Chapter 10:
Hydrology

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Chapter 10 Hydrology

10.1 Introduction

The proposed development for the Trinity Wharf site will facilitate a mix of office, leisure and residential development, with a primary objective of increased sustainable employment. It will also include the development of high quality public realm spaces within the development and pedestrian friendly links along the waterfront linking to Crescent Quay and to Wexford town centre.

The development as described in Chapter 4 will include a boardwalk link to Paul Quay north of the Trinity Wharf site and a 64-berth marina within the Lower Slaney Estuary, located off the northern corner of the site. This chapter has assessed the potential impacts on the hydrology of the local environment as a result of the construction and operation phases of the proposed development.

10.2 Methodology

This chapter has been prepared having due regard to relevant legislation guidance documents which are listed below:

- EPA Guidelines on the Information to be contained in Environmental Impact Statements (2002);
- EPA Advice Notes on Current Practice (in the preparation of Environmental Impact Statements) (2003);
- Draft EPA (Environmental Protection Agency) Guidelines on the Information to be contained in Environmental Impact Assessment Reports, August 2017 (referred to where appropriate);
- Draft EPA Advice Notes for Preparing Environmental Impact Statements, September 2015;
- NRA 2009 Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.
- NRA 2008 Guidelines for the crossing of watercourses during the construction of National Road Schemes.

10.3 Description of Receiving Environment

10.3.1 Site Description & Topography

Trinity Wharf is a brownfield site, approximately 3.6 ha in area, located at the southern end of Wexford's quay-front. The total development will comprise 5.47 ha with the additional lands being required for the access from the Trinity Street, the marina, boardwalk and Paul Quay. The existing site consists of reclaimed land that extends into Wexford Harbour and was gradually reclaimed, with the northern part reclaimed around 1832 initially as a dockyard area and then extended south-eastwards through the late 1800s and early 1900s. The northern part of the site changed from being a dockyard to a market and then a bacon processing plant (Clover Meats) which closed in the late 1980s leaving the site vacant. The southern part of the site developed as an ironworks which operated from 1911 – 1964, following which it was used as a car assembly plant until the early 1980s, and then for manufacturing electronic components (Wexford Electronix) until 2001. The site is now disused and partly overgrown with most structures demolished, except for a masonry stone boundary wall dividing the two compounds.

There are a number of spoil embankments and concrete surfaces on the site, however the topography of the site generally falls from the centre towards the west and eastern boundaries.

10.3.2 Regional & Local Hydrology

The development site is bound to the north, south and east by the Lower Slaney Estuary. The River Slaney rises on Lugnaquilla Mountain, approximately 70km north of the subject site, and generally flows south towards the Irish Sea. The River Slaney becomes tidal, approximately 5km south of Enniscorthy town. There are a number of minor tributaries that join the River Slaney, upstream of the development site.

The River Slaney is located within Hydrometric Area No.12 (Slaney & Wexford Harbour). This catchment has a total draining area of approximately 1,980km^2. The proposed development is within the Forth Commons WFD sub-catchment.

10.3.2.1 EPA Monitoring River Programme

The EPA carries out water quality assessments of rivers, transitional and coastal water bodies as part of a nationwide monitoring programme. Data is collected from physico-chemical and biological surveys, sampling both river water and the benthic substrate (sediment).

Water sampling is carried out throughout the year and the main parameters analysed include: conductivity, pH, colour, alkalinity, hardness, dissolved oxygen, biochemical oxygen demand (BOD), ammonia, chloride, ortho-phosphate, oxidised nitrogen and temperature.

As is the case for rivers and lakes the impact of nutrient enrichment and the process of eutrophication is also a major concern in the tidal waters environment. The direct negative effects of excessive nutrient enrichment include increases in the frequency and duration of phytoplankton blooms and excessive growth of attached opportunistic macroalgae. The subsequent breakdown of this organic matter can lead to oxygen deficiency which in turn can result in the displacement or mortality of marine organisms. As such the effects of over enrichment can severely disrupt the normal functioning of tidal water ecosystems.

