LAKESIDE EFW

Ch 9

Ground conditions and the water environment

9 Ground conditions and the water environment

Introduction

9.1 Ramboll was appointed to undertake the assessments of the potential for effects on ground conditions and the water environment, including a flood risk assessment (FRA). The findings of the assessments are summarised in this chapter and the full reports are included as technical appendices H1 (ground conditions) and H2 (water environment). The data sources and references used in the assessments are shown in table 9.1.

Borehole logs from WRLtH Phase 1 and Phase 2 GI – Shaft 2 Location (extract)
British Geological Survey website: http://mapapps2.bgs.ac.uk/geoindex/home.html
British Standards Institute, 2011, BS 10175:2011+A2:2017 Investigation of Potentially Contaminated Sites – Code of Practice
Environment Agency, 2004, CLR 11 Model Procedures for the Management of Land Contamination
Environment Agency landfill records: www.data.gov.uk
Environment Agency catchment data: https://environment.data.gov.uk/catchment-planning/
Environment Agency flood risk mapping: https://flood-map-for-planning.service.gov.uk
Fugro, 2018, GI Factual Report, Heathrow Expansion Project Stage 1, Package 3
Landmark Information Group, 2019, Envirocheck Report 193955180_1_1
Magic website: www.magic.gov.uk
Ministry of Housing, Communities and Local Government, 2016, National Planning Practice Guidance: Flood Risk and Coastal Change
NHBC and Environment Agency, 2008, Guidance for Safe Development of Housing on Land Affected by Contamination. R&D Publication 66:2008
Slough Borough Council, 2016, Flood Risk and Surface Water Drainage – Planning Guidance
Slough Borough Council, 2012, Strategic Flood Risk Assessment
WSP, 2012, Slough Surface Water Management Plan
Table 9.1: References and data sources

Legislation and policy

Ground conditions

9.2 Environmental risks are assessed in accordance with the Contaminated Land (England) Regulations 2006 (as amended), which consolidated previous regulations that addressed contaminated land, including Part IIA of the Environmental Protection Act 1990 (as introduced by the Environment Act 1995). Part IIA defines contaminated land as:

> *"land which appears to the local authority in whose area it is situated to be in such a condition that, by reasons of substances in, on or under the land that significant harm is being caused, or there is a significant possibility of such harm being caused, or significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused."*

9.3 The Environmental Damage (Prevention and Remediation) (England) Regulations 2015 state that land contamination may be classed as environmental damage if it creates a significant risk of harm to human health, or has serious adverse effects on the water environment or the biodiversity of protected species or habitats.

9.4 Paragraph 178 of the National Planning Policy Framework (NPPF; 2019) states in relation to contamination that planning policies and decisions should ensure that:

- A site is suitable for its proposed use, taking account of ground conditions and any risks arisings from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation, including land remediation (as well as potential impacts on the natural environment arising from that remediation)
- After remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA
- Adequate site investigation information, prepared by a competent person, should be available to inform these assessments

9.5 The Environment Agency's *Contaminated Land Report 11: Model Procedures for the Management of Land Contamination* (CLR 11) provides the technical framework for structured decision making about land contamination. It advocates a phased approach to risk assessment.

9.6 Core policy 8 of Slough Borough Council's (2008) adopted Slough Local Development Framework Core Strategy 2006-2026 states that developments must not cause contamination or a deterioration in land, soil or water quality, or be located on polluted land unless the development incorporates appropriate mitigation measures to limit adverse effects.

Water environment

9.7 The Water Framework Directive (2000/60/EC) was published in December 2000 and transposed into English law in December 2003 through the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003, which were subsequently updated in 2015 and 2017. The intention of the directive is to provide a more holistic approach to protection of the water environment by addressing a wide range of aspects, including physico-chemical, chemical, hydromorphological and ecological.

9.8 The Groundwater Directive (2006/118/EC) established a framework to prevent the input of hazardous substances and manage the input of non-hazardous pollutants into groundwater. It was transposed into English law by the Groundwater (England and Wales) Regulations 2009, which were subsequently revoked by the Environmental Permitting (England and Wales) (Amendment) Regulations 2010 and onwards. The latter require an environmental permit or registered exemption to be obtained from the Environment Agency to discharge anything other than clean, uncontaminated water into inland freshwaters, groundwater, estuaries and coastal waters.

9.9 The Environmental Quality Standards Directive (2008/105/EC, as amended by 2013/39/EU) sets out standards for certain priority and priority hazardous substances considered to be of concern, with the aim of reducing or phasing out their presence in the water environment. The directive was transposed into English law by the Water Environment (WFD) (England and Wales) (Amendment) Regulations 2015.

9.10 Government policy on flood risk and the water environment is set out in the NPPF and the National Planning Practice Guidance: *Flood Risk and Coastal Change* (updated 2016). The latter contains advice to planning authorities and developers about flood risk and the role played by the Environment Agency in advising on planning applications in possible flood risk areas. It recommends that a risk-based approach should be applied to assess the risk of all forms of flooding to and from development, taking climate change into account. It also contains guidelines for carrying out a FRA.

9.11 Core policy 8 of Slough Borough Council's (2008) adopted Slough Local Development Framework Core Strategy 2006-2026 states that developments must not cause a deterioration in water quality, will only be permitted where it can be demonstrated that there is a minimal risk of flooding and the development will not increase the risk of flooding elsewhere, and must manage surface water arising from the site in a sustainable manner that will reduce the risk of flooding and improve water quality.

Methodology

Ground conditions

Levels of assessment

9.12 The principle of risk assessment underlies the determination of whether land is contaminated. The risk assessment includes the development of a conceptual site model, which describes the types and locations of contamination source(s), potential receptor(s) and potential migration / transportation pathway(s) that may link the identified source(s) to the identified receptor(s). The methodology is endorsed in relevant technical guidance. A tiered approach to risk assessment is outlined as follows:

- Tier 1 preliminary risk assessment – a qualitative assessment informed by a phase 1 study comprising a desk study and walkover
- Tier 2 generic risk assessment – a quantitative assessment of site-specific data by comparison to generic assessment criteria informed by a phase 2 study comprising intrusive investigations and laboratory testing
- Tier 3 detailed quantitative risk assessment – a quantitative risk assessment by comparison to site-specific assessment criteria

9.13 The guidance for the assessment methodology advocates that each tier of assessment should be undertaken in a stepwise approach until the level of risk posed by the site is fully understood and deemed to be acceptable. Therefore, if a tier 1 assessment concludes that the risks associated with the site are acceptable, no further assessment is required. Similarly, where unacceptable risks can be ruled out by a tier 2 assessment, then there is no need for a tier 3 assessment.

