Table 3.3.12: Average and maximum concentrations of *Norovirus* in Cork Lower Harbour in 2010 (treated effluent).

Year Repeating Tide	2010 Treated Average	2010 Treated Max
Fountainstown	195	695
Myrtleville	285	798
Roches Point	532	1254
Crosshaven	368	917
Ringaskiddy	219	550
Monkstown Ck	186	556
Oyster F – NC	89	550
Marlogue Point	252	933
Oyster F - Outer	219	545
Cobh	430	1374
Spike Island	523	1203
Shoreline	496	1028
Upstream Outfall	701	3157
West Passage	205	817
Lough Mahon	98	471
All concentrations are expressed in no of Norovirus per m^3		
The average values are for the 20 day viral pulse		

Organic nitrogen, ammonia and nitrate

Table 3.3.13 *Concentration of organic nitrogen, ammonia and nitrate in raw and treated sewage* details the concentrations of organic nitrogen, ammonia and nitrate in untreated and treated sewage. Table 3.3.14 *Maximum concentrations of nitrogen, ammonia and nitrate in the Lower Harbour area in 2010* lists the concentrations of nitrogen, ammonia and nitrate at fifteen points of interest following the discharge of untreated and treated effluent from the Lower Harbour area. The concentrations of each of these species of nitrogen in the harbour was found to decrease following secondary treatment of the effluent, with the exception of organic nitrogen concentrations at Fountainstown, Myrtleville, Roches Point and upstream of the IDA outfall. These slight increases are due to the discharge of all treated effluent through a single outfall, compared to the present scenario where there are numerous outfall points. It is evident that the proposed development will reduce considerably the forcing on primary production in the Inner Harbour (Lough Mahon) and in the North Channel behind Great Island. There is also an improvement throughout the Outer Harbour with the possible exception of the immediate vicinity of the diffuser itself. As discussed previously, DIN levels in the harbour have exceeded the criterion value during winter sampling periods in recent years. The reduction in nitrate and ammonia in treated effluent from the proposed WWTP will have a moderate positive impact on water quality in Cork Lower Harbour in terms of DIN.

Table 3.3.13: Concentration of organic nitrogen, ammonia and nitrate in raw and treated sewage.

Nutrient	Raw Sewage	Treated sewage
Organic Nitrogen	15mg/l	15mg/l
Ammonia	25mg/l	12.5mg/l
Nitrate	1mg/l	1mg/l

Table 3.3.14: Maximum concentrations of nitrogen, ammonia and nitrate in the Lower Harbour area in 2010.

	Nitrogen (mg/L)		Ammonia (mg/L).		Nitrate (mg/L)	
	2010 MAX (Untreated)	2010 MAX (Treated)	2010 MAX (Untreated)	2010 MAX (Treated)	2010 MAX (Untreated)	2010 MAX (Treated)
Fountainstown	0.000321	0.000432	0.000655	0.000553	0.000684	0.00046149
Myrtleville	0.000413	0.000500	0.000836	0.000631	0.000832	0.0005058
Roches Point	0.001366	0.001779	0.002529	0.001785	0.001582	0.00073657
Crosshaven	0.001325	0.001038	0.002549	0.001156	0.001792	0.00067713
Ringaskiddy	0.001831	0.000393	0.003655	0.000543	0.003576	0.00064122
Monkstown	0.001853	0.000413	0.003688	0.000560	0.003527	0.00060934
Oyster F - NC	0.000805	0.000390	0.001640	0.000526	0.001813	0.00056257
Marlogue Point	0.002090	0.000689	0.003966	0.000850	0.002705	0.00070098
Oyster F - OH	0.000884	0.000809	0.001756	0.000954	0.001812	0.00064305
Cobh	0.002976	0.001831	0.005501	0.001858	0.004048	0.00081516
Spike Island	0.001770	0.001385	0.003422	0.001472	0.002581	0.00074446
Shoreline	0.001344	0.000976	0.002647	0.001060	0.002279	0.00067418
Up. Outfall	0.004708	0.006471	0.008214	0.005683	0.002188	0.00105842
West Passage	0.002601	0.000870	0.004962	0.001027	0.003609	0.00074542
Lough Mahon	0.002517	0.000471	0.00480	0.000614	0.003512	0.00062927

From the data presented above, water quality in Cork Lower Harbour is expected to moderately improve with the operation of a WWTP in the Lower Harbour area due to reductions in the concentrations of faecal coliforms, *Norovirus*, organic nitrogen, ammonia and nitrate entering the Harbour. However, the operation of the WWTP and collection system will have a significant positive impact on the towns, villages and population of the Lower Harbour catchment area.