The status of individual estuarine and coastal water bodies is assessed using the EPA"s Trophic Status Assessment Scheme (TSAS). This assessment is required for the Urban Waste Water Treatment Directive and Nitrates Directive. The scheme compares the compliance of individual parameters against a set of criteria indicative of trophic state (Table 10.1). These criteria fall into three different categories which broadly capture the cause-effect relationship of the eutrophication process, namely nutrient enrichment, accelerated plant growth, and disturbance to the level of dissolved oxygen normally present.

Table 10.1 Biological River Water Quality Classification System

Trophic Status	Pollution Status	Condition
Unpolluted	Unpolluted	Unpolluted water bodies are those which do not breach any of the criteria in any category
Intermediate	Unpolluted	Intermediate status water bodies are those which breach one or two of the criteria

Trophic Status	Pollution Status	Condition
Potentially Eutrophic	Slightly polluted	Potentially Eutrophic water bodies are those in which criteria in two of the categories are breached and the third falls within 15 per cent of the relevant threshold value
Eutrophic	Polluted	Eutrophic water bodies are those in which criteria in each of the categories are breached, i.e. where elevated nutrient concentrations, accelerated growth of plants and undesirable water quality disturbance occur simultaneously

The Lower Slaney Estuary had an EPA Transitional Surface Water Quality Status of "Potentially Eutrophic" from 2010 – 2012 and a Water Framework Directive (WFD) Status of "Poor" from 2010 - 2015.

10.3.3 Site Drainage

The development site is a brownfield site. Drainage records indicate that there is an existing combined sewer located along Trinity Street, immediately southwest of the site. These existing drainage records do not show a surface water outfall from the site to the existing drainage network on Trinity Street. The existing topography dictates that runoff discharges directly to the Lower Slaney Estuary.

10.3.4 Groundwater Dependant Terrestrial Ecosystems (GWDTE) /Special Areas of Conservation (SAC)

Sites designated under the Natura 2000 and within 2km are listed in Table 10.2 below:

Table 10.2 Sites designated under Natura 2000

Natura 2000 Sites	Distance from Site
Slaney River Valley SAC (000781)	Within Project Area
Wexford Harbour and Slobs SPA (004076)	Immediately Adjacent to site
Nationally Designated Sites	**Distance from Site**
Wexford Slobs and Harbour Proposed NHA (000712)	Within Project Area

There are no GWDTE present within the site.

10.3.5 Water Supplies

There are no recorded public groundwater supplies or group water schemes within the GSI database. There are a small number of recorded boreholes within 1km of the development site which are for industrial use. There are also a number of abstraction points on the River Slaney, upstream of the development site that are used for drinking water purposes.

10.3.6 Flood Risk Identification

The flood risk of the proposed development has been assessed as part of this study. Previous flood studies have been undertaken as part of the national Preliminary Flood Risk Assessment (PFRA), the Catchment Flood Risk Assessment and Management (CFRAM) Programme, the Irish Coastal Protection Strategy Study (ICPSS) and the Wexford Town and Environs Development Plan 2009 – 2015 (as extended).

10.3.6.1 OPW Preliminary Flood Risk Assessment (PFRA)

As required by the EU Floods Directive, the OPW carried out a PFRA to identify areas where the risk of flooding may be significant. The PFRA is a broad scale assessment

based on historic flooding, predictive analysis and consultation with local communities and experts. As part of the PFRA, maps of the country were produced showing the indicative fluvial, pluvial and tidal flood extents. Areas for Further Assessment (AFA's) were identified.

The PFRA map at the proposed development location indicates that the site is located within the 1 in 200 year and extreme coastal flood extents. There is no indication of groundwater flooding within the vicinity of the site, however there is indications of pluvial flooding, immediately south east of the development site. The PFRA mapping shows the 1 in 100 year and extreme pluvial flood extents immediately to the south east of the site.