Baseline

9.14 In order to establish the existing baseline condition of the site and its surrounds, a site walkover and desktop studies were undertaken. The desktop studies followed the guidance set out in BS 10175:2011+A2:2017 *Investigation of*

Potentially Contaminated Sites – Code of Practice and CLR 11 and can be found in technical appendix H1.

9.15 No intrusive investigations were undertaken, but the findings of previous investigations carried out by Network Rail and Heathrow Airport Ltd (HAL) within the site have been reviewed. A full list of the references and data sources used in the baseline study is set out in table 9.1.

Assessment of risk

9.16 A qualitative risk assessment was undertaken using the following three stages:

- Hazard identification and assessment: development of a source-pathway-receptor conceptual site model and identification of potential pollutant linkages
- Risk estimation: a qualitative risk estimation predicting the magnitude and probability of potential consequences that may arise as a result of a hazard
- Risk evaluation: deciding whether a risk is unacceptable

9.17 The contamination assessment focused on the identification of pollutant linkages in order to evaluate whether the presence of a source of contamination could potentially lead to harmful consequences. A pollutant linkage consists of the following three elements, all of which must be present for a pollutant linkage to occur:

- A source – a substance that is capable of causing pollution or harm
- A receptor – something that could be adversely affected by the contaminant
- A pathway – a route by which the contaminant can reach the receptor

9.18 The level of risk to receptors was classified with reference to the criteria set out in figures 9.1 to 9.3. Risks that are moderate to low or above are considered to be significant for the purposes of the EIA. Full details of the assessment methodology are set out in technical appendix H1.

Uncertainties and limitations

9.19 Detailed review of the existing ground investigation data will be required to inform necessary additional works (such as a foundations works risk assessment), implications for design and further data needs in due course. Additional ground investigations and monitoring will be required, which can be combined with investigations to inform the geotechnical design of the proposed development.

Water environment

Baseline

9.20 Baseline conditions were identified through a desk study and site walkover. Consultation was undertaken with the Environment Agency and relevant data and published materials relating to the local and wider water environment were reviewed. This review included establishing the existing quality of local

watercourses and groundwater and the runoff rates on site. No difficulties were encountered in obtaining the necessary information.

Impact assessment

9.21 There are no standard significance criteria for assessing effects on the water environment. The significance of effects has been derived from measures of receptor sensitivity and magnitude of change, as shown on figures 9.4 and 9.5 respectively. The sensitivity and magnitude criteria were combined to determine the degree of effect using the matrix shown in figure 9.6, which was then used to determine whether the effect was significant. As discussed in chapter 5, effects that are moderate or above (including slight to moderate effects) are considered to be significant in EIA terms.

Baseline

Ground conditions

Geology

9.22 The published geological mapping shows that the bedrock at the site comprises the London Clay Formation. Beneath this, at a depth of approximately 30 m below ground level, lie the Woolwich and Reading Formations and, beneath those, the White Chalk Subgroup. The bedrock is overlain by the Shepperton Gravel Member of the Maidenhead Formation, which is a stratum of river terrace deposits consisting generally of clay and sand. The bedrock in the northern portion of the site is overlain by alluvium.

9.23 Previous site investigations by Network Rail and HAL found a general sequence of Made Ground over alluvium, river terrace deposits and the London Clay Formation. To the south of the ditch that runs through the site, Made Ground was encountered up to depths of 8.8 m, while to the north it was only encountered down to 0.8 m. In some locations where Made Ground was recorded, it lies directly over the London Clay Formation. However, in most locations it is underlain by either alluvium or river terrace deposits, indicating that there is the potential for direct contact of any contamination present within the Made Ground with water in the deposits.

9.24 Details of the site's hydrogeology are set out in the water environment section of this chapter.

Site history

9.25 The site history was established by a review of historic Ordnance Survey maps dating back to 1876, which are provided in technical appendix H1. The site was undeveloped agricultural fields until the early 1970s, by which point several areas of land had been excavated and filled with water. The 1972 map labels these as disused. The pits appear to have been filled by 1988, with the area identified as being used as a landfill site.

9.26 The site is divided in two by a ditch running north west to south east. The land to the south of the ditch is currently an open field with scrub, which was being grazed by horses at the time of the site walkover. To the north of the ditch is an

area of mixed scrub land and bushes that is used by a clay shooting club. The open fields continue for approximately 500 m to the south and west of the site and are crossed by the route of the proposed access road. To the north, the site is bounded by the rest of the clay shooting ground and the M4. A sludge dewatering centre lies to the east of the site, beyond which are the Colne Brook and a series of lakes.

9.27 Several areas of flytipping were recorded during the site walkover, including near the entrance to the sludge dewatering centre, to the south of the site, by the Colne Brook immediately south of the access road to the treatment works, and where a bridle path crosses the A4.

9.28 The southern half of the site is recorded as being part of the former Tanhouse Farm Gravel Pit, a sand and gravel opencast excavation that extracted minerals from the Shepperton Gravel. The Replacement Minerals Plan for Berkshire (2001) shows the area of the site to the north of the ditch as being within 'preferred area 14' containing valley gravels, which also includes an area to the west of the site. Lying within a preferred area implies a general presumption that the site is suitable for sand and gravel extraction.

9.29 Environment Agency licensing information indicates that the Tanhouse Farm Landfill underlies the southern half of the site and continues to the south. It was operational from 1964 to 1991 and the Environment Agency's database lists it as having accepted inert, industrial, commercial and liquid sludge wastes. However, the Envirocheck database lists construction and demolition wastes and excavated natural materials as being accepted and household, commercial, industrial, liquid and poisonous wastes as being prohibited. There are other former landfills in the vicinity of the site, including the Colnbrook Landfill, approximately 350 m to the west, and the Tanhouse Landfill, approximately 350 m to the south.

9.30 The sludge dewatering centre to the east of the site first appeared on the 1932 map, when it used natural filter beds for secondary wastewater treatment. By 1972, these beds had been replaced with formal sludge beds. The M4 had been constructed to the north of the site by 1966, while the M25 first appeared on the 1989 map.

Past intrusive investigations

9.31 A limited amount of information regarding ground contamination is available from two ground investigations undertaken on and up to 200 m from the site. Within the area encompassed by the historic landfill site, the presence of material consistent with landfilling was recorded in the logs. This included black organic clay, clinker, wood, textiles, glass, brick, concrete, roadstone, ash, bricks, plastic, tiles, metal, polystyrene and a small number of household items, including pegs and a shuttlecock.

9.32 The site investigations undertaken by Network Rail indicated very high concentrations of iron within soils on the site, although these are not atypical of the area north west of London. Concentrations of other metals such as lead, copper and zinc were also elevated, but may be within the ranges observed as background this close to London. Heavier end hydrocarbons and polycyclic aromatic hydrocarbons were noted in a number of samples, but not at

significantly high concentrations. Asbestos was recorded within Made Ground in the north of the site and also in the south of the area proposed for the access road.

9.33 The site investigations undertaken by HAL indicated the presence of hydrocarbons in a number of locations, although no exceptionally high concentrations were recorded. Asbestos identification tests consistently resulted in no asbestos being detected.

9.34 Methane and carbon dioxide have been recorded in wells, both as part of HAL's intrusive investigations and within the boundary of the landfill site. Elevated concentrations were recorded, but these were well within the levels that would be expected from Made Ground. Concentrations from a gassing landfill would be expected to be higher than those recorded. Based on the currently available information, the site would be classified as representing a low to very low risk from ground gases. However, almost none of the measurements were taken in low pressure conditions, meaning that they may not represent the worst case scenario. In addition, only limited numbers of methane records are available.

Summary of potential sources of contamination

9.35 Based on the findings of the desk study, potential sources of contamination are summarised in table 9.2. A detailed table is provided in technical appendix H1.

Source	Contaminants of concern
Carbon in natural strata: peat, organic matter in alluvium, chalk etc	Bulk gases, e.g. carbon dioxide and methane
Landfills and other waste treatment / disposal	Metals / metalloids, sulphates / sulphides, asbestos, pH, polycyclic aromatic hydrocarbons, total petroleum hydrocarbons, volatile organic compounds, dioxins / furans, bulk gases, microbiological
Clay shooting range	Metals / metalloids, polycyclic aromatic hydrocarbons
Flytipping	Metals / metalloids, asbestos, total petroleum hydrocarbons, PCBs
Agricultural land	Nitrates / ammonia, pesticides, herbicides, fertilisers, microbiological
Sludge dewatering centre adjacent to site	Metals / metalloids, cyanide, nitrates / ammonia, sulphates / sulphides, pH, total petroleum hydrocarbons, volatile organic compounds, bulk gases, radioactivity, microbiological

Table 9.2: Potential sources of contamination

Water environment

Surface water

9.36 The Colne Brook and Horton Brook lie approximately 400 m to the east and 450 m to the west of the site respectively. Both are Water Framework Directive waterbodies for which the Environment Agency has responsibility. The Agency uses over 30 measures to classify the quality of waterbodies under the directive. The status of waterbodies against these measures is classified by the Agency as high, good, moderate, poor or bad. 'High' represents 'largely undisturbed conditions', while the other classes show increasing deviation from undisturbed conditions.

9.37 The Colne Brook was classified as being of good status with respect to its chemical quality in 2016, but its ecological classification was moderate potential and so did not comply with the requirements of the Water Framework Directive. This was as a result of the presence of phosphates in the water, the quality of the fish population and the fact that not all the measures to mitigate the impacts of modifications on the brook's ecology have been put in place. The pressures that the Agency identifies as contributing to the brook's moderate status include urbanisation, contaminated land, sewage discharges, transport and physical modification.

9.38 The Horton Brook is also of good chemical status and moderate ecological status. The latter is as a result of the presence of phosphates in the water and the quality of the invertebrate population. The pressures that the Agency identifies as contributing to the brook's moderate status include urbanisation, trade and industry discharges, reservoir impoundment and urban transport.

9.39 A group of four lakes lies to the east of the site. The lakes are artificial and not designated under the Water Framework Directive. They lie along the eastern edge of the Colne Brook and are likely to have a degree of hydrological connection to the brook, either through flood control water balancing or through gravels that underlie the area and form an aquifer.

9.40 There is a small artificial pond within the boundary of the sludge dewatering centre to the east of the site. This is likely to be used for settlement purposes and not be hydraulically connected to the adjacent lakes.

9.41 There are several ditches within the site. During the site walkover, they were observed to be heavily overgrown, with poor water quality and algal growth. Ditch 1 flows south east to north west across the north of the site and joins Horton Brook. No flow was visible during the site visit and the ditch is considered likely to be ephemeral and dependent upon incident rainfall and overland flow. Ditch 2 joins ditch 1 at the site's northern end. A small amount of flow was observed in this ditch during the site visit. The ditch's bed was stained ochre, which is potentially indicative of an upstream source of pollution from iron-sulphide minerals.

9.42 There are no drinking water protected areas in the vicinity of the site, although there is a surface water drinking water safeguard zone approximately 1.5 km to the south.

Flood risk

9.43 The existing greenfield runoff rates for the site have been calculated as follows:

- 1-in-1 year storm: 4.5 l/s
- 1-in-30 year storm: 12.0 l/s
- 1-in-100 year storm: 17.0 l/s

9.44 The majority of the site is in fluvial flood zone 1, although a narrow section on the south east corner of the temporary construction compound area is in flood zone 2. The Environment Agency's historic fluvial flood records indicate that flooding has occurred in the past around both the Colne Brook and Horton Brook. This is confirmed by the *Slough Surface Water Management Plan* (WSP, 2012),

which states that the Colnbrook and Poyle areas have experienced flooding. Overall, given that the majority of the site is in flood zone 1, the site is considered to be at low risk of fluvial flooding.

9.45 The Environment Agency's online flood mapping shows that there is a risk of surface water flooding along the drainage ditches within the site and their banks. During extreme rainfall events, surface water accumulates along the line of the ditches and the depressions in the north of the site, eventually draining to either the central narrow drainage ditch or south west towards Horton Brook. In the latter case, the stream created by the runoff during these events crosses the access road area of the site. The associated depth of flooding at the stream is estimated to be between 150 and 300 mm.

9.46 In addition, the Environment Agency's mapping identifies a risk of surface water flooding along the eastern side of the construction compound area, with an estimated depth of 150-600 mm. The access road is shown to be at low risk of surface water flooding. Overall, the risk of surface water flooding in the northern half of the main site is considered to be high. The area to the south of the drainage ditch is at very low risk, with a narrow area on the eastern side of the site at medium risk.

9.47 The *Slough Surface Water Management Plan* and Thames Water's DG5 register (Slough Borough Council, 2016) show that areas around Colnbrook and Poyle have experienced flooding as a result of overloaded sewers in the last 10 years. However, considering the location, topography and existing land use on site, the sewer drainage flood risk is considered to be low.

9.48 Slough Borough Council's (2012) *Strategic Flood Risk Assessment* states that there is a risk of groundwater flooding in the whole Colnbrook and Poyle area. Groundwater levels are high where the impermeable clay is close to the surface, forming a perched water table. The report states that areas prone to groundwater flooding are also generally prone to surface water flooding, so understanding the latter can help in predicting the former. The Environment Agency's groundwater flood mapping indicates that the site is highly susceptible to groundwater flooding. Overall, therefore, the risk of groundwater flooding is considered to be high.

9.49 The Environment Agency's mapping shows that the site could potentially be at risk of flooding from reservoirs because of its proximity to the Queen Mother Reservoir. The depth of flooding resulting from the failure of the reservoir embankments is predicted to be between 0.3 and 2 m, according to Environment Agency modelling. However, reservoirs in the UK have an extremely good safety record and all large reservoirs must be inspected and supervised by reservoir panel engineers. Reservoirs are therefore considered to present a minimal risk and the overall risk of flooding from this source is low.

Hydrogeology

9.50 Groundwater mapping shows that the London Clay Formation bedrock beneath the site is classified as unproductive strata, which are layers with low permeability that have negligible significance for water supply or river base flow. However, the Shepperton Gravel Member superficial deposits are classified as a principal aquifer. This means that they are layers that provide a high level of

water storage and may support water supply and / or river base flows on a strategic scale. The aquifer is classified as being of high vulnerability, meaning that it is potentially vulnerable to pollution from activities on land. The White Chalk Subgroup is also classified as a principal aquifer.

Groundwater

9.51 Monitoring undertaken as part of HAL's intrusive investigations show that groundwater is present at shallow depths below the site, with a 0.5-0.8 m seasonal range for the main EfW / HTI site and access road and a 0.3-1.59 m range for the construction compound area. Data are only available for the area of the main EfW / HTI site to the north of ditch 1; however, groundwater levels are likely to be similar to the south of the ditch.

9.52 Given the location of the River Thames to the south, and the southerly direction of flow of the Colne Brook, it is anticipated that groundwater is likely to flow in a southerly or south easterly direction. The water levels in the lakes to the east of the site are considered likely to be representative of groundwater levels in the study area, as the lakes and groundwater are likely to be in hydraulic connectivity through the underlying gravels.

9.53 Analysis of groundwater samples from HAL indicates the presence of elevated concentrations of hydrocarbons and ammonia in some locations within the boundary of the former landfill site. No dense non-aqueous phase liquids or light non-aqueous phase liquids were recorded in any of the monitoring wells.

9.54 The Environment Agency also monitors groundwater quality under the Water Framework Directive. It considers both quantitative quality (the degree to which a body of groundwater is currently affected by direct or indirect abstractions) and chemical quality. The groundwater in the area is currently classified as being of good quality for both indicators.

9.55 The site is not within an Environment Agency groundwater source protection zone or groundwater drinking water safeguard zone. There are two groundwater abstractions within 1 km of the site: one by Thames Water for process water, around 170 m to the north east, and one by RMC Aggregates (Greater London) Ltd for mineral washing, around 950 m to the west.

Sensitive receptors

9.56 The following sensitive receptors have been identified, with regard to the guidance in figure 9.4:

- Colne Brook – medium sensitivity
- Horton Brook – medium sensitivity
- Lakes to the east of the site – medium sensitivity
- Ditches within and adjacent to the site – low sensitivity
- Groundwater in Lower Thames Gravels – medium sensitivity
- Groundwater in White Chalk Subgroup – high sensitivity

Future baseline

9.57 In the absence of the replacement facilities, the site would continue in its current use. It is therefore unlikely that there would be any change in contamination conditions. The existing water environment could be subject to change as a result of climate change or changes of land use upstream within the catchments of the Horton and Colne brooks.

Effects of the proposed development

Ground conditions

9.58 In order for potential contaminants to pose a risk to receptors, there has to be a viable pathway for the contaminant to reach the receptor. Construction workers have the potential to come into direct contact with soil and groundwater during site works and construction activities, including during the construction of the connecting cablework to the National Grid, and also to be subject to accidental soil ingestion and inhalation of dust and asbestos fibres. The latter could also affect adjacent site users if dusts are blown from the site. Future site users could come into direct contact with soils in soft landscaped areas and could also be impacted through inhalation or the ingestion of dust and asbestos fibres from these areas. These pathways will be eliminated where buildings, hardstanding and other engineering surfaces remove the pathway.

9.59 Organic contaminants could permeate buried plastic water supply pipes and enter the water system. This may affect the health of future site users. Volatiles from organic compounds could be generated from contaminants in the ground. These have the potential to build up in buildings and confined spaces, potentially affecting both construction workers and future site users. Carbon dioxide and methane generated from underlying geology, landfilled waste and / or contaminants in the ground could also build up in buildings and confined spaces and pose a risk to the buildings and to health.

9.60 There is the potential for rainfall infiltration, leaching and contaminant migration in open areas of the site and areas of potential soakaways to affect the water environment. Deep foundations will be required to support the replacement facilities and building levels require excavation to at least 5 m below ground level to allow installation of the main building itself. There is the potential for contamination within Made Ground to be mobilised via newly created pathways into the river terrace deposits, or potentially deeper strata, depending on the depth of the piles.

9.61 Given the excavation requirements, dewatering may need to be undertaken. This has the potential to mobilise contamination into water in the excavations, causing contamination of water that is pumped out, groundwater and adjacent waterbodies that are in hydrological continuity with the groundwater. Mobilised surface contamination also has the potential to enter the ditches that cross and border the site. Some contaminants can pose a risk to subsurface construction materials, leading to damage to buried structures and services. There is the potential for harm to plants as a result of the direct uptake of contamination. This is considered to be unlikely because of the minimal soft landscaping proposed.

9.62 A conceptual site model has been developed for the proposals, informed by the desk study, to illustrate potential sources, pathways and receptors at the site (table 9.3; potentially significant risks are highlighted in bold). The assessment assumes that embedded mitigation will be incorporated into the design of the replacement facilities to address any risks identified as potentially significant within the assessment, following completion of additional ground investigations and / or environmental monitoring at the site. This may include gas protection, inclusion of hardstanding, and capping of landfill material where excavation into it is required.

Contaminant	Pathway	Receptor	Likelihood of risk	Consequence of risk	Risk classification
Asbestos	Inhalation of fibres	Human health (ground workers)	Likely	Medium	**Moderate**
		Human health (end users)	Unlikely	Medium	Low
Bulk gases	Build up of ground gases within confined spaces	Human health (ground workers)	Likely	Severe	**High**
		Human health (end users)	Unlikely	Severe	**Moderate to low**
		Human health (adjacent site users)	Unlikely	Severe	**Moderate to low**
	Creation of pathways via piling or other construction activities / development design	Human health (ground workers)	Unlikely	Medium	Low
		Human health (end users)	Unlikely	Medium	Low
Cyanide	Creation of pathways via piling or other construction activities / development design	Waterbodies (groundwater)	Unlikely	Mild	Very low
	Dermal contact	Human health (ground workers)	Likely	Mild	**Moderate to low**
		Human health (end users)	Unlikely	Minor	Very low
	Dust / soil ingestion / inhalation	Human health (ground workers)	Likely	Mild	**Moderate to low**
		Human health (end users)	Unlikely	Minor	Very low
		Human health (adjacent site users)	Unlikely	Minor	Very low
	Leaching of contaminants and migration into water environment	Waterbodies	Unlikely	Minor	Very low
	Mobilisation of contaminated soils into surface water	Waterbodies (surface water)	Unlikely	Minor	Very low
Fertilisers	Creation of pathways via piling or other construction activities / development design	Waterbodies (groundwater)	Unlikely	Mild	Very low
	Leaching of contaminants and migration into water environment	Waterbodies	Unlikely	Minor	Very low
	Mobilisation of contaminated soils into surface water	Waterbodies (surface water)	Unlikely	Minor	Very low
Herbicides	Creation of pathways via piling or other construction activities / development design	Waterbodies (groundwater)	Unlikely	Minor	Very low
	Dermal contact	Human health (ground workers)	Unlikely	Minor	Very low
		Human health (end users)	Unlikely	Minor	Very low
	Dust / soil ingestion / inhalation	Human health (ground workers)	Unlikely	Minor	Very low
		Human health (end users)	Unlikely	Minor	Very low

Contaminant	Pathway	Receptor	Likelihood of risk	Consequence of risk	Risk classification
		Human health (adjacent site users)	Unlikely	Minor	Very low
	Leaching of contaminants and migration into water environment	Waterbodies	Unlikely	Minor	Very low
	Mobilisation of contaminated soils into surface water	Waterbodies (surface water)	Unlikely	Minor	Very low
	Plant uptake	Flora	Unlikely	Minor	Very low
Metals / metalloids	Creation of pathways via piling or other construction activities / development design	Waterbodies (groundwater)	Likely	Mild	**Moderate to low**
	Dermal contact	Human health (ground workers)	Likely	Mild	**Moderate to low**
		Human health (end users)	Unlikely	Minor	Very low
	Dust / soil ingestion / inhalation	Human health (ground workers)	Likely	Mild	**Moderate to low**
		Human health (end users)	Unlikely	Minor	Very low
		Human health (adjacent site users)	Unlikely	Minor	Very low
	Leaching of contaminants and migration into water environment	Waterbodies	Likely	Minor	Low
	Mobilisation of contaminated soils into surface water	Waterbodies (surface water)	Likely	Medium	**Moderate**
	Plant uptake	Flora	Unlikely	Minor	Very low
Nitrates / ammonia	Creation of pathways via piling or other construction activities / development design	Waterbodies (groundwater)	Likely	Mild	**Moderate to low**
	Leaching of contaminants and migration into water environment	Waterbodies	Unlikely	Minor	Very low
	Mobilisation of contaminated soils into surface water	Waterbodies (surface water)	Unlikely	Minor	Very low
Polycyclic aromatic hydrocarbons	Creation of pathways via piling or other construction activities / development design	Waterbodies (groundwater)	Likely	Mild	**Moderate to low**
	Dermal contact	Human health (ground workers)	Likely	Mild	**Moderate to low**
		Human health (end users)	Unlikely	Minor	Very low
	Dust / soil ingestion / inhalation	Human health (ground workers)	Likely	Mild	**Moderate to low**
		Human health (end users)	Unlikely	Minor	Very low
		Human health (adjacent site users)	Unlikely	Minor	Very low
	Leaching of contaminants and migration into water environment	Waterbodies	Likely	Mild	**Moderate to low**
	Mobilisation of contaminated soils into surface water	Waterbodies (surface water)	Unlikely	Minor	Very low
	Vapour inhalation	Human health (ground workers)	Unlikely	Minor	Very low
		Human health (end users)	Unlikely	Minor	Very low
		Human health (adjacent site users)	Unlikely	Minor	Very low
Pesticides	Creation of pathways via piling or other construction activities / development design	Waterbodies (groundwater)	Unlikely	Minor	Very low
	Dermal contact	Human health (ground workers)	Unlikely	Minor	Very low

Contaminant	Pathway	Receptor	Likelihood of risk	Consequence of risk	Risk classification
		Human health (end users)	Unlikely	Minor	Very low
	Dust / soil ingestion / inhalation	Human health (ground workers)	Unlikely	Minor	Very low
		Human health (end users)	Unlikely	Minor	Very low
		Human health (adjacent site users)	Unlikely	Minor	Very low
	Leaching of contaminants and migration into water environment	Waterbodies	Unlikely	Minor	Very low
	Mobilisation of contaminated soils into surface water	Waterbodies (surface water)	Unlikely	Minor	Very low
Semi-volatile organic compounds	Creation of pathways via piling or other construction activities / development design	Waterbodies (groundwater)	Unlikely	Mild	Very low
	Dermal contact	Human health (ground workers)	Unlikely	Minor	Very low
		Human health (end users)	Unlikely	Minor	Very low
	Dust / soil ingestion / inhalation	Human health (ground workers)	Unlikely	Minor	Very low
		Human health (end users)	Unlikely	Minor	Very low
		Human health (adjacent site users)	Unlikely	Minor	Very low
	Leaching of contaminants and migration into water environment	Waterbodies	Unlikely	Minor	Very low
	Mobilisation of contaminated soils into surface water	Waterbodies (surface water)	Unlikely	Minor	Very low
	Permeation of buried water supply pipes	Human health (end users)	Unlikely	Minor	Very low
	Vapour inhalation	Human health (ground workers)	Unlikely	Minor	Very low
		Human health (end users)	Unlikely	Minor	Very low
		Human health (adjacent site users)	Unlikely	Minor	Very low
Total petroleum hydrocarbons	Creation of pathways via piling or other construction activities / development design	Waterbodies (groundwater)	Likely	Mild	**Moderate to low**
	Dermal contact	Human health (ground workers)	Likely	Mild	**Moderate to low**
		Human health (end users)	Unlikely	Minor	Very low
	Dust / soil ingestion / inhalation	Human health (ground workers)	Likely	Mild	**Moderate to low**
		Human health (end users)	Unlikely	Minor	Very low
		Human health (adjacent site users)	Unlikely	Minor	Very low
	Leaching of contaminants and migration into water environment	Waterbodies	Likely	Mild	**Moderate to low**
	Mobilisation of contaminated soils into surface water	Waterbodies (surface water)	Unlikely	Minor	Very low
	Permeation of buried water supply pipes	Human health (end users)	Unlikely	Minor	Very low
	Vapour inhalation	Human health (ground workers)	Unlikely	Minor	Very low
		Human health (end users)	Unlikely	Minor	Very low

Contaminant	Pathway	Receptor	Likelihood of risk	Consequence of risk	Risk classification
		Human health (adjacent site users)	Unlikely	Minor	Very low
Volatile organic compounds	Creation of pathways via piling or other construction activities / development design	Waterbodies (groundwater)	Unlikely	Mild	Very low
	Dermal contact	Human health (ground workers)	Unlikely	Minor	Very low
		Human health (end users)	Unlikely	Minor	Very low
	Dust / soil ingestion / inhalation	Human health (ground workers)	Unlikely	Minor	Very low
		Human health (end users)	Unlikely	Minor	Very low
		Human health (adjacent site users)	Unlikely	Minor	Very low
	Leaching of contaminants and migration into water environment	Waterbodies	Unlikely	Minor	Very low
	Mobilisation of contaminated soils into surface water	Waterbodies (surface water)	Unlikely	Minor	Very low
	Permeation of buried water supply pipes	Human health (end users)	Unlikely	Minor	Very low
	Vapour inhalation	Human health (ground workers)	Unlikely	Minor	Very low
		Human health (end users)	Unlikely	Minor	Very low
		Human health (adjacent site users)	Unlikely	Minor	Very low

Table 9.3: Conceptual site model

9.63 In summary, a small number of potentially significant risks have been identified. These generally result from the landfill beneath the south of the site and are associated with ground gases, contact of construction workers with contaminants (including asbestos), the potential to cause contamination of the underlying aquifer by creating new pathways, and runoff of contaminated sediments into nearby ditches.

9.64 As discussed above, excavation to a depth of a minimum of 5 m below ground level will be required to allow installation of the main building. Where this takes place within minerals preferred area 14 and removes sand and gravel, there would not be sufficient time available to practicably extract this relatively small volume of minerals and meet the tight project timescales to secure this regionally important waste management infrastructure. Use of part of the preferred area for the replacement facilities, rather than minerals extraction, will result in the partial loss of a relatively small volume of safeguarded minerals resources, which is unlikely to be commercially or practicably viable for extraction in the foreseeable future.

Water environment

Effects during construction

Surface water and flood risk

9.65 During the construction phase, there is the potential for rainfall to mobilise materials stored within the site, such as silt, topsoil, stockpiles and cement, into the surrounding surface water drainage network. Surface water quality can also

be affected by pollution from accidental spillages and leaks from fuels, oils and chemicals stored on site and washing and refuelling of vehicles and plant. In the absence of mitigation, this is predicted to lead to a small change in the quality of the ditches and waterbodies further afield, resulting in a slight adverse effect that will not be significant.

9.66 The proposed diversion of the existing ditches has the potential to lead to an increased sediment load entering the ditches in the period following installation. Given the low sensitivity of the ditches, this medium change is predicted to lead to a slight adverse effect that will not be significant.

9.67 A small area at the eastern corner of the temporary construction compound site lies within flood zone 2. The layout of the construction compound will be designed to ensure that no activities are placed in this area that could be at risk from flooding or exacerbate flood risk off site. The construction compound site will be returned to its existing use at the end of the construction period. No significant adverse effects are predicted.

Groundwater

9.68 There is a risk that accidental spillages and leaks of fuels, oils and chemicals could affect groundwater quality during construction. In the absence of mitigation, this is predicted to be a small change to the groundwater within the Lower Thames Gravels, which is within the proposed depth of excavations required for construction, leading to a slight adverse effect that will not be significant. No effects are predicted on the quality of the deeper groundwater resources.

9.69 Dewatering of excavations has the potential to affect groundwater levels in the Lower Thames Gravels in the area immediately surrounding the excavation, through the creation of a cone of depression. However, any changes are likely to be short term and levels would revert back to the existing situation following cessation of dewatering activities. Overall, a small change is predicted, leading to a slight adverse effect that will not be significant.

Effects post-construction

Surface water

9.70 Post-construction, there is a risk that pollution associated with the replacement facilities, such as accidental spillages of fuels, oils and chemicals associated with vehicle or building maintenance, could affect the quality of surface waterbodies on and near the site. However, the proposed sustainable drainage systems (SuDS) network is designed to prevent this.

9.71 As discussed in chapter 3, SuDS measures proposed at the site include below-ground cellular storage, diverted and new ditches and conveyance swales. There is the potential for permeable paving to be used in the car parking areas and for infiltration drainage to be used in the north west of the site, depending on the outcome of infiltration testing. Infiltration drainage will not be used in the area of the former landfill site. Class 1 petrol interceptors will be installed within the system and trapped gullies will be incorporated into the highway drainage. Together, these measures will ensure that runoff will receive adequate treatment.

9.72 A detailed maintenance regime will be put in place for the drainage system by the site management team, including regular inspections and removal of sediment and debris and repair as necessary. With the proposed surface water drainage system in place, no significant adverse effects are predicted on surface water quality post-construction.

Flood risk

9.73 The main site and proposed access road lie outside the 1-in-100 year floodplain and their development will not give rise to a reduction in floodplain storage. The proposed surface water drainage system will provide sufficient storage for up to a 1-in-100 year storm (plus 40% allowance for climate change). Discharge rates will be restricted to greenfield runoff rates and this will ensure that there will be no downstream increase in flood risk as a result of the proposed development.

9.74 As discussed above, the existing ditches on site will be diverted and new conveyance swales will be constructed. As well as ensuring that the drainage of the existing catchment is managed appropriately, these will provide an overland flow path for extreme rainfall events. The implementation of the proposed drainage system will therefore ensure that localised ponding of surface water or groundwater will not be exacerbated as a result of the proposed development.

9.75 Overall, therefore, no significant effects on flood risk are predicted as a result of the proposed development and the built development will not be at risk from flooding.

Groundwater

9.76 Direct infiltration of runoff into the ground has the potential to affect groundwater quality through the introduction of pollutants such as spilled fuels, oils or chemicals. However, as discussed above for surface water, if infiltration drainage is used, the proposed SuDS measures will ensure that there will be no significant effects on groundwater quality post-construction.

Mitigation and monitoring

Ground conditions

9.77 The construction of the proposed development will be carried out in line with a construction environmental management plan (CEMP), which will include best practice measures to manage potential effects associated with ground conditions. A framework CEMP is provided in technical appendix C. At the current level of knowledge on the site's level of contamination, it is anticipated that standard personal protective equipment will be sufficient to provide protection to ground workers, although asbestos may need a specific protocol and equipment.

9.78 Construction works will be carried out in accordance with the Environment Agency's (2007) *Pollution Prevention Guideline 5: Works and Maintenance on or Near Water.* While this document has now been withdrawn, it is still considered to be representative of good practice.

9.79 In addition to the CEMP, the following mitigation measures and further work will be undertaken:

- Additional ground investigations and ongoing monitoring of groundwater quality and levels and ground gas concentrations
- Incorporation of gas protection measures into the design of the buildings if the gas monitoring indicates that this is required
- Development of a waste soils management strategy
- Completion of a foundation works risk assessment, in accordance with Environment Agency standards, prior to construction to inform the potential risks associated with foundation types under consideration or to identify mitigation measures that may be needed
- Further interpretation of existing ground investigation information with regard to existing surface water and groundwater quality and leachate results
- Minimisation of dewatering requirements by programming excavation works to be as short as possible. The need for an environmental permit to undertake dewatering will be established and the necessary applications made as required. Coordination with Thames Water will be undertaken regarding dewatering activities should a potential risk to the deeper chalk aquifer be identified as part of the interpretation of ground investigation data and the environmental permit risk assessment process
- Development of a remediation strategy (if needed), together with validation and verification documentation as necessary
- Development of a materials management strategy
- Development of an asbestos management and health and safety plan
- Confirmation from Slough Borough Council as to any restrictions or requirements at the site with respect to minerals extraction

Water environment

9.80 The implementation of a CEMP during construction will include best practice measures to minimise potential effects on the water environment. These will include the preparation of a pollutants, water and sediment management protocol to inform construction works, which will set out measures such as the following:

- Minimise storage of hazardous chemicals on site and, where storage is necessary, use anti-pollution measures such as bunded trays or leak-proof containers
- Use designated refuelling sites, located away from open water
- Any cleaning materials or chemicals used during the construction phase are not to be hazardous to the water environment
- No storage of potentially contaminating materials in areas liable to water inundation
- Use of electrical power, rather than diesel, where possible
- Design of construction methods to minimise disturbance to, and mobilisation of, sediment
- No washing down of plant while on site
- Implementation of piling design with tight quality assurance / quality controls

- Oil spill kits to be kept on site, and site staff trained in their use

Monitoring

9.81 Regular on site monitoring of the works will need to be undertaken by an environmental specialist during the construction phase. This will include groundwater sampling, surface water inspections, surface water runoff management observations, and materials handling observations. The detailed scope of the monitoring will be refined following detailed interpretation of the existing ground investigation data and data from any additional ground investigations undertaken.

Residual effects

Ground conditions

9.82 With the above measures in place, no significant residual risks are predicted as a result of contamination.

Water environment

9.83 With the above measures in place, no significant residual effects are predicted on the water environment.

Cumulative effects

9.84 As no significant ground conditions or water environment effects are predicted as a result of the proposed development, there is no potential for significant cumulative effects with other consented developments in the area.

Ground conditions – classification of consequence

Classification	Definition
Severe	Highly elevated concentrations likely to result in 'significant harm' to human health as defined by the Environmental Protection Act 1990, Part 2A, if exposure occurs. Equivalent to Environment Agency Category 1 pollution incident including persistent and / or extensive effects on water quality; leading to closure of a potable abstraction point; major impact on amenity value or major damage to agriculture or commerce. Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long term maintenance of the population. Catastrophic damage to crops, buildings or property.
Medium	Elevated concentrations that could result in 'significant harm' to human health as defined by the Environmental Protection Act 1990, Part 2A, if exposure occurs. Equivalent to Environment Agency Category 2 pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce. Significant damage to aquatic or other ecosystems, which may result in a substantial adverse change in its functioning or harm to a species of special interest that may endanger the long term maintenance of the population. Significant damage to crops, buildings or property.
Mild	Exposure to human health unlikely to lead to 'significant harm'. Equivalent to Environment Agency Category 3 pollution incident including minimal or short lived effect on water quality; marginal effect on amenity value, agriculture or commerce. Minor or short lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change in its functioning or harm to a species of special interest that would endanger the long term maintenance of the population. Minor damage to crops, buildings or property.
Minor	No measurable effect on humans. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects of damage to buildings, structures and services.

From: Environment Agency, NHBC and Chartered Institute of Environmental Health, 2008, Guidance for the Safe Development of Housing on Land Affected by Contamination.

Figure 9.1 Ground conditions: classification of consequence

Ground conditions – classification of probability*

Category	Definition
High likelihood	There is a pollutant linkage and an event would appear very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a pollutant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low likelihood	There is a pollutant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a long period such an event would take place, and is less likely in the shorter term.
Unlikely	There is a pollutant linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

From: Environment Agency, NHBC and Chartered Institute of Environmental Health, 2008, Guidance for the Safe Development of Housing on Land Affected by Contamination.

*only applies if there is a possibility of a pollutant linkage being present

Figure 9.2 Ground conditions: classification of probability

Ground conditions – the classification of risk

Probability	Consequence: Severe	Consequence: Medium	Consequence: Mild	Consequence: Minor
High likelihood	Very high risk	High risk	Moderate risk	Low risk
Likely	High risk	Moderate risk	Moderate / low risk	Low risk
Low likelihood	Moderate risk	Moderate / low risk	Low risk	Very low risk
Unlikely	Moderate / low risk	Low risk	Very low risk	Very low risk

Description of the classified risks

Very high risk
There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without remediation action OR there is evidence that severe harm to a designated receptor is already occurring. Realisation of that risk is likely to present a substantial liability to the site owner or occupier. Investigation is required as a matter of urgency and remediation works are likely to follow in the short term.

High risk
Harm is likely to arise to a designated receptor from an identified hazard at the site without remediation action. Realisation of the risk is likely to present a substantial liability to the site owner or occupier. Investigation is required as a matter of urgency to clarify the risk. Remediation works may be necessary in the short term and are likely over the longer term.

Moderate risk
It is possible that harm could arise to a designated receptor from an identified hazard. However, it is relatively unlikely that any such harm would be severe and, if any harm were to occur, it is more likely that the harm would be relatively mild. Further investigative work is normally required to clarify the risk and to determine the potential liability to the site owner / occupier. Some remediation works may be required in the longer term.

Low risk
It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely, at worst, that this harm if realised would normally be mild. It is unlikely that the site owner / occupier would face substantial liabilities from such a risk. Further investigative work (which is likely to be limited) to clarify the risk may be required. Any subsequent remediation works are likely to be relatively limited.

Very low risk
It is a low possibility that harm could arise to a designated receptor, but it is likely, at worst, that this harm if realised would normally be mild or minor.

No potential risk
There is no potential risk if no pollution linkage has been established.

From: Environment Agency, NHBC and Chartered Institute of Environmental Health, 2008, Guidance for the Safe Development of Housing on Land Affected by Contamination.

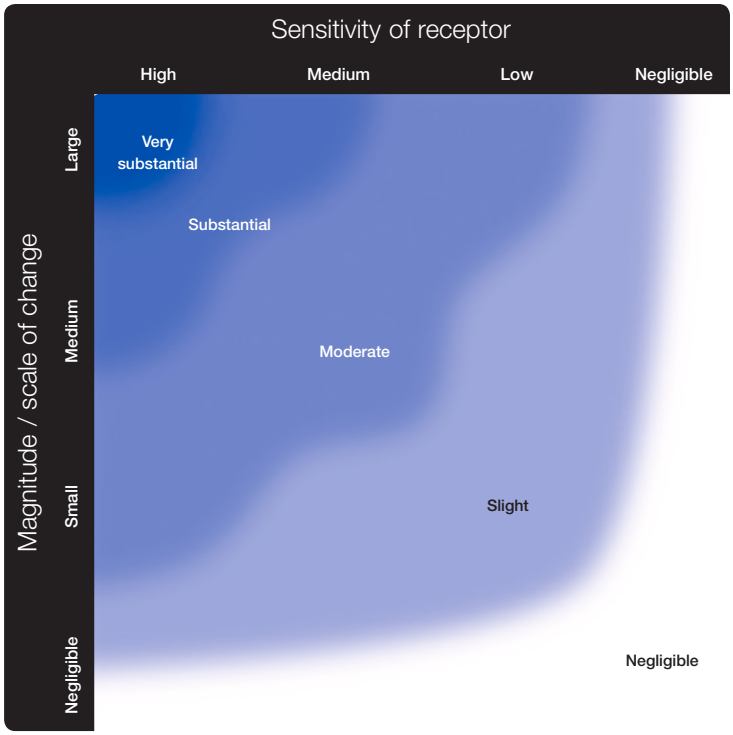
Sensitivity of receptor – Water

Figure 9.4 Receptor sensitivity (water environment)

Magnitude of change – Water

Figure 9.5 Impact magnitude (water environment)

Determination of significance matrix – Water



Degrees of effect

Very substantial:
Wholesale change to watercourse, water chemistry, erosion and sedimentation characteristics within areas protected for their environmental importance or significance as water supply sources.

Substantial:
Wholesale or fundamental changes to water bodies, which are not water supply sources, but of good quality. Wholesale and/or moderate changes to associated erosion/sedimentation patterns and water chemistry. Also, moderate changes to watercourse, water chemistry, erosion and sedimentation characteristics within areas protected for their environmental importance or significant as water supply sources.

Moderate:
Wholesale and/or fundamental changes to water bodies of average quality, and features of local interest. Also minor changes to important water bodies such as those in areas protected for their environmental significance, water bodies of good quality, and both water supply and non-water supply sources.

Slight:
Small changes to water bodies of local interest or of average water quality.

Not significant:
No change to water bodies of poor quality and artificial watercourses.

Professional judgement can be used to vary the category of significance where specific circumstances dictate, for example due to the vulnerability or condition of the receptor.

The reason for and nature of any variation will be made clear in the assessment.

Figure 9.6 Degree of effect matrix (water environment)