The potential impact on the receiving waters from emergency overflows from the pumping stations may affect water quality in the receiving water to which the outfall is discharging. However, the risk of such an event occurring is extremely low in a modern well managed plant as is proposed. During storm events the potential exists for storm water overflows to be discharged directly to the harbour. The large size of Cork Lower Harbour along with tidal currents would mean that the receiving waters would have a high resilience to such unlikely events and the risk of such an event happening with the proposed WWTP would be much lower than is currently the case. The normal operating quality of the proposed discharge into Cork Lower Harbour will be much improved from the existing discharges it would replace and will have a long term moderate positive impact on water quality.

Positive impacts on aquaculture, recreation and the economic value of the harbour will also occur as a result of improved water quality.

(iii) Cumulative Impacts

Cork County Council are committed to improving water quality in Cork Harbour and a number of sewerage schemes and WWTPs are due to commence in 2008, namely: Midleton Sewerage Scheme; Little Island Sewerage Scheme; Carrigtwohill Sewerage Scheme and Midleton WWTP extension. The cumulative impact of these domestic sewerage schemes and the proposed WWTP in Cork Lower Harbour will be an improvement in water quality in Cork Harbour due to the treatment of raw effluent prior to discharge to the harbour.

The *Water Framework Directive* (WFD) (2000/60/EC) came into force in 2000 and its target is to achieve the objectives listed below by 2015. Its objectives are to:

- Achieve good ecological and chemical status in surface waters
- Achieve good chemical status and quantitative status in groundwaters
- Achieve good ecological potential and chemical status in artificial and heavily modified waters
- Prevent deterioration in status of surface and groundwaters
- Reverse pollution trends
- Achieve objectives and standards for protected areas
- Cease Priority Hazardous Substances discharges

At present, the EPA's *Proposed Quality Standards for Surface Water Classification* is open for public consultation. Following public consultation, the EPA will make recommendations to the Minister of the Environment, Heritage and Local Government for input into additional Regulations which will give statutory effect to these measures for implementation of the WFD. At present, there are no statutory regulations with regard to a Programme of Measures and Quality Standards for the South Western River Basin District.

Cork County Council are investing in several WWTPs and sewerage schemes in County Cork and in so doing are contributing to the achievement of good ecological and chemical status in surface waters, reversal of pollution trends and ceasing the discharge of Priority Hazardous Substances, which are objectives of the WFD.

(iv) 'Do Nothing' Impact

In the event that the proposed development does not proceed, water quality in Cork Lower Harbour would expect to remain variable and eutrophic in parts. The effects of an increasing population coupled with increased housing demands in the Lower Harbour area would be an increase in the amount of untreated discharges entering the harbour. Impacts would include deterioration in water quality which could negatively impact on ecology, human beings and economic activity due to restricted development as a result of insufficient waste water infrastructure and treatment.

(v) 'Worst Case Scenario' Impact

Where the mitigation measures are not implemented correctly, or fail, the potential exists for the WWTP to discharge untreated effluent into Cork Lower Harbour. The large size of Cork Lower Harbour along with tidal currents would mean that the receiving waters would have a high resilience to such short-term and unlikely events and the risk of such an event happening with the proposed WWTP scheme would be much lower than is currently the case. These situations are unlikely to occur on effective construction and operational management of the development and the implementation of the mitigation measures proposed in the appropriate sections of this statement.

3.3.5 Mitigation Measures

(i) Construction Phase

To prevent chemical pollution, all fuels or chemicals kept on the construction site will be stored in bunded containers. All refuelling and maintenance will be carried out in ramped containment areas away from sensitive environments (i.e. up-gradient of protected habitats or adjacent watercourses). In the event of any spillage or accident occurring below the high water mark of ordinary or medium tides, or above the high water mark which may impact on the foreshore during the carrying out of the works, or during operations following the completion of these works, the Irish Coast Guard will be notified immediately by telephone.

During the construction of the marine crossing, if open-cut techniques are employed, the disturbed area will be protected so as to reduce potential bed erosion by tidal movements during construction.

(ii) Operational Phase

Currently all waste water from the population centres within the Cork Lower Harbour Drainage Scheme is generally not treated (significant elements receive no treatment and limited volumes receive comminution) and is discharged directly to the Lower Harbour. Consequently, the quality of the discharge from any future overflows will be a significant improvement on current practice. Emergency overflows will be located on the collection system at individual pumping stations to prevent localised flooding in the event of a power failure. The provision of duty/standby pumping arrangements in each pumping station will minimise the potential for the discharge of raw sewage except in an emergency. All overflow arrangements will be designed to minimise nuisance and associated health hazards. Where overflows occur, their design will be refined at detailed design to the extent that they meet all accepted industry design parameters and will not have a significant impact on water quality. All pumping stations and associated overflows will be designed in accordance with the Department of the Environment, Heritage and Local Government guidelines including the guideline document issued entitled *Procedures and Criteria in relation to Storm Water Overflows*. The storm water management and treatment system at the WWTP is described in Section 2.5.5 *Proposed WWTP Treatment Options*

In order to minimise the risk of untreated effluent discharging from pumping stations an automated control operating system should be put in place to ensure that if a downstream pumping station fails to operate, the upstream pumping station will cease pumping.

