11 HYDROLOGY, HYDROGEOLOGY AND DRAINAGE

11.1 introduction

11.1.1 The objective of this section and the statements presented is to assess the existing hydrological and hydrogeological conditions to understand the geo- constraints and sensitivities of the Island Farm site in relation to the proposed development. This section also addresses the points raised by the Environment Agency in their scoping consultation report ref. *"P/09/97/ESO Scoping Opinion for Proposed Leisure and Employment Development, 13th February 2009".*

11.1.2 In order to address the points raised by the EA in the scoping opinion a two stage geo-environmental and geo-technical investigation was carried out at the Island Farm site to support the statements and conclusions made in this Section

11.1.3 Section 7 contains a summary of the geo-environmental aspects of the propose development including contamination and receptors, which includes hydrological receptors. Reference should be made back to this Section.

11.2 Policy and Legislation

11.2.1 Welsh Assembly Government's: "Planning Policy Wales, Technical Advice Note 15: Development and Flood Risk" has been used to assess the flood risk potential for the Island Farm site, reproduced in Volume 2, Figure 12 Flood Map.

11.2.2 TAN 15 provides technical guidance which supplements the policy set out in Planning Policy Wales in relation to development and flooding. It advises on development and flood risk as this relates to sustainability principles, and provides a framework within which risks arising from both river and coastal flooding can be assessed.

11.2.3 TAN15 Development and Flood risk: Development Advice Map SS87NE (Figure 12 Flood Map, Key Planning Figures) shows that the site is wholly within Zone A *"Considered to be at little or no risk of fluvial or tidal/coastal flooding"*. A detailed flood consequences assessment is not required.

11.3 Baseline data and Assessment

Existing Hydrological Features

11.3.1 The Groundwater Vulnerability map series published by the Environment Agency (1996) shows that the south of the site is underlain by a major aquifer overlain by soils which can possibly transmit a wide range of pollutants, associated with Carboniferous Limestone at shallow depth beneath the Lias bedrock. The major aquifer is use for potable supply with 1.5km of the site.

11.3.2 The geology beneath the north of the site has been classified as a minor aquifer, also overlain by soils of Intermediate classification. In addition, low permeability drift deposits have been identified at the site.

11.3.3 A summary of anticipated hydro-geological properties of the geologies beneath the site is provided in the following table:

Table 11.1

Hydro-geological Significance of Ground Conditions		
Soil/Rock Horizon	Soil/Rock Properties	Hydro-geological Significance
Made Ground	Likely to comprise re-worked deposits and/or spoil, with variably clayey, silty and granular content. Variably permeable.	There may be discontinuous perched water bodies at the junction of the made ground and underlying deposits or within the made ground.
Glacial Sand and Gravel	Likely to comprise poorly sorted granular deposits with variable content of fines (silt and clay).	Granular component should prove permeable although due to variable fines content, impermeable horizons will exist, possibly resulting in perched groundwater bodies.
Boulder Clay	Likely to comprise cohesive soils with granular content	Boulder Clay is generally found to have a low permeability on account of its high silt/clay content although perched water can reside in sandy horizons
Lias Bedrock	Thinly interbedded limestones and calcareous mudstones.	EA Publication *The Physical Properties of minor aquifers in England and Wales* described the Lower Lias as relatively impermeable. The limestones and mudstones are likely to have low primary permeability with flow dominated by secondary flow.
Carboniferous Limestone (Anticipated at shallow depth beneath the Lias in south of the site)	Typically comprises un-dolomitised bioclastic and oolitic limestones of shallow-water origin.	See comment below *

* *EA Publication "The physical properties of major aquifers in England and Wales" describes the hydrology as displaying karst hydrology (i.e. dominated by high rock solubility and well developed secondary permeability). The aquifer may be confined when beneath the Lias.*

Groundwater is likely to flow in a southerly to south-westerly direction, towards the valley floor.

11.4 Predicted Effects

Risk to Controlled waters

11.4.1 The Environment Agency in their scoping consultation report ref. "P/09/97/ESO Scoping Opinion for Proposed Leisure and Employment Development, 13th February 2009" have stated that the controlled waters identified under the southern half of the site are highly sensitive.

11.4.2 The preliminary site conceptual model carried out under the stage 1 site investigation outlines the potential for risk to the controlled waters identifying the following pollution linkages

- Surface runoff
- Leaching into the groundwater
- Groundwater transport

11.4.3 Following the Stage 2 Site Investigation works the revised site conceptual model (refer to Section 7.8.5) has determined that there are no risks to the controlled waters from site derived contaminants as the essential element a "source" (contamination) is not present, despite clear pathways and receptors identifying a linkage.

11.4.4 In addition, Leachate analysis has revealed that the made ground soils do not leach the determinants tested at concentrations exceeding the guidelines for environmental protection. The site can therefore be considered as not posing a risk to the aquatic environment.

11.4.5 The EA Scoping opinion highlighted the issue of the karst features known to exist on the site as presenting a risk to the controlled waters this has been considered in Section 7.6 as requiring further detailed intrusive assessment to fully determine nature and extent prior to the development of strategies for managing associated risk. However it is considered that informed engineering solutions to these features will reduce the risk to a negligible level

11.4.6 Preventing risks to the identified receptors during the construction stage is covered in Section 11.4.

Risk to Controlled Waters During Construction.

11.4.7 One of the potential effects of the construction phase is contamination of the controlled waters from a pollution incident resulting from construction equipment and materials on site. Transportation, storage and use of fuels oils and chemicals and handling of cement and concrete for construction purposes all pose a risk of pollution. Pollution incidents may be small and localised or could be more significant being directly discharged into a water body.

11.4.8 Good construction practice involving an Environmental Impact Assessment including risk reduction methodology for all potential polluting activities would be carried out prior to construction commencing on site.

11.4.9 Procedures for pollution control and clean up will implemented and included within the site wide environmental management plan, the waste management plan and the earthworks management plan developed alongside the contractor. Utilising current legislation and good practice the potential impact should be considered low.

Risk via karst features during construction

11.4.10 As noted under Section 7 the karst features that may present a direct pathway to the controlled waters will be identified in the detailed design stage along with proposed engineering solutions.

11.4.11 Where it is not anticipated to carry out stabilisation works to any existing karst features, the location and extent will be recorded and documented and management strategies will be developed to protect these areas of the site during the construction works.

11.4.12 These features would be identified as construction activity constraints to be incorporated into the earthwork/construction management plans. Exclusion zones during earthworks, infrastructure construction or building works will be set up, enforced and monitored.

Risk during site clearance, earthworks and foundation construction:

11.4.13 A site waste management plan will be developed in accordance with the Site Waste Management Plans Regulations 2008 alongside the earthworks management plan to address the issues with earthmoving and reuse associated with clearance operations. The plan will be developed with and approved by the Environment Agency.

11.4.14 All excavation and other works will be carried out in a carefully controlled manner that will not result in water pollution but the strict management of site working areas, haul routes, storage areas and by minimising any open, unprotected area of cut. The control of construction stage runoff will be achieved by ground protection to reduce surface erosion and runoff and by intercepting runoff water into sediment traps or settlement lagoons.

11.4.15 Once engineering solutions have been fully developed for the various foundation requirements, the contractor will develop detailed method statements for foundation construction activities prior to construction taking place.

11.4.16 It is likely that a combination of traditional raft concrete/strip foundations will be utilised across the site which will not require excavation into the lias/limestone aquifer, therefore the risk to the controlled waters with these foundation solutions is considered low.

11.4.17 If further investigation and stadium design dictate, then cast in-situ reinforced piles would be the likely solution founded into competent bedrock, which reduce the formation of new vertical pathways.

11.4.18 The final solution for any required piling would be assessed against EA Guidance on pollution prevention *'Piling and Penetrative Ground Improvement methods on land Affected by Contamination'* this document identifies 6 potential Source- Pathway-Receptor linkages detailed below.

- Creation of preferential pathways, through a low permeability layer (An Aquitard), to allow potential contamination of an underlying aquifer
- Creation of preferential pathways, through a low permeability layer to allow upwards migration of land fill gas, soil gas or contaminant vapours to the surface.
- Direct contact of site workers and others with contaminated soil arisings which have been brought to the surface.

- Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials (where the secondary effects are to increase the potential for contaminant migration
- The driving of solid contaminants down into an aquifer during pile driving
- Contamination of groundwater and subsequently, surface waters by concrete, cement paste or grout.

11.4.19 It has already been shown that there are no site derived contaminants of concern in the soils above the appropriate limits and the only potential linkages that could create a risk to controlled waters are items 5 & 6 in the previous list.

11.4.20 In order to reduce risks associated with these scenarios if a piling solution is required the intention would be to design the pile to be founded within the minor lower lias aquifer thus avoiding the linkage to the major aquifer

11.4.21 It is also recognised that the lias minor aquifer, into which the piles would found contains shale horizons which should prove relatively impermeable making the strata itself relatively vertically impermeable

11.4.22 The clearly defined karst feature identified under the stadium will require treatment and following treatment and subsequent testing of the in filled feature there may be a requirement for piling in this area to penetrate below the base of the treated feature.

11.4.23 This may result in penetration into the major aquifer and scenario's 5 & 6 would apply. In this case it is likely that a non displacement pile solution with a permanent casing would be utilised which would eliminate the issues raised with Scenario 5 and significantly reduce or eliminate any risk of leaching of wet concrete into the aquifer identified in scenario 6

11.4.24 Following more detailed investigation around the karst features and utilising modern construction methods it is considered that the developed foundation risk to controlled waters from construction activities can be minimised.

Risk to Controlled Waters during operation.

11.4.25 Long term risk associated with the life span of development life is associated with treatment of surface water runoff from structures, car parks and hard standing areas. Refer to Section 14 for drainage strategy and pollution prevention measures.

11.5 Summary and Conclusions

11.5.1 Following a two stage geo-environmental and geo-technical investigation at the proposed site the following conclusions have been presented in relation to hydrology and hydrogeology:

11.5.2 In accordance with TAN 15 development and flood risk, the proposed development site is considered to be at little or no risk of fluvial or tidal/coastal flooding.

11.5.3 The desk top study and intrusive site investigation carried out have concluded that the controlled waters are not at risk from site derived contaminated materials as the development site has been classified as 'uncontaminated' there is therefore no site derived source of contamination to impact the controlled waters.

11.5.4 The site investigation work has presented an number of foundation solution for different development locations and proposed uses, it has been identified that karst features (natural cavity formations) exist under elements of proposed footprints and that a potential risk to controlled water is associated with these features. It is recognised that further detailed investigation will be required to fully inform the foundation solutions and

11.5.5 where required any necessary treatment strategies however it is considered that utilising informed design solutions developed in consultation with the EA and modern methods of construction the risk to the controlled waters can be designed out and is considered low

11.5.6 Construction activities associated with the development have the potential to pose a risk to the controlled waters good site management practices in accordance with current guidelines will be in place to mitigate this risk. Procedures will be developed to ensure that environmental impact

11.5.7 Assessments of all potential polluting sources are carried out and control and clean up strategies or defined and in place prior to construction.

11.5.8 Where karst features are noted across the site constraint drawings will be development within the earthworks management plan to ensure that appropriate procedures are in place to prevent potential sources of construction derived contamination a pathway to the sensitive receptor.

11.5.9 The risk from construction based activates adopting and implementing the above procedures is considered manageable and therefore low

11.5.10 It is considered that where strategy dictates the use of open drainage ditches, swales or lagoons the lining of these systems will prevent any ingress of surface water from the development site to the controlled aquifer. Therefore the operational risk from the development is considered low.