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GROUNDWATER ENVIRONMENTAL MANAGEMENT - DEWATERING AND MONITORING STRATEGY

Alterations No. 2 (Revised April 2017).

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Groundwater Environmental Management - Dewatering and Monitoring Strategy

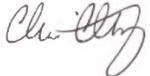
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TIDEWAY

Groundwater Environmental Management - Dewatering and Monitoring Strategy

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Abbreviations

BGS	British Geological Survey
CAP	Contingency action plan
CoCP	Code of Construction Practice
CSO	Combined sewer overflow
DCO	Development Consent Order
EA	Environment Agency
EPR	Environmental Permitting Regulations
ES	Environmental Statement
GEMDMS	Groundwater environmental management – dewatering and monitoring strategy
GHSP	Ground source heat pump
PW	Project wide
RTD	River Terrace Deposits
SPZ	Source protection zone
TWG	Technical working group

X. Executive summary

- X.1 The Groundwater environmental management – dewatering and monitoring strategy is a revised version of the Groundwater environmental monitoring strategy first issued as part of the *Environmental Statement (ES)* (Doc. ref: 6.02.03, Vol 3, Appendices (F to M), Appendix K) in February 2013 and then reissued on 3rd March 2014 under Document Reference APP141. This revised version of the document, prepared in April 2017, is submitted to the Environment Agency for approval, in accordance with Project-Wide requirement 13 (PW13) of Schedule 3 of the Development Consent Order (DCO, as amended)¹.
- X.2 The report is divided into four sections:
- Part A of this document contains the project context, the environmental setting and the source-pathway-receptor model.
 - Part B presents the Project Wide Dewatering Strategy and an outline of the Employers (Thames Tideway’s) Dewatering Plan.
 - Part C presents the Groundwater Management and Monitoring Strategy, including details of the monitoring network, the measurement procedures and the suites of determinants to be analysed.
 - Part D presents the project Groundwater Monitoring and Management Plan for pre-construction, construction and operation of the Thames Tideway Tunnel.
- X.3 The Contractors will be responsible for preparing individual site-specific Monitoring and Dewatering plans. The Employer will review and approve the Plans prior to submission to the Environment Agency for approval.
- X.4 Any further changes to this strategy will be submitted to the Environment Agency for approval prior to implementation in accordance with PW13.

¹ The Thames Water Utilities Limited (Thames Tideway Tunnel) Order (SI:2014/2384) as amended by the Thames Water Utilities Limited (Thames Tideway Tunnel)(Correction) Order (SI:2015/723) and the Notice of Variation No 1 to the Deemed Marine Licence

A. Part A: Introduction

A.1 Introduction

- A.1.1 The project will install a tunnel to transfer sewage from the most polluting combined sewer overflows (CSO) under central London to Beckton Sewage Treatment Works, via the Lee Tunnel (which will run between Abbey Mills and Beckton). The tunnel will extend from Ealing in the west, to Newham in the east and Greenwich in the southeast. It is proposed to construct 24 shafts both to facilitate the construction of the tunnel and to connect the tunnel to the CSOs.
- A.1.2 The Groundwater Environmental Management – Dewatering and Monitoring Strategy (GEMDMS) represents an updated version of the Groundwater environmental monitoring strategy, which was appended to the ES. This version of the Strategy (Alterations No. 2) has been produced to update the strategy following completion of the Employer’s Pre-Construction Baseline Report (2530-TDWAY-TTTUN-182-NZ-RG-100006-P01)².
- A.1.3 The groundwater monitoring strategy and the dewatering strategy are secured via project-wide Requirement PW13 of Schedule 3 of the DCO. PW13 relates to groundwater and dewatering monitoring and management and states that:
- “Groundwater and dewatering monitoring and management shall be carried out in accordance with the Groundwater Environmental Management - Dewatering and Monitoring Strategy. Any alterations to the strategy should be submitted to, and agreed, by the Environment Agency.”*
- A.1.4 Part B of this document contains the dewatering strategy and the outline dewatering plan.
- A.1.5 Parts C and D of this document contains the groundwater monitoring strategy and plan.
- A.1.6 The results of the monitoring required by this strategy will be reported annually as an interpretive groundwater environmental monitoring report and via quarterly factual reports. Details of the reporting protocol is included in Part D.
- A.1.7 The following terminology is used in this document, consistent with that used in the *Code of Construction Practice (CoCP)*:
- The Employer is the party in whom the DCO powers are vested, or transferred under the terms of the DCO, and implements the project, including where appropriate the Employer’s project management organisation.
 - The Contractor is the party engaged by the Employer to exercise the powers described in the DCO.

² Note that as of July 2016 the ongoing baseline monitoring was handed over to Contractors to complete at sites where construction works are yet to commence. The Employer’s baseline monitoring period was completed in July 2016.

A.2 Objectives

- A.2.1 The objective of this document is to set out a strategy to manage and monitor the effects of the proposal on groundwater quality and quantity in the upper and lower aquifer from baseline, throughout construction (including dewatering) and during operation of the Thames Tideway Tunnel. This includes measures to monitor the following:
- a. mobilisation and migration (with the prevailing groundwater flow) of constituents (for example approved grout mixes) used in tunnel/shaft construction, both during construction and in the long term
 - b. increased turbidity in groundwater due to the physical action of tunnelling and shaft construction within the Chalk, and subsequent migration with the prevailing groundwater flow
 - c. effects of seepage from the tunnel on groundwater quality
 - d. mobilisation of contaminant already present in groundwater by the creation of alternative pathways, or significantly altering existing pathways
 - e. changes in water quality and levels as a result of dewatering and the effectiveness of mitigation measures to counter these effects.
- A.2.2 This strategy sets out the framework for baseline, construction, post-construction and long-term monitoring. It provides the process for determining Alert and Trigger levels and identifies generic mitigation measures and a contingency action plan in the event of significant exceedances during and post construction.
- A.2.3 The strategy has been developed in consultation with the Environment Agency and reviewed at regular intervals. Revisions to the Groundwater environmental management dewatering and monitoring strategy shall be the responsibility of the Employer and must be approved by the Environment Agency; the Environment Agency and Contractor(s) may request amendments to the strategy if required.
- A.2.4 Potential environmental risks related to other construction works not covered by this document will be addressed by the Code of Construction Practice (Part a), the relevant site specific contaminated land requirements, foundations works risk assessments or other documents as required by Environment Agency for the specified works. Hence groundwater monitoring may also be required for other purposes on each of the sites which is outside the scope of this Strategy.

A.3 Structure of the document

- A.3.1 **Part A** of this document contains the project context, the environmental setting and the source-pathway-receptor model.
- A.3.2 **Part B** presents the Project Wide Dewatering Strategy and an outline of the Employers (Thames Tideway's) Dewatering Plan.
- A.3.3 **Part C** presents the Groundwater Management and Monitoring Strategy, including details of the monitoring network, the measurement procedures and the suites of determinants to be analysed.

Part A: Introduction

A.3.4 **Part D** presents the project Groundwater Monitoring and Management Plan, including:

- a. The overarching Project Wide Groundwater Monitoring Plan to be implemented by the Employer;
- b. The scope of the Contractor’s Groundwater Monitoring Plans to be implemented construction of the project.
- c. The reporting requirement of the Employer and Contractor during the monitoring periods.

A.3.5 Additional supporting information is presented in the Appendices as:

- **Appendix A** presents plans of monitoring locations, the tunnel alignment and pertinent hydrogeological information.
- **Appendix B** presents the register of the monitoring locations.
- **Appendix C** presents the required laboratory suites and detection limits.
- **Appendix D** presents the template for the Integrated Groundwater Monitoring and Dewatering Plan which should be adopted by the Contractors.
- **Appendix E** presents the Time-Chainage plot for construction activities across the project (correct to time of publication).

A.3.6 Figure 1 below shows the relationships between the Groundwater Monitoring Strategy and the Dewatering Strategy.

Figure A.1. Structure of Groundwater Monitoring Strategy and Plan.

Groundwater Environmental Management – Dewatering and Monitoring Strategy (GEMDMS). <i>(this document)</i>	Other pre-commencement documents required by GEMDMS
Part B Project Wide Dewatering Strategy Employer’s Dewatering Plan	Part B Contractor’s Dewatering Plan * Site Specific Dewatering Method Statement.
Part C Project Wide Monitoring Strategy	Part C n/a
Part D Employer’s Groundwater Monitoring Plan	Part D Contractor’s Groundwater Monitoring Plan *

* The template for these sections is included in the Integrated Groundwater Monitoring and Dewatering Plan presented in Appendix D, as agreed with the Environment Agency.

A.4 Project description and environmental setting

Project layout

- A.4.1 The proposed tunnel alignment and locations of the shafts are shown in Appendix A.

Tunnel construction

- A.4.2 The elements of construction for the proposed development, relevant to the consideration of groundwater includes:
- a. A main tunnel approximately 25km in length and extending from Acton Storm Tanks to Abbeys Mills Pumping Station.
 - b. Two long connection tunnels:
 - i. Greenwich connection tunnel (4.6km) from Greenwich Pumping Station to Chambers Wharf
 - ii. Frogmore connection tunnel (1.1km) between the main tunnel at Carnwath Road Riverside and south to King George's Park.
 - c. Nine short connection tunnels totalling approximately 1.2km which will be constructed in the London Clay and the Lambeth Group.
 - d. Tunnel intervention locations will be determined by the Contractor. At these locations the pressures are reduced to hydrostatic to allow man entry for maintenance works.

Programme of works

- A.4.3 The works programme for August 2016 is presented in Appendix D which indicates the proposed periods of shaft construction and tunnelling.

Shaft construction

- A.4.4 The Thames Tideway Tunnel requires the construction of 24 shafts (becoming deeper from west to east), and associated shallow infrastructure, at 23 sites (two shafts are required at Beckton Sewage Treatment Works).
- A.4.5 The ES (Volume 3 to 27, Section 13) includes indicative construction methods, methods of dewatering and an estimate of the amount of dewatering at all of the sites (used to assess the impact of dewatering within the ES).
- A.4.6 No dewatering of the upper aquifer (in the superficial deposits) is expected to be required for construction of the shafts due to planned piling, segmental shaft or diaphragm walls. Some dewatering would be required in some cases to maintain a safe working environment in the vicinity of other excavations, e.g. for the interception chambers and connection culverts.
- A.4.7 Groundwater in the lower (Chalk and Basal Sand) and intermediate aquifer (water bearing units generally isolated within the Lambeth Group) may have to be controlled at shaft locations in the central and eastern area shafts by barriers and dewatering to allow construction of the main tunnel shafts and CSO drop shafts.

- A.4.8 The construction and dewatering methods at each shaft site are subject to detail design and will be confirmed in the Contractors Dewatering Management Plans.

Tunnel dewatering

- A.4.9 No dewatering is anticipated to be required for the construction of the main tunnels. The short connection tunnels in the central section will require dewatering or depressurisation
- A.4.10 At tunnel intervention locations the pressures are reduced to hydrostatic to allow man entry for maintenance works which will involve any inflows of groundwater into the tunnel being removed by the TBM.

Environmental setting

Regional geology

- A.4.11 The regional geology of the London Basin is summarised in Table 1 below. The geology is also presented in the figures in Appendix A.

Table A.1. Regional geology (solid strata) of the London Basin

Era	Group	Formation	Approx thickness (m)
Palaeogene	Thames	Bagshot Formation	10-25
		Claygate Member London Clay	30-90
		Harwich Formation	0-10
	Lambeth	Woolwich and Reading Beds	10-20
		Upnor Formation	5-7
	Thanet Sands	0-30	
Cretaceous	Chalk	180-245	

(Source: BGS Memoir Geology of London 2004)

Tunnel alignment geology

- A.4.12 The route of the main tunnel will pass from west to east through a sequence of sedimentary strata from the London Clay Formation for approximately 9,150m then through the Lambeth Group (7,550m), Thanet Sands Formation (2150m) and finally into the Chalk Group (6,300m). This sequence is shown in Table 2. Cross sections along the tunnel alignment are presented in Appendix A.

Table A.2. Geology of main tunnel and connection tunnel sections.

Geology	Tunnel chainage m (start)	Tunnel chainage m (end)	Approx. m ATD (start)	Approx. m ATD (end)
Main Tunnel – Acton Storm Tanks to Abbey Mills				
London Clay	0	9150	75	61
Lambeth Group	9150	16700	61	51
Thanet Sands	16700	18850	51	51
Chalk	18850	25150	51	49
Greenwich Connection Tunnel – Chambers Wharf to Greenwich Pumping Station				
Chalk	0	4600	49	59
Frogmore Connection Tunnel – King George's Park to Carnwath Road Riverside				
London Clay	0	1120	83	55

(m ATD – metres above tunnel datum. Conversion from m ATD to m AOD can be done by subtracting 100 mAOD)

Shaft geology

- A.4.13 Of the 23 shafts, eight shafts will extend down into the London Clay Formation, seven into the Lambeth Group/Upnor Formation and eight into the Thanet Sands/Seaford Chalk. The geology and hydrogeology at these sites are summarised in Table 3 below.

Table A.3. Geology at base of drop shaft sites.

Site name	Approx. shaft depth (m) ³	Geology
Acton Storm Tanks	30.8	London Clay Formation
Hammersmith Pumping Station	32.6	London Clay Formation
Barn Elms	33.8	London Clay Formation
Putney Embankment Foreshore	36.2	London Clay Formation
Dormay Street	23.6	London Clay Formation
King George's Park	20.4	London Clay Formation
Carnwath Road Riverside	42.3	Lambeth Group
Falconbrook Pumping Station	40.1	London Clay Formation
Cremorne Wharf Depot	42.1	London Clay Formation

³ These depths are not the total depths required for construction works, such as D-Walling to a greater depth to reduce dewatering requirements for example.

Site name	Approx. shaft depth (m) 3	Geology
Chelsea Embankment Foreshore	45.5	Lambeth Group
Kirtling Street	47.6	Upnor Formation
Heathwall Pumping Station	46.3	Lambeth Group
Albert Embankment Foreshore	47.1	Upnor Formation
Victoria Embankment Foreshore	49.5	Lambeth Group
Blackfriars Bridge Foreshore	53.3	Thanet Sands Formation
Chambers Wharf	57.3	Chalk
King Edward Memorial Park Foreshore	60.3	Chalk
Earl Pumping Station	50.4	Chalk
Deptford Church Street	47.8	Chalk
Greenwich Pumping Station	45.9	Chalk
Abbey Mills Pumping Station	66.8	Chalk
Beckton Sewage Treatment Works - Drive Shaft	32.0	Upnor Formation
Beckton Sewage Treatment Works - Reception Shaft	30.0	Thanet Sands Formation

Hydrogeology

- A.4.14 The hydrogeological baseline for the project is summarised below and described in more detail in the ES.
- A.4.15 The Chalk is the main aquifer of the London Basin and is confined over much of the area by the Tertiary formations (the Lambeth Group and Thanet Sands) and superficial deposits (Alluvium and River Terrace Deposits). The Chalk is classified by the Environment Agency as a Principal Aquifer. The Upnor Formation, Thanet Sands and Chalk are referred to as the lower aquifer.
- A.4.16 The most permeable superficial deposits, the River Terrace Deposits, are referred to as the upper aquifer and are classified by the Environment Agency as a Secondary A Aquifer. The Alluvium, overlying the River Terrace Deposits, may act as confining layer for the upper aquifer at certain locations. At other locations, the Alluvium may be in hydraulic continuity with the upper aquifer.
- A.4.17 The upper and lower aquifers are generally hydraulically separated by the London Clay Formation. The London Clay Formation is considered to act as an aquiclude between the upper and lower aquifers. Any groundwater present in a majority of the London Clay Formation is likely to consist of localised seepages and/or minor flows. The London Clay Formation is absent or less than 1m thick at the King Edward Memorial Park, Earl Pumping Station, Deptford Church Street

and Greenwich Pumping Station shaft sites and therefore in these locations, depending on local conditions, the upper and lower aquifers may be in hydraulic continuity.

- A.4.18 The Harwich Formation is present across much of the assessment area and is considered to form a minor aquifer unit where it is isolated from the lower aquifer by the Lambeth Group.
- A.4.19 Within the Lambeth Group, several confined groundwater bodies are expected to be encountered. Groundwater is expected to be present through the Upper Shelly Beds and Upper Mottled Beds (potentially small inflows) and under high pressure within the Laminated Beds (formerly part of the Woolwich Formation).
- A.4.20 For the purposes of this strategy, the isolated water bearing units within the Harwich Formation and the Lambeth Groups are termed the intermediate aquifer. This collection of water bearing units, will be intercepted by many of the shafts and some connection tunnels and hence groundwater control may be required in these Formations.
- A.4.21 The Thanet Sands and the Upnor Beds (lower unit of the Lambeth Group) are known as the 'Basal Sands' and are in hydraulic continuity with the Chalk aquifer beneath London.
- A.4.22 The regional direction of groundwater flow within the London Basin is towards an area of low piezometric levels within central London. However, the groundwater gradient may be affected locally by abstractions, particularly during peak demand periods associated with major licences.
- A.4.23 There are limited monitoring boreholes within the upper aquifer and at most shaft sites it has not been possible to accurately determine the direction of groundwater flow at these depths; however, it is likely to be local and towards the River Thames due to surrounding topography.

Licensed abstractions

- A.4.24 Based on information available in the *ES*, there is one Environment Agency licensed abstraction (28/39/39/0225) from the upper aquifer located within 1km of the proposed shaft sites and the tunnel route. This licensed abstraction abstracts from the River Terrace Deposits.
- A.4.25 In 2013, there were 40 Environment Agency licensed abstractions from the lower aquifer located within 1km of either the proposed shaft sites or the tunnel route (where abstractions are identified to be of particular importance and are beyond a kilometre from the tunnel they have been considered). The licensed abstraction sources listed in Table 4 all abstract from the lower aquifer. In addition, there is one source in the upper aquifer, located in the central area which is used for industrial, commercial and public service purposes. The known abstractions from the lower aquifer assessed in the *ES* are summarised in table below.

Table A.4. Environment Agency licensed abstractions from the lower aquifer

Area	Licence purpose	No. of licences
Central	Drinking water supply	11

Area	Licence purpose	No. of licences
	GSHP (heat pump or cooling)	12
	Industrial, commercial & public service (process water or irrigation)	4
Eastern	Drinking water supply	5
	GSHP (cooling)	3
	Industrial, commercial & public service (amenity top-up water or horticultural)	4

A.4.26 There were three unlicensed abstractions from the Chalk aquifer located within 1km of the shaft sites and tunnel route, based on information provided by the London boroughs in 2013. One of these unlicensed sources is used for drinking water supply and the purpose of the remaining two is unknown.

Source protection zones

A.4.27 The Source Protection Zones (SPZ) presented within the vicinity of the Tideway Tunnel route are presented in Appendix A.

A.4.28 The proposed Kirtling Street and Heathwall Pumping Station shaft sites are located within SPZ 1 associated with the Thames Water Battersea public water abstraction (not currently operational).

A.4.29 The proposed Deptford Church Street shaft is located within SPZ 3 of the Thames Water Deptford public water abstraction. Greenwich Pumping Station shaft is located within SPZ 1 of the Deptford abstraction.

A.4.30 The tunnel crosses SPZ 1 and 2 associated with the Battersea abstraction, and passes in close proximity to the SPZ 1 associated with the Mantilla Ltd Dolphin Square private water supply.

A.4.31 The tunnel passes through SPZ 1 and 2 associated with the Thames Water Deptford abstraction between the Earl and Greenwich Pumping Station sites.

A.5 Preliminary conceptual model

Sources of potential contamination

A.5.1 Site specific sources of potential contamination will be identified through the land quality assessments required for each site and reported in line with the contaminated land DCO Requirements.

A.5.2 A high level summary of the potential sources across the route is presented below. More detailed information is presented in the ES and the relevant site specific contaminated land documents for each site. Recent groundwater quality information is summarised in the Pre-Construction Baseline Report (2530-TDWAY-TTTUN-182-NZ-RG-100006-P01).

Part A: Introduction

- Made Ground is present across all the sites, of varying thickness and quality and occasionally containing perched water. The extent to which the Made Ground represents a potential source of contamination is dependent on the levels and type of contamination.
- Upper aquifer. Shallow groundwater in the RTD is present at all the shaft sites. It is generally known that the groundwater in the RTD is of variable quality and has often been impacted by commercial and industrial landuses as well as by increased salinity from the tidal Thames.
- Lower aquifer. Several 'hotspots' of groundwater contamination have been identified within the Thanet Sands and the Chalk (lower aquifer), around the central and eastern shaft sites. Where contaminants have been recorded, they are generally at lower concentrations than in the upper aquifer.
- Construction materials. There is the potential for construction materials (bentonite, grout, concrete and additives, tail skin sealant) to come into contact with groundwater. As set out in the CoCP Part A Section 8, approval will be sought from the Environment Agency regarding all materials prior to use.
- Tunnel seepage. Seepage of CSO discharges during operation of the tunnel has the potential to act as a source of pollution.

Pathways

A.5.3 There is considered to be the potential for a pathway to the lower aquifer at the following shaft sites:

- Blackfriars Bridge Shaft which penetrates the Thanet Sands
- Chambers Wharf, King Edward Memorial Park, Earl Pumping Station, Deptford Church Street, Greenwich Pumping Station, and Abbey Mills Pumping Station shafts, all within the Chalk
- Kirtling Street and Albert Embankment Foreshore, whose base slabs are within the Upnor Formation.

A.5.4 The potential pathway mechanisms are considered to include:

- the temporary creation of preferential pathways between the upper, intermediate and lower aquifer units during construction activities (such as shaft construction or piling works).
- uncontrolled losses of construction materials during shaft construction, tunnelling or ground treatment to the aquifers.
- mobilisation of any contaminants in the upper, intermediate or lower aquifer due to dewatering or other construction activities and migration towards sensitive receptors.
- Leakage through tunnel linings into the lower aquifer during tunnel operation.

Receptors

A.5.5 The main sensitive groundwater receptors are considered to be:

- the upper aquifer (RTD secondary aquifer);

- lower aquifer (Chalk Principal aquifer, in hydraulic continuity with the basal sands unit);
- groundwater abstractions; and
- The River Thames and any other surface watercourses adjacent to the construction sites.

A.6 Mitigation measures

- A.6.1 The Thames Tideway Tunnel has been designed to minimise environmental effects and the principles behind the construction design and methods take account of groundwater resources. These environmental design measures include:
- The installation of shaft walls in advance of bulk excavation where required to minimise the inflow of groundwater from the upper aquifer.
 - The reduction of inflows from the lower aquifer by driving the diaphragm walls to a suitable depth to reduce inflows.
 - The use of ground treatment techniques (e.g. grouting or freezing) to stem fissure flows if and where required.
 - The reduction of dewatering of the lower aquifer and mobilisation of poor quality groundwater by pumping internal to the diaphragm walls where feasible.
- A.6.2 This Groundwater Environmental Management – Dewatering and Monitoring Strategy has been developed as a means of identifying and addressing potential impacts on groundwater resources as a result of the construction, including dewatering, and operation of the shafts and tunnels of the Thames Tideway Tunnel project.
- A.6.3 Potential environmental risks related to construction are also addressed by the Code of Construction Practice (Part a), the relevant site specific contaminated land requirements, foundations works risk assessments or other documents as required by Environment Agency.
- A.6.4 Part C and D of this strategy outline how groundwater levels and quality will be monitored and how specific mitigation measures will be applied should adverse impacts be identified.
- A.6.5 Unless otherwise agreed with the Employer and the Environment Agency, the construction activities which will require approval of groundwater monitoring and dewatering plans under this strategy are considered to comprise those activities:
- a. Which will involve construction or dewatering activities which have the potential to impact groundwater quality or levels in the upper, intermediate or lower aquifer where no or limited London Clay is present;
 - b. Which have the potential to impact on groundwater quality in the lower aquifer by creation of temporary preferential pathways or mobilise existing contamination in the lower aquifer;

Part A: Introduction

- c. Which will involve dewatering activities which have the potential to impact groundwater levels in the lower aquifer;
- d. Which involve the use of grouting or other groundwater control techniques or any other additives in the lower aquifer; or
- e. Which comprise the main works associated with the construction of the main shafts, including where no works will impact on the lower aquifer.

A.6.6 Activities which do not require dewatering to be undertaken do not require a dewatering plan to be approved, although they may require a groundwater monitoring plan if they fall into one of categories b to e above.

B. Part B: The dewatering strategy

B.1 The project wide strategy

- B.1.1 The project's approach to dewatering⁴ is to keep the duration of pumping and the rates to a minimum. This will be achieved by minimising dewatering outside of the works. Groundwater will be controlled as follows:
- a. Within the Chalk and Thanet Sands: internal dewatering with cut-off from the wider aquifer with diaphragm walls and ground treatment (e.g. fissure grouting or ground freezing) will be used to minimise the volume of dewatering required.
 - b. Within the Lambeth Group: local depressurisation using drains or vacuum ejectors in the sand lenses. Given nature of the Upnor Formation (lower part of the Lambeth Group) freezing of sand horizons may be required.
- B.1.2 By applying these control measures (which are secured via the DCO Requirement PW13 in Schedule 3), this will ensure that the following objectives are met:
- a. The project is compliant with Environmental Permitting Regulations (EPR) - Schedule 22 (England and Wales) 2010 with respect to dewatering⁵.
 - b. Adequate protection of surface water and groundwater resources, in line with principles as set out under the Water Resources Act 2003 (required for abstraction licence applications).
 - c. Construction effects arising directly or indirectly from dewatering systems and from discharges to the water environment are mitigated.
- B.1.3 The Employer is aware of proposed changes to Environment Agency licensing policy which will mean that licences with damaging effects on the environment will not be issued by the Environment Agency. A number of previously exempt activities, including dewatering, are likely to require authorisation from the Environment Agency (licences or permits) from 2016 onwards. The Contractors shall be responsible for obtaining all necessary licences and permits from the Environment Agency prior to dewatering commencing.
- B.1.4 The Thames Tideway Tunnel project will reduce the amount of dewatering by constructing barriers to cut-off (seal out) any flows from the River Terrace Deposits (upper aquifer). The form of barrier which will be used in this situation is either a sheet pile or secant pile walls, which will be driven down into the relatively impermeable London Clay Formation where sufficient thickness is present.

⁴ Dewatering – the control of groundwater levels, usually by abstraction, to enable construction to continue below the water table-

⁵ Schedule 22 – groundwater activities of EPR 2010 (see page 164).

Code of Construction Practice

- B.1.5 All dewatering works will be undertaken in accordance with the *Code of Construction Practice (CoCP)*, as well as this Strategy. Relevant measures included within the *CoCP* (Part A) Section 8 to ensure effects on groundwater are minimised are as follows:
- a. A precautionary approach, involving targeted risk-based audits and checks of water quality monitoring, will be applied to licensed abstractions thought to be at risk.
 - b. Monitoring arrangements for dewatering permits and any permits required on change of licensing regulations will be developed in liaison with the Environment Agency.
 - c. At the end of construction where temporary support for excavations does not form part of the operational structure it will be removed, piped through or cut down to avoid the build-up of groundwater on the upstream side of underground structures.

Stakeholder engagement

- B.1.6 As part of the project there have been regular Technical Working Group (TWG) meetings with Environment Agency, at which experts from both groundwater resources and groundwater quality sections of the Environment Agency have attended. These meetings have enabled the latest design thinking for the Thames Tideway Tunnel and the proposed methods of construction to be developed.

B.2 The Employer's dewatering plan

- B.2.1 The Dewatering Plan is the method by which the dewatering strategy will be delivered and is secured via DCO Requirement PW13. The Dewatering Plan is divided into two parts:
- a. The Employer's Dewatering Plan
 - b. The Contractor's Dewatering Plan
- B.2.2 The Employers Dewatering Plan is a project-wide overview of dewatering, prepared by the Employer which has been submitted and approved by the Environment Agency.
- B.2.3 The Employers Dewatering Plan has been embedded into the Integrated Dewatering and Monitoring Plan template which is presented in Appendix D to this Strategy for use by the Contractors.
- B.2.4 The Employers Dewatering Plan will be common to each of the Contractors Site Specific Dewatering Plans and is based on the Dewatering Strategy outlined above.
- B.2.5 The Employer will review and approve the Contractors Site-Specific Dewatering Plans prior to submission to the Environment Agency for approval.

B.3 The Contractor's Site Specific Dewatering Plan

- B.3.1 The Contractor's Site Specific Dewatering Plan will summarise all licences and permits to abstract and discharge from dewatering systems issued by the Environment Agency and Thames Water (where discharge will be to sewer) which are relevant to the site. It will also put the proposed dewatering at the site into the project-wide context.
- B.3.2 The Contractor's Site Specific Dewatering Plan can form part of the Integrated Groundwater Monitoring and Dewatering Plan presented in Appendix D to this Strategy.
- B.3.3 The Contractor's Site Specific Dewatering Plans will be informed by the Contractor's Dewatering Method Statement. The Method Statement can be a separate document which will be prepared by the Contractor and submitted to the Environment Agency for approval no later than 35 business days in advance of any dewatering works commencing at the site.
- B.3.4 The Contractor can undertake construction activities not involving dewatering at their sites (such as piling and D-Wall construction) without the need for an approved Dewatering Method Statement.
- B.3.5 Any dewatering requirements at tunnel intervention points will be included in the Contractor's Dewatering Plan.
- B.3.6 Depending on the quality of groundwater (based primarily on concentrations of hazardous substances), an outline of pre-treatment measures would be provided to the Environment Agency and/or sewerage provider for approval.
- B.3.7 The Contractor's Dewatering Plan shall include the following:
- a. main discharge points for the site
 - b. abstraction and discharge rates
 - c. details of well installation
 - d. details of monitoring network (surface and groundwater)
 - e. details of equipment used
 - f. proposed construction sequence
 - g. licences and permits from the Environment Agency
 - h. prior authorisation from local sewerage provider
 - i. details of any pre-treatment required prior to discharge approved by the Environment Agency.
- B.3.8 The Contractor's Groundwater Monitoring Plan for each site shall be developed to mitigate any dewatering requirements and will be presented with the Dewatering Plan. A template for the Integrated Groundwater Monitoring and Dewatering Plan is included in Appendix D.
- B.3.9 It will be the responsibility of the Contractor to update the Site Specific Dewatering Plans and Method Statements based on any design change for the relevant site. Any amendments to the Contractor's Plans will be reviewed and

Part B: The dewatering strategy

approved by the Employer prior to submission to the Environment Agency for approval.

- B.3.10 The requirements of the Contractor's Groundwater Monitoring Plans are detailed in Part D of this Strategy.

C. Part C: Groundwater management and monitoring strategy

C.1 Objectives and rationale

C.1.1 This Strategy requires the management and monitoring of groundwater resources during the baseline (pre-construction), construction and operation phases of the Thames Tideway project.

C.1.2 Groundwater monitoring is required to enable the following:

- a. Collection of groundwater level data pre-construction to provide a baseline, and during construction and operation and to assess whether the tunnel and shafts have significantly impacted groundwater flow during construction and operation.
- b. Collection of baseline groundwater quality samples to identify trends and determine trigger levels, where possible.
- c. Assessment of risk of mobilisation and migration of pre-existing contaminants affecting the lower aquifer (ie. if source-pathway-receptor linkages exist) as a result of construction and to inform any remediation works required.
- d. Collection of groundwater quality samples during construction and operation to establish whether:
 - i. mobilisation and migration of constituents in grout/ lubricant mixes has taken place
 - ii. increases in turbidity in groundwater due to the physical action of tunnelling and shaft construction within the lower aquifer can be detected
 - iii. significant changes in water quality as a result of dewatering and tunnel seepages have occurred
 - iv. mobilisation and migration of contaminants has taken place.
 - v. Initiate relevant contingency action plans or emergency response procedures in the event of any significant impacts

C.1.3 To achieve these objectives a framework of monitoring locations, monitoring frequency, laboratory suites and reporting has been established for the Thames Tideway project. This is presented in detail below.

C.2 Scope of groundwater monitoring

C.2.1 Monitoring of construction and operational effects are embedded in the environmental design of the project through the application of this Strategy. The monitoring includes both groundwater levels and groundwater quality. The monitoring regime described in this Strategy may be further developed during the life of the project to ensure that the Employer and the Contractors can identify

and respond to changes in groundwater levels or groundwater quality as a result of any changes in the project design and/or the site conceptual model.

Baseline pre-construction groundwater monitoring

- C.2.2 Baseline groundwater monitoring will continue prior to construction. The pre-construction monitoring dataset will be used to establish a baseline against which the construction phase monitoring will be compared.
- C.2.3 The pre-construction baseline will inform the setting of alert and trigger levels, for both quality and levels, for the construction monitoring phase. The Employer and the Contractors will develop a common methodology, as far as is practicable, for the setting of the alert and trigger levels. The methodology will be used to set the alert and trigger levels which will be agreed between the Employer and the Contractor. The alert and trigger levels will then be approved by the Environment Agency. Any changes to the Alert and Trigger Levels proposed by the Contractors must be approved by the Employer and the Environment Agency before use.

Construction monitoring

- C.2.4 Construction groundwater monitoring will be undertaken by the Contractor(s) during construction of the Thames Tideway Tunnel project. The results shall be reported to the Employer and the Environment Agency. The overall construction programme would be from 2016 until 2022.
- C.2.5 Unless otherwise agreed with the Employer and the Environment Agency, the construction activities which will require approval of groundwater monitoring and dewatering plans are considered to comprise those activities outlined in Section A.6.
- C.2.6 Unless otherwise agreed with the Employer and the Environment Agency, construction monitoring will be required during, and three months prior to the activities outlined in Section A.6.
- C.2.7 Potential environmental risks related to other construction works not included in Section A.6 will be addressed by the Code of Construction Practice (Part a), the relevant site specific contaminated land requirements, foundations works risk assessments or other documents as required by Environment Agency for the specified works. It is therefore possible that groundwater monitoring may be required for other purposes, outside the scope of this Strategy.
- C.2.8 Given that changes to groundwater generally take place slowly, it will be necessary to continue monthly groundwater monitoring for a minimum of one year after the end of any construction ground disturbance unless otherwise approved by the Environment Agency. In certain situations, the construction monitoring may run into the period when operational monitoring is being carried out.

Operational monitoring

- C.2.9 It is recognised that operational monitoring will be required throughout the commissioning and operational life of the project. The Employer will be

responsible for ensuring that the operational monitoring is undertaken. The operational monitoring results shall be reported quarterly via factual reports and annually in the form of an interpretative report to the Environment Agency by the Employer.

- C.2.10 As a minimum operational groundwater monitoring will include compounds for which alert and trigger levels have been set during the construction period as well as indicator parameters for the operation of the Thames Tideway Tunnel as a sewer.
- C.2.11 Monitoring requirements will be reviewed with the Environment Agency after a two-year period.

C.3 Proposed monitoring network

- C.3.1 A network of 44 groundwater monitoring locations have been selected along the tunnel alignment to satisfy the above objectives. The locations of the boreholes have been chosen based on the tunnel/ shaft geology, anticipated groundwater flow directions during abstraction, proximity to groundwater abstractions, and groundwater quality. They also take into account existing third party monitoring locations, for example Environment Agency and Thames Water Monitoring boreholes.
- C.3.2 The borehole locations are shown in Appendix A. The purpose of each location and justification of each borehole is summarised in the register in Appendix B.
- C.3.3 The network of monitoring boreholes will be reviewed and updated during the Thames Tideway project. Any amendments to the register in Appendix B by the Employer or the Contractor will be agreed in consultation with the Environment Agency.
- C.3.4 Additional locations to those in Appendix B may be added to the monitoring framework by the Contractors for each site location based on their dewatering designs. Details of any additional will be provided in the Contractors Groundwater Monitoring Plans.
- C.3.5 Any new additional or new replacement monitoring wells will be constructed in accordance with: BS ISO 5667-22: 2009 “Water Quality – Sampling – Part 22: Guidance on the design and installation of groundwater monitoring points”.
- C.3.6 The deep borehole well screens will be installed within either the Chalk or Thanet Sands using a minimum screen length of 10m. A bentonite seal will be used through the overlying strata to ensure that no contamination pathway is created between the lower and the upper aquifers. For the same reason, standard practice aquifer protection methods will be employed during drilling (see CoCP (Part A)).
- C.3.7 All construction details will be provided once installation has been completed.
- C.3.8 Measurements shall be made in SI units and level data shall be in metres above ordnance datum.

C.4 Monitoring methodology

General

- C.4.1 The groundwater monitoring required under this strategy is a combination of groundwater level and groundwater quality monitoring.
- C.4.2 Groundwater will be sampled in accordance with the following industry standards and guidance (or more recent updated versions as they become available):
- BS 5930:2015+A2:2010 'Code of practice for site investigations' (BSI, 2015);
 - BS EN ISO 5667-1:2006, BS 6068-6.1:2006 'Water quality. Sampling. Guidance on the design of sampling programmes and sampling techniques' (BSI 2007);
 - BS EN ISO 5667-11:2009, BS 6068-6.11:2009 'Water quality. Sampling. Guidance on sampling of groundwaters' (BSI 2009);
 - Environment Agency Publication TGN02 'Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water' (Environment Agency, 2003);
 - D4448 – 01 Standard Guide for Sampling Ground-Water Monitoring Wells (ASTM. 2013); and,
 - Environment Agency Technical Report P5-065/TR 'Technical aspects of site investigation' (Environment Agency, 2000).

Data loggers

- C.4.3 Data loggers are to be installed at set locations as presented in Appendix B to record measurements of water level, temperature and electrical conductivity at one hour intervals.

Groundwater sampling

- C.4.4 Groundwater samples will not be collected from monitoring holes until the standing water/stagnant water has been suitably purged/removed, to ensure that the groundwater sample collected is representative of groundwater within a given formation.
- C.4.5 Samples for dissolved metals analysis are to be filtered on site in accordance with BS EN ISO 5667-11:2009.
- C.4.6 Some groundwater chemistry parameters are unstable and are liable to change during sample collection, handling, transport and storage. Representative readings of the following parameters will be taken in the field, before the samples are placed in suitable containers:
- pH value
 - Electrical Conductivity ($\mu\text{S}/\text{cm}$)
 - Redox Potential
 - Dissolved Oxygen (percentage)

- Temperature (°C).

- C.4.7 Turbidity monitoring is required from boreholes located within groundwater source protection zones during construction activities in the lower aquifer and also if works could impact other private or licenced abstractions.
- C.4.8 A minimum of one turbidity reading shall be collected one week prior to activities commencing.
- C.4.9 To ensure that turbidity readings are representative, turbidity monitoring shall be completed under dynamic conditions (i.e. under pumped conditions, not from static water), with pump rates recorded for comparative purposes if required.
- C.4.10 TWUL shall be consulted on the appropriate locations, duration and frequency of turbidity monitoring, with the details provided in the Contractors Groundwater Monitoring Plan for agreement with the Employer and the Environment Agency.

C.5 Monitoring frequency

Baseline

- C.5.1 Sampling the monitoring holes will continue on a quarterly basis before construction activities start at each site or in advance of tunnelling works for those boreholes distant from shaft sites (to be agreed with the Employer and Environment Agency).
- C.5.2 A minimum of four consecutive quarterly samples should be collected prior to construction activities commencing.
- C.5.3 Samples shall be submitted to suitable accredited laboratories to analyse for the parameters presented in Appendix C.
- C.5.4 The first sample collected at any borehole will be analysed for a comprehensive suite of analysis presented as the 'Long List'. Samples collected thereafter shall be analysed for the 'Project List'.
- C.5.5 Any parameters that are detected above method detection limits in the first sample shall be added to the 'Project List' for that specific location.
- C.5.6 Data loggers are being and will continue to be used to monitor water level, temperature, and electrical conductivity at one hour intervals to provide a pre-construction baseline.
- C.5.7 Manual water level readings will be collected during each sampling visit.

Construction

- C.5.8 Data loggers will continue to be used to monitor water level, temperature, electrical conductivity at a minimum of one hour intervals.
- C.5.9 Three months prior to and during construction the frequency of borehole monitoring will be increased to monthly. The activities requiring monthly monitoring are defined as those activities detailed in Part A.
- C.5.10 Samples will be submitted for laboratory analysis using the parameters identified in Appendix C unless an alternative strategy (such as a justifiable, risk based list

of parameters) is agreed with the Employer and the Environment Agency. Any alternative strategy should include the analysis for the Project List parameters on a minimum biannual frequency.

- C.5.11 If dewatering is required at a shaft site then weekly monitoring of discharge water (in-line tap) will be undertaken using the Project List parameters unless an alternative suite is agreed with the Employer and Environment Agency.
- C.5.12 Within source protection zones, or in the vicinity of other private or licenced abstraction wells, turbidity monitoring shall be undertaken on a weekly basis during construction activities or tunnelling in the lower aquifer, or as otherwise agreed with the Employer and the Environment Agency.
- C.5.13 Following completion of the construction activities, a period of post-construction monitoring will be undertaken for a minimum of one year, or as otherwise agreed with the Employer and the Environment Agency, following the activities detailed in Part A.

Operation

- C.5.14 Data loggers will continue to be used to monitor water level, temperature and electrical conductivity at one hour intervals for a period of up to two years.
- C.5.15 Quarterly monitoring of groundwater quality will be undertaken using the same rationale as during the construction phase for a minimum period of two years or as agreed with the Environment Agency.
- C.5.16 The monitoring results shall be reported to the Environment Agency within two months for each round of monitoring.

Long term

- C.5.17 The requirements for long-term monitoring will be agreed with the Environment Agency following completion of construction. The scope of operational groundwater quality monitoring will be quarterly for the first two years. This frequency will be reviewed by the Employer after two years and any changes submitted to the Environment Agency for approval.
- C.5.18 It is anticipated that the long-term monitoring will be progressively scaled back in the future assuming that no detrimental impacts on groundwater quality as a result of the Thames Tideway Tunnel are recorded. Any change to the long term monitoring regime would be submitted to the Environment Agency for approval in advance of any change.

C.6 Tunnel route risk assessment

- C.6.1 No tunnel construction works^{vi} shall be undertaken until the following has been submitted, as part of the Groundwater Monitoring Plans, and approved by the Environment Agency.

^{vi} As defined as Work No. 1a, 1b, 1c, 1b, 7, and 20 of Schedule 1 of the DCO.

- a. A preliminary risk assessment of potential contamination plumes along the tunnel route, including results from the monitoring scheme and identification of previous uses at ground level with potential for contaminants to reach the lower aquifer within the vicinity of the tunnel and the potential contaminants associated with those uses. In particular, the assessment should focus on the areas where a conceptual model of the tunnel alignment links the source with pathways and receptors.
- b. If the outcome of the preliminary risk assessment identifies a potential impact on receptors, as a result of tunnelling, the proposed groundwater monitoring plans will be amended to reflect the findings and include additional monitoring and risk assessment if required.
- c. Remedial groundwater works as mitigation shall be proposed where a detailed quantitative risk assessment identifies an unacceptable risk to receptors as a result of tunnelling is likely to occur. The proposal shall include an options appraisal and full details of the remedial works required and how they are to be undertaken. Any risks assessments and remediation works shall be approved by the Employer and the Environment Agency prior to tunnelling commencing.
- d. Proposals for additional and/or more frequent monitoring (including long term monitoring) are to be based on the risk identified.

C.6.2 The Groundwater Monitoring Plans shall be implemented as approved unless otherwise agreed with the Environment Agency.

C.6.3 If in undertaking the tunnelling works, contamination not previously identified is found to be present, a revised Groundwater Monitoring Plan shall be submitted to and approved in writing by the Environment Agency which will include proposed contingency measures to be introduced.

C.6.4 It should be noted that Tunnel Route Preliminary Risk Assessments have already been completed by the Employer and should be updated by the Contractor for agreement with the Environment Agency.

- Acton Storm Tanks to Carnwath Road Riverside (Ref: 321835HH01/EVT/EES/01/B June 2014).
- Carnwath Road Riverside to Chambers Wharf (Ref: 321835HH02/EVT/EES/01/B June 2014).
- Greenwich Pumping Station to Chambers Wharf (Ref: 321835HH03/EVT/EES/01/B June 2014).
- Chambers Wharf to Abbey Mills Pumping Station (Ref: 321835HH04/EVT/EES/01/B 10 June 2014).

C.7 Mitigation measures

Assessment and compliance criteria

C.7.1 The baseline groundwater level and water quality data will be used to derive assessment and compliance criteria against which project impacts can be

assessed. These criteria will be derived by the Employer and the Contractors in consultation with the Environment Agency (Part D).

C.7.2 A two-tier system of screening criteria shall be adopted.

- a. Assessment criteria (Alert Levels) will be used to provide early warning of potential issues.
- b. Compliance criteria (Trigger Levels) will be used to identify potentially significant risks to receptors.

C.7.3 Guidance on the setting of assessment criteria for water quality is presented in the following documents which should be referenced by the Contractors in the setting of alert and trigger levels:

- Environment Agency 2011. Horizontal guidance Note H1 - Annex J 3. Additional guidance for hydrogeological risk assessments for landfills and the derivation of groundwater control levels and compliance limits^{vii};
- Environment Agency 2003. Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water (especially Chapter 7, Assessment Criteria and Contingency Actions); and
- Environment Agency 2002. Techniques for the Interpretation of Landfill Monitoring Data - Guidance notes. (TRP1-471).

C.7.4 Alert levels will be used on a day-to-day basis by the Contractor. Alert levels aim to draw the attention of the Contractor's site management team to the development of adverse trends in monitoring. This should be treated primarily as an early warning system to enable appropriate investigative or corrective measures to be implemented so that the risk of breaching a compliance limit can be reduced and before impacts can cause harm to the environment or human health.

C.7.5 Comparison of measured water quality with Trigger levels will be used to demonstrate compliance with agreed water quality standards to stakeholders. Trigger Levels are standards agreed with the Environment Agency through the approval of the relevant site specific Groundwater Monitoring Plan and, at sites where relevant, the dewatering plan. Breaches of the Trigger Levels should be prevented. Should a breach of a Trigger level occur a Contingency Action plan will be followed as detailed below.

C.7.6 Alert and Trigger levels will not be derived for every water quality monitoring parameter. Instead, key indicator parameters shall be identified using a risk-based approach that reflects the baseline water quality dataset. The indicator parameters will be agreed with the Environment Agency through the approval of the Contractors Groundwater Monitoring and Dewatering Plan. The choice of indicator parameters shall be reviewed by the Contractor at least annually for adequacy; any proposed changes must be approved by the Employer and the Environment Agency prior to implementation.

^{vii} Note this document has been superseded by (<https://www.gov.uk/guidance/landfill-developments-groundwater-risk-assessment-for-leachate>), however the EA state the guidance is still applicable.

- C.7.7 Alert and Trigger levels shall be derived on a borehole-specific basis. The levels shall be based on the baseline dataset and shall take into account existing variability and trends. Statistical methods shall be used where possible to derive appropriate Alert and Trigger levels. The Alert and Trigger levels shall be reviewed at least annually by the Contractor for adequacy; any proposed changes must be approved by the Employer and the Environment Agency prior to implementation.
- C.7.8 In the event that statistical methods cannot be used for the setting of realistic alert and trigger levels, e.g. due to insufficient or highly variable data, alternative methods will need to be agreed between the Contractor, Employer and the Environment Agency.
- C.7.9 These alternatives could include one or more of the approaches below:
- Reliance on a smaller dataset (use of less than twelve months of monitoring data);
 - Reliance on a shorter duration of monitoring (but potentially with a higher frequency of sampling prior to construction to establish more data points and reduce variability);
 - Use of data collected from other wells within the same site area installed in the same strata which could be considered surrogate data to support decisions on alert and trigger levels;
 - Initial use of alert and trigger levels which are based on minimum reporting values and relevant water quality standards until further data is collected; and/or
 - Use of more restrictive short term alert and trigger levels, which would be revised when and if a sufficient dataset is established to enable the revision.
- C.7.10 During construction, the groundwater level and quality data will be screened on a weekly basis using data loggers^{viii}. The loggers will measure physical and chemical parameters as listed in Table C.1 below.

Table C.1. Datalogger physical and chemical parameters

Test	Unit	Alert Level Type	Trigger Level Type	Basis
EC (20°C)	mS /cm	>value	>value	Value based on baseline monitoring
Temperature	°C	>Step-change	>Step-change	Step-change (e.g. ±20%) based on baseline monitoring
Water level	M	>value	>value	Value based on baseline monitoring and impact assessment

^{viii} Unless otherwise agreed with the Environment Agency on a site-specific basis.

- C.7.11 The Alert and Trigger levels, and associated procedures will determine whether Contingency Action Plans need to be activated (see below). The assessment process involves evaluation of the significance of a departure from baseline conditions.

Contingency action plan

- C.7.12 If, during construction or operation, Trigger Levels are exceeded the contingency action plan (CAP) will be followed. This will include the following actions:
- a. The Contractor to notify of the exceedances to the Environment Agency, within 24 hours
 - b. The Contractor to determine the cause of any exceedances (for example by reviewing laboratory data, re-sampling the location to assess accuracy of results or by reviewing on-site activities)
 - c. If re-sampling and secondary analysis is undertaken, the Contractor shall notify of the Employer and the Environment Agency of the results.
 - d. Prepare a notification report and inform key stakeholders (eg, the Environment Agency and the Employer) within seven days of exceedance.
 - e. Within one week of the Trigger Levels exceedance being verified the Contractor shall evaluate the location, likely scale, duration and effect and identify an appropriate mitigation strategy for agreement with the Environment Agency.
- C.7.13 In all cases, the need for remediation should be balanced against the risk posed to groundwater receptors and the benefits gained by remediation. Remedial actions and their objectives shall be agreed in with the Environment Agency.
- C.7.14 Exceedances of Alert Levels should also be investigated by reviewing laboratory data and if necessary re-sampling of the location to assess the accuracy of the results. However, any exceedances of Alert Levels will be reported to the Environment Agency using the quarterly factual reporting process.
- C.7.15 Only in cases where Trigger Levels are exceeded will the Environment Agency be contacted.

C.8 Groundwater monitoring deliverables

Baseline groundwater monitoring

- C.8.1 Monitoring by the Employer has finished and is reported in the ES groundwater baseline monitoring report.

Pre-construction baseline groundwater monitoring

- C.8.2 A one-off pre-construction groundwater baseline monitoring report for the whole Thames Tideway Tunnel has been completed by the Employer and approved by the Environment Agency (Tideway Baseline Groundwater Monitoring Report June 2016, 2530-TDWAY-TTTUN-182-NZ-RG-100006-P01).

Tunnel preliminary risk assessments

C.8.3 A preliminary risk assessment shall be completed by the Contractor of potential contamination plumes along the tunnel route, for sites identified as having a potential to connection to the lower aquifer.

Construction monitoring

C.8.4 Construction monitoring reports will be produced for the Environment Agency to the schedule defined in the approved monitoring plan (discussed further in Part D), and summarised below.

Table C.2. Reporting requirements during the construction period

Responsible Party	Event based	Quarterly	Annual
Contractor	Notification reports.	Site specific factual reports.	Area wide interpretative report.
Employer	-	-	Groundwater Monitoring and Management Review.

C.8.5 At the end of construction period (or a minimum of one year after construction ground disturbance, whichever is the later^{ix}), a ‘Post-Construction Groundwater Environmental Monitoring Report’ will be prepared by the Employer and submitted to the Environment Agency for approval.

C.8.6 This document will form the baseline against which the operational monitoring will be compared and confirm the framework for monitoring going into the operational phase.

Operational monitoring

C.8.7 Long-term groundwater quality monitoring will be undertaken by the Employer. The scope of the long term monitoring and reporting requirements will be presented in the Post-Construction Groundwater Environmental Monitoring Report produced by the Employer for information to the Environment Agency.

^{ix} This is assumed to be during 2024.

D. Part D: Groundwater monitoring and management plan

D.1 Project wide groundwater monitoring plan

Overview

D.1.1 This overarching, project wide Groundwater Monitoring Management Plan defines the Employer's responsibilities outlined in Part C of this Strategy and formalises the Employer's project wide Groundwater Monitoring Plan.

Employer's responsibilities

D.1.2 The Employer will be responsible for:

- a. Maintaining the project wide Groundwater Monitoring Plan.
- b. Pre-construction baseline groundwater monitoring (now complete: monitoring responsibility has been transferred to the Contractors¹⁰).
- c. Preparing a pre-construction baseline monitoring report prior to the start of the construction phase (now complete: Tideway Baseline Groundwater Monitoring Report June 2016, 2530-TDWAY-TTTUN-182-NZ-RG-100006-P01).
- d. Agreeing alert and trigger levels in consultation with the Contractors and the Environment Agency.
- e. Reviewing Contractor's Groundwater Monitoring and Dewatering Plans.
- f. Managing co-ordination of the monitoring programmes between the Contractors during construction.
- g. Providing the Contractor's Quarterly Factual Reports to the Environment Agency for information.
- h. Reviewing combined monitoring results across the project area as a whole during construction to assess local and regional impacts.
- i. Preparing annual 'Groundwater Monitoring Management Review' reports.
- j. Preparing a 'Post-Construction Groundwater Environmental Monitoring Report' in 2024 or in an agreed time-frame with the Environment Agency.
- k. Groundwater monitoring during operational phase.

D.1.3 Responsibility for undertaking the ongoing baseline and construction phase groundwater monitoring has been transferred to the Contractors and will continue until the operational phase.

¹⁰ Groundwater monitoring was transferred to the Contractor's between May and July 2016.

Employer's management responsibilities

- D.1.4 Overarching management of the monitoring programme by the Employer is required to ensure consistency between the three project areas.
- D.1.5 The Employer will review and approve the Contractor's Groundwater Monitoring Plans prior to submission to the Environment Agency for approval. This review process shall include:
- a. Assessment of consistency in approach by the three Contractors with respect to:
 - i. monitoring methodology
 - ii. choice of contamination indicator species
 - iii. approach to alert and trigger levels
 - iv. contingency plans
 - v. reporting templates¹¹.
 - b. Identification and resolution of any significant discrepancies between neighbouring Contractors' Groundwater monitoring plans.
- D.1.6 The Employer shall review the Contractor's Quarterly Factual and Annual Interpretative Monitoring Reports and provide comments to Contractors within four weeks. The scope of this review shall include:
- a. Assessment of Contractor compliance with agreed monitoring plan.
 - b. Identification and assessment of any significant discrepancies between neighbouring Contractors' findings or conclusions.
 - c. Identification and assessment of any spatial or temporal patterns affecting the project as a whole.
 - d. Identification and assessment of any consistency issues between Contractors that might result from proposed amendments to monitoring plans.
 - e. Identification and assessment of groundwater-related issues that might affect the Operational phase of the project.
- D.1.7 The findings of this overarching monitoring review process shall be presented by the Employer to the Environment Agency in an Annual Monitoring Management Review report.
- D.1.8 The Employer shall be responsible for mediating disputes between Contractors over groundwater issues along the boundaries between Contractor's areas.

Employer's monitoring requirements

- D.1.9 The Employer has collected some baseline groundwater data. The Employer will be responsible for the operational monitoring during commissioning and operation of the project, and following the completion of the Contractor's construction and post-construction phase monitoring.

¹¹ Reporting template included in Appendix D 'Integrated Groundwater Monitoring and Dewatering Plan'.

- D.1.10 The Employer will present the framework for commissioning and operational phase monitoring in an Employers 'Post-Construction Groundwater Environmental Monitoring Report' for agreement with the Environment Agency.

D.2 Contractor groundwater monitoring plan

Overview

- D.2.1 The Contractor shall be responsible for groundwater monitoring during the Construction phase (and for at least twelve months following completion of construction).
- D.2.2 The Contractor shall prepare a detailed Groundwater Monitoring Plan. The Contractor's Groundwater Monitoring Plan must be approved by the Employer and the Environment Agency prior to relevant construction works commencing on site (as detailed in section A.6).
- D.2.3 It should be consistent with the Groundwater Monitoring Strategy (Part C) and overarching Groundwater Monitoring Plan (Part D, this section).
- D.2.4 The Contractor's Groundwater Monitoring Plan shall include the following elements:
- a. management structure, including roles and responsibilities within Contractor team
 - b. monitoring network already in existence
 - c. monitoring measurements and methodology
 - d. monitoring schedules
 - e. data management procedures
 - f. data review procedures, including comparison with alert and trigger levels.
 - g. contingency actions; and
 - h. reporting procedures.
- D.2.5 A template for the Contractors Groundwater Monitoring Plan is included in Appendix D as part of the Integrated Groundwater Monitoring and Dewatering Plan.
- D.2.6 The Contractor Groundwater Monitoring Plan shall be submitted no later than three months before construction to the Employer for comment. The Employer's comments should be addressed prior to submission of the Plan to the Environment Agency for approval, in line with the Requirements of PW13 of Schedule 3 of the Development Consent Order (DCO).
- D.2.7 The Contractor shall not deviate from the approved Contractor Groundwater Monitoring Plan without written permission from the Employer and the Environment Agency.
- D.2.8 The Contractor Groundwater Monitoring Plan shall be a live document and subject to annual review as part of the Employer's annual 'Groundwater Monitoring Management Review' report.

Monitoring networks

- D.2.9 The Contractor Groundwater Monitoring Plans shall present details regarding the groundwater monitoring network that will be used during the Construction phase.
- D.2.10 Groundwater monitoring shall be undertaken in the monitoring boreholes summarised in Appendix B. Additional monitoring locations may be utilised by the Contractor as required.
- D.2.11 The Contractor Groundwater Monitoring Plan shall include a protocol and schedule for regular monitoring point inspection and maintenance. This shall include the Contractor's procedures for the repair and replacement of monitoring points as required.
- D.2.12 An up-to-date register of all permitted monitoring points should be incorporated within the Contractor Groundwater monitoring plan and annual review report.

Monitoring methodology

- D.2.13 The Contractor Groundwater Monitoring Plan shall present the monitoring methodology and laboratory protocols that will be implemented during the Construction phase for approval by the Employer and the Environment Agency.

Sampling and field analysis

- D.2.14 The Contractor Groundwater monitoring plan shall specify field protocols with respect to:
- a. monitoring network condition inspections
 - b. in situ groundwater level measurement protocols:
 - i. manual measurements
 - ii. data loggers.
 - c. sampling method(s) and protocols, including purging (where appropriate)
 - d. field analysis protocols including calibration details of field equipment where appropriate.
 - e. sample handling protocols:
 - i. sample containers and preservation
 - ii. sample labelling
 - iii. sample storage and transportation.
 - iv. Chain of custody procedures.
 - f. QA/QC protocols, including:
 - i. Frequency and type of blank samples collected.
 - ii. Frequency of duplicate sampling in the field.
 - iii. Methods for resolving any QA/QC issues.
- D.2.15 The Contractor's Groundwater Monitoring Plan shall reference the standards and guidance documents detailed in Part C of this document.

- D.2.16 The Contractor's Groundwater monitoring plan shall reference appropriate protocols for managing and disposal of waste waters and disposable equipment generated during sampling procedures.

Laboratory analysis

- D.2.17 The Contractor Groundwater monitoring plan shall specify laboratory analysis protocols with respect to:
- a. laboratory selection, including accreditation requirements
 - b. analytical suite
 - c. analytical methods
 - d. detection limits
 - e. laboratory QA/QC protocols.

Monitoring schedule

- D.2.18 The Contractor Groundwater monitoring plan shall present a detailed schedule for groundwater monitoring pre-construction, during the construction activities and post- construction, with monitoring frequencies provided.
- D.2.19 As a minimum, groundwater monitoring shall be undertaken at the frequency defined in Part C of this document. Additional monitoring rounds may be undertaken by the Contractor (on behalf of the Employer) as required.
- D.2.20 All scheduled monitoring shall be based on the calendar year, with monitoring year end being 31 December.

Data management and review

- D.2.21 The Contractor shall be responsible for managing the groundwater monitoring data collected during the Contractor's monitoring period and providing the data to the Employer.
- D.2.22 The Contractor's Groundwater Monitoring Plan shall specify protocols for data management, including:
- data collection
 - data collation
 - data validation
 - data storage.
- D.2.23 As a minimum, monitoring data shall be validated within five working days of receipt.
- D.2.24 The Contractor shall be responsible for keeping original monitoring records and submitting these to the Employer on completion of construction.
- D.2.25 All data shall be stored in Excel-compatible formats unless where otherwise agreed (pdf laboratory certificated for example).
- D.2.26 The Contractor shall be responsible for reviewing the groundwater monitoring data collected. The Contractor's data review will include:

- comparison of actual against specified monitoring and laboratory schedules;
- comparison of new data against recent data to review trends in groundwater quality and levels.
- comparison of data against applicable Alert and Trigger Levels;
- a review of the conceptual site model; and
- a review of the suitability of the Contractors Groundwater Monitoring Plan.

D.2.27 The Contractor shall be responsible for ongoing review of the Alert and Trigger Levels for adequacy during the construction period.

D.2.28 Any proposed changes to the Alert and Trigger may be implemented only after consultation and agreement between the Contractor, the Employer and the Environment Agency.

Contingency planning

D.2.29 The Contractor's Groundwater Monitoring Plan shall outline a phased contingency response process that shall be implemented by which the risks to the project and nearby receptors can be assessed and managed in the event of any breach of approved Alert or Trigger Levels.

D.2.30 Where unacceptable risks are identified, confirmatory, corrective or remediation measures should be initiated. A strategy to monitor their effectiveness should be determined within one week of the Trigger Level exceedance being confirmed.

D.2.31 Initially, resampling and reanalysis by the laboratory should be undertaken. Where appropriate, correction or remediation measures shall be then be initiated in consultation with the Environment Agency.

D.2.32 In all cases, the need for remediation should be balanced against the risk posed to groundwater receptors and the benefits gained by remediation. In complex cases, specialist advice should be taken and remedial actions and their objectives agreed in consultations between the Contractor and the Environment Agency.

D.2.33 Recommended contingency strategies are outlined below; the Contractor's Groundwater Monitoring Plan may include alternative or additional contingency plans as appropriate. The Contractor's Groundwater Monitoring Plan shall specify the required timescales and parties responsible for implementing each action.

Assessment criteria (Alert Levels)

D.2.34 Alert Levels are intended to draw the attention of site management to the development of adverse trends in monitoring data by the breach of a specified Alert Level.

D.2.35 The Alert Levels should be treated primarily as an early warning system to enable appropriate investigative or corrective measures to be implemented, in a timely manner particularly where there is the potential for a compliance limit to be breached.

D.2.36 The Contractor's Groundwater Monitoring Plan shall specify the Alert Levels and the protocols for identifying adverse trends.

- D.2.37 If an Alert Level is breached on a single occasion:
- a. notify Site Management Team
 - b. repeat sampling round if no routine sampling is planned within 14 days
 - c. report in next quarterly factual monitoring report.
- D.2.38 If an Alert Level is breached on three consecutive monitoring rounds or if the Contractor's ongoing review process identifies significant adverse trends in four monitoring rounds, further assessment will be required:
- a. Characterise observed issues (desk-based data review), including:
 - i. parameter(s) involved
 - ii. magnitude of exceedance(s)
 - iii. frequency of exceedance(s)
 - iv. spatial pattern
 - v. temporal trends.
 - b. Review relevant site activities.
 - c. Review potential cause(s) for observed results (both within and from outside Contractor's area).
 - d. Review monitoring plan for adequacy.
 - e. Undertake additional investigation or monitoring (if required) to better characterise issue.
 - f. Identify likely cause(s) for observed results.
- D.2.39 If the observed issue is considered to relate to the project:
- a. consult with regulator(s)/stakeholders (as appropriate)
 - b. review significance of potential risks to receptors
 - c. implement appropriate mitigation measures to try and halt or reverse adverse trends and/or manage risks for receptors
 - d. carry out ongoing monitoring at an increased frequency and review to confirm effectiveness of measures implemented.
- D.2.40 The assessment findings and actions shall be reported in the next monitoring report.

Compliance Criteria (Trigger Levels)

- D.2.41 If a Trigger Level is breached on a single occasion:
- a. notify Site Management Team in writing
 - b. undertake Assessment of Significance (desk-based data review):
 - i. parameter(s) involved
 - ii. magnitude of exceedance(s)
 - iii. frequency of exceedance(s)
 - iv. spatial pattern

- v. temporal trends
 - vi. risks to nearby receptors
 - c. repeat sampling round if no routine sampling is planned within 7 days
 - d. prepare notification report and inform key stakeholders (eg, Environment Agency, the Employer) within 7 days .
- D.2.42 If a Trigger Level breach occurs on three consecutive monitoring rounds, is part of a significant adverse trend, or is considered to indicate an immediate and significant risk to nearby receptors, then the Contractor shall undertake the following additional actions:
- a. Prepare notification report and inform key stakeholders (eg, Environment Agency, the Employer), as soon as possible.
 - b. Notify other relevant stakeholders within one week as appropriate, eg, other abstractors.
 - c. Review relevant activities occurring on site.
 - d. Review potential cause(s) for observed results.
 - e. Review existing monitoring plan for adequacy.
 - f. Undertake additional targeted monitoring or investigation (if required) to better characterise issue.
 - g. Identify likely cause(s) for observed results.
- D.2.43 If the observed issue is considered to relate to the project:
- a. Review significance of risks to nearby receptors.
 - b. Develop strategy within one week of a single Trigger Level exceedance being confirmed by the laboratory, to mitigate and/or remediate issue(s) in consultation with key stakeholders.
 - c. Implement mitigation and/or remedial measures (as appropriate) to reduce risk of future breaches affecting project or nearby receptors.
 - d. Ongoing monitoring and review to confirm effectiveness of measures implemented.
- D.2.44 The assessment findings and actions shall be reported in the next monitoring report.

Emergency measures

- D.2.45 Additional groundwater monitoring may be required in the event of a pollution incident^{12, 13}, occurring at or near the site. The scope of any such additional monitoring shall be proposed by the Contractor for the approval of the Employer and the Environment Agency. The scope should be targeted to reflect the nature of pollution incident and potential risks. This cannot be readily defined in advance of any incident occurring. Instead, the Contractor Groundwater monitoring plan

¹² The Construction Environmental Management Plan for each site will include pollution incident response plans.

¹³ A pollution incident is a specific event that may have a negative environmental impact. In this case it could be considered as an event which has the potential to cause groundwater pollution.

must include a phased process by which the necessary scope of additional monitoring is to be proposed by the Contractor for approval by the Employer and the Environment Agency following a pollution incident.

- D.2.46 In the event of a pollution incident, the Contractor shall undertake the following additional actions:
- a. Comply with agreed pollution incident response plans.
 - b. Notify key stakeholders (eg, Environment Agency and the Employer) as soon as possible.
 - c. Review significance of risks to nearby groundwater receptors.
 - d. Notify other relevant stakeholders within 1 week as appropriate, eg, other nearby abstractors.
 - e. Review existing groundwater monitoring plan for adequacy.
 - f. Design additional targeted monitoring or investigation (if required) to better characterise issue; consult with the Environment Agency and other stakeholders as appropriate.
 - g. Undertake additional targeted monitoring or investigation (if required) and review results.
 - h. Develop strategy to mitigate and/or remediate issue(s) in consultation with key stakeholders.
 - i. Implement mitigation and/or remedial measures (as appropriate) to reduce risk of future breaches affecting project or nearby receptors.
 - j. Ongoing monitoring and review to confirm effectiveness of measures implemented.
- D.2.47 The assessment findings and actions shall be reported in the next monitoring report.

Contractor's reporting requirements

- D.2.48 The Contractor shall be responsible for reporting the groundwater monitoring results during the construction phase of the project. The monitoring reporting shall include:
- a. notification reports (if required)
 - b. quarterly factual reports
 - c. annual interpretative reports.
- D.2.49 The monitoring reports shall be:
- a. submitted on time
 - b. quality assured
 - c. collated and presented in a consistent format.
- D.2.50 The templates for the monitoring reports shall be approved in advance by the Employer in consultation with the Environment Agency. The reporting templates may not be altered without approval from the Employer.

D.2.51 The reports shall be submitted electronically in PDF format. The factual data shall be submitted in an Excel-compatible format.

Notification report

D.2.52 Notification reports shall be used to disseminate information regarding breaches of Trigger Levels or other groundwater pollution incidents. These reports should provide clear, concise information. Notification reports should be issued within a time frame approved by the Employer and the Environment Agency.

D.2.53 Notification reports should include:

- a. date and time of issue of report
- b. name, position and contact information for person issuing report
- c. date and time of monitoring surveys or observations that confirm the breach of a compliance limit, or an actual pollution incident
- d. pollution incident recorded or compliance limit breached
- e. details of any emergency contingency actions implemented
- f. details of mitigation measures proposed
- g. an indication of the urgency of response needed by the Employer and/or the Environment Agency.

D.2.54 In instances where assessment criteria or compliance limits are breached regularly and action is being implemented by the site operator (eg, where remedial measures are underway or where the source of contamination to groundwater is being investigated), alternative ongoing reporting procedures may be agreed between the site operator and the Environment Agency to avoid unnecessary duplication of notification reports.

Quarterly factual report

D.2.55 Quarterly factual monitoring reports shall be prepared by each Contractor.

Table D.1 Factual monitoring report requirements

Suggested chapter heading	Recommended content
Summary of monitoring completed	<ul style="list-style-type: none"> • Summary of locations sampled within quart in tabular form. • Audit of compliance with monitoring plan requirements.
Summary of key results	<ul style="list-style-type: none"> • Groundwater level data in graphical form against alert and trigger levels. • Groundwater quality data in graphical form against alert and trigger levels. • Number and location of breaches of Alert Levels in tabular form. • Number and location breaches of Trigger Levels in tabular form.

Suggested chapter heading	Recommended content
	<ul style="list-style-type: none"> Number and location of notification reports provided to the Environment Agency.
Recommendations and Ongoing Actions.	<ul style="list-style-type: none"> Summary of contingency actions completed / required / ongoing. Summary of emergency procedures completed / required / ongoing. Summary of agreed changes to Contractor's Groundwater Monitoring Plan.
Appendices	<ul style="list-style-type: none"> Factual datasets of water quality and groundwater levels (electronic).

D.2.56 The quarterly factual reports shall be submitted to the Employer within four weeks of the end of each quarter. The quarterly reports shall be made available to the Environment Agency (or via project data portal) by the Employer.

D.2.57 Quarterly factual reports will be based on standard calendar year rather than based on start of construction to ensure the Contractor's reporting cycles are consistent.

Annual interpretative report

D.2.58 Interpretative monitoring reports shall be prepared by each Contractor annually based on the monitoring data collected to monitoring year end (31 December).

Table D.2 Annual interpretative monitoring report requirements

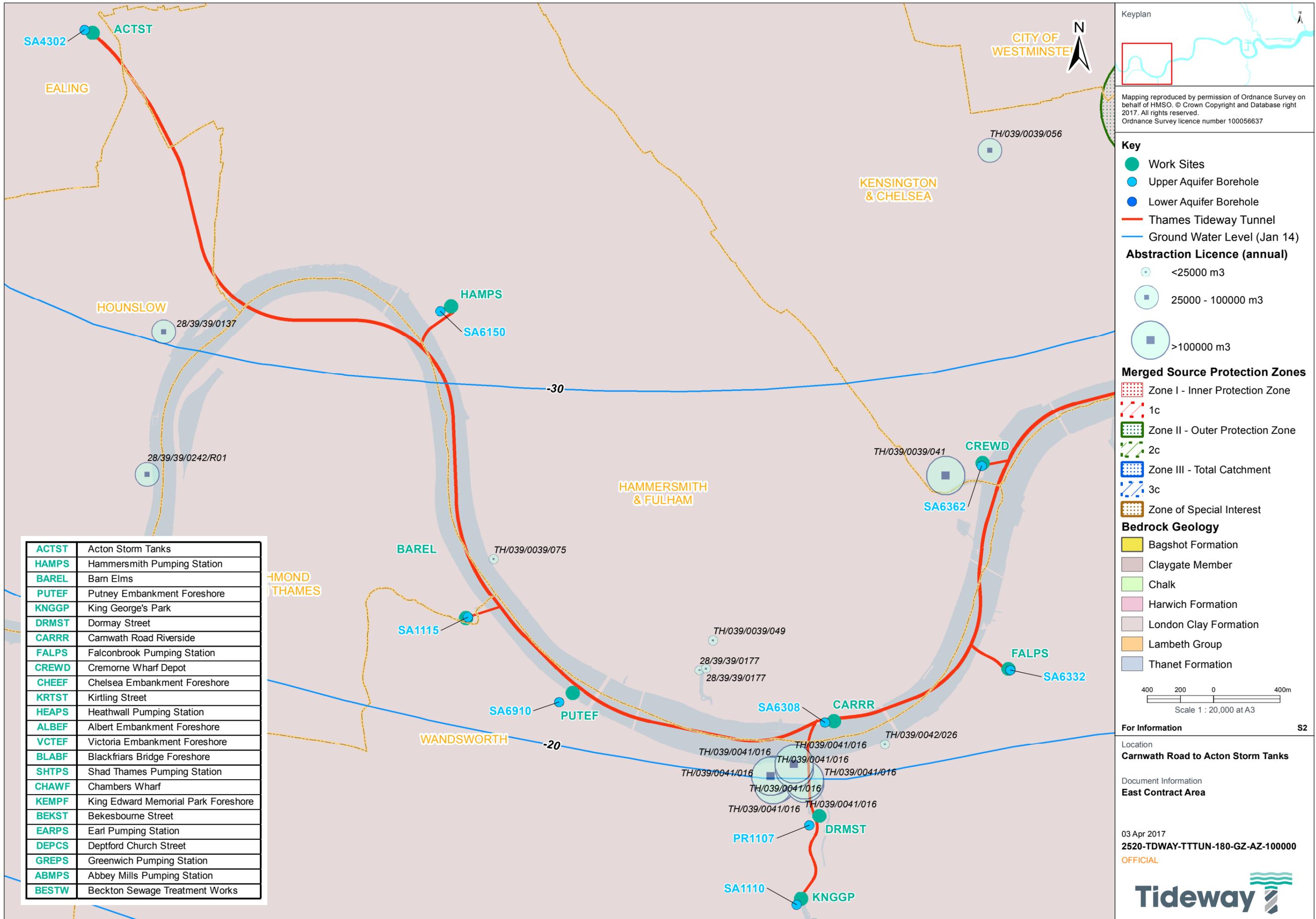
Suggested chapter heading	Recommended content
Summary of monitoring completed	<ul style="list-style-type: none"> Summary of locations sampled in tabular form. Audit of compliance with monitoring plan requirements. Updated register of monitoring network.
Summary of key results	<ul style="list-style-type: none"> Groundwater level data in graphical form. Spatial contour plots of groundwater levels in upper and lower aquifers. Key groundwater quality data to be displayed in graphical form. Spatial plots of key groundwater quality and salinity (EC) in upper and lower aquifer at an appropriate scale. Breaches of Alert Levels in tabular form. Breaches of Trigger Levels in tabular form.
Interpretation of results	<ul style="list-style-type: none"> Review of trends in water level and quality. Assessment of construction works on trends in water quality and level.

Suggested chapter heading	Recommended content
	<ul style="list-style-type: none"> • Assessment of off-site / third party works on trends in water quality and level. • Additional risk assessment, if required. • Update or refinement of conceptual model (if appropriate). • Assessment of effectiveness of any implemented mitigation measures. • Review of monitoring network and laboratory suites.
Recommendations	<ul style="list-style-type: none"> • Proposed modifications to Contractor's Monitoring Plan (if required) <ul style="list-style-type: none"> • Changes to monitoring locations • Changes to monitoring frequency • Changes to sampling methodology • Changes to analytical suites • Proposed revisions to Alert and Trigger Levels (if appropriate) • Mitigation and/or remedial measures (if required) to manage groundwater-related risks to project or nearby receptors • Other proposed modifications to site activities to better manage risks to/from groundwater (if appropriate)

D.2.59 The annual reports shall be submitted by the Contractors in draft to the Employer within four weeks of monitoring year end (31 December). The approved draft final annual reports shall be submitted by the Contractors to the Environment Agency within two months of monitoring year end. Following receipt of corrections and comments from the Environment Agency, the final report will be produced within one month of receipt of these comments.

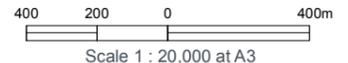
Appendix A– Figures

Title	Reference
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Kirtling Street to Carnwath Road	2530-TDWAY-TTTUN-180-GZ-AZ-100001
Kirling Street to Chambers Wharf	2530-TDWAY-TTTUN-180-GZ-AZ-100002
Chambers Wharf to Abbey Mills	2530-TDWAY-TTTUN-180-GZ-AZ-100003
Greenwich Pumping Station to Chambers Wharf	2530-TDWAY-TTTUN-180-GZ-AZ-100004



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- Key**
- Work Sites
 - Upper Aquifer Borehole
 - Lower Aquifer Borehole
 - Thames Tideway Tunnel
 - Ground Water Level (Jan 14)
- Abstraction Licence (annual)**
- <25000 m3
 - ◻ 25000 - 100000 m3
 - ◻ >100000 m3
- Merged Source Protection Zones**
- Zone I - Inner Protection Zone
 - 1c
 - Zone II - Outer Protection Zone
 - 2c
 - Zone III - Total Catchment
 - 3c
 - Zone of Special Interest
- Bedrock Geology**
- Bagshot Formation
 - Claygate Member
 - Chalk
 - Harwich Formation
 - London Clay Formation
 - Lambeth Group
 - Thanet Formation



ACTST	Acton Storm Tanks
HAMPS	Hammersmith Pumping Station
BAREL	Barn Elms
PUTEF	Putney Embankment Foreshore
KNGGP	King George's Park
DRMST	Dormay Street
CARRR	Carnwath Road Riverside
FALPS	Falconbrook Pumping Station
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KRTST	Kirtling Street
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CHAWF	Chambers Wharf
KEMPF	King Edward Memorial Park Foreshore
BEKST	Bekesbourne Street
EARPS	Earl Pumping Station
DEPCS	Deptford Church Street
GREPS	Greenwich Pumping Station
ABMPS	Abbey Mills Pumping Station
BESTW	Beckton Sewage Treatment Works

For Information S2

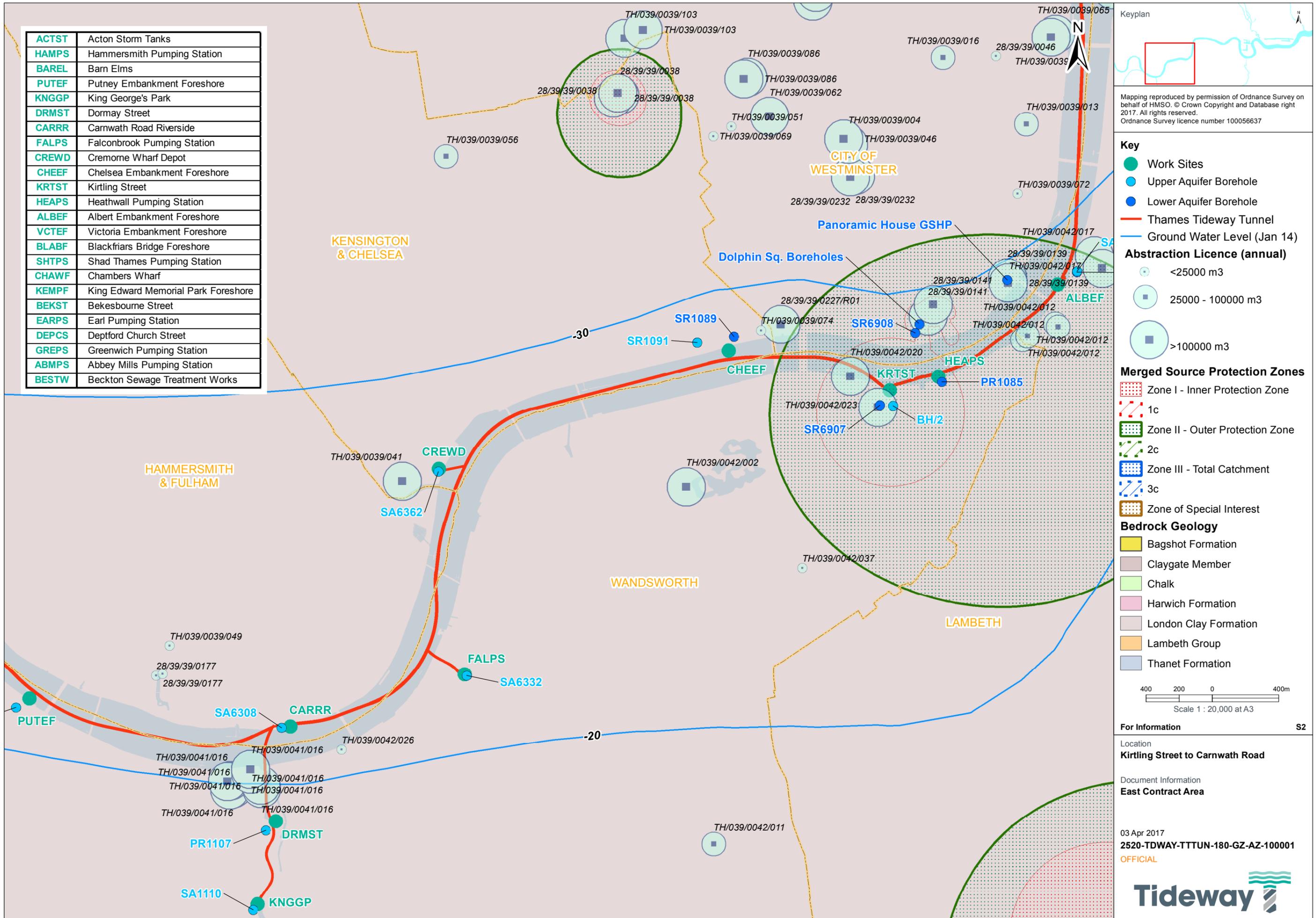
Location
Carnwath Road to Acton Storm Tanks

Document Information
East Contract Area

03 Apr 2017
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ACTST	Acton Storm Tanks
HAMPS	Hammersmith Pumping Station
BAREL	Barn Elms
PUTEF	Putney Embankment Foreshore
KNGGP	King George's Park
DRMST	Dormay Street
CARRR	Carnwath Road Riverside
FALPS	Falconbrook Pumping Station
CREWD	Cremorne Wharf Depot
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KRTST	Kirtling Street
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Key

- Work Sites
- Upper Aquifer Borehole
- Lower Aquifer Borehole
- Thames Tideway Tunnel
- Ground Water Level (Jan 14)

Abstraction Licence (annual)

- <25000 m3
- 25000 - 100000 m3
- >100000 m3

Merged Source Protection Zones

- Zone I - Inner Protection Zone
 - 1c
- Zone II - Outer Protection Zone
 - 2c
- Zone III - Total Catchment
 - 3c
- Zone of Special Interest

Bedrock Geology

- Bagshot Formation
- Claygate Member
- Chalk
- Harwich Formation
- London Clay Formation
- Lambeth Group
- Thanet Formation

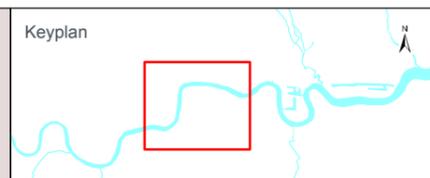
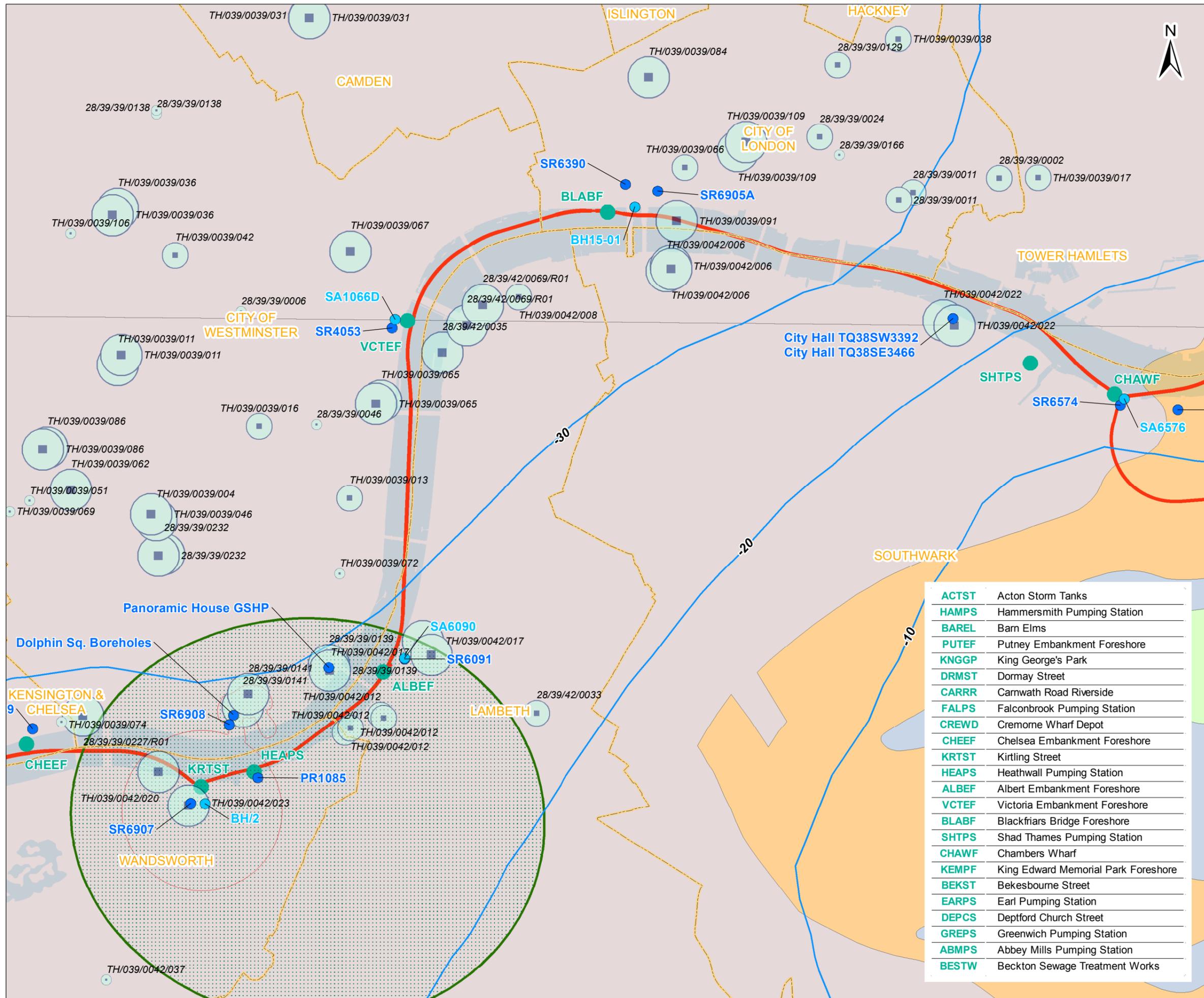
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Location
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Document Information
East Contract Area

03 Apr 2017
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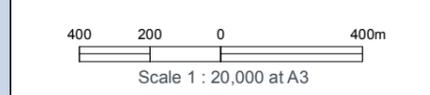
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For Information S2

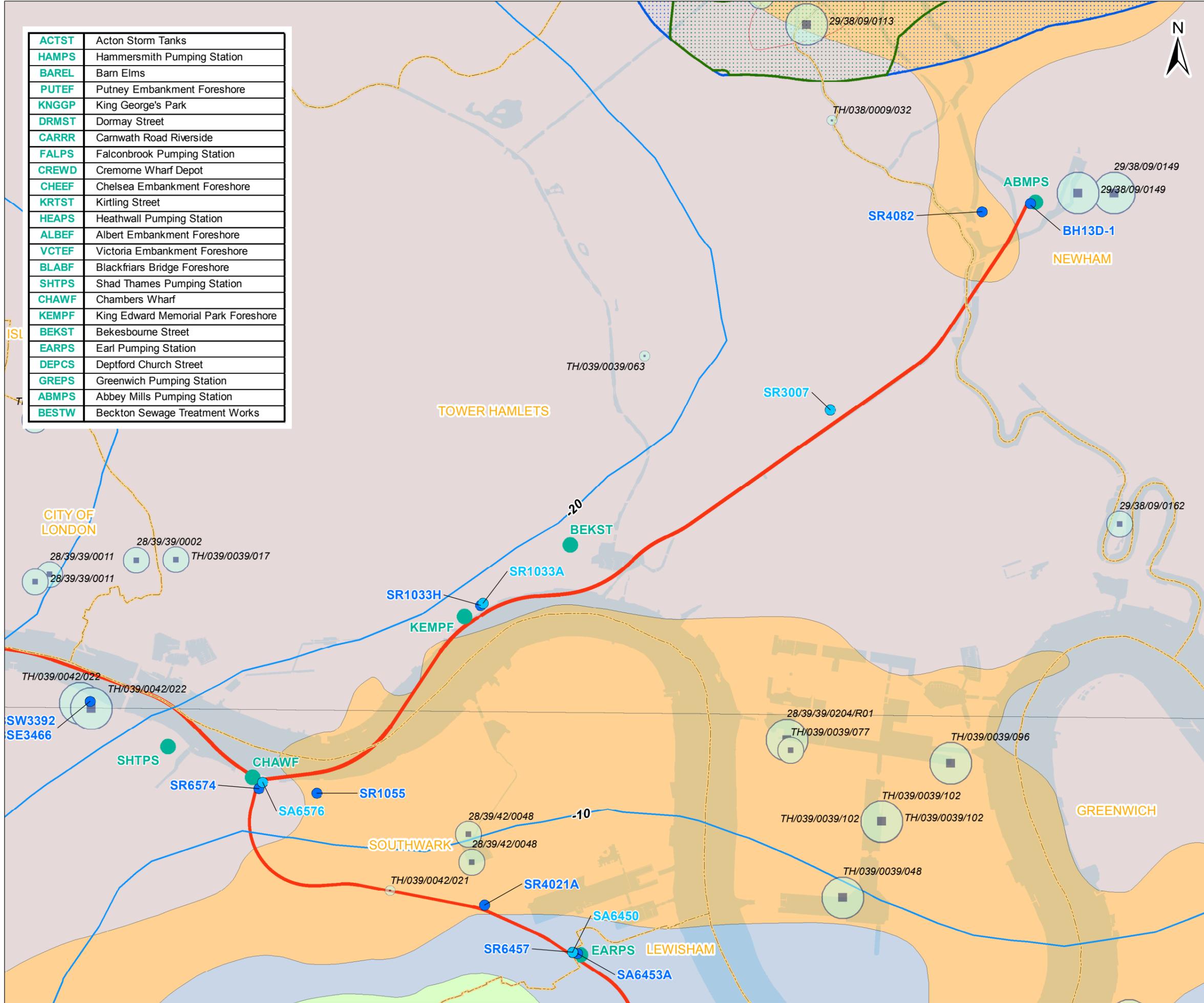
Location
Kirtling Street to Chambers Wharf

Document Information
East Contract Area

03 Apr 2017
2520-TDWAY-TTTUN-180-GZ-AZ-100002
OFFICIAL



ACTST	Acton Storm Tanks
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Key

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- Ground Water Level (Jan 14)

Abstraction Licence (annual)

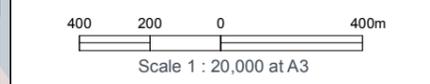
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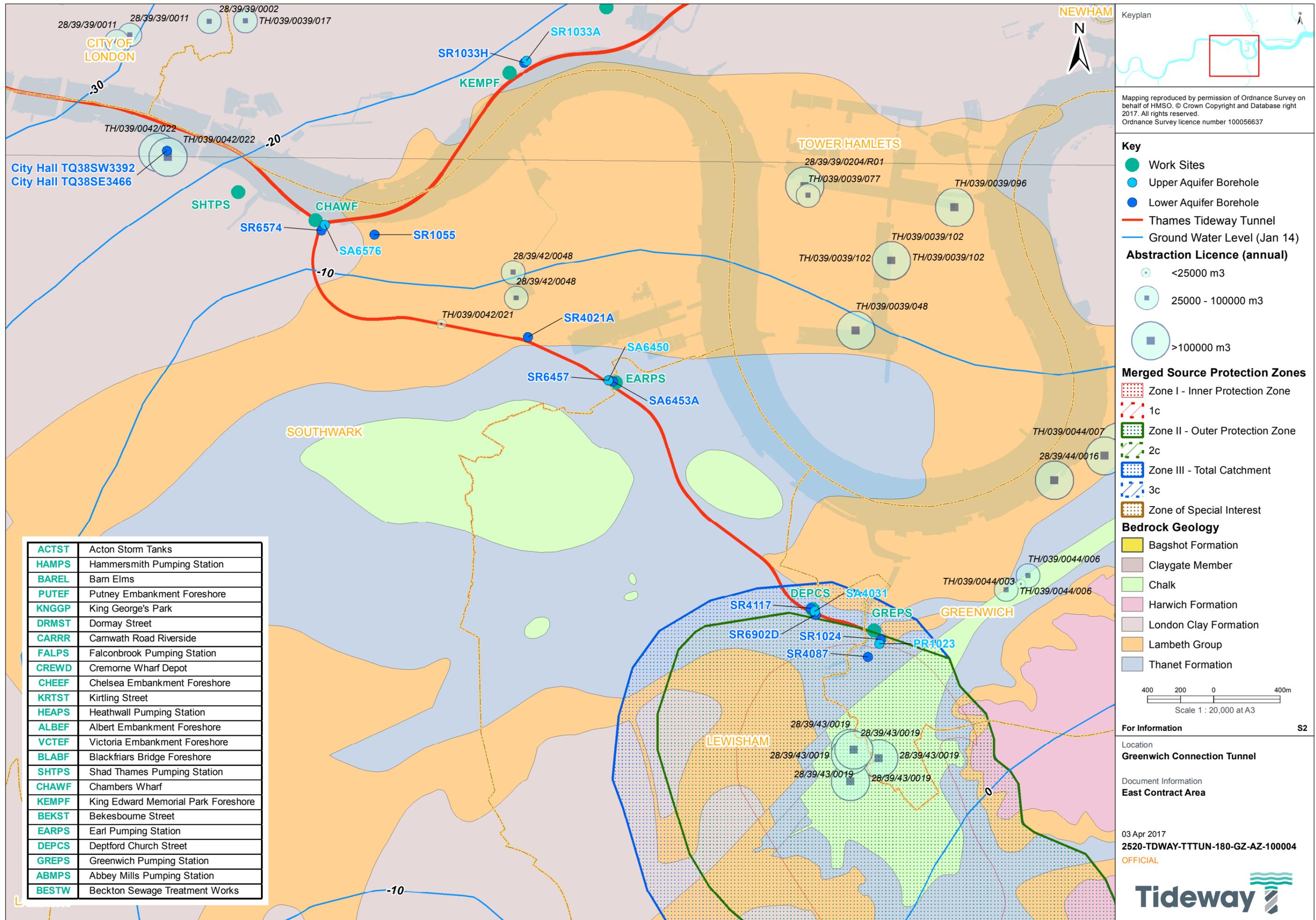
For Information S2

Location
Chambers Wharf to Abbey Mills

Document Information
East Contract Area

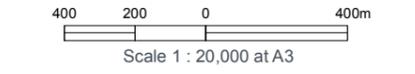
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 - Thanet Formation



For Information S2

Location
Greenwich Connection Tunnel

Document Information
East Contract Area

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ACTST	Acton Storm Tanks
HAMPS	Hammersmith Pumping Station
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ABMPS	Abbey Mills Pumping Station
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Appendix B– Register of monitoring locations

GEMDMS Location							
Site / Location	Borehole	Status	Purpose			Response Zone	Aquifer unit
		(as of March 2017)	Manual groundwater level recording	Groundwater quality sampling	Data-logger (EC, temp, level)		
WEST							
Acton Storm Tanks	SA4302	Existing	✓	✓		ALV	Upper
Hammersmith Pumping Station	SA6150	Existing	✓	✓		RTD	Upper
Barn Elms	SA1115	Existing	✓	✓		RTD	Upper
Putney Embankment Foreshore	SA6910	Existing	✓	✓		RTD	Upper
Dormay Street	PR1107	Existing	✓	✓		RTD	Upper
King George's Park	SA1110	Existing	✓			MG	Upper
Carnwath Road Riverside	SA6308	Existing	✓	✓		RTD	Upper
CENTRAL							
Falconbrook Pumping Station (Bridge Court Car Park)	SA6332	Existing	✓	✓		RTD	Upper
Cremorne Wharf Depot	SA6362	Existing	✓	✓		MG/RTD	Upper
Chelsea Embankment Foreshore	SR1091	Existing	✓	✓		RTD	Upper
	SR1089	Existing	✓	✓	✓	TSF	Lower
Kirtling Street	SR6907	Existing	✓	✓	✓	CHALK	Lower
	BH2	Existing	✓	✓		RTD	Upper
Dolphin Sq.	BH1 to 4	New	✓	✓		CHALK	Lower
Heathwall Pumping Station	PR1085	Existing	✓	✓		ALV	Upper

GEMDMS Location							
Site / Location	Borehole	Status	Purpose			Response Zone	Aquifer unit
		(as of March 2017)	Manual groundwater level recording	Groundwater quality sampling	Data-logger (EC, temp, level)		
	SR6908	Existing	✓	✓	✓	CHALK	Lower
Albert Embankment Foreshore	SR6090	Existing	✓	✓		RTD	Upper
	SR6091	Existing	✓	✓		CHALK	Lower
	Panoramic Buldiling GHSP	Existing	✓	✓	✓	CHALK	Lower
Victoria Embankment Foreshore	SA1066D	Existing	✓	✓		RTD	Upper
	SR4053	Existing	✓	✓	✓	TSF	Lower
Blackfriars Bridge Foreshore	BH15-01	Existing	✓	✓		RTD	Upper
	SR6390	Existing	✓	✓	✓	CHALK	Lower
	SR6905	Existing	✓	✓	✓	CHALK	Lower
City Hall (between Blackfriars Bridge and Chambers Wharf)	City Hall (TQ38SW3392 / TQ38SE3466)	Existing	✓	✓	✓	CHALK	Lower
EAST							
Chambers Wharf	SR6574	Existing	✓	✓	✓	CHALK	Lower
	SA6576	Existing	✓	✓		RTD	Upper
Kings Stairs Garden (near Chamber Wharf)	SR1055	Existing	✓	✓		CHALK	Lower
King Edward Memorial Park	SR1033H	Existing	✓	✓		CHALK	Lower

GEMDMS Location							
Site / Location	Borehole	Status	Purpose			Response Zone	Aquifer unit
		(as of March 2017)	Manual groundwater level recording	Groundwater quality sampling	Data-logger (EC, temp, level)		
	SR1033A	Existing	✓	✓		RTD	Upper
Abbey Mills to King Edward Memorial Park	SR3007	Existing	✓	✓		CHALK	Lower
Abbey Mills PS	PW4	Location decommissioned by Lee Tunnel, new location required.	✓	✓		CHALK	Lower
	BH13D-1	Existing Lee Tunnel location	✓	✓		RTD	Upper
	SP1-CH	Location decommissioned by Lee Tunnel, new location required.	✓	✓	✓	CHALK	Lower
	SR4082	Interim for use until Lee Tunnel borehole available.	✓	✓	✓	CHALK	Lower
Greenwich Connection Tunnel							
Surrey Quays Shopping Centre (BH3) (near Earl Pumping Station)	SR4021A	Existing	✓	✓	✓	CHALK	Lower
Earl Pumping Station	SA6450	Existing	✓	✓		RTD	Upper

GEMDMS Location							
Site / Location	Borehole	Status	Purpose			Response Zone	Aquifer unit
		(as of March 2017)	Manual groundwater level recording	Groundwater quality sampling	Data-logger (EC, temp, level)		
	SR6457	Existing	✓	✓		CHALK	Lower
	SA6453A	Existing	✓	✓		TSF	Lower
Deptford Church Street	SR4117	Existing	✓	✓		CHALK	Lower
	SA4031	Existing	✓	✓		RTD	Upper
	SR6902D	Existing	✓	✓		CHALK	Lower
Greenwich Pumping Station	SR1024	Existing	✓	✓		CHALK	Lower
	PR1023	Existing	✓	✓		ALV	Upper
	SR4087	Existing	✓	✓	✓	CHALK	Lower

Appendix C – Laboratory suites

Parameter	Laboratory Method detection limit	Unit	Thames Tideway Project List	Environment Agency Long List
1,1,1,2-Tetrachloroethane	<0.1	µg/l		Yes
1,1,1-Trichloroethane	<0.1	µg/l	Yes	Yes
1,1,2,2-Tetrachloroethane	<0.1	µg/l		Yes
1,1,2-Trichloroethane	<0.1	µg/l	Yes	Yes
1,1-Dichloroethane	<0.1	µg/l		Yes
1,1-Dichloroethene	<0.1	µg/l		Yes
1,1-Dichloropropene	<0.1	µg/l		Yes
1,2,3-Trichlorobenzene	<0.1	µg/l		Yes
1,2,4-Trichlorobenzene	<0.1	µg/l		Yes
1,2-Dichloroethane	<0.2	µg/l	Yes	Yes
1,2-Dichloropropane	<0.2	µg/l		Yes
1,3,5-Trimethylbenzene	<0.1	µg/l		Yes
1,3-Dichloropropane	<0.1	µg/l		Yes
2,3,5,6-Tetrachlorominobenzene {2,aniline}	<0.01	µg/l		Yes
2,3,5,6-Tetrachlorothioanisole	<0.01	µg/l		Yes
2,3,6-Trichlorobenzoic acid	<0.04	µg/l		Yes
2,3-Dimethylphenol {2,3-Xylenol}	<0.01	µg/l		Yes
2,4,5-trichlorophenol	<0.5	µg/l		Yes
2,4,5-Trichlorophenoxyacetic acid	<0.04	µg/l		Yes
2,4,6-trichlorophenol	<0.5	µg/l		Yes
2,4-DB	<0.04	µg/l		Yes
2,4-dichlorophenol	<0.5	µg/l		Yes
2,4-Dichlorophenoxyacetic acid	<0.04	µg/l		Yes
2,4-dimethylphenol	<0.5	µg/l		Yes
2,5-Dichlorophenol	<0.01	µg/l		Yes
2,5-Dimethylphenol {2,5-Xylenol}	<0.01	µg/l		Yes
2,6-dichlorobenzoic acid (DBA)	<0.02	µg/l		Yes
2,6-dichlorophenol	<0.5	µg/l		Yes
2,6-Dimethylphenol {2,6-Xylenol}	<0.01	µg/l		Yes
2-chlorophenol	<0.5	µg/l		Yes

Parameter	Laboratory Method detection limit	Unit	Thames Tideway Project List	Environment Agency Long List
2-methylphenol	<0.5	µg/l		Yes
3,4-Dimethylphenol {3,4-Xylenol}	<0.01	µg/l		Yes
3,5-Dimethylphenol {3,5-Xylenol}	<0.01	µg/l		Yes
3-Chlorophenol*	<0.01	µg/l		Yes
3-methylphenol	<0.5	µg/l		Yes
4-chloro-3-methylphenol	<0.5	µg/l		Yes
4-Chlorophenol	<0.5	µg/l		Yes
4-methylphenol	<0.5	µg/l		Yes
Acenaphthene	<5	ng/l		Yes
Acenaphthylene	<5	ng/l		Yes
Aldicarb Sulphone	<0.005	µg/l		Yes
Aldicarb Sulphoxide	<0.005	µg/l		Yes
Aldicarb	<0.1	µg/l		Yes
Aldrin	<0.01	µg/l		Yes
Alkalinity, Bicarbonate as CaCO ₃	<2	mg/l	Yes	Yes
Alkalinity, Carbonate as CaCO ₃	<2	mg/l	Yes	Yes
alpha-HCH	<0.01	µg/l		Yes
Aluminium (diss.filt)	<2	µg/l	Yes	Yes
Ammoniacal Nitrogen as N (low level)	<0.01	mg/l	Yes	Yes
Anthracene	<5	ng/l		Yes
Antimony (tot.unfilt)	<4	µg/l		Yes
Arsenic (diss.filt)	<0.51	µg/l	Yes	Yes
Asulam	<0.005	µg/l		Yes
Atrazine	<0.01	µg/l	Yes	Yes
Atrazine Desethyl {De-ethylatrazine}	<0.01	µg/l		Yes
Atrazine Desisopropyl	<0.05	µg/l		Yes
Azinphos ethyl	<0.02	µg/l		Yes
Azinphos methyl	<0.02	µg/l		Yes
Barium (diss.filt)	<0.2	µg/l	Yes	Yes
Barium (tot.unfilt)	<0.5	µg/l		Yes
Benazolin	<0.04	µg/l		Yes
Bendiocarb	<0.01	µg/l		Yes

Parameter	Laboratory Method detection limit	Unit	Thames Tideway Project List	Environment Agency Long List
Bentazone	<0.04	µg/l	Yes	Yes
Benzene	<0.2	µg/l	Yes	Yes
Benzo(a)anthracene	<5	ng/l		Yes
Benzo(a)pyrene	<2	ng/l	Yes	Yes
Benzo(b)fluoranthene	<5	ng/l		Yes
Benzo(g,h,i)perylene	<5	ng/l		Yes
Benzo(k)fluoranthene	<5	ng/l		Yes
Beryllium (tot.unfilt)	<1	µg/l		Yes
beta-HCH	<0.01	µg/l		Yes
Bicarbonate Alkalinity as HCO ₃	<2	mg/l		Yes
Bifenthrin	<0.05	µg/l		Yes
Boron (diss.filt)	<5	µg/l	Yes	Yes
Boron (tot.unfilt)	<135	µg/l		Yes
Bromate	<0.5	µg/l	Yes	Yes
Bromide	<0.06	mg/l		Yes
Bromodichloromethane	<0.1	µg/l		Yes
Bromoform	<0.1	µg/l		Yes
Bromomethane	<1	µg/l		Yes
Bromoxynil	<0.04	µg/l		Yes
Bupirimate	<0.001	µg/l		Yes
Cadmium (diss.filt)	<0.08	µg/l	Yes	Yes
Cadmium (tot.unfilt)	<0.5	µg/l		Yes
Calcium (diss.filt)	<0.012	mg/l	Yes	Yes
Calcium:Magnesium Ratio	Calculated	-		Yes
Carbaryl	<50	ng/l		Yes
Carbendazim	<0.02	µg/l	Yes	Yes
Carbetamide (aq)	<0.04	µg/l	Yes	Yes
Carbofuran	<50	ng/l		Yes
Carbon dioxide, dissolved	<1.3	mg/l		Yes
Carbon, Organic (diss.filt)	<3	mg/l		Yes
Carbontetrachloride	<0.1	µg/l	Yes	Yes
Carbophenothion	<0.01	µg/l		Yes
Chlorfenvinphos	<0.01	µg/l	Yes	Yes
Chloridazon (aq)	<0.03	µg/l		Yes

Parameter	Laboratory Method detection limit	Unit	Thames Tideway Project List	Environment Agency Long List
Chloride	<0.08	mg/l	Yes	Yes
Chlormequat	<0.1	µg/l		Yes
Chloroethane	<0.2	µg/l		Yes
Chloroform	<0.1	µg/l	Yes	Yes
Chloromethane	<1	µg/l		Yes
Chlorothalonil	<0.01	µg/l		Yes
Chlorotoluron	<50	ng/l	Yes	Yes
Chloroxuron	<0.001	µg/l		Yes
Chlorpyriphos	<0.01	µg/l		Yes
Chlorpyriphos-methyl	<0.01	µg/l		Yes
Chlortoluron (aq)	<0.03	µg/l	Yes	Yes
Chromium (diss.filt)	<1.2	µg/l		Yes
Chromium (tot.unfilt)	<3	µg/l		Yes
Chromium low (diss.filt)	<0.7	µg/l	Yes	Yes
Chrysene	<5	ng/l		Yes
cis-Chlordane	<0.01	µg/l		Yes
Clopyralid	<0.04	µg/l	Yes	Yes
Cobalt (tot.unfilt)	<0.5	µg/l		Yes
COD, unfiltered	<7	mg/l		Yes
Conductivity (in-situ)	-	µS/m	Yes	Yes
Copper (diss.filt)	<0.85	µg/l	Yes	Yes
Copper (tot.unfilt)	<4	µg/l		Yes
Coumaphos	<0.01	µg/l		Yes
Cyanazine	<0.01	µg/l	Yes	Yes
Cyanide, Total (low level)	<5.0	µg/l		Yes
Cyfluthrin	<0.05	µg/l		Yes
Cypermethrin	<0.01	µg/l	Yes	Yes
Cypermethrin	<0.05	µg/l		Yes
Dalapon (2,2-Dichloropropionic acid)	<0.04	µg/l	Yes	Yes
delta-HCH	<0.01	µg/l		Yes
Deltamethrin	<0.05	µg/l		Yes
Diazinon	<0.01	µg/l	Yes	Yes
Dibenzo(ah)anthracene	<5	ng/l		Yes

Parameter	Laboratory Method detection limit	Unit	Thames Tideway Project List	Environment Agency Long List
Dicamba	<0.04	µg/l		Yes
Dichlobenil	<0.01	µg/l		Yes
Dichlorodifluoromethane	<1	µg/l		Yes
Dichloromethane	<3	µg/l	Yes	Yes
Dichlorprop DCPD	<0.04	µg/l	Yes	Yes
Dichlorvos	<0.01	µg/l		Yes
Dieldrin	<0.01	µg/l		Yes
Diflurobenzuron	<0.005	µg/l		Yes
Dimethoate	<0.01	µg/l		Yes
Dissolved oxygen (in-situ)	-	mg/l	Yes	Yes
Dissolved oxygen (in-situ)	-	% Sat.	Yes	Yes
Diuron (aq)	<0.03	µg/l	Yes	Yes
Endosulphan I	<0.01	µg/l		Yes
Endosulphan II	<0.02	µg/l		Yes
Endrin	<0.01	µg/l		Yes
EPH (DRO) (C10-C40) (diss.filt)	<10	µg/l	Yes	Yes
Ethiofencarb	<0.01	µg/l		Yes
Ethion	<0.01	µg/l		Yes
Ethofumesate	<0.01	µg/l		Yes
Ethylbenzene	<0.1	µg/l	Yes	Yes
Faecal Coliforms	<1	CFU/100ml		Yes
Fenitrothion	<0.01	µg/l		Yes
Fenoprop (Silvex)	<0.04	µg/l		Yes
Fenpropimorph	<0.01	µg/l		Yes
Fenthion	<0.01	µg/l		Yes
Fenuron	<0.002	µg/l		Yes
Flumethrin	<0.1	µg/l		Yes
Fluoranthene	<5	ng/l		Yes
Fluorene	<5	ng/l		Yes
Fluoride	<0.1	mg/l	Yes	Yes
Fluoroxypyr	<0.04	µg/l		Yes
Flutriafol	<0.01	µg/l		Yes
Fonofos	<0.01	µg/l		Yes
gamma-HCH (Lindane)	<0.01	µg/l		Yes

Parameter	Laboratory Method detection limit	Unit	Thames Tideway Project List	Environment Agency Long List
Glyphosate	<0.02	µg/l	Yes	Yes
GRO >C5-C10	<10	µg/l	Yes	Yes
Hardness, Total as CaCO ₃ unfiltered	<0.35	mg/l		Yes
Heptachlor	<0.01	µg/l		Yes
Heptachlor epoxide	<0.01	µg/l		Yes
Hexachlorobenzene	<0.01	µg/l		Yes
Hexachlorobutadiene	<0.01	µg/l		Yes
Indeno(123cd)pyrene	<5	ng/l		Yes
Iodine	<0.5	mg/l		Yes
Iodofenphos	<0.01	µg/l		Yes
Ionic balance	-	% Diff		Yes
Ioxynil	<0.04	µg/l		Yes
Iprodione	<0.01	µg/l		Yes
Irgarol 1051	<0.01	µg/l		Yes
Iron (diss.filt)	<0.019	mg/l	Yes	Yes
Isodrin	<0.01	µg/l		Yes
Isoproturon (aq)	<0.04	µg/l	Yes	Yes
Lambda-Cyhalothrin	<0.05	µg/l		Yes
Lead (diss.filt)	<0.1	µg/l	Yes	Yes
Lead (tot.unfilt)	<0.5	µg/l		Yes
Linuron (aq)	<0.04	µg/l		Yes
Lithium (diss.filt)	<1.00	µg/l		Yes
Lithium (tot.unfilt)	<5	µg/l		Yes
m,p-Xylene	<0.2	µg/l	Yes	Yes
Magnesium (diss.filt)	<0.036	mg/l	Yes	Yes
Malathion	<0.01	µg/l		Yes
Manganese (diss.filt)	<0.76	µg/l	Yes	Yes
Manganese (tot.unfilt)	<0.5	µg/l		Yes
MCPA	<0.04	µg/l	Yes	Yes
MCPB	<0.04	µg/l		Yes
Mecoprop (MCPB)	<0.04	µg/l	Yes	Yes
Mercury (diss.filt)	<0.01	µg/l	Yes	Yes
Metalaxyl	<0.01	µg/l		Yes

Parameter	Laboratory Method detection limit	Unit	Thames Tideway Project List	Environment Agency Long List
Metazachlor	<0.01	µg/l	Yes	Yes
Methabenzthiazuron (aq)	<0.04	µg/l		Yes
Methane, dissolved	<1	µg/l		Yes
Methiocarb	<0.05	µg/l		Yes
Methomyl	<0.01	µg/l		Yes
Methyl Parathion	<0.01	µg/l		Yes
Methyl tertiary butyl ether (MTBE)	<1	µg/l		Yes
Metoxuron	<0.001	µg/l		Yes
Metsulfuron - Methyl	<0.01	µg/l		Yes
Mevinphos	<0.01	µg/l		Yes
Molybdenum (diss.filt)	<0.62	µg/l	Yes	Yes
Molybdenum (tot.unfilt)	<9	µg/l		Yes
Monolinuron	<0.05	µg/l		Yes
Monuron	<50	ng/l		Yes
Naphthalene	<50	ng/l		Yes
Neburon	<0.001	µg/l		Yes
Nickel (diss.filt)	<0.44	µg/l	Yes	Yes
Nickel (tot.unfilt)	<0.5	µg/l		Yes
Nitrate as N	<0.02	mg/l	Yes	Yes
Nitrite as N	<0.01	mg/l		Yes
o,p'-DDD (TDE)	<0.01	µg/l		Yes
o,p'-DDE	<0.01	µg/l		Yes
o,p'-DDT	<0.01	µg/l		Yes
o,p'-Methoxychlor	<0.01	µg/l		Yes
Oxamyl	<0.1	µg/l		Yes
o-Xylene	<0.2	µg/l	Yes	Yes
p,p'-DDD (TDE)	<0.01	µg/l		Yes
p,p'-DDE	<0.01	µg/l		Yes
p,p'-DDT	<0.01	µg/l		Yes
p,p'-Methoxychlor	<0.01	µg/l		Yes
PAH, Total Detected USEPA 16	<50	ng/l	Yes	Yes
Parathion	<0.01	µg/l		Yes
PCB congener 101	<0.015	µg/l		Yes
PCB congener 105	<0.015	µg/l		Yes

Parameter	Laboratory Method detection limit	Unit	Thames Tideway Project List	Environment Agency Long List
PCB congener 118	<0.015	µg/l		Yes
PCB congener 138	<0.015	µg/l		Yes
PCB congener 153	<0.015	µg/l		Yes
PCB congener 156	<0.015	µg/l		Yes
PCB congener 180	<0.015	µg/l		Yes
PCB congener 28	<0.015	µg/l		Yes
PCB congener 52	<0.015	µg/l		Yes
Pendimethalin	<0.01	µg/l		Yes
Pentachlorophenol	<0.04	µg/l	Yes	Yes
Pentachlorophenol	<2	µg/l		Yes
Permethrin I	<0.01	µg/l	Yes	Yes
Permethrin II	<0.01	µg/l	Yes	Yes
pH	<1.00	pH Units	Yes	Yes
pH (in-situ)	-	pH units	Yes	Yes
Phenanthrene	<5	ng/l		Yes
Phenol	<0.5	µg/l	Yes	Yes
Phorate	<0.01	µg/l		Yes
Phosphate (ortho) as PO ₄	<0.14	mg/l		Yes
Phosphamidon I	<0.01	µg/l		Yes
Phosphamidon II	<0.01	µg/l		Yes
Phosphate as P	<0.046	mg/l		Yes
Picloram	<0.01	µg/l		Yes
Pirimicarb	<0.01	µg/l		Yes
Pirimiphos-methyl	<0.01	µg/l		Yes
Potassium (diss.filt)	<1	mg/l	Yes	Yes
Prochloraz	<0.1	µg/l		Yes
Prometryn	<0.01	µg/l		Yes
Propachlor	<0.01	µg/l		Yes
Propazine	<0.01	µg/l	Yes	Yes
Propetamphos	<0.01	µg/l	Yes	Yes
Propoxur	<0.1	µg/l		Yes
Propyzamide	<0.01	µg/l		Yes
Pyrene	<5	ng/l		Yes
Redox Potential (in-situ)	-	mV	Yes	Yes

Parameter	Laboratory Method detection limit	Unit	Thames Tideway Project List	Environment Agency Long List
Selenium (tot.unfilt)	<1	µg/l		Yes
Silica	<0.5	mg/l		Yes
Silver (tot.unfilt)	<2	µg/l		Yes
Simazine	<0.01	µg/l	Yes	Yes
Sodium (diss.filt)	<0.076	mg/l	Yes	Yes
Sodium:Chloride Ratio	Calculated	-		Yes
Strontium (diss.filt)	<0.4	µg/l	Yes	Yes
Strontium (tot.unfilt)	<0.5	µg/l		Yes
Styrene	<0.1	µg/l		Yes
Sulphate	<0.1	mg/l	Yes	Yes
Sulphide	<0.01	mg/l		Yes
Tecnazene	<0.01	µg/l		Yes
Temperature (in-situ)	-	Degrees C	Yes	Yes
Terbutryn	<0.01	µg/l	Yes	Yes
tert-Amyl methyl ether (TAME)	<1	µg/l		Yes
Tetrachloroethene	<0.1	µg/l	Yes	Yes
Thallium (tot.unfilt)	<3	µg/l		Yes
Tin (tot.unfilt)	<3	µg/l		Yes
Tin(diss.filt)	<0.36	µg/l	Yes	Yes
Titanium (diss.filt)	<1.5	µg/l	Yes	Yes
Toluene	<0.2	µg/l	Yes	Yes
Total Aliphatics & Aromatics >C5-35 (aq)	<10	µg/l		Yes
Total Oxidised Nitrogen as N	<0.02	mg/l		Yes
TPH CWG (W)	<10	µg/l		Yes
trans-Chlordane	<0.01	µg/l		Yes
Triazophos	<0.01	µg/l		Yes
Trichloroethene	<0.1	µg/l	Yes	Yes
Trichlorofluoromethane	<0.1	µg/l		Yes
Triclopyr	<0.04	µg/l		Yes
Trietazine	<0.01	µg/l	Yes	Yes
Trifluralin	<0.01	µg/l	Yes	Yes
Turbidity	<0.1	ntu		Yes
Turbidity (in-situ)	-	NTU	Yes	Yes

Parameter	Laboratory Method detection limit	Unit	Thames Tideway Project List	Environment Agency Long List
Uranium (diss.filt)	<0.5	µg/l		Yes
Vanadium (tot.unfilt)	<8	µg/l		Yes
Vinyl chloride	<0.1	µg/l		Yes
Zinc (diss.filt)	<1.3	µg/l	Yes	Yes
Zinc (tot.unfilt)	<3	µg/l		Yes

Appendix D– Integrated Groundwater Monitoring and Dewatering Plan template

Document reference:

2530-TDWAY-TTTUN-150-YH-PQ-100000

Appendix E– Time Chainage Plot