14. SURFACE WATER DRAINAGE AND FLOOD RISK

INTRODUCTION

14.1 This chapter, written by Waterman Environmental, examines the potential effects of the four Development Scenarios upon surface water drainage and flooding.

14.2 This chapter provides an overview of the prevailing surface water drainage and flood risk characteristics of the sites of the three applications. It then identifies the potential flooding risks associated with the demolition and construction works for all four Development Scenarios, and once the four Development Scenarios are completed and operational. Appropriate mitigation measures are outlined in order to prevent, reduce or offset the identified potential risks and the resulting residual effects are summarised.

14.3 The assessment has been informed by a Phase 1 Land Quality Assessment undertaken by Waterman Environmental (refer to Technical Appendix 13a) and a Flood Risk Assessment (FRA) undertaken by Peter Brett Associates (PBA) (refer to Technical Appendix 14a).

LEGISLATIVE AND PLANNING POLICY CONTEXT

Legislation

Water Resources Act, 1991

14.4 The Water Resources Act (Ref. 14.1) relates to the control of the water environment. Aspects of the Act which are relevant to the Development Scenarios include provisions concerning land drainage and flood mitigation. Within the Thames region, the Water Resources Act is complemented by local Land Drainage Byelaws.

Water Framework Directive, 2000

14.5 The aim of the Water Framework Directive (WFD) (Ref. 14.2) is to protect and improve all European Union water bodies and make sure they are protected from further deterioration, and that improvements in water quality can be made. The assessment and protection of water bodies will be undertaken in terms of political/administrative boundaries, i.e. their river basins. In the UK, River Basin Districts have been set up. Each will be provided a River Basin Management Plan. All water bodies will be assessed to determine the 'ecological status' and 'chemical status' of its water. Of those not deemed to have ‘good status’, measures would be taken to improve the waterbody so as to become of 'good status'. This would be implemented through the relevant River Basin Management Plan.

14.6 Although the WFD discusses ways to mitigate the effects of flooding, it does not contain any specific flood risk management objectives. However, in general terms there is an onus on developers to protect and, if possible, enhance waterbodies close to proposed developments or activities which can be done through effective flood risk management.

Water Industry Act, 1991

14.7 The Water Industry Act (Ref. 14.3) covers a wide-range of activities of the privatised water companies that were created in 1989. The main relevant provisions relate to trade effluent discharges made to sewers for which the privatised companies act as the regulatory authorities.

14.8 Under the Act, discharge of effluent to a public sewer can only take place with the agreement or consent of the sewerage undertaker (that is, the water company). The relevant sewerage undertaker for the three application sites is Thames Water Utilities Limited (TWUL). The water companies control the nature and composition of the effluent, the maximum daily volume permitted the maximum flow rate and the sewer into which the effluent is discharged.

National Planning Policy

Planning Policy Statement 25: Development and Flood Risk, 2006

14.9 Planning Policy Statement 25 (PPS25) (Ref. 14.4) sets out Government policy on development and flood risk. Its aims are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding. The guidance aims to direct development away from areas of highest flood risk. In circumstances where new development is located in areas of high flood risk, PPS25 aims to make such development safe, without increasing flood risk elsewhere and, where possible, reducing overall flood risk.

14.10 PPS25 considers both fluvial and tidal flooding and highlights the requirements for developers to assess flood risk, including run-off implications, appropriate to the nature and scale of the development proposed and the risks involved.

14.11 PPS25 reinforces previous policy guidance in respect of locating development proposals in lower risk Flood Zones. PPS25 advocates the use of the risk based sequential test, in which new development is directed towards the areas of lowest probability of flooding, which are identified by Flood Zones, as follows:

- **Flood Zone 1:** Low probability of flooding (less than 1 in 1,000 annual probability of river or sea flooding in any year);
- **Flood Zone 2:** Medium probability of flooding (between a 1 in 100 and 1 in 1,000 annual probability of river flooding and between a 1 in 200 and 1 in 1,000 annual probability of sea flooding in any year);
- **Flood Zone 3a:** High probability (1 in 100 or greater annual probability of river flooding or 1 in 200 or greater annual probability of sea flooding in any year); and
- **Flood Zone 3b:** The functional floodplain (where water is stored in times of flood, including water conveyance routes, annual probability of 1 in 20 or greater in any given year or designed to flood in a 1 in 1,000 flood).

14.12 It should be noted that the above Flood Zones do not take the presence of flood defences into consideration, which are particularly critical in London.

14.13 In addition, PPS25 attempts to match the sensitivity level of a development proposal to a flood risk level. For example, more sensitive developments, like hospitals, should not be permitted in areas at high risk of flooding, although leisure and tourism developments may be allowed.

14.14 PPS25 also provides advice on the definition of a functional floodplain and the accommodation of the potential effects of climate change on development. Accordingly, PPS25 recommends a precautionary increase in flood flows of 10% by 2025 and 20% from 2025 to 2115 in rivers, with rainfall intensities gradually increasing by between 5% and 30% from now until 2115.

14.15 PPS25 further reinforces the Government's commitment to Sustainable Drainage Systems (SuDS). It also acknowledges the Town and Country Planning (Flooding) (England) Direction 2007 which is to be applied to all new major development (i.e. residential developments of ten or more houses or with a site area of 0.5 hectares (ha) or more, or non-residential development with more than 1,000sq.m of new floorspace or a site area of 1ha or more). Clearly each of the four Development Scenarios would fall into this category. If the Environment Agency (EA) were to raise objections on flood risk grounds, and the Local Planning Authority (LPA) still wish to approve a planning application, there would be an automatic referral to the Government Office.

Regional Planning Policy

The London Plan: Spatial Development Strategy for Greater London (consolidated with alternations since 2004), 2008

14.16 The London Plan (Ref. 14.5) considers water as both a resource and a risk to development in terms of rising groundwater and flooding. Policy 4A.12 Flooding states that within areas at risk from flooding, the flood risk for development proposals should be carried out in accordance with PPS25.

14.17 Policy 4A.13 Flood Risk Management also states that where development is permitted within areas at risk from flooding, the risk should be managed to account for the future increased risk and consequences of flooding as a result of climate change, by:

- Protecting the integrity of existing flood defences
- Setting permanent built development back from existing flood defences to allow for the management, maintenance and upgrading of those defences to be undertaken in a sustainable and cost effective way;
- Incorporating flood resilient design; and
- Establishing flood warning and emergency procedures.

14.18 Policy 4A.14 Sustainable Drainage seeks to ensure that surface water run-off is managed as close to its source as possible. The use of SuDS should be promoted for development unless there are practical reasons for not doing so. It further states that developers should aim to achieve greenfield run-off from their site through incorporating rainwater harvesting and sustainable drainage. Drainage should be designed in line with the following drainage hierarchy:

- "Store rainwater for later use;
- Use infiltration techniques, such as porous surfaces in non-clay areas;
- Attenuate rainwater in ponds or open water features for gradual release to a watercourse;
- Attenuate rainwater by storing in tanks or sealed water features for gradual release to a watercourse;
- Discharge rainwater direct to a watercourse;
- Discharge rainwater to a surface water drain; and
- Discharge rainwater to the combined sewer,

14.19 Policy 4A.15 Rising Groundwater states that where rising groundwater is an existing or potential problem, reasonable steps should to be taken to abstract and use that groundwater.

Local Planning Policy

Westminster City Council Replacement Unitary Development Plan, 2007

14.20 Policy ENV 9 of Westminster City Council's (WCC's) Replacement Unitary Development Plan (UDP) (Ref. 14.6) notes that developments should seek to protect and conserve water in a number of ways, including through the use of techniques to control surface water run-off.

Westminster City Council Victoria Area Planning Brief, 2006

14.21 In line with WCC's Replacement UDP, WCC's Victoria Area Planning Brief (VAPB) (Ref. 14.7) encourages the use of SuDS (where appropriate) within new developments.

14.22 The VAPB outlines the requirement for planning applications to be supported with an FRA, in compliance with PPS25.

Other Guidance

Environment Agency National Standing Advice to Local Planning Authorities on Development and Flood Risk, 2005

14.23 This document (Ref. 14.8) advises that an FRA should be undertaken in accordance with PPS25 for all proposed developments within Flood Zones 2 and 3 and developments greater than 1ha within Flood Zone 1. If a planning application for such development is made without an FRA, then the EA would be highly likely to raise objections.

ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

Assessment Methodology

14.24 The potential and residual effects of the each of the four Development Scenarios upon surface water drainage and flood risk have been established through the following:

- A visual inspection of the application sites;
- A review of information held within the Phase 1 Land Quality Assessment for the four Development Scenarios (refer to Technical Appendix 13a);
- A topographic survey of the application sites to local Ordnance Survey Benchmark (OSBM) provided on a drawing by ELS Land Consultants Ltd. (Ref. 14.9);
- A utilities survey undertaken by ELS Land Consultants (Ref. 14.10);
- Consultation with the EA, WCC and TWUL;
- Liaison with the project drainage advisors (PBA) and project structural engineers (Arup) regarding the proposed diversions of the foul public sewer;
- Liaison with the lead architects (Kohn Pederson Fox (KPF)) regarding the proposed landscaping for each of the Development Scenarios;
- Establishment of the existing baseline conditions on the application sites to include surface water characteristics, existing flood defences and potential sources of flood risks;
- Assessment of tidal, fluvial, surface water drainage, groundwater and foul drainage flooding for each of the four Development Scenarios;
- Investigation into the applicability of potential SuDS solutions for each of the four Development Scenarios;
- Selection of the most appropriate mitigating drainage strategy for each of the four Development Scenarios;
- Incorporation of appropriate mitigation measures into the design of the four Development Scenarios; and
- Assessment of appropriate safe access/egress routed to and from the sites of the four Development Scenarios.

14.25 An FRA was undertaken in line with the requirements of PPS25 and EA guidance. The purpose of the FRA was to identify potential sources of flooding at the application sites and determine the risk posed by these flooding sources to each of the Development Scenarios. Both tidal and fluvial flood risks have been considered with and without allowances for the effects of climate change.

14.26 As the application sites are located over 1km from the River Thames and are at the very edge of the high probability Flood Zone (assuming flood defences are ignored) (see Baseline Conditions, below), they are highly unlikely to be impacted by flooding from a breach of the defences. As such, the EA has confirmed that breach modelling is not required. Furthermore, the residential components of all Development Scenarios are located on the first floor or above (at a minimum level of 11.1m Above Ordnance Datum (AOD)), which is set well above guidance threshold levels for breach modelling.

14.27 Full details of the FRA can be obtained by reference to Technical Appendix 14a.

Significance Criteria

14.28 In accordance with Chapter 2: EIA Methodology, this assessment determines the relative significance of surface water drainage issues and a range of flood risk effects. The assessment of potential and residual effects has therefore used the following seven-point scale of significance, based upon professional judgement and experience:

- **Substantial beneficial:** Significant local-scale, or moderate to significant regional-scale reductions in flood risk;
- **Moderate beneficial:** Moderate local-scale, or minor regional-scale reduction in flood risk;
- **Minor beneficial:** Minor local-scale reduction in flood risk;
- **Negligible:** No appreciable effects upon flood risk;
- **Minor adverse:** Minor local-scale increase in flood risk;
- **Moderate adverse:** Moderate local-scale, or minor regional-scale increases in flood risk; and
- **Substantial adverse:** Significant local-scale, or moderate to significant regional-scale increases in flood risk.

BASELINE CONDITIONS

14.29 Due to the similar existing surface water drainage and flood risk characteristics of each of the application sites, this section describes the baseline conditions of the three application sites as a whole. However, where there is a specific need to highlight differences between the existing surface water drainage and flood risk characteristics of the each Development Scenario, further details are provided,

Topography

14.30 All three application sites are located within the floodplain of the River Thames and are therefore characterised by low-lying land, with a relatively flat topography. The lowest point of the three application sites lies at 3.3m AOD at Allington Street, close to the centre of the site of Application 1. Levels rise to a maximum of 5.6m AOD at Buckingham Palace Road in the west of all three application sites.

Geology

14.31 The BGS Geological Map for South London (Ref. 14.11) reveals that the three application sites are underlain by Made Ground overlying Alluvium. Taplow Terrace River Gravels underlie the Alluvium followed by the London Clay, the Thanet Sand and the Upper Chalk. Further details pertaining to the geology of all four Development Scenarios can be obtained by reference to Chapter 13: Ground Conditions and Contamination and Technical Appendix 13a: Phase 1 Land Quality Assessment.

Surface Water

14.32 All three application sites are entirely covered in hardstanding or solid, impermeable structures. As shown on Figure 14.1, the nearest surface water features relates to the ponds and lakes located approximately 175m northwest of the application sites in Buckingham Palace Gardens and 330m northeast of the application sites in St James's Park. The closest watercourse to the application sites is that of the River Thames. This is located approximately 1.2 km to the south and east of the sites.

14.33 A utilities survey undertaken by ELS Land Consultants shows that the existing surface water drainage system at the application sites comprises combined sewer infrastructure owned and maintained by TWUL. The sewers convey both surface and foul water flows and are located beneath all roads within and around the application sites.

14.34 The combined sewer infrastructure falls into three categories:

- **The Strategic Tank Sewer (Western Deep Sewer)** runs east-west and north-south beneath all three application sites at an approximate depth of 30m below ground level (BGL). It is currently functioning at maximum capacity;
- **The Strategic Trunk Sewer (Kings Scholar Pond Sewer)** is located at a depth of approximately 2.8m BGL. The sewer runs north-south beneath all three application sites. It is currently functioning below maximum capacity; and
- **The Ordinary Sewers** are generally old brick-egg sewers which are at a depth of approximately 1-2m BGL. These sewers run beneath all three application sites.

14.35 The existing combined sewer infrastructure layout is provided in Technical Appendix 14a.

Foul Water Drainage

14.36 As noted above, the combined sewer infrastructure provides both surface water and foul drainage. Further details are provided in Technical Appendix 14a. Potential contamination risks associated with the existing sewer have been dealt with in Chapter 13: Ground Conditions and Contamination.

Groundwater Levels

14.37 According to the EA Groundwater Vulnerability Map, Sheet 39 (West London) (Ref. 14.12), the Alluvium and Taplow Terrace River Gravels underlying the three application sites are classified as Minor Aquifers. The London Clay Formation is classed as a Non-Aquifer and the Upper Chalk, at depth, is classified as a Major Aquifer. The groundwater level is approximately -3m AOD, and is considered to be permanently depressed as a result of pumping by London Underground Limited (LUL) (associated with the cooling of their infrastructure) and abstraction for the nearby Royal Parks.

Flood Risk

Risk of Tidal and Fluvial Flooding

14.38 As already noted, the River Thames is located approximately 1.2km to the south and east of the application sites. Accordingly, the EA flood map (refer to Figure 14.2) shows the sites are located within Flood Zone 3a. This zone comprises land assessed as having a 1 in 100 or greater probability of river (fluvial) flooding or a 1 in 200 or greater annual probability of sea (tidal) flooding in any year.

14.39 The above classification does not account for the protection provided by the flood defences along the River Thames, including the Thames Barrier (located approximately 14km downstream from the three application sites) and the river walls of the River Thames. The EA has confirmed that the river walls are currently in a 'good' condition and, in conjunction with the Thames Barrier, provide a statutory defence level of 5.41m AOD. Thus, accounting for the flood defences, a 1 in 1,000 (0.1%) standard of flood protection is provided up to the year 2030. The existing risk of tidal and fluvial flooding at the application sites is therefore considered to be minimal. Furthermore, the EA has confirmed no records of tidal or fluvial flooding on the application sites.

Risk of Surface Water Drainage Flooding

14.40 As noted above, surface water is drained by the existing combined sewer infrastructure. TWUL and the Applicant have confirmed that there have been previous incidents of flooding within and in the vicinity of the application sites due to surface water surcharging of the combined sewer infrastructure. Further details are provided in Technical Appendix 14a.

Risk of Foul Water Drainage Flooding

14.41 As noted above, surface water surcharging of the combined sewer infrastructure has resulted in some previous instances of foul drainage flooding within and in proximity to the three application sites.

Risk of Groundwater Flooding

14.42 The EA has confirmed that there have been a number of reported instances of basement flooding due to groundwater conditions underlying the application sites (refer to Technical Appendix 14a).

POTENTIAL EFFECTS

Demolition and Construction

Development Scenarios 1, 2, 3 and 4

14.43 The excavation work, basement construction and other sub-structural or surface work which may affect flood risk in all four Development Scenarios are anticipated to occur within Timeslices 2 to 4 (comprising Phases 1 and 2) (refer to Chapter 6: Demolition and Construction). As such, all four Development Scenarios have been considered together in relation to potential effects related to demolition and construction.

Tidal and Fluvial Flooding

14.44 With the existing flood defences, the three application sites are protected for the 1 in 1,000 year flood up to 2030. The demolition and construction programme would run from 2010 until early 2017 for Development Scenarios 1 and 2, until late 2016 for Development Scenario 3 and until late 2014 for Development Scenario 4. Therefore the risk posed by tidal and fluvial flooding for each of the four Development Scenarios would be **negligible**.

Surface Water Drainage Flooding

14.45 Construction earthworks, temporary drainage associated with construction traffic routes, temporary car parks and potential dewatering during basement construction all have the potential to give rise to changes in surface water run-off regimes, including peak flows and low flows.

14.46 In the absence of mitigation, the above effects could increase the risk of surface water run-off flooding for all four Development Scenarios. However, assuming the adoption of best practice construction techniques, it is considered that the risk would be low. Nonetheless, in the absence of mitigation, the temporary change in on-site conditions during the demolition and construction period for each of the four Development Scenarios could give rise to, at worst, **short** to **medium term, local** risks of flooding of **minor adverse** significance.

Foul Water Drainage Flooding

14.47 All four proposed Development would include two new basement levels covering the area below Warwick Row, Allington Street and bordering on Buckingham Palace Road to the west and Bressenden Place on the north (refer to planning application drawings 201-MB-A-DR-M0096, 201-MB-A-DR-M0097, 201-MB-A-DR-M0098 and 201-MB-A-DR-M0099), with a maximum depth of -8.25m AOD. Therefore all sewers situated within the affected area would require abandonment or diversion.

14.48 As the nearest watercourse, the River Thames, is a considerable distance from the application sites, the most appropriate drainage mechanism would be to discharge to sewer. Following discussions with the Applicant, TWUL and LUL, PBA has produced a detailed strategy for the realignment of the sewers on and around the three application sites. All works to the foul drainage system, including the diversion of the public foul sewer, would be undertaken in

consultation and agreement with TWUL (refer to Figure 14.3 and Technical Appendix 14a for existing and proposed sewer diversions).

14.49 In order to safeguard surcharge and flood protection within the existing area-wide drainage system, TWUL requires that existing volumetric storage lost in the abandonment of sewers in Warwick Row and Allington Street be replaced. The proposed diversion and augmentation works would be accommodated within the existing highways of Victoria Street and Bressenden Place.

14.50 The following sewer diversions are proposed, and would apply equally for all four Development Scenarios:

- **Bressenden Place**: Diversion of the sewer from Buckingham Palace Road to the north, and abandonment of the sewers in Allington Street and Warwick Row which conflict with new basement area. A further constraint for this system is the Victoria Palace Theatre which must remain in operation throughout the construction period and which currently drains into the brick-egg sewer in adjacent Allington Street. This existing brick-egg sewer would be reused but stopped off at the northern end. The diversion would consist of approximately 65m of similarly sized brick-egg sewer cross-connecting to the Kings Scholars Pond Sewer in Bressenden Place.
- **Allington Street**: With the construction of the Bressenden Place diversion, all flows within the existing brick-egg Sewer in Allington Street would cease except for those directly entering it (e.g. the Victoria Palace Theatre). Therefore, approximately 66m of existing sewer in Allington Street would remain so that these existing flows can be maintained as well as new incoming flows from the any of the four Development Scenarios.
- **Victoria Street**: The loss of storage within the sewer system due to the abandonment of the sewers in Warwick Row and Allington Street would require that a similar amount of storage is added back by the system to maintain balance. This would be partly achieved by the establishment of the diversion in Bressenden Place. A second bore to the existing brick-egg sewer in Victoria Street would be added in order that sufficient storage would be provided. Approximately 108m of new sewer would be laid alongside the existing sewer in Victoria Street which would also take a variety of new connections generated by any of the four Development Scenarios without the need to break into the existing brick-egg sewer.