10.3.6.2 OPW Catchment Flood Risk Assessment and Management (CFRAM)

Following on from the PFRA study, the OPW commissioned The South Eastern CFRAM Study Flood Risk Review which highlighted Wexford as an AFA for fluvial and Coastal flooding. This was based on a review of historic flooding and the extents of flood risk determined during the PFRA study. The Wexford town AFA incorporates the River Slaney and its associated tributaries.

The published final CFRAM (20/04/2017) fluvial mapping indicates that the development site is within the 1 in 10 year, 1 in 100 year and 1 in 1000 year fluvial flood extents. The site also lies within the 1 in 10 year, 1 in 200 year and 1 in 1000 year tidal flood extents, as indicated on the final CFRAM (18/07/2018) tidal mapping.

10.3.6.3 OPW Irish Coastal Protection Strategy Study (ICPSS)

The Irish Coastal Protection Strategy Study (ICPSS) is a national study that was commissioned in 2003 with the objective of providing information to support decision making about how best to manage risks associated with coastal flooding and coastal erosion.

The published tidal flood extent mapping indicates that the development site is within the 1 in 200 year and 1 in 1000 year tidal flood extents.

10.3.6.4 Wexford Town and Environs Development Plan 2009-2015 (as extended)

No flood risk assessment was undertaken as part of the Wexford Town and Environs Development Plan however, policy statements SW6-SW11 relate to flood risk in the planning document. The plan stipulates that floor levels of all buildings must be 300mm above the 1 in 100 year fluvial or 1 in 200 year tidal flood level.

10.4 Description of Potential Impacts

This section will discuss the impacts associated with the proposed development before mitigation measures are applied.

10.4.1 Construction

The potential impacts as a result of construction works are discussed below.

10.4.1.1 Construction Works

Construction activities pose a significant risk to watercourses, particularly contaminated surface water runoff from construction activities entering the watercourses.

Construction activities within and alongside surface waters, can contribute to the deterioration of water quality and can physically alter the stream/river bed and bank

morphology with the potential to alter erosion and deposition rates locally and downstream. Activities within or close to the watercourse channels can lead to increased turbidity through re-suspension of bed sediments and release of new sediments from earthworks. The potential impact is moderate to significant.

The main contaminants arising from construction runoff include:

- Elevated silt/sediment loading in construction site runoff. Elevated silt loading can lead to long-term damage to aquatic ecosystems by smothering spawning grounds and gravel beds and clogging the gills of fish. Increased silt load in receiving watercourses stunts aquatic plant growth, limits dissolved oxygen capacity and overall reduces the ecological quality with the most critical period associated with low flow conditions. Chemical contaminants in the watercourse can bind to silt which can lead to increased bioavailability of these contaminants. Should significant sediment loading occur in the River Slaney Estuary the associated impact rating is assessed as moderate to significant.
- Spillage of concrete, grout and other cement based products. These cement based products are highly alkaline (releasing fine highly alkaline silt) and extremely corrosive and can result in significant impact to watercourses altering the pH, smothering the stream bed and physically damaging fish through burning and clogging of gills due to the fine silt. Construction spillages, if uncontrolled, represent a moderate impact to the River Slaney Estuary.
- Accidental Spillage of hydrocarbons from construction plant and at storage depots / construction compounds. Construction spillages, if uncontrolled, represent a Moderate Impact to the River Slaney Estuary.
- Faecal contamination arising from inadequate treatment of on-site toilets and washing facilities – this represents a slight impact the River Slaney Estuary.
- Contaminated ground excavated as part of the rock armour revetment works entering the Slaney Estuary. Should contaminated material enter the River Slaney the associated impact rating is assessed as slight to moderate.

The construction works required for the proposed marina will most likely involve pre-cast concrete anchor blocks being gently lowered to the seabed where they will then embed within the existing silt/sediment/mud providing an anchoring point for the marina. The placement of the anchor blocks in this manner could potentially release a very short-term and limited quantity of sediment to the estuary. This would result in negligible impacts to the River Slaney Estuary given the existing disturbance of sediment during tidal events. In the unlikely event that the seabed be unsuitable for such works it would be necessary to locally excavate the seabed to provide a level area onto which block anchors would be placed and then partially buried. Alternatively, should bedrock be encountered at a shallow depth, chain mooring could be fixed to a metal plate which would be rock bolted down onto the surface of the bedrock. This option would also require the local excavation of seabed material to expose bedrock for fixing works by divers. Any local excavation works of the seabed could cause a short-term and temporary sediment load being released to the estuary. Local excavations for the installation of block anchors, in the absence of mitigation, represents a slight impact to the River Slaney Estuary.

During site clearance and grading works there is potential for generation of contaminated surface water runoff arising from rainwater coming in contact with temporarily exposed contaminated material. This contaminated runoff could, in the absence of controls, then enter the River Slaney estuary and negatively affect water quality. In addition, deep excavations which encounter contaminated material may

require dewatering of potentially contaminated surface water or groundwater. This pumped water could, in the absence of control measures, discharge overland to the River Slaney. Should contaminated surface water or groundwater enter the River Slaney the associated impact rating is assessed as slight to moderate.

10.4.1.2 Flooding

The proposed construction works will include for the construction of a new sea wall consisting of steel sheet piles to be installed around the perimeter of the site, with a reinforced concrete capping beam to be constructed on top of the sheet piles which will support a handrail. The proposed boardwalk will also consist of driven pile foundations.

The volumes of water displaced by the proposed sheet pile wall and board walk foundations during the construction phase is extremely small relative to the volumes of the receiving waterbody and will result in an imperceptible impact.

10.4.1.3 Sediment Transport

Hydrodynamic modelling was undertaken for the proposed marina in 2018 by RPS Consulting Engineers as part of the Trinity Wharf Marina Feasibility Study (RPS). This study concluded that the marina development would not significantly alter the sediment supply or flow of sediment in Wexford Harbour. Therefore, the associated impact is deemed to be slight.

10.4.2 Operational

The potential impacts as a result of the operational phase of the development are outlined below.

10.4.2.1 Morphological Changes to Surface Watercourses & Drainage Patterns

The existing surface water drainage pathways on the site will be altered as a result of the development and as a result, the impact is deemed to be slight.

10.4.2.2 Hardstanding Runoff

As a result of the proposed development, runoff from hardstanding areas such as roads, parking bays, roofs and footpaths will be generated. Unmitigated, this would increase the rate of runoff from the site and as a result, the associated effect is deemed to be slight.

10.4.2.3 Drainage and Foul Sewers

There is no indication of any existing foul or surface water drainage connections to the site. New separate foul and surface water drainage systems will be developed to serve the site.

Due to topographical constraints, foul effluent will require pumping to the existing foul/combined sewer network located on Trinity Street, south west of the site, where the effluent will ultimately be conveyed to the Wexford Wastewater Treatment Works for treatment.

10.4.2.4 Implications for Designated Sites

The potential impact associated with discharging untreated surface water into the Slaney River Valley SAC, Wexford Harbour and Slobs SPA and Wexford Slobs and Harbour Proposed NHA is considered moderate to significant, due to the environmental sensitivities of the area.

10.4.3 Flood Risk

The development site is located within Flood Zone A. The OPW "The Planning System and Flood Risk Management – Guidelines for Planning Authorities" (The Guidelines), 2009 states that for Flood Zone A, the probability of flooding from rivers and the sea is highest (greater than 1% or a 1 in 100 return period for river flooding or 0.5% or a 1 in 200 year return period for coastal flooding). As a result of the proposed development, there will also be an increase in impermeable areas on the site, as mentioned in Section 10.4.2.2 above.

Flood risk assessments at strategic and site specific scale have been undertaken as part of the following studies:

- Irish Coastal Protection Strategy (ICPSS);
- The South Eastern CFRAMs and;
- Trinity Wharf Marina Feasibility Study (RPS).

Extreme sea level return periods detailed in these studies are listed in table 10.3 below.

Table 10.3 Calculated sea Water Levels (WL) (all figures include a climate change factor as per the OPW MRFS)

Study	1 in 200 year WL (mOD)	1 in 200 year WL (mOD) + 300mm	1 in 1000 year WL (mOD)
Irish Costal protection Strategy Study	2.24	2.54	2.47
South Eastern CFRAMs	2.14	2.44	2.32
Trinity Wharf Marina Feasibility Study	2.34	2.64	2.56

The highest values among the various flood studies (Table 10.3) were calculated as part of the Trinity Wharf Marina Feasibility Study (RPS). As per the precautionary approach, these are considered the most suitable indicators of flood risk prior to a detailed flood risk assessment of the Proposed Development being undertaken. The impact associated with flooding during the operational stage in the absence of appropriate mitigation is deemed to be moderate to significant.

10.4.4 Tide and Wave Height

The ICPSS states that there are no significant interactions of tidal currents and surges. Anecdotal evidence suggests that during frequent easterly wind conditions, the tidal levels in the Harbour do not drop during ebb flow (ICPSS Phase 2 South East Coast).

A Marina Feasibility Study was completed RPS Group for the Trinity Wharf Site in January 2018 (see Appendix 4.3), this builds upon the works undertaken as part of the ICPSS and South Eastern CFRAMs where extreme sea levels and wave action were examined.

The two wave height acceptance thresholds used in the study were based on guidelines published by the Yacht Harbour Association and the Australian Standard (AS3962) Guidelines for design of Marinas. The assessment concluded that for the marina to be viable and safe, a suitably designed defence structure would be required. The study calculated a 1 in 50 year significant wave height of 0.9m. The simulated wave height was significantly reduced by the implementation of defences such as breakwaters.

10.4.5 Cumulative Impacts of the Proposed Development

The cumulative impact as a result of the construction works and operational phase in the absence of mitigation is considered slight to moderate, mainly as a result of the proposed construction works. The construction related activities associated with the development are temporary and short term in nature. The mitigation and monitoring measures detailed below will aid in minimising the impacts associated with this development.

10.5 Mitigation and Monitoring Measures

10.5.1 Construction Mitigation

10.5.1.1 Construction Works

A project-specific Construction Environmental Management Plan (CEMP) and Environmental Operating Plan (EOP) will be prepared by the contractors appointed for the development following the Outline CEMP attached as Appendices 4.1 and 4.2 to this EIAR. The CEMP will list any difficulties encountered and it will be maintained by each Contractor for the duration of the construction phase. The CEMP and EOP will cover all potentially polluting activities and include an emergency response procedure. All personnel working on the site will be trained in the implementation of the procedures. As a minimum, the CEMP and EOP for the proposed development will be formulated in consideration of the standard best practice. The following will be implemented as part of this plan:

- A draft Incident Response Plan detailing the procedures to be undertaken in the event of spillage of chemical, fuel or other hazardous wastes, non-compliance incident with any permit of license or other such risks that could lead to a pollution incident, including flood risks;
- All necessary permits and licenses for in stream construction work for provision of the sea walls, boardwalk and marina works will be obtained prior to commencement of construction; and
- Inform and consult with Inland Fisheries Ireland (IFI) and Waterways Ireland (WI).

The draft CEMP and EOP will be developed by the selected construction contractors to suit the detailed construction methodology and allocate responsibilities to individuals in the construction team.

During construction, cognisance will have to be taken of the following guidance documents for construction work on, over or near water.

- Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites (Eastern Regional Fisheries Board);
- Central Fisheries Board Channels and Challenges – The enhancement of Salmonid Rivers;
- CIRIA C532 Control of Water Pollution from Construction Sites Guidance for Consultants and Contractors;
- CIRIA C648 Control of Water Pollution from Constructional Sites; and
- Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes (NRA/TII, 2006).

Based on the above guidance documents concerning control of constructional impacts on the water environment, the following outlines the principal mitigation measures that

will be prescribed for the construction phase in order to protect all catchment, watercourse and ecologically protected areas from direct and indirect impacts:

- Exposure of contaminated material shall be minimised by placing the low permeability clay capping layer immediately following initial site grading and clearance works. Grading works shall progress in a manner which always allows runoff to be directed towards a temporary treatment facility without surface ponding. This will minimise contact time between the contaminated material and surface water and thus limit the opportunity for contamination to occur. Runoff which has been in contact with exposed contaminated material will be captured and directed to a temporary lined facility, where the flow will be attenuated and sediment allowed to settle, before passing through a hydrocarbon interceptor and being discharged to Wexford Harbour.
- Should temporary dewatering be required during deep excavations within the contaminated material, strict control measures will be put in place for disposal of same. Water pumped from excavations within the contaminated material shall either be passed through the temporary surface water treatment/attenuation facilities before discharge to Wexford Harbour or discharged to a foul sewer. Should very heavily contaminated groundwater be encountered during deep excavations and pumping be required of same, temporary dewatering shall be either collected and discharged to a foul sewer via tanker or treated on-site by way of a temporary water treatment works. Groundwater samples shall be taken from boreholes across the site in advance of construction works taking place to determine which method of disposal is required. Specialist advice will be sought as to the most appropriate form of treatment required as determined by the pre-construction groundwater sampling results. The works shall be planned in an appropriate manner so as to minimise the need for construction dewatering. Where excavation into contaminated material does take place, control measures to limit or prevent surface water runoff from entering the excavation shall be incorporated. These measures may include shoring, sheet piling, benching/battering or embankment of the excavation perimeters.
- All construction compound areas will be required to be set back a minimum of 50m from the seaward boundary of the site. Protection of waterbodies from silt load will be carried out through use of grassed buffer areas, timber fencing with silt fences or earthen berms to provide adequate treatment of runoff to watercourses;
- In order to attenuate flows and minimise sediment input into Wexford Harbour through run-off, all surface water run-off from the construction site shall be directed to a temporary facility, where the flow will be attenuated and sediment allowed to settle, before passing through a hydrocarbon interceptor and being discharged to Wexford Harbour. An impermeable membrane overlaid with suitable fill will be provided to storage areas to prevent contamination or pollution of the groundwater;
- Settlement ponds, silt traps and bunds will be used where appropriate and construction within watercourses will be minimised. Where pumping of water is to be carried out, filters will be used at intake points and discharge will be through a sediment trap. General Constructional Compounds will not be permitted within 50m of Slaney River Valley SAC and Wexford Harbour and Slobs SPA. It may, however, be necessary to locate temporary storage areas adjacent to the Slaney Estuary when the marina and flood protection works are being undertaken. Measures will be implemented to ensure that silt laden or contaminated surface water runoff from the compound does not discharge directly to the estuary. This will primarily be in the form of silt fences which will be installed along the

compound boundary to stop 'dirty' surface water runoff from entering the estuary without treatment;

- Protection measures will be put in place to ensure that all hydrocarbons used during the construction phase are appropriately handled, stored and disposed of in accordance with the NRA/TII document "Guidelines for the crossing of watercourses during the construction of National Road Schemes". All chemical and fuelling locations will be contained within bunded areas and set back a minimum of 50m from watercourses;
- All construction machinery operating in-stream should be mechanically sound to avoid leaks of oils, hydraulic fluid, etc. Machinery shall be steam cleaned and checked prior to commencement of in-stream works to avoid spread of invasive species;
- Oil booms and oil soakage pads should be maintained on-site to enable a rapid and effective response to any accidental spillage or discharge;
- No refuelling of construction plant shall be undertaken while the vehicles are in or adjacent to watercourses, as this could lead to contamination of the watercourse through spillage of fuel. In addition, all construction vehicles entering the watercourse should be in good condition and be provided with drip trays to prevent pollution through dripping of oil or fuel from the vehicle;
- Foul drainage from all site offices and construction facilities will be contained and disposed of in an appropriate manner to prevent pollution;
- The construction discharge will be treated such that it will not reduce the environmental quality standard of the receiving watercourses;
- Any surface water abstracted from a watercourse for use during construction will be through a pump fitted with a filter to prevent intake of fish;
- The use and management of concrete in or close to watercourses will be carefully controlled to avoid spillage. Washout from concrete mixing plant will be carried out only in a designated contained impermeable area;
- All shuttering shall be securely installed and inspected for leaks prior to cement being poured and all pouring operations shall be supervised monitored for spills and leaks at all times;
- All pouring of concrete, sealing of joints, application of water-proofing paint or protective systems, curing agents etc. for outfalls shall be completed in dry weather;
- Any concrete used in or over the estuary shall be pre-cast, where possible;
- Where concrete or other wet materials are to be used over water, appropriate bunded platforms shall be in place to capture any spilled concrete, sealants or other materials;
- A geotextile screen and boom with oil barrier will be required around such marine works to prevent runoff, silt, oil or other deposits generated by construction activities such as boring in overburden or rock from polluting the river;
- Any materials collected on these platforms shall be transferred to the landside construction areas and disposed of in accordance with the Construction and Demolition Waste Management Plan; and
- The placing of anchor blocs (if required) shall be undertaken so as to minimise disturbance of sediment from the sea-bed. Should local excavation of the seabed be required it shall be carried out behind a geotextile screen and boom with oil barrier to prevent pollution of the river/estuary.

10.5.2 General Operational Mitigation

10.5.2.1 Morphological Changes to Surface Watercourses & Drainage Patterns

SuDS components will convey runoff to the Lower Slaney Estuary while attenuation will be provided for the 1 in 100 year 6-hour event. The conveyance of runoff to the Lower Slaney Estuary will generally follow the existing site topography. The implementation of these proposed mitigation measures reduces the impact to imperceptible.

10.5.2.2 Hardstanding Runoff

As a result of the increase in hardstanding areas, runoff from the site will increase. The proposed surface water drainage system will comprise predominantly SuDS features which will attenuate and cleanse the surface water runoff from the site prior to discharge to sea through multiple outfalls located along the extent of the proposed sea wall. Whilst the base of the permeable paving and grassed swales will allow very limited percolation to the underlying subsoils, the percolating portion is expected to be minimal due to the incorporation of a low permeability clay layer across the entire site.

The surface water drainage system will be designed to store the 1 in 100 year 6 hour rainfall event plus a climate change factor (between tidal cycles). The OPW FSU Portal calculates this rainfall depth to be 80.76mm. Attenuation of surface water runoff will occur within a layer of coarse graded clean aggregate material installed below the permeable paving which will have a voids ratio of typically 30%. These proposed mitigation measures reduced the associated impact from hardstanding runoff from moderate/significant to slight. The provision of permeable paving within the development will negate the need to provide numerous individual petrol interceptors throughout the development. Treatment to runoff generated will be provided within the pavement layers through the processes of filtration, biodegradation, adsorption of pollutants and the settlement and retention of solids within the pavement layers.

10.5.2.3 Foul Drainage Infrastructure

In the event of a pump failure at the proposed foul pumping station, mitigation measures have been proposed. The pumping station has been designed to provide 24-hour effluent storage in case of failure. Standby pumps will also be provided.

10.5.2.4 Implications for Designated Sites

It is proposed that surface water from the proposed development discharges to the Slaney Estuary, which is an environmentally sensitive area. Mitigation measures that will be implemented include the design of a surface water drainage system to serve the proposed development. The proposed surface water drainage system will comprise predominantly SuDS features which will attenuate and cleanse the surface water runoff from the site prior to discharge to sea through multiple outfalls located along the extent of the proposed sea wall (with some limited percolation into the subsoil). The incorporation of a SuDS based approach will ensure that discharge will be controlled, and treatment of runoff will take place within the SuDS components. The implementation of these mitigation measures will reduce the associated impact from moderate/significant to imperceptible.

10.5.3 Flood Risk Mitigation

The flood risk associated with the proposed development is deemed to be moderate to significant. As discussed in Section 10.4.3, the following minimum levels will be required within the site:

- To satisfy the Wexford Town and Environs Development Plan 2009-2015 (as extended) all buildings as part of the proposed development must have a minimum floor level of 2.64mOD; and
- As per the OPWs Flood Risk Management Guidelines for Local Authorities (2009) "Less vulnerable developments" such as local transport infrastructure must have a minimum level of 2.34mOD.

The lowest proposed finished floor level for the development is 3.3mOD, while the lowest road level will be at 2.80mOD (generally 3.5mOD).

In addition to the flood risk measures above, a new steel sheet pile sea wall is to be provided along the northwest, southeast and northeast edges of the site as part of the development, while sections of the northwest and southwest edges will comprise an area of rock armour revetment outside of the sheet piles. A sheet pile driving rig will mobilise and begin driving sheet piles in front of the existing sea wall to approximately -10.5mOD into the stiff gravelly clay. The existing wall will remain in place until the sheet pile wall is correctly installed and only then will be demolished. Construction of the rock armour revetment will involve suitable boulders being placed directly onto the silt/sediment of the seabed.

The marina will also be sheltered by a breakwater on the seaward side. This will involve driving pile sockets for the breakwater units and the pontoon walkways into the seabed. Vertical steel piles will then be grouted into the pile sockets to give good line and plumbness.

Alternatively, helical anchors can be drilled into the seabed via a barge at the location for the lower terminal of anchor chains that will connect and secure the breakwater units and pontoon walkways and finger berths. Depending on substrate conditions, restraint chains could also be anchored by appropriately sized anchor blocks buried into the seabed.

The actual method of securing the marina elements (i.e. piled restraints or chained restraints) will be subject to ground investigations during detailed design phase. The proposed marina breakwater, sea wall and rock armour revetment along the perimeter of the site will protect the development against storm surge and wave action.

The proposed mitigation measures outlined above indicate that the risk associated with flooding can be reduced from moderate/significant to slight.

10.6 Residual Impacts

10.6.1 Construction Phase

Construction shall be undertaken in accordance with the measures outlined in Section 10.5.1 and the CEMP and EOP adapted by the contractors. If these measures are adapted, the risk of any residual impact as a result of construction should be imperceptible.

10.6.2 Operational Phase

The use of SuDS features and the attenuation of storm water will mitigate any potential impacts relating to changes in runoff rates and volumes whilst also maintaining or indeed potentially improving the quality of water in the estuary. The proposed design will also mitigate any potential impacts arising from flooding. There will therefore be an imperceptible impact from development in the operational phase.

10.7 Difficulties Encountered

No difficulties were encountered in undertaking this hydrological assessment.

10.8 References

Water Features, Rivers and Streams, EPA (gis.epa.ie/Envision);

Geological maps, Geological Survey of Ireland (GSI) (www.gsi.ie);

Groundwater quality status maps (watermaps.wfdireland.ie);

Environmental Protection Agency Drinking Water Reports;
OPW Flood Mapping (www.floodinfo.ie/map/floodmaps/);

Myplan.ie (http://www.myplan.ie/webapp/);

OPW Irish Coastal Protection Strategy Study Mapping
(https://www.opw.ie/en/floodriskmanagement/floodanderosionmapping/icpss/);

Trinity Wharf Marina Feasibility Study (RPS, 2018)