Provision of continuous monitoring and sampling of waste water flow entering and leaving the site will be provided. This will also include monitoring and measuring of the storm water content. In order to comply with the provisions of the *Urban Waste Water Treatment Regulations 2001 & 2004* comprehensive monitoring will be carried out as described in Section 2.10 *Waste Water Monitoring.*

To comply with the *Waste Water Discharge (Authorisation) Regulations* of 2007, a waste water discharge licence will be required from the EPA for the Cork Lower Harbour WWTP. The purpose of the licence is to make provision for the protection of human, animal and plant life from harm and nuisance caused by the discharge of dangerous substances to the aquatic environment as well as to ensure compliance with National law.

The WWTP in Cork Lower Harbour will also be designed so that it can be retro-fitted for nutrient removal, if required in the future.

3.3.6 Residual impacts

Residual impacts which are likely to occur following the implementation of mitigation measures include improved water quality in Cork Lower Harbour which in turn will have positive impacts for ecology, aquaculture, recreation, economic activity and development in Cork Lower Harbour.

3.4 Soils, Geology and Hydrogeology

3.4.1 Introduction

This chapter of the EIS describes the Soils, Geology and Hydrogeology in the existing environment surrounding the proposed development. Significant impacts likely to affect soils, geology and hydrogeology are identified and mitigation measures have been proposed where considered appropriate.

3.4.2 Methodology

(i) Existing Environment

Soils and Geology

The methodology specified hereunder was used by the project team to assess the baseline drift geology and bedrock geology environment of the proposed development area. The baseline information that is detailed in this section of the statement was obtained from publicly available information.

Existing literature on soils and geology in the existing environment were reviewed in light of the proposed development. Information on drift and solid geology was obtained from the Geological Survey of Ireland (GSI) database and maps for the area. The following documents and sources were referenced:

- *An Assessment of the Bedrock Geology of South Cork,* Geological Survey of Ireland (GSI; 1994) and Sheet No. 25 (GSI; 1995);
- *General Soil Map of Ireland* 2nd Edition, (1980), the National Soil Survey, An Fóras Taluntais.
- Geological Heritage, consultation with GSI (Sarah Gatley, Senior Geologist, Head IGH Programme)
- *Geology of the Lough Mahon Area, Preliminary Report 1977* (for Cork Harbour Commissioners), T.A. Reilly and A.G. Sleeman. Historical Marine Geology Report.
- Geophysical Survey – Cork Harbour Main Drainage Scheme, November 2007. Minerex Geophysics Ltd.
- *Groundwater and Human Development*, 2002. 'Buried valley ribbon aquifers. A significant groundwater resource of South West Ireland'. Dejan Milenic and Alistair Allen.
- GSI quaternary maps (http://gis3.dcmnronline.ie/imf5104/imf.jsp?site=GSI_Simple)
- *N28 Geotechnical Report*, Priority Geotechnical, October 2006 (part of the N28 Cork to Ringaskiddy Road Scheme)
- National Radon Survey, Cork Map. Radiological Protection Institute of Ireland (http://www.rpii.ie/radon/maps/cork.html)
- *Site Investigation on Lands in Ringaskiddy*, 1977 (carried out for the Industrial Development Authority). E.G. Pettit & Company

- Soil Associations of Ireland and their Land Use Potential, Explanatory Bulletin to Soil Map of Ireland 1980, M.J. Gardiner and T. Radford, the National Soil Survey, An Fóras Taluntais.
- Subsoil map (Teagasc Classification) and 'Soil Parent Material Classification and Map Codes' (Teagasc 2004).

A site walk over of the proposed WWTP site was carried out on 22nd June 2007 and 23rd August 2007. A geophysical investigation was carried out at the site in November 2007. Intrusive subsurface data was not available; however geotechnical borehole and trial pit data from the proposed N28 located directly north of the site has been referenced.

Hydrology, Hydrogeology and Groundwater Chemistry

A desk-based assessment was used to assess baseline hydrology, hydrogeology and groundwater chemistry for the receiving environment of the proposed site.

In addition to those identified above, the following documents and sources were referenced:

- 1:50,000 Discovery Series Maps and 6" maps
- Aquifer classification and vulnerability identification from the Geological Survey of Ireland (GSI web page http://www.gsi.ie);
- GSI well search to determine the location of groundwater wells within a 3 kilometre radius of the WWTP site;
- Water Framework Directive – groundwater classifications (information supplied by the South Western River Basin District (SWRBD) project office.

Impact Assessment Methodology

This section provides an assessment of the environmental impacts of the proposed development on the bedrock geology, drift geology and hydrogeology. Consideration is given to the nature of the underlying limestone bedrock and the implications this may have on the subterranean drainage and groundwater quality. The environmental impacts due to the proposed development are described in terms of predicted impacts during the construction and operational phases of the proposed development.

The importance or sensitivity of the geological and groundwater interest of the study area was determined using the criteria set out below in Table 3.4.1 *Geology and Groundwater Sensitivity.*

Table 3.4.1: Geology and Groundwater Sensitivity

Sensitivity of Geological Interest	Description
High	Areas containing geological or geomorphological features considered to be of national interest, for example, Special Areas of Conservation (SAC). Designated sites of nature conservation importance dependent on groundwater.
Medium	Areas containing geological features of designated regional importance, for example regionally important geological sites, considered worthy of protection for their educational, research, historic or aesthetic importance. Exploitation of local groundwater is not extensive and/or local areas of nature conservation known to be sensitive to groundwater impacts.
Low	Geological features not currently protected and not considered worthy of protection. Poor groundwater quality and/or very low permeabilities make exploitation of the aquifer(s) unfeasible. Changes to groundwater not expected to impact on local ecology.

The assessment of the magnitude of predicted impacts on solid and drift geology and groundwater was based on the criteria defined in Table 3.4.2 *Definition of Magnitude of Impacts Criteria* and the combination of sensitivity and magnitude are used to derive the impact significance as detailed in Table 3.4.3 *Assessment of Significance Criteria for Impacts on Geology and Groundwater*.

Table 3.4.2: Definition of Magnitude of Impacts Criteria

Magnitude of Impacts	Description of Degree of Impact
High	Partial (greater than 50%) or total loss of a geological site, or where there would be complete severance of a site such as to affect the value of the site. Major permanent or long term change to groundwater quality or available yield. Existing resource use is irreparably impacted upon. Changes to quality or water table level will impact upon local ecology.
Medium	Loss of part (between approximately 15% to 50%) of a geological site, major severance, major effects to the setting, or disturbance such that the value of the site would be affected, but not to a major degree. Changes to the local groundwater regime are predicted to impact slightly on resource use but not rule out any existing supplies. Minor impacts on local ecology may result.
Low	Minimal effect on the geological site (up to 15%) or a medium effect on its setting, or where there would be a minor severance or disturbance such that the value of the site would not be affected. Changes to groundwater quality, levels or yields do not represent a risk to existing resource use or ecology.
Negligible	Very slight change from baseline condition. Change hardly discernible, approximating to a 'no change' condition.

Table 3.4.3: Assessment of Significance Criteria for Impacts on Geology and Groundwater

	Magnitude of Impact			
Site sensitivity	**High**	**Medium**	**Low**	**Negligible**
High	Substantial	Substantial	Moderate	Slight
Medium	Moderate	Moderate	Slight	Negligible
Low	Slight	Negligible	Negligible	Negligible

The assessment of the duration of predicted impacts on solid and drift geology and groundwater was based on the criteria defined in Table 3.4.4 *Assessment of the Duration for Impacts on Geology and Groundwater.*

Table 3.4.4: Assessment of the Duration for Impacts on Geology and Groundwater.

Temporary Impact	≤ 1 year
Short-term Impact	1 – 7 years
Medium-term Impact	7 – 15 years
Long-term Impact	15 – 60 years
Permanent Impact	≥ 60 years

3.4.3 Existing Environment

(i) Background

This section of the statement provides the baseline information in relation to geology, soils, and hydrogeology that exists in the vicinity of the proposed development. The proposed new WWTP will be constructed on a green field site in the townland of Shanbally, approximately 11km south of Cork City, 2.24km west of Ringaskiddy and circa 1.06km to the north east of Carrigaline. The N28 (National Primary Road) is 490m from the northern boundary of the site and links Cork City to Ringaskiddy.

Both the geology and soils play an important part in determining the environmental characteristics of a region. The underlying geology has a major influence on landform and rocks provide the parent material from which soils are created. The nature of the rock helps to determine not just the nature and chemistry of the soil formed, but also the rate at which it forms. This in turn strongly affects the natural vegetation and the type of agriculture or horticulture that can be sustained.

(ii) Receiving Environment

The receiving environment is described below for the proposed WWTP site and collection system under the following headings:

- Geomorphology
- Topography

- Drift Geology
- Bedrock Geology
- Marine Geology
- Structural Geology
- Karstification
- Radon
- Geological Heritage
- Hydrology
- Hydrogeology
- Hydrochemistry

Geomorphology

The topography of the South Cork region is controlled by the geological structure, with the anticlines forming upland areas and the synclines occupied by valleys. These valleys were formed during the Pleistocene glaciations (2 million to 10 thousand years ago), as prior to this the regional topography sloped southwards and the region was drained by southerly flowing rivers. This Tertiary drainage was truncated by glaciers advancing outwards from the mountainous regions of western Ireland, preferentially exploiting the weaker shales or karstified limestone coring the synclines, resulting in the development of a large number of broad u-shaped valleys where previously there has only been only north-south drainage patterns. Superimposed on these u-shaped valleys are a number of buried valleys infilled with sand and gravel. At the peak of the last glaciation 15,000 years ago when much of Europe was covered by ice, sea level fell to approximately 130m lower than present day, so the rivers eroded down to the new base level cutting new steep sided gorges. When temperatures subsequently improved towards the end of the Pleistocene glacial epoch (10,000 – 12,000 years ago) the ice sheets receded, sea level rose again and the gorges rapidly became infilled with fluvioglacial sand and gravels as the rivers responded again to changing base level. The south of Ireland continues to sink so sea level carries on rising (estimated 16m over the past 8,000 years) (Milenic & Allen, 2002).

Topography

The proposed site of the WWTP and collection system is located in a coastal region of undulating terrain where the topography in the local area is defined by ridgelines that typically run east west to form a rolling landscape.

The proposed WWTP site consists of portions of two large agricultural fields located on sloping ground. The site covers an area of approximately 7.36ha and is situated on a south facing hillside. The site is essentially of gently sloping south-facing topography and has an elevation of approximately 30m (Ordnance Datum). The two fields range in elevation from approximately 40m in the north to approximately 28m in the south.

Drift Geology

Typical Quaternary deposits across the Cork Harbour region are largely composed of:

- Devonian and Carboniferous sandstone, shale and limestone
- River alluvium and
- Coastal deposits.

Generally within the South Cork area, glacial deposits are thin (1-3m) on the ridges and thicker (up to 30m) in the valley bottoms, the thicker sediment being largely fluvioglacial in origin (deposited by melt-water) and the thinner sediments being tills. Thick melt-water sands and gravels have been identified in the Cork Harbour region (GSI, 1994).

Quaternary mapping is available for the study area; however there is no GSI information on the depth of overburden. The quaternary maps (available on the GSI web page) identify the predominant deposits at the WWTP site as undifferentiated till (denoted as Ut) with glaciofluvial sand and gravels (denoted as G) in the eastern side of the site. The range of Quaternary deposits mapped by the GSI for the collection system includes undifferentiated till, alluvium, colluvium and bedrock close to or at the surface.

The Soil Classification Map identifies one soil association (Acid Brown Earths 70% – Association 13) at Shanbally and the proposed WWTP site. Topography is of gently rolling lowlands. These soils have a wide use and are very suitable for both tillage and grass production. This association is dominated by well drained soils of sandy loam texture and structure. Because of this they are easy to cultivate and can produce a wide range of crops. The climatic advantages of being in a southern location increase both crop and pasture yields. Soil associations are cartographic units used for mapping the landscape and consist of two or more soil types generally formed from the same parent material. Acid Brown Earth is typically formed from glacial drift of mixed Old Red Sandstone (ORS)/Carboniferous limestone composition while the underlying rock is typically Carboniferous limestone (*Soil Association of Ireland and their Land Use Potential*, Gardiner and Radford, 1980). The range of Associations mapped for the collection system includes Acid Brown Earths and Brown Podzolics. Brown podzolics are formed from glacial drift of ORS, shale and slate composition. Elevations range mainly from 30-150m. The soil is well drained sandy loam to loam texture and of low to medium base status. Brown Podzolics have a similar land use range as Acid Brown Earths.

A walkover survey was carried out at the proposed WWTP site in June and August 2007. The topsoil encountered consisted of brown sandy clay. These soils are capable of producing a range of agricultural crops and are good pastureland. The site was well drained and no springs or areas of standing water were observed. Site visits carried out by the design engineers during the winter months of 2006/2007 also confirmed these ground conditions. It should be noted that the rainfall totals for the summer of 2007 were above normal throughout the country. According to Met Éireann it was the wettest summer for at least nine years. A total of between 55 and 65 rain-days was recorded generally for the 3-month period (June, July and August) compared with the normal range for summer of between 45 and 55 days.

A small number of minor ground depressions (one noticeable feature and 3-4 possible features) were observed in the eastern field. The noticeable conical shaped depression was 3-4m diameter and approximately 0.5m deep. An example of this is illustrated in Plate 3.4.1 Ground Depression Located Near the Eastern Field Boundary. Local knowledge of the area suggests that the underlying limestone bedrock may have been subjected to solution weathering and these features may be a surface manifestation of this process. This is discussed in further detail below (Section 3.4.2 *Existing Environment*).

Borehole and trial pit logs directly north of the site (as part of the N28 Cork to Ringaskiddy Road Scheme, Priority Geotechnical, 2006) have been used for reference. Logs in the vicinity of the development site indicate a range of subsurface deposits (summarised on Table 3.4.5 *Borehole Summary Details* and Table 3.4.6 *Trial Pit Summary Details*). The closest borehole (RC 1041) was excavated to a total depth of 18m below ground level. Bedrock was not encountered therefore the depth of overburden extends below this depth.

Table 3.4.5: Borehole Summary Details

Borehole Reference Number	Depth Metres OD	Soil Type	Description
RC 1041 Located at field boundary directly north of proposed site	38.94 - 38.64	Topsoil	
	38.64 – 35.49	Gravel	Loose, brown, very silty, very sandy, fine-coarse grained, subangular
	35.49 – 32.94	Clay	Stiff, brown, slightly sandy
	32.94 – 29.94	Silt	Stiff, brown, slightly sandy, slightly gravelly
	29.94 – 27.64	Sand	Medium dense, brown, clayey, fine to medium grained
	27.64 – 25.94	Sand	Dense, dark brown, clayey, fine to coarse grained
	25.94 – 20.94	Gravel (Overburden)	Sandstone and mudstone gravel with rare mudstone cobble
Total Depth – 18.00m			
BH 1042 Located NE of proposed site (adjacent to sports field)	38.92 – 38.62	Topsoil	
	38.62 – 37.42	Clay	Firm, brown, slightly sandy, gravelly
	37.42 – 35.42	Clay	Firm to stiff, brown, gravelly
	35.42 – 34.32	Clay	Stiff, brown, slightly sandy, gravelly
	34.32 – 33.68	Clay	Stiff, brown, slightly sandy, gravelly (Chisel for 1hr at 33.68mOD)
Total Depth – 5.24m			
RC 1043 Located ENE of the proposed site, east of the club house	32.19 – 31.89	Topsoil	
	31.89 – 30.69	Silt	Firm, brown, slightly sandy, slightly gravelly, occasional cobbles
	30.69 – 29.59	Silt	Firm, brown, sandy, gravelly
	29.59 – 28.69	Silt	Firm to stiff, brown, slightly gravelly
	28.69 – 27.69	Silt	Firm, brown, gravelly
	27.69 – 26.19	Silt	Stiff, brown, slightly sandy, gravelly
	26.19 – 24.09	Silt	Firm, brown, sandy, gravely, rare cobbles
	24.09 – 13.19	-	(Poor recovery) Boulder clay & cobbles
Total Depth – 19.00m			

Table 3.4.6: Trial Pit Summary Details

Trial Pit Reference Number	Depth Metres OD	Soil Type	Description
TP 2019 Located at field boundary directly north of proposed site	35.86 – 35.66	Clay	Firm, brown, slightly sandy, slightly gravelly, occasional cobbles
	35.66 – 34.66	Clay	Firm to stiff, brown, slightly sandy, slightly gravelly, with rare cobbles
	34.66 – 33.36	Clay	Firm to stiff, brown, slightly sandy, slightly gravelly, with occasional cobbles and possible weathered rock at 34.36m
	33.36 – 32.16	Gravel	Firm to stiff, brown mottled dark brown, very clayey, very sandy, with occasional cobbles with possible weathered siltstone and limestone rock
Total Depth – 3.70m			
TP 2020 Located just outside field boundary NW of proposed site	38.29 – 37.89	Topsoil	Soft brown
	37.89 – 37.29	Clay	Slightly sandy, slightly gravelly
	37.29 – 35.49	Gravel	Dense, brown, silty, very sandy, large pockets of fine sand with rare cobbles
	35.49 – 34.49	Sand	Brown, slightly gravelly, predominantly fine grained sand, with rare cobbles
	34.49 – 34.29	Silt	Brown, sandy, slightly gravelly
Total Depth – 5.24m			

A geophysical survey was carried out in November 2007 for the WWTP site which provides information on the likely subsoil units and depths. These are based on the conductivity of each unit. As the proposed development has not yet progressed to detailed design stage, no intrusive site investigative work has been completed.

The geophysical survey consisted of EM31 Ground Conductivity, 2D-Resistivity and Seismic Refraction measurements for the proposed WWTP site. The results of this show a thick overburden of soils and subsoils with a gravelly nature (gravelly clay or sand and gravel) overlying clean limestone and mudstone bedrock lithologies. No soft clays or organic muds have been identified at this site. Four layers have been identified in the earth model (described in *Volume III, Appendix 4A*). The results indicated a thick overburden at a depth of 20m and greater below ground level; however at the south eastern corner of the site this has been interpreted at 8m below ground level. This interpretation includes fractured rock. The conductivity values also suggest a well drained overburden which is consistent with the site walkover/visual assessment.

In view of the minor land-take required for the proposed WWTP, the soils which are likely to be affected by the development represent a minor resource in a local context. In a regional context, this soil resource is less significant as such soils occur in abundance over the South Cork region.

Bedrock Geology

The rocks of South Cork were deposited during the later Devonian and Carboniferous periods (370 to 310 million years ago). The ridges and valleys that are visible today mirror the underlying geological structure produced when the rocks were folded some 290million years ago during the Variscan Orogeny (this is discussed in greater detail below under the heading *Structural Geology*).

According to the GSI web page and the 1:100,000 bedrock geology map of South Cork (Geological Survey of Ireland, Sheet No. 25:1995), bedrock underlying and surrounding the proposed location for the new WWTP comprises:

- Dinantian grey mudstone with subordinate sandstone (*Kinsale Formation* – Cuskinny Member which is a flaser-bedded sandstone and mudstone)
- Dinantian massive unbedded fine grained limestone (*Waulsortian Limestone Formation*).

The Kinsale Formation is predominantly mudstone and sand lensed mudstone (linsen) and represents mainly a water depth within reach of wave influence. This formation was deposited on a shallow marine shelf across which sand-bars migrated during frequent storms. Sedimentation in the South Munster Basin generally kept pace with subsidence during the deposition of this thick formation. At a later time the sea deepened due to continued subsidence and a slowing down in the rate of sedimentation.

The growth of carbonate mud mounds (Waulsortian Limestone) are likely to have developed as individual mounds on the sea floor at a depth of at least 200m. These contained abundant crinoids and bryozoa. The mounds maintained high depositional slopes due partly to the binding action of algae. These started to grow in the Ringaskiddy area of Cork harbour earlier than anywhere else in Ireland. Many of the original cavities, including stromatactis cavities, are filled with internal sediments and cements. In the South Cork area the regional cleavage has affected the limestone. In some places there are zones of intense fracture cleavage and structural recrystallisation of the matrix. This deformation affects the internal characteristics of the Waulsortian Limestone and often makes identification of internal features difficult to interpret during ground investigations.

According to the GSI database the Cuskinny Member is the predominant bedrock with Waulsortian limestone only located in the south western and south eastern corners of the site (refer to Figure 3.4.1 *Local Bedrock Geology* and Figure 3.4.2 *Proposed WWTP & Collection System with Underlying Bedrock*). It is possible that the geophysical survey has picked this up in the 2D-resistivity profile (R1) where faulting/fracturing of the rock or karstification of the limestone has been suggested at the eastern side of the WWTP site (refer to *Volume III, Appendix 4A*).

Bedrock geology likely to be present at the proposed collection system footprint is presented below on Table 3.4.7 *Bedrock Geology Summary.* A full description of each Formation/Member is included in *Volume III, Appendix 4B.*

Table 3.4.7: Bedrock Geology Summary

Location	Bedrock Geology
WWTP Site	Cuskinny Member and Waulsortian Limestone
Raffeen Pumping Station	Cuskinny Member
Monkstown Pumping Station	Gyleen Formation
Carrigaloe Pumping Station	Ballytrasna Formation
West Beach Pumping Station	Cuskinny Member
Marine Crossing	Ballytrasna Formation (assumed)
Collection System (Pipeline)	Ballytrasna Formation, Gyleen Formation, Old Head Sandstone Formation, Cuskinny Member, Ballysteen Formation, Pigs Cove Member, Waulsortian Limestone, Lispatrick Formation and White Strand Formation

Marine Geology

A survey was carried out in West Passage by the Voyager in 2005; however no information is available in relation to sediment and bedrock conditions. The GSI were contacted regarding available information for the marine crossing. Historical information is available for a cross section of Marino Point to Lee Carrow House dating back to 1977 (T.A. Reilly and A.G. Sleeman). Although this cross section is further north of the proposed crossing between Carrigaloe and Glenbrook, it demonstrates the extension of the bedrock across the West Passage and the nature of the sediment to depths greater than 20m (refer to Figure 3.4.3 *Marine Cross section* below). Estuarine silts and sands are present above the gravels which in turn overlay the bedrock.

Structural Geology

Over several million years, South Cork has often been the site of large rivers flowing over arid deserts, shallow tropical seas and more recently buried beneath glaciers. According to the GSI major earthquakes are unlikely to have affected this area since the late Tertiary (65-1.6 million years ago). Rock types in the Cork area are sedimentary and were deposited during the later Devonian and Carboniferous Periods (370-310 million years ago). There is considerable complexity in the structure of the rocks. This is reflected in the complex pattern of faults and folds. All these rocks have been weakly metamorphosed (GSI, 1994).

Local uplift from these folding events results in a convex upwards fold (like a ridge), where older rocks are bordered on two sides by younger rocks (anticline structure). When strata is folded in a concave upwards shape, younger rocks are flanked on both sides by older rocks (syncline structure). Faults are also features of folding events where planar fractures appear in the rock across which there is some displacement.

Cork Harbour lies within the very low grade Rheno-Hercynian fold thrust terrain of the late Carboniferous Variscan Orogenic Belt. The area is characterised by a series of horizontal upright east-west anticlines and synclines, the former cored up by Upper Devonian sandstones and shales and the latter by massive Lower Carboniferous reef limestones. The folded sequence is cut by east west thrusts and steep north south compartmental faults. Tropical conditions during the Tertiary resulted in erosion of Mesozoic cover, intense karstification of the highly fractured Carboniferous limestone and the establishment of a north-south drainage pattern (Milenic & Allen, 2002).

Bedrock in the Shanbally area forms part of the Ringaskiddy anticline and the Cloyne syncline. Bedding details indicates relatively shallow to moderate dipping bedding in the Waulsortian Limestone and moderate to steep dipping bedding in the Cuskinny mudstone.

The proposed WWTP site is located in the Ringaskiddy anticline. Faults with a NNW to SSE trend dissect the regional folds in the area close to and at the proposed site (refer to Figure 3.4.1 *Local Bedrock Geology* and Figure 3.4.4 *Structural Geology*). The faults in this area are mainly strike-slip where horizontal movement between the different bedrock formations has occurred. Bedding dip is variable throughout this area because of its intense folding history. The bedding dip in the vicinity of the development site is expected to be steepest in the vicinity of the anticlinal axis. No outcrop is visible within the site.

Karstification

Karst landforms are generally the result of mildly acidic water acting on soluble bedrock such as limestone or dolomite. This mildly acidic water begins to dissolve the surface and any fractures or bedding planes in the bedrock. Over time these fractures enlarge as the bedrock continues to dissolve. It is influenced by the type and solubility of the rock, the degree of jointing, faulting and bedding, the chemical character of the groundwater, the rate of circulation and the overburden cover. Solution results in the development of enlarged joints, conduits and localised groundwater flow, particularly at the water table.

The karstification of a landscape may result in a variety of large or small scale features both on the surface and beneath. The main topographic features of karst areas include:

- swallow holes
- dry valleys
- sparse and intermittent streams
- bare rock
- deep water tables
- caves
- large springs

Karst aquifers indicate a number of problems and difficulties such as:

- Poor predictability of groundwater supplies due to uneven distribution of permeability
- Low storage of groundwater particularly in drained areas
- High vulnerability to pollution because the pollutants can enter the rock fissures readily where the overburden is thin and because the rock itself is unable to attenuate the pollutants

According to the GSI there are two types of bedrock present at the WWTP site. The Cuskinny Member (sandstone and mudstone) is the predominant bedrock with Waulsortian limestone only located in the south western and south eastern corners. Waulsortian limestone is permeable, porous and particularly susceptible to solution. This permeability has developed in response to structural movements and karstification to deeper drainage levels that existed in the past. The limestone at the WWTP site is unconfined and is classified as a minor (locally important) karst aquifer.

In South Cork there are numerous karst features in this limestone lithology i.e., caves, swallow holes, collapse features and large springs. An example of a feature north of the study area is a Waulsortian limestone cave that has been recorded by the GSI in Shanbally (National Grid reference 175544, 64445). During the site walk over, one noticeable depression was observed and a further two to three possible features within the site boundary (located in the eastern field of the proposed site). An example of one of these features is illustrated on Plate 3.4.1 *Ground Depression Located Near the Eastern Field Boundary.*

A geophysical survey (*Volume III, Appendix 4A*) was carried out to determine the ground conditions, depth to rock, existence of karst features and reduce the risk of encountering difficult subsurface conditions. During this assessment an area of possible faulting/fracturing or karstification was identified in the SE corner of the site where strong lateral variations in the model resistivity values were recorded. It is possible that this variation represents the change in bedrock to Waulsortian limestone in the area.

Radon

Radon gas is a naturally occurring radioactive gas, originating from the decay of uranium on rocks and soils. It is a colourless, odourless and tasteless gas and its presence can only be measured using specialist equipment. Radon dissipates readily in open air and is not considered harmful. However, in enclosed spaces, such as a building, radon can accumulate to unacceptably high concentrations. When inhaled, radon particles result in a radiation dose that can cause damage to lungs and eventually lead to lung cancer.

Radon is measured in Becquerel's per cubic metre of air (Bq/m^3). A Becquerel is a unit of radioactivity and corresponds to one radioactive disintegration per second. A High Radon Area is one where more than 10% of houses are predicted to have radon levels in excess of 200 Bq/m^3.

Information on radon levels around the development site was obtained from the *Radiological Protection Institute of Ireland.* Figure 3.4.5 *Radon Levels in Cork Harbour* illustrates that the development site is within a moderate radon area of 5-10%, (i.e. 5-10% of dwellings are predicted to have radon levels in excess of 200 Bq/m^3).

Exposure to natural radon levels in the workplace is governed by the *Radiological Protection Act* (1991) (*Ionising Radiation Order, 2000 (S.I. No. 125 of /2000*). A reference level for radon in workplaces of 400 Bq/m^3 averaged over a period of three months is specified in the Act.

Geological Heritage

A Geological Heritage Area is one which contains geological or geomorphological features considered to be of national interest and recommended for Natural Heritage Area (NHA) designation by the GSI under the *Wildlife (Amendment) Act* (2000).

According to the GSI there are no areas of geological heritage significance which could be impacted on by the WWTP site and collection system. Three sites have been identified in the surrounding area and are referenced in *Volume III, Appendix 4C*.

Hydrology

Cork Lower Harbour is located on a largely low-lying coastal region in the South of Ireland. The proposed site of the WWTP is located adjacent to a coastal area of undulating terrain near Shanbally. The dