4 Environmental Baseline and Assessment of Impacts: Route Wide

4.1 Scope

This section presents an overview of the route wide impacts and the reasons why certain potential impacts are considered as not applicable or insignificant after generic mitigation. A summary of the route wide impacts and generic mitigation register is given in Appendix F.

Route wide impacts have been defined as:

- Impacts that are felt at a regional level or which cannot be attributed to a particular section of the project route, or
- Impacts that occur across a number of route windows

The majority of route wide issues relate to temporary impacts on the water environment, and include selection of working practices, construction equipment and materials. These Important general provisions covering management and route wide generic mitigation measures are required. These provisions are described in Appendix B. Where the type of work, the environment itself and the works proposed differ significantly between each route section the assessment is discussed under the relevant route section in this report.

4.2 Guidelines

The Government/Environment Agency and CIRIA have published a series of guidelines, which include the prevention of pollution from construction sites as listed in the table below. These would be considered during further development of the provisions for generic mitigation and of the method statements.

Table 4.1: Guidelines for Prevention of Pollution from Construction Sites

Reference	Title
PPG01	General guide to the prevention of water pollution
PPG03	The use and design of oil separators
PPG05	Works in, near or liable to affect watercourses
PPG06	Working at construction and demolition sites
PPG08	Storage and disposal of used oils
PPG10	Highway depots
PPG11	Preventing pollution at industrial sites
PPG13	High pressure water and steam cleaners
PPG18	Control of spillages and fire fighting run-off
PPG19	Garages and vehicle service centres
PPG20	Dewatering underground ducts and chambers
PPG21	Pollution incident response planning
PPG22	Dealing with spillages on highways
PPG23	Maintenance of Structures over Water

Reference	Title
PPG26	Storage and Handling of Drums & Intermediate Bulk Containers
PPG27	Installation, decommissioning and removal of underground storage tanks
CIRIA /Environment Agency Joint Guidelines	Concrete Bunds for Oil Storage Tanks (reinforced concrete bunds for oil storage tanks up to 3.5 m wide and 900mm high; based upon CIRIA Report 163)
CIRIA /Environment Agency Joint Guidelines	Masonry Bunds for Oil Storage Tanks
CIRIA report C532	Control of water pollution from construction sites
Environment Agency Guideline NC/99/73	Piling into Contaminated Sites and Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination
CIRIA report R169	Inland dredging - guidance on good practice
PIANC	Handling and Treatment of Contaminated Dredged Material from Ports and Inland Waterways, Report of Working Group 17
PIANC	Site investigation requirements for dredging works, Report of Working Group 23

4.3 Generic Mitigation Measures - General Site Operations

There are some route wide, potential temporary impacts on the water environment, which apply to the complete series of proposed construction sites along the route. These potential impacts include those arising from operations such as refuelling equipment, stockpiling materials, use of wheel washes and washdowns, demolition, dust control, painting etc.

Generic mitigation measures to deal with these potential impacts are set out in Appendix B. Crossrail would draw attention to certain features where the regulatory approach or guidance is evolving, or where Crossrail would require a particularly environmentally sustainable solution. One example of this is the requirement to use only biodegradable hydraulic oils as far as reasonably practicable in machines working near or over water. This has been the Environment Agency’s practice for some years but is not normally a requirement for works where the Agency is not the Employer. Another example is the requirement to develop a specific plan dealing with major pollution incidents at the main work sites (plans would be developed in accordance with the PPG 21 and would be incorporated within the emergency procedures for the project).

Appendix B describes the provisions for mitigation measures including those that would be applied generally for control, storage and handling of hydraulic fluids, fuel oils, cement products, paints etc, storage of other raw materials and excavated materials and avoidance of impacts from runoff from exposed earthworks. In practice, Crossrail would require certain materials to be selected to meet the target performances identified below where practicable and would not approve use of materials unless the following options considered:

- tailskin greases for tunnelling boring machines should be biodegradable;
- additives in cement grouts should be inert or non-toxic;

- other chemical grout should be non-toxic;
- conditioning fluids, where in contact with the natural ground, should be inert or biodegradable;
- hydraulic oils in tunnelling equipment, where contact with the natural ground is possible, should be biodegradable;
- bearing greases in tunnelling equipment where contact with the natural ground is possible should be biodegradable;
- in addition, records would be maintained of the consumption of the above materials and any significant increases in consumption would be investigated;
- temporary casing or steel sections used for piling should be free of contaminants. Where contact with aquifer materials is possible within an area designated as an Inner Source Protection Zone or 50 Day Time of Travel Zone, temporary casing or steel sections used for piling should be steam cleaned prior to first use.

It is assumed (A.RW.1) that the Environmental Management Plan (EMP) 'process' aspects such as training, management responsibility, verification, consultation and monitoring of compliance are dealt with separately from the water issues.

A key feature of the approach to mitigation is that it is the contractor's responsibility to organise his temporary works and equipment accordingly and meet legal requirements.

Route wide construction site activities are assessed as having no significant impacts on groundwater levels and flows and no significant effect on infiltration since any areas where temporary hard surfacing is introduced would be of limited extent.

There is, however, potential for significant pollution of shallow groundwater from spillage or leaching from contaminated materials as well as pollution of surface water unless runoff from rainfall is controlled. Measures are therefore required to manage site drainage including the control of the quantity and quality of surface runoff from the sites whether to sewer, watercourse or land, and to prevent infiltration of pollutants into the ground. These types of measures usually aim to prevent pollution occurring at source and this is particularly important for avoidance of infiltration of pollutants to groundwater. The full scope of control measures covering general construction site practices would be developed to accord with the Environment Agency guidelines for prevention of pollution.

Site drainage, including surface runoff and dewatering effluents would be discharged to sewer where possible. As described in Appendix B, Crossrail would require all necessary discharge permits and consents to be obtained from the drainage authority or the Environment Agency as appropriate. Site drainage by discharge to watercourses would only be permitted where discharge consents or other Environment Agency approval has been obtained. It would be a Crossrail requirement that all site drainage meets the effluent standards required by the sewerage undertaker or Environment Agency as appropriate. The monitoring programme would be as required by the sewerage undertaker or Environment Agency as appropriate. Provision of holding or settling tanks, bunds, silt traps and fences, separators and other measures may be required. Measures would be taken to protect erodable earthwork surfaces and manage any associated runoff from rainfall which might otherwise lead to silt entering watercourses or sewers.

Working in or near watercourses and the Thames Estuary is normally covered by bylaws and notice will be provided to the Environment Agency, local authority or British Waterways as required.

It is concluded that the potential impacts from general site operations would not occur or would not be significant after application of the generic mitigation measures described above and in Appendix B.

4.4 Impacts on Groundwater

4.4.1 Construction Works Requiring Dewatering

The general, route wide case is that groundwater levels and flows in the deep aquifer of the Chalk, Thanet Sands and lower Lambeth Group would not be significantly altered since dewatering in these layers is not required. A group of exceptions would occur during construction at the Isle of Dogs Station and at some vent shafts and portals in the central and southeast route sections between Lowell Street and Arsenal Way. These are discussed in the respective route windows, and in Chapter 9 - Cumulative Impacts and Mitigation Measures, with further details in Appendix E.

The general route wide case is that the construction of Crossrail is assessed as having no significant temporary effects on groundwater levels and flows in the shallow aquifer since no major dewatering of this aquifer is planned during construction. No extensive areas of such dewatering are planned since major open excavation would be generally avoided.

Since all the construction sites on the route involve some ground break and excavation through the drift deposits, it is assumed (A.RW.2) they are all likely to contain some minor, local dewatering of the shallow aquifer where small structures are being constructed, but this work would not have significant impacts since the flows would be small and the shallow aquifer is not normally used for abstraction. These structures might include platform extensions, shallow foundations for footbridges, new or modified drainage, service connections and service connections through, or corners of, cut off walls etc. More specific cases would include dewatering at some portals and the diveunders.

The general route wide case is that the construction of Crossrail is assessed as having no significant temporary effects on groundwater levels and flows in the sand lenses and sand and gravel layers within the Thames Group and Lambeth Group. These do not form significant aquifers and no major dewatering of these materials is planned during construction since major open excavations would be generally avoided. Minor, local dewatering of these materials would take place during construction of some deep structures since high water pressures are frequently encountered. An exception would occur at Stepney Green (route window C9) where more extensive dewatering would be undertaken.

4.4.2 New Structures in the Shallow and Deep Aquifers

In general, no significant permanent effects on groundwater levels and flows are expected. Construction of portals, stations and vent shafts in the tunnelled sections would produce a cut off effect and would divert groundwater flows in the shallow aquifer. However, the footprints of minor foundations, vent shafts and most station shafts are sufficiently small that groundwater flows in the shallow aquifer would redistribute around the works without a significant rise in water levels. Some groundwater modelling work has been undertaken to support this conclusion, as described in Appendix E. The four key conclusions are:

- The water level change at a given point is approximately a linear function of the width of the structure and the original hydraulic gradient.
- The modelling shows that for the worst case scenario, examined with an 80 m long structure located perpendicular to the groundwater flow (as at the larger underground station boxes), the rise in groundwater levels on the upgradient side of the structure is likely to be less than 0.4 m. It would be less than 0.3 m at a distance of 20 m away. Other underground station boxes are around 40 m long where the rises would be less than 0.2 m.
- The fall in the water levels on the downgradient side of an 80 m long structure would be up to 0.35 m at a distance of 20 m away. It would be greater closer to the structure.
- For a typical intervention shaft with a maximum width of around 20 m, the rise in groundwater levels on the upgradient side of the structure is likely to be less than 0.1 m.

Exceptions to the general case, with potentially greater impacts, can occur at longer structures where piled or diaphragm walled foundations form a long cut off wall. Significant groundwater level rises would occur on the upstream side of the structures at the portals, Paddington Station and the Isle of Dogs Station and possibly some of the other, smaller structures if these block off incised channels in the shallow aquifer. These are discussed in detail in the appropriate route windows. The prediction of water level changes at portals, diveunders and long station structures has been made by extrapolating from the model cases described above. This usually gives an upper bound estimate for the rises since, in reality, very long structures such as diveunders or portals would not form a complete cutoff over their full length. The potential impact for water ingress into any cellars in unlisted buildings has not been individually assessed but the potential groundwater flows within the shallow aquifer would be investigated further, as necessary, through site investigation and review of water levels which would be monitored during construction. Where necessary, changes to groundwater levels would be mitigated by introducing drainage around the structure leading to no significant residual impacts.

Where works (such as tunnels, stations, service shafts and cross passages) are constructed in the London Clay, the Lambeth Group and the deep aquifer, they would obstruct transverse groundwater flows, across the alignment, by blocking off sand lenses in the Thames Group and Lambeth Group (the aquitard), fissures in the Chalk and porous flow through the Thanet Sands. Sand lenses in the aquitard are not part of the aquifer system and mitigation is not considered necessary. However, the effective thickness of the Chalk is large enough to enable flows in the deep aquifer to simply bypass the obstruction caused by the works. External grout and in situ concrete would avoid permeable, longitudinal pathways being developed.

It is assumed (A.RW.3) that groundwater quality in the shallow aquifer is generally non potable and not utilised, particularly in the built up areas of the route, and so any water quality impacts from the works would be minor unless a surface water receptor is potentially also affected by seepage outflows.

Some redistribution or change in rainwater infiltration may occur as a result of permanent works at each site. However, the new areas of hard surfacing would be small and the loss of recharge to the shallow aquifer is not significant. Any infiltration measures used to reduce surface runoff (see below) would enhance recharge. In those cases where contaminated land has been remediated, infiltration would be of better quality; in all cases impacts on groundwater quality would be considered when dealing with contaminated land.

4.4.3 Modifications to Railway Usage

The secondary impact of an increased risk of groundwater pollution accidents due to higher railway usage is also assessed as not being significant. Rail incidents comprise a very small proportion of major pollution incidents recorded by the Environment Agency. The majority of rail pollution incidents are oil or hydrocarbon related and Crossrail would be a low risk for this kind of pollution since it will be electrically powered and usually operating on dedicated track.

4.4.4 Railway Systems Infrastructure and Railway Operations

Works for Railway Systems Infrastructure for surface railways can be considered at the route wide level although water impacts are not covered explicitly by the provision for generic mitigation described in Appendix B due to the type of work involved. The works would include relocation of existing OHLE gantries and masts, signals, cable ducts in the cess and controls to switches. These changes would take place at areas where track realignment is carried out or station platforms are being extended. These works are assessed as having no significant impact on surface water or groundwater since the works would be minor and the amount of ground break would be insignificant. Exceptions could occur where the ground is contaminated and it is assumed (A.RW.4) that this would be dealt with through appropriate mitigation measures developed in relation to contaminated land.

OHLE would be installed between Maidenhead (route window W25) and Stockley (route window W12) and from Custom House (route window SE2) to Abbey Wood (route window SE8). This would lead to a change in the type of potential pollution from train operations. Electric trains with regenerative braking are considered to be inherently less polluting that diesel powered trains. The use of OHLE introduces a different potential contaminant as copper is lost from the contact wires. However, research carried out for high speed railways in Holland (www.hslzuid.nl//Overig__Verspreiding_van_koper_1852285.html) has shown that the build up of copper in lineside vegetation is not significant. Although the research base in UK is more limited, no reports of contamination of groundwater or surface water by copper from contact wires have been identified.

A review of other potential contaminants from railway operations is given in DOE (1995), Contaminated Land and Liabilities Division, 'Industry Profile-Railway Land'. Crossrail operations would not produce many of these contaminants to a significant degree and therefore they would not percolate to groundwater or appear in surface water runoff. Track laying leads to weld residues containing heavy metals although it is understood that current railways practice is to avoid burying these on site. Track wear and regrinding tends to produce iron in particulate form. Ash, sulphates, creosote (on sleepers), ethylene glycol (antifreeze – used in larger quantities on third rail systems) are all examples of pollutants which Crossrail would generally avoid.

A number of power system upgrades would be required especially in areas of new OHLE. The risk of contamination of groundwater and surface water is not considered significant since modern transformer oils do not present the same risk of PCBs and other contaminants as in the past. The design of the new feeder stations would meet current standards for bunds and drainage.

4.4.5 Grout Shafts

Compensation grouting would be undertaken at a limited number of locations along the Central Route Section to mitigate for the effect of settlement. At all these locations the London Clay and Lambeth Group are usually present. Therefore, grouting would have no impact on groundwater levels or flow in the deep aquifer. There may be some localised impacts on the permeability of the surface aquifer, however, these will be limited in extent and would not cause a significant impact on groundwater levels or flows. Any dewatering to install compensation grout shafts through the shallow aquifer is assessed as being minor and having no significant impacts.

4.5 Impacts on Surface Water

4.5.1 Disposal of Dewatering Effluent

The majority of the dewatering effluent from the deep aquifer would be discharged to the River Thames or the Docks. These are discussed in the respective route windows, in Chapter 9 - Cumulative Impacts and Mitigation Measures and with further details in Appendix E.

Where the dewatering effluents would be disposed of to sewer there would therefore be a temporary loss of sewer capacity and it is assumed (A.RW.5) that this would be acceptable although this would depend on the amount of water to be disposed of as well as the existing spare capacity of the sewer. This would be resolved by consultation and obtaining permission from the utility company (usually Thames Water).

4.5.2 Works Affecting Surface Water Runoff

(i) Environment Agency Guidance

The Environment Agency has indicated that, due to the scale of the development, they are concerned about "*its impact on surface water runoff from the site*" (Ref email of 30 July 2004). Although a 1 ha threshold is considered for most planning applications, the Environment Agency consider that the aggregate of the Crossrail sites exceeds this threshold and therefore all of the sites should be considered for design purposes.

The Environment Agency have also indicated that their concerns apply to both greenfield and brownfield sites although "*on sites where surface waters drain into combined sewers then the Agency will not seek to reduce the discharge rate*" (Ref email of 18 August 2004).

However, "*on sites which drain to Watercourses or Thames Water Surface Water Sewers then the Agency will place surface water restrictions on the site*" (Ref email of 18 August 2004) and "*would be unlikely to accept a drainage proposal that did not meet the following criteria:*

> *1. Surface water discharges from the site should not exceed the existing greenfield runoff rate (defined by using the methodology given by the ADAS Reference Book 345).*
>
> *2. The drainage system must be able to accommodate the worst case 1 in 100 year storm event without the flow balancing system being bypassed. (Rainfall rates should be taken from the Flood Estimation Handbook (FEH) and the 1 in 100 year volume producing storms up to 48 hours must be used to predict balancing volumes before overflow).*"

(Ref email of 30 July 2004)

(ii) Modifications to Drainage: General

It is assumed (A.RW.6) for assessment purposes that runoff to drains from existing, undrained surfaces would be attenuated to greenfield surface runoff rates between 2 to 8 l/s/ha, and that drained surfaces would normally be attenuated to 'Not Worse Than Existing' (NWTE) rates where discharging to a combined sewer. It is assumed (A.RW.7) that the majority of the Crossrail route through Central and East London and the 'Lost Rivers' drain through to Beckton and Crossness and is therefore classed as draining to a combined sewer.

Where existing drainage is to a watercourse or Thames Water surface water sewer, the Agency would require betterment to be provided unless a flood risk assessment is accepted showing otherwise. However, an approach based on sustainable urban drainage systems (SUDS) may be inapplicable in the parts of the route section that are heavily urbanised and where providing betterment of runoff rates by additional recharge to the shallow aquifer is normally to be avoided if it is likely to cause groundwater level rises. Further consultation with the Environment Agency would take place during the detailed design stage when the status of existing drainage would be determined.

The generic assessment is, therefore, that there are no significant impacts on surface water flows. Site specific exceptions have been identified within route windows where hard surfaces such as roofs or access roads are replacing permeable surfaces such as parks or gardens. Platform extensions over existing surface railway cess are discussed in relation to track drainage below.

In general it is assumed (A.RW.8) the works would generate no permanent impacts because there are no discharge consents being sought or modified. There may be some minor changes in runoff where track drainage is upgraded (see next section). There would also be some betterment where existing track and platform drainage arrangements are upgraded with the possible inclusion of silt or oil interceptors (see next section).

(iii) Modifications to Drainage: Track and Stations

Requirements for railway track drainage are given in Network Rail Standard GC/RT5014 and Code of Practice RT/CE/C/006. Standard 5014 applies to all new and renewals of trackbed. Standard 006 implies how the trackbed drainage may also be designed to cope with runoff from platforms. Network Rail RT/CE/C/039 confirms that track drainage is required to avoid water in the trackbed compromising track performance and adds that, in practice, track drains are normally required in all cuttings and low embankments (<1 m) where the natural ground is not free draining or the highest groundwater level is within the trackbed. Other occasions include where low permeability materials are within the embankment or dishing of the top surface has occurred.

The track drainage on the surface railways interacts with the surface and groundwater environment in a number of ways that often create a close linkage between the groundwater and surface water issues.

The drainage elements of the work that would be carried out fall into two categories; platform extensions that would raise very similar issues at every station, and the longer stretches of new or modified railway alignment at the turnbacks, stabling, loops and at any bridge sites where the track would be lowered to give adequate clearance for OHLE.

The generic potential impacts on runoff from rainfall resulting from platform extensions are as follows:

- Where platform extensions are less than 25% of the existing length, the existing platform would not normally be re-profiled to slope away from the track. Where re-profiling is needed, a drainage gully or pipe would be installed but if drained to the same point as any existing platform, no change in peak runoff would occur. If not, attenuation measures would be considered.

- Platform extensions are generally to be constructed using precast concrete slabs supported on blockwork crosswalls or proprietary systems. These would result in a small increase in peak runoff if they are drained to any existing piped track drain, otherwise there would be no change if they continue to drain to the cess.

- Where new waiting shelters are provided on platforms, the rate of runoff would be the same as for a platform.

The main variation between the sites is in the existing disposal arrangements and the degree to which there are existing flooding or surcharging problems. These issues would be investigated as part of the detailed design process. Further discussions with Network Rail, Thames Water and the Environment Agency would take place during detailed design to determine if any consents or permits need to be revised.

Where railways are constructed on embankments, the unsaturated zone within the trackbed and embankment would provide some attenuation of contaminants such as fuels, track grease and heavy metals. As described in Section 4.5.2, rainfall infiltrating through the cess would normally encounter lower levels of contaminants at the surface than in many existing railways. Any surface runoff would flow to embankment toe ditches if present. In the event of a major pollution incident such as could result from a fire or a fuel tanker being ruptured, the emergency services would have to provide booms or secondary pumping to prevent pollutants escaping further downstream. As described in Section 4.4.3, the increase in traffic loadings would provide an increase in the risk of such incidents but it is assessed that this secondary impact would remain insignificant.

Detailed design of track and platform drainage would take place in the future. For assessment purposes it is assumed (A.RW.9) that the review of Network Rail's inspection and assessment reports and record drawings would identify any areas where piped trackbed drains are present and areas where they require upgrading or any areas where they need to be provided because of drainage problems. It is further assumed (A.RW.10) that, in general, the existing track drainage is directed to ground in the cess and is adequate. It is also assumed (A.RW.11) that the track and cess would be able to cope with concentrations of flow at any catchpits that would be built to deal with runoff from platform extensions. These assumptions are based on the widespread occurrence of moderate to free draining materials and the assumed (A.RW.12) general absence of heavy clays in the subsurface.

New and replacement track drainage would normally comprise a drainage trench with a drainage pipe at a depth of 1 m below rail level. The drainage water would then be collected in slotted pipe some 250 mm to 300 mm in diameter. Should the gradient for any reason be flatter than 1 in 240, the collection pipe would be wrapped in a non-woven geotextile to prevent the ingress of silt into the drainage system. There would be a free draining catchpit every 30 m along the track, and at changes of direction of the drains, to enable inspections and capture and removal of silt. Consideration would be given to the installation of an oil/water interceptor or catchpit at any new pipe drainage in station locations. The drainage pipe would then be connected to existing outfalls.

It is assumed (A.RW.13) that any new piped track drainage including oil/water interceptors or an impermeable membrane under the ballast would not be required purely on the basis of potential point sources of extra contamination such as at signals, switches, rail greasers and at stations. In general, new drainage would only be constructed to overcome specific drainage problems, rather than to mitigate pollution risks.

It is assumed (A.RW.14) that local slewing and realignment of tracks around platform extensions would not require significant alteration of the existing track drainage system and drainage rates would not be changed.

It is assessed that no increase in runoff rates or potential pollution would occur where runoff is returned to the formation or existing catchpits. Where increased runoff or new drainage would be directed to surface water, the detailed design would examine the requirements for new or varied discharge consents and appropriate consultations and applications to the Environment Agency would take place.

There would, therefore, be no residual impacts after mitigation resulting from the general case of refurbishment of track drainage.

Track drainage is only discussed in the individual route windows assessment section where there is a specific drainage issue; otherwise the assessment assumes (A.RW.15) that the existing drainage and runoff management system is adequate to accommodate any changes in runoff caused by the works.

4.6 Additional Monitoring of the Water Environment

In common with other, similar projects of this nature, additional information would be obtained from additional monitoring during the detailed design and construction phases. The following activities would take place as part of the mitigation measures, subject to review of the need at each site and further discussions with the Environment Agency, as the detailed design and construction progresses.

- Additional site investigation (SI) would take place and some SI boreholes near long walls and major dewatering sites would be converted to stand pipes to allow the water level in the shallow aquifer to be monitored. At least three such pipes would be monitored monthly from the start of construction at those sites where long walls are being constructed until at least two winters have passed after the cut off is fully effective.
- Visits to other groundwater abstractions would take place where there are potential impacts on water quality. Water quality would be measured at monthly intervals from two months before the relevant construction starts until two months after it finishes. Two follow up water samples would also be collected after 6 months and 1 year respectively.
- Prior to the start of dewatering of the deep aquifer, test wells and associated observation wells would be constructed at each dewatering site. After testing, water levels would be measured at least monthly up to the start of dewatering. Once dewatering starts, water levels would be measured at least weekly for at least four weeks, and then monthly, after any major change in discharge rate including switching off. During initial test pumping, the water chemistry would be measured and a proposal for long term quality monitoring then agreed with the Environment Agency.
- Water level data from the deep aquifer monitoring network around the major dewatering sites would be collected from the Environment Agency at three monthly intervals until two years after the dewatering ceases.
- New observation wells would be constructed or located in areas where the Environment Agency network is too sparse for monitoring the regional impact of deep aquifer dewatering. The locations of such wells would be agreed with the Agency as part of the application for consent to drill and test the dewatering wells.

- The quality of water discharged from construction sites would be monitored by Thames Water where discharging to their network. Discharges to watercourses would be monitored according to the terms of the relevant agreement with the Environment Agency.

- Settlement monitoring would be carried out, where works could affect flood defences or river training works, according to the terms of the relevant agreement with the Environment Agency.