14.51 Such works would be subject to standard best practice and mandatory regulatory controls. Consequently, there would be no significant environmental effects resulting from these works. The overall risk posed by foul drainage flooding during the demolition and construction works would therefore be **negligible**.

Groundwater Flooding

14.52 The presence of the water table at approximately -3m AOD has the potential to create an on-site flood risk during the excavation and ground works during Timeslices 2 to 4 associated with the construction of the proposed basement, which would be to a maximum depth of -8.25m AOD for all four Development Scenarios. With the adoption of best practice construction techniques, it is considered that the risk would be low. However, in the absence of mitigation, a precautionary approach considers the risk to be **short** to **medium term**, **local** and of **minor adverse** significance.

14.53 As basement structures are installed, the basement walls have the potential to dam the groundwater outside of the application site boundaries. This has the potential to increase the groundwater level surrounding the application sites. Accordingly, the risk posed by groundwater flooding has the potential to be elevated as a result of the construction of the basement within all four Development Scenarios. In the absence of mitigation, the risk is considered to be **short** to **medium term**, **local** and of **minor adverse** significance.

Completed Development

Development Scenarios 1, 2, 3 and 4

14.54 It is considered that the potential effects on flood risk once any of the four Development Scenarios are complete and operational would remain largely the same for each of the Development Scenarios. Therefore, the potential effects for the four Development Scenarios have been considered together.

Tidal and Fluvial Flooding

14.55 With the area draining to a combined sewer system, the discharge of surface water from the application sites does not affect flood risk associated with discharge to the fluvial system. In addition, as mentioned previously, the application sites are defended to the 1 in 1,000 (0.1%) annual probability level, and would therefore have no effect on the floodplain storage or flood flow routes during events of up to this magnitude.

14.56 As the application sites are protected by flood defences, in accordance with current EA guidance, the minimum residential floor levels within all four Development Scenarios (Buildings 5, 7b and 7c) have been designed above the level of the flood defences. This relates to Building 5 (within all four Development Scenarios) and also building 7b/c (within Development Scenarios 1 and 2). The statutory defence level at each of the application sites is 5.41m AOD. The lowest level residential component within Development Scenarios 1 and 2 is located on the first floor of Building 7b/c at 11.1m AOD. The lowest level residential component within Development Scenarios 3 and 4 is located on the first floor of Building 5 at 14.5m AOD.

14.57 Within each of the four Development Scenarios, the basement is intended to be used for car parking and utilities services. The flood risk to this area would be managed by suitable waterproof sealing and appropriate drainage.

14.58 Furthermore, the application sites are located over 1km from the River Thames and are at the edge of the high probability flood zone (assuming flood defences are not considered). Consequently, they are highly unlikely to be affected by flooding even if a breach of the defences was to occur. In accordance with health and safety requirements, safe, dry escape routes from the basement to a higher part of all Development Scenarios have also be incorporated into the design.

14.59 In view of the above, the risk of tidal and fluvial flooding presented by all Development Scenarios would be **negligible**.

Surface Water Drainage Flooding

14.60 As all proposed Development Scenarios would be effectively 100% impermeable, TWUL has accepted that infiltration drainage or attenuation to the degree considered by the EA would not be viable. Instead, the Development Scenarios would incorporate sedum roofs within Building 5 (all four Development Scenarios) and green roofs within Building 7b/c (Development Scenarios 1 and 2) to intercept and retain rainwater. Such sedum and green roofs would reduce the volume of surface water runoff from the sites of the four Development Scenarios and attenuate surface water flows. This would include a rainwater harvesting system within every building, where rainwater would be collected from roofs of the buildings and stored in the basement. A grey water system would also be installed to collect and recycle grey water within Buildings 5 and 7b/c. Discussions with TWUL are current and ongoing, and they are also undertaking a detailed hydraulic modelling exercise, which would provide further quantification of the benefits of the above measures.

14.61 Taking into consideration all of the above, the potential surface water drainage flooding risks of all four Development Scenarios is considered to be **long term, local** and of **minor beneficial** significance.

Foul Water Drainage Flooding

14.62 As mentioned above, the surface water drainage would be via a combined sewer network. TWUL have confirmed through consultation that the existing foul and surface water systems are adequate to accept any of the proposed Development Scenarios and no attenuation would be required.

14.63 As part of each of the four Development Scenarios, the following would be undertaken:

- The local sewer system would be rebuilt, with TWUL approval and guidance using their network analysis recommendations;
- Flows from sewers subject to regular flooding would be realigned to those with capacity and hence creating a more balanced system;
- Existing infrastructure would be renewed with construction forms that give increased storage capacity and hence flood protection;
- Foul and surface water flows would be separated to allow further system modernisation in future.

14.64 The potential risk of foul drainage flooding is therefore considered to be **negligible** for all four Development Scenarios.

Groundwater Flooding

14.65 As discussed in the demolition and construction section, the basement walls have the potential to dam the groundwater outside each of the four Development Scenario boundaries. This could have the potential to increase the groundwater level surrounding the application sites. If no mitigation measures are implemented at that stage, the risk posed by groundwater flooding once any of the Development Scenarios are completed and operational would be **long-term**, **local** and of **minor adverse** significance.

MITIGATION

Demolition and Construction

Development Scenarios 1, 2, 3 and 4

General Protection of Surface Water and Groundwater

14.66 As outlined in Chapter 6: Demolition and Construction, whichever Development Scenario is consented, contractors would be required to comply with a site-specific Environmental Management Plan (EMP) throughout the demolition and construction works. The EMP would reflect relevant legislative requirements and best practice guidance of the relevant statutory authorities including the EA and TWUL. With respect to drainage, the EMP would include for the implementation of:

- Careful siting and bunding of fuel storage facilities and any areas used for the storage of potentially hazardous materials;
- Careful control of works involving concrete and washing out of ready-mix concrete wagons in a safe area;
- Management of site drainage to prevent sediment laden/contaminated run-off entering the wider environment;
- Use of settlement tanks and oil interception facilities where required to deal with surface drainage, and discharge arrangements would be agreed with TWUL and WCC;
- Paving of construction vehicle parking areas if necessary; and
- Provision for the safe disposal of wastewaters.

Maintenance of Surface Water and Foul Drainage Capacity

14.67 All drainage flow routes and connections would be appropriately maintained throughout the demolition and construction works for the consented Development Scenario. Any alterations would be subject to the relevant controls set out by the EA and TWUL.

Prevention of Groundwater Flooding

14.68 Due to the proximate groundwater level, the basement of all four Development Scenarios would be constructed using standard sealed construction techniques in order to prevent groundwater ingress. Dewatering is also likely to be required, although this would need to be confirmed through a programme of groundwater monitoring. This could be undertaken at the same time as the proposed intrusive site investigation (refer to Chapter 13: Ground Conditions and Contamination). The monitoring would need to include for winter and spring, when groundwater levels would be at their highest. The precise scope of the groundwater monitoring would be discussed and agreed with the EA. Should dewatering be required, this would be carried out using standard techniques such as sumps and pumping. Appropriate dewatering discharge rates would be agreed with the EA prior to any works being undertaken.

14.69 Mitigation would be dependent on the results of the groundwater monitoring and discussions with the EA. If it was considered that groundwater flows were likely to be disrupted by the basement, a permeable drainage blanket (e.g. pea shingle) could be provided to allow groundwater to flow unimpeded around and beneath the structure.

14.70 The programme of groundwater monitoring would also determine the rate and direction of groundwater flow. This information would be subsequently used to inform an appropriate mitigation strategy at the detailed design stage in order to prevent any potential groundwater rising up-gradient of the proposed sub-surface basement.

Completed Development

Development Scenarios 1, 2, 3 and 4

Tidal and Fluvial Flooding

14.71 Despite the potential negligible and/or beneficial risks of minor significance in relation to tidal and fluvial flooding of the three application sites, the EA has requested a Flood Warning and Evacuation Plan be formulated for the consented Development Scenario. It is envisaged that this would be by way of an appropriate planning condition. The Flood Warning and Evacuation Plan would clarify the evacuation route from the consented Development Scenario site and provide further details of the flood warning system (which includes broadcast warnings by way of TV and radio, weather bulletins and, in designated flood warning areas, direct to the local community by siren, loudhailer or flood wardens and, in high risk areas, by phone or fax).

Surface Water, Foul Water and Groundwater Flooding

14.72 All mitigation of surface water, foul water and groundwater flooding effects would be implemented during the demolition and construction works. There would therefore be no additional mitigation required for the completed Development Scenarios.

RESIDUAL EFFECTS

Demolition and Construction

Development Scenarios 1, 2, 3 and 4

Tidal and Fluvial Flooding

14.73 The application sites are protected for the 1 in 1,000 year flood up to 2030 with the existing flood defences. As the demolition and construction programme for the proposed Development Scenarios would run from 2010 until 2017 at the latest, the risk posed by tidal and fluvial flooding would be **negligible**.

Surface Water Drainage Flooding

14.74 With the adoption of best practice construction techniques and implementation of the mitigation measures described, it is considered that the risk of flooding from surface water drainage in the case of all four Development Scenarios would be **negligible**.

Foul Water Drainage Flooding

14.75 Similarly, with the adoption of best practice construction techniques and implementation of the mitigation measures described, it is considered that the risk of flooding from surface water drainage in relation to all four Development Scenarios would be **negligible**.

Groundwater Flooding

14.76 The dewatering and mitigation strategy, to be informed by the results of the groundwater monitoring, would be designed to reduce the risk of flooding to a negligible level. The appropriate procedures applied to the construction of the basements would also maintain groundwater flooding risks at a **negligible** level, maintaining the current level of protection to the three application sites.

Completed Development

Development Scenarios 1, 2, 3 and 4

Tidal and Fluvial Flooding

14.77 The three application sites are defended to a 1 in 1,000 year standard, and risk of failure of the flood defences is very low. The design and implementation of a Flood Warning and Evacuation Plan in consultation and to the satisfaction of the EA and WCC would result in **negligible** risks of tidal and fluvial flooding for all completed and operational Development Scenarios.

Surface Water Drainage Flooding

14.78 The proposed surface water drainage strategy would maintain the current surface water runoff, as it is accepted by TWUL that there would be no change in the amount of hardstanding. With the implementation of the surface water flooding mitigation in place, and the provision of sedum and green roofs in all four Development Scenarios, the residual risks of surface water drainage flooding in relation to any of the four completed and operational Development Scenarios would be **long term, local** and of **minor beneficial** significance.

Foul Water Drainage Flooding

14.79 The proposed sewer network would maintain the capacity for current flow. The residual risks of foul water drainage flooding in relation to any of the four completed and operational Development Scenarios would be **negligible**.

Groundwater Flooding

14.80 Assuming the appropriate mitigation strategy at the detailed design stage and off-site mitigation are implemented, the risk of groundwater flooding would be **negligible** for all four Development Scenarios.

SUMMARY AND CONCLUSIONS

14.81 Best practice construction techniques and the implementation of suitable mitigation measures in the case of all four Development Scenarios would result in a negligible risk in relation to surface water and foul water drainage flooding. Appropriate dewatering and mitigation strategies for the works, to be informed by the results of the groundwater monitoring, would be designed to reduce the risk of flooding.

14.82 As the three application sites are protected for the 1 in 1,000 year flood up to 2030, the risk posed by tidal and fluvial flooding during both demolition and construction and once the Development Scenarios are completed and operational would be negligible. In addition, a Flood Warning and Evacuation Plan would be developed and implemented for the completed Development. Residential components of all four Development Scenarios have been designed to exceed the minimum level of the flood defences. The risk of flooding to the basement would be managed through effective design. Safe, dry emergency escape routes would also be built in.

14.83 TWUL has accepted that the volume of surface water runoff from each the proposed Development would be similar to existing conditions due to the impermeability of the three application sites. Any sewer diversions would be undertaken to accommodate the existing volume and to improve flow rates. Each of the four Development Scenarios would also include SuDS infrastructure such as sedum and green roofs, rainwater harvesting and a grey water system.

14.84 Appropriate mitigation strategy at the detailed design stage and off-site mitigation would ensure that the risk associated with foul water drainage and groundwater flooding is negligible.