at Colne Fen Quarry, as the Landfill Technical Guidance Note LFTGN03 indicates that new inert landfills do not pose a landfill gas hazard. However, a screening report has been carried out in accordance with the requirements of LFTGN03.

3.7.6 This Landfill Gas Screening Report indicates that there is unlikely to be a significant risk posed by the development.

Environmental Risk Assessment

3.7.7 The receptors identified in Table 2 of the Environmental Risk Assessment, have been considered in the Environmental Risk Assessment.

4.0 Site Condition Report

4.0.1 Environmental Permitting Regulations – Site Condition Report (H5) states that as Site Condition Report (SCR) is '*not applicable to those parts of a permitted landfill that have permanent deposits of wastes'.* However, in accordance with the EA's Regulatory Guidance Note RGN 9 – Surrender, a SCR is required for areas within a permitted facility that will not be used for the permanent deposit of waste.

4.0.2 As such, a SCR has been prepared in relation to these areas of the site using the EA's H5 SCR template. A copy of the SCR is provided as Appendix K of the main application.

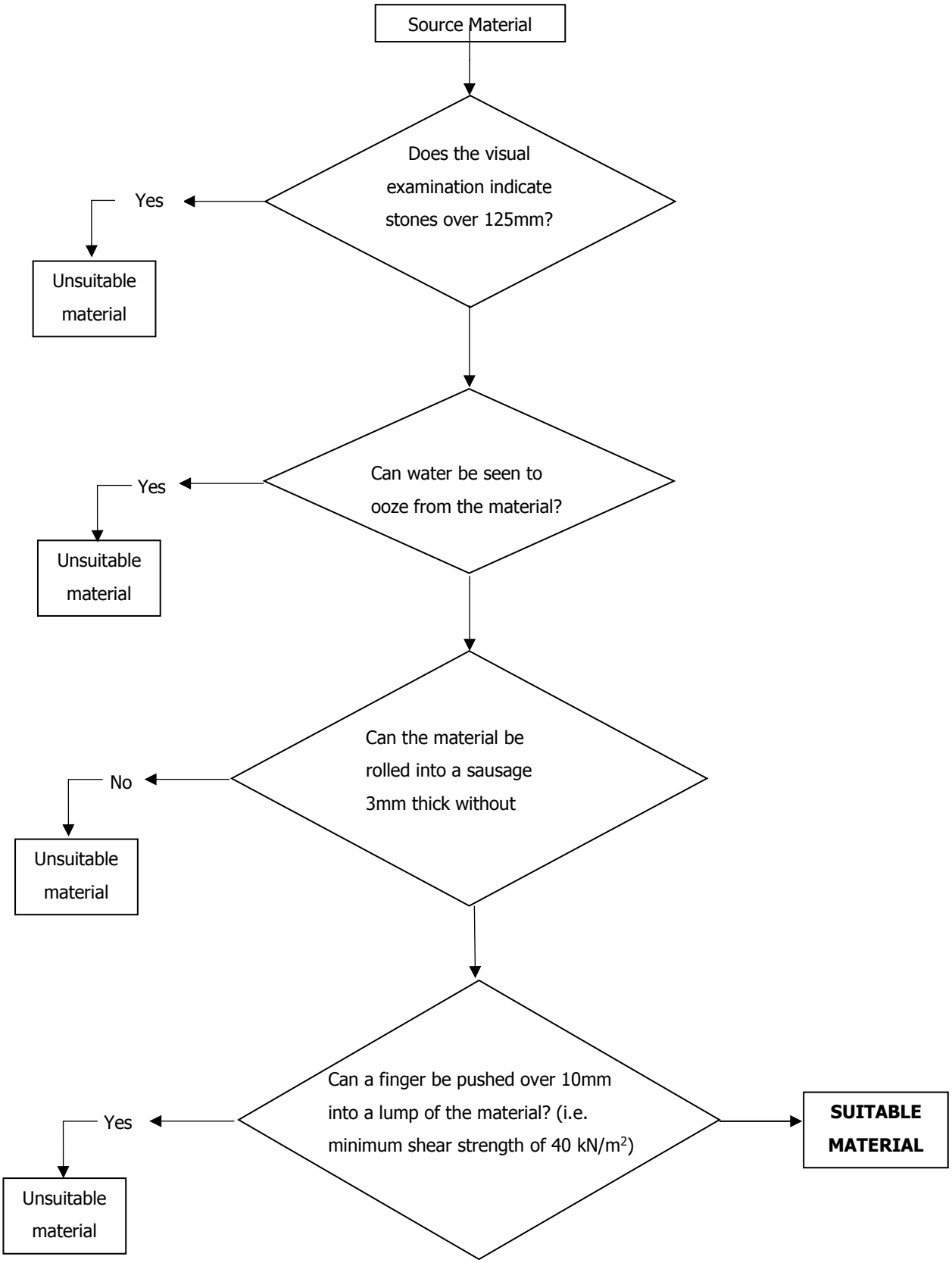
Drawings

A097237/LOC/01– Location Plan

P1/869/8A – Final Restoration Plan

P1/689/5 – General Method of Working

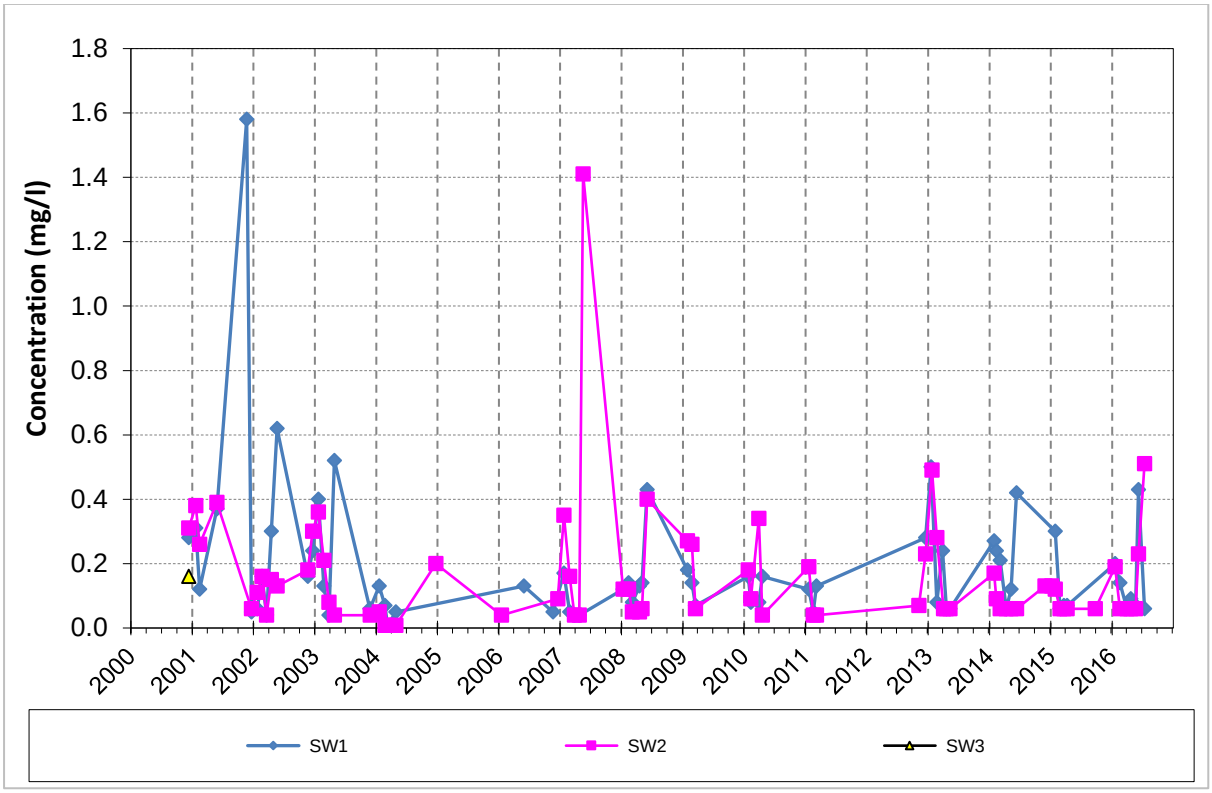
Appendix A – Flowchart for the selection of suitable material for the construction of a geological barrier


Source Material
Does the visual examination indicate stones over 125mm?
Yes
Unsuitable material
Can water be seen to ooze from the material?
Yes
Unsuitable material
Can the material be rolled into a sausage 3mm thick without
No
Unsuitable material
Can a finger be pushed over 10mm into a lump of the material? (i.e. minimum shear strength of 40 kN/m²)
Yes
Unsuitable material
SUITABLE MATERIAL

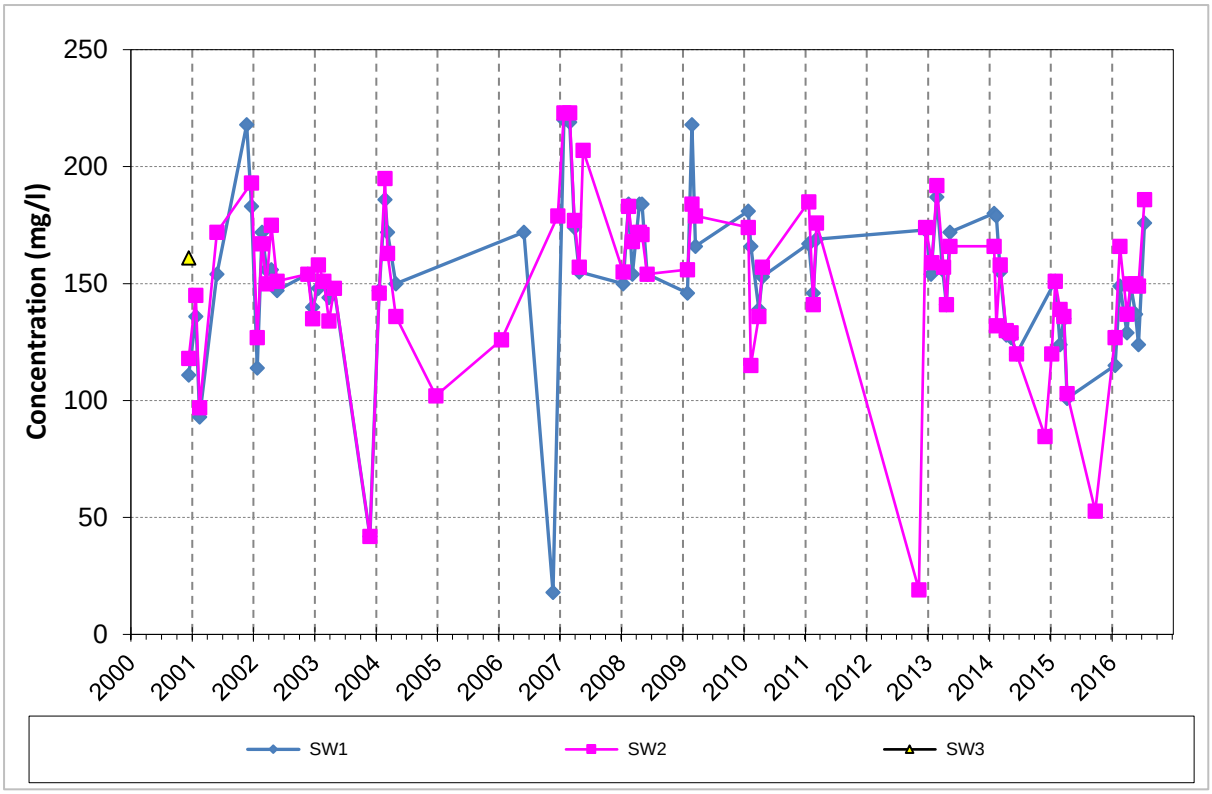
Appendix B – Historical Reports

Appendix C – Time Series Concentrations of Surface Water Chemistry

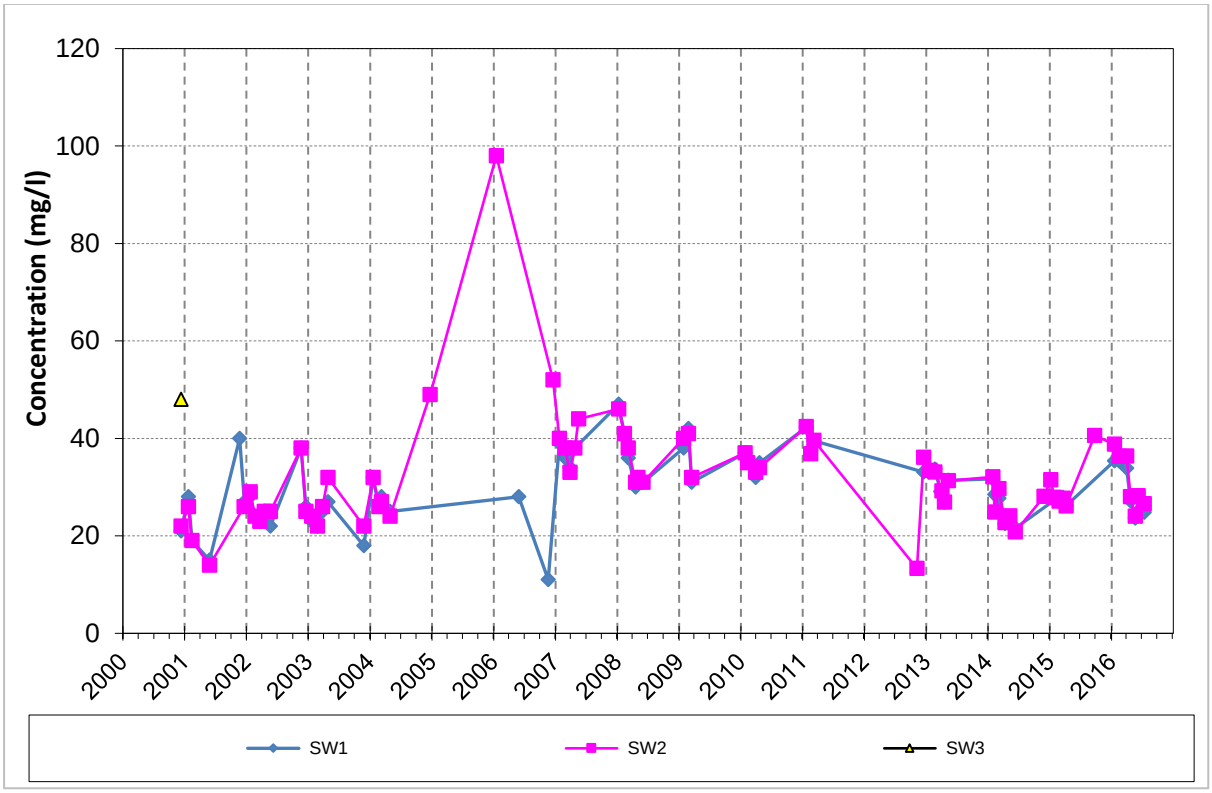
Appendix C Figure 1 Historical surface water ammoniacal nitrogen concentrations



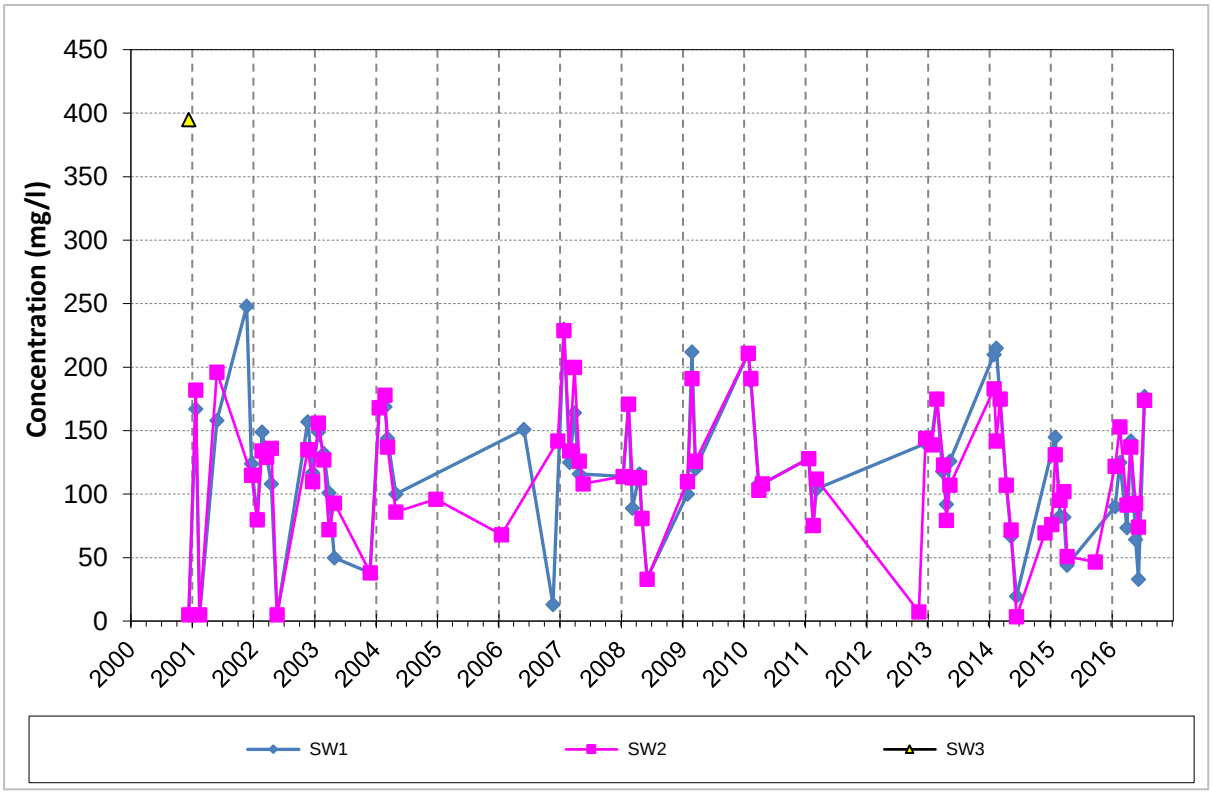
Appendix C Figure 2 Historical surface water calcium concentrations



Appendix C Figure 3 Historical surface water chloride concentrations

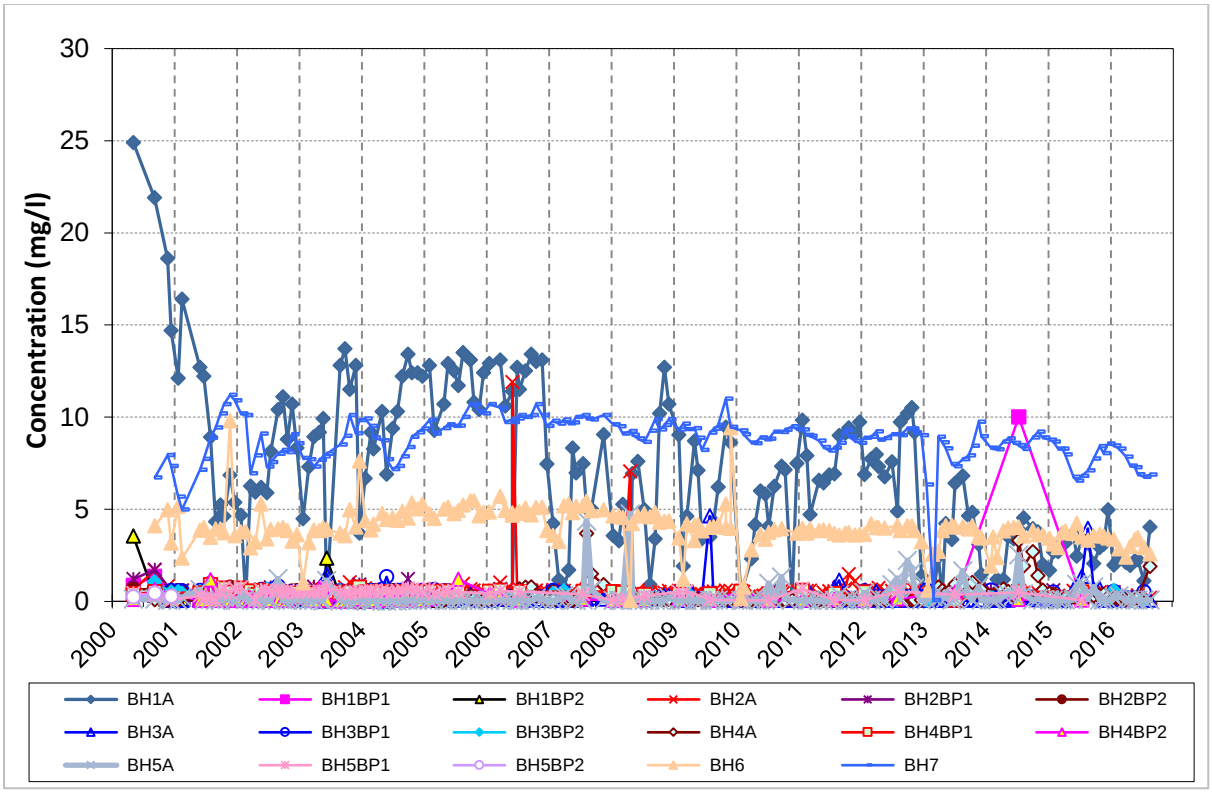


Appendix C Figure 4 Historical surface water sulphate concentrations

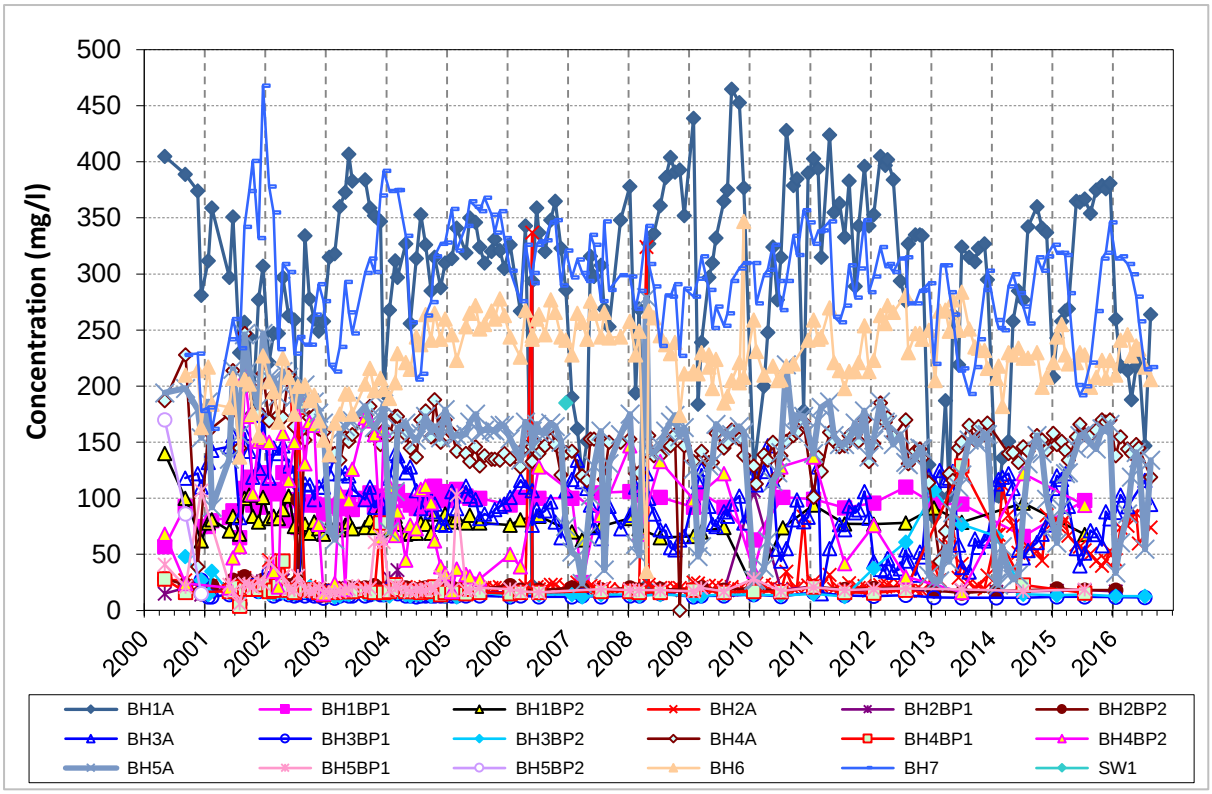


Appendix D – Time Series Concentrations of Groundwater Quality

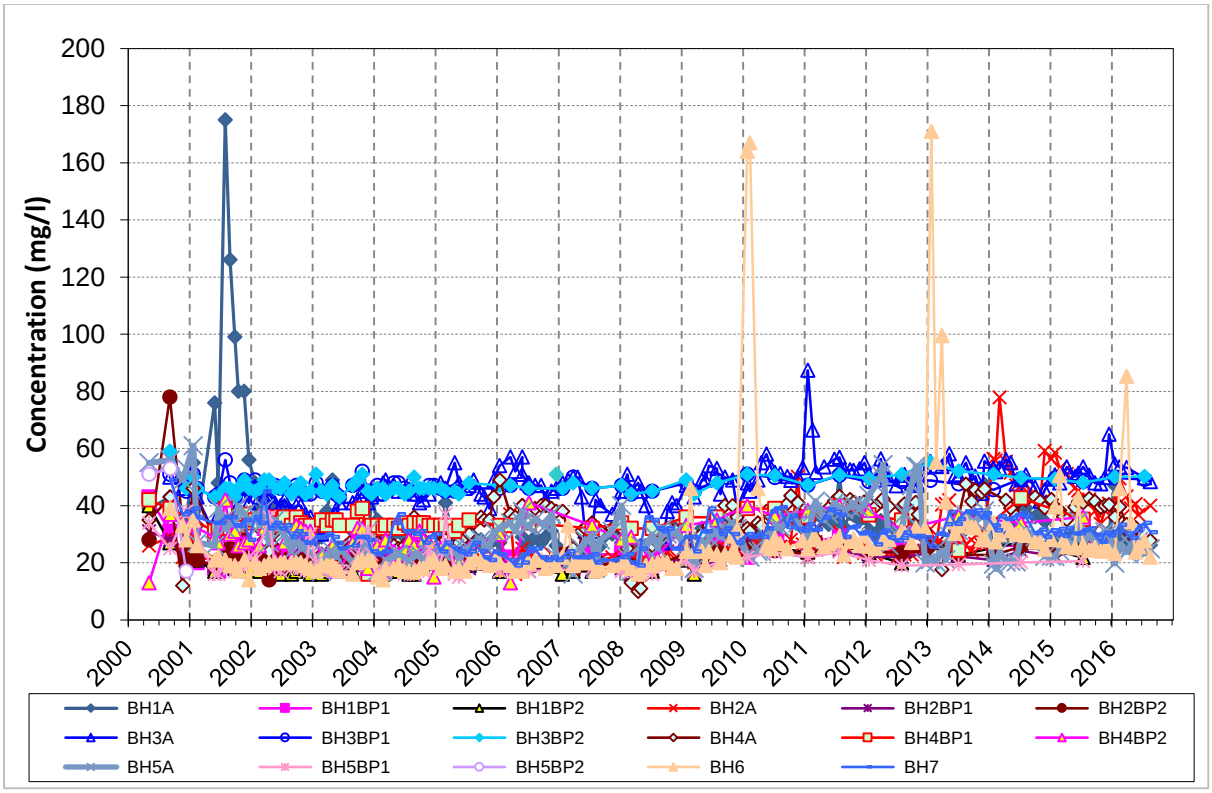
Appendix D Figure 1 Historical groundwater ammoniacal nitrogen concentrations



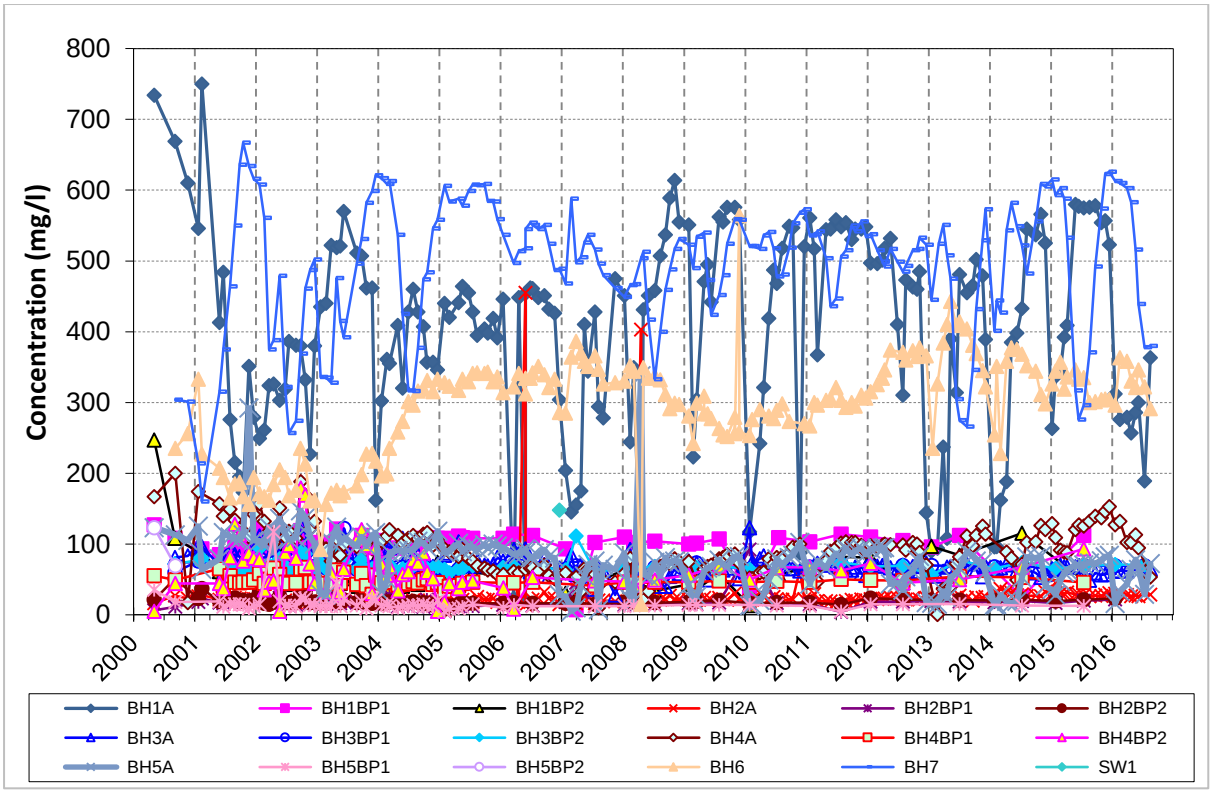
Appendix D Figure 2 Historical groundwater calcium concentrations



Appendix D Figure 3 Historical groundwater chloride concentrations



Appendix D Figure 4 Historical groundwater sulphate concentrations



Appendix E – Borehole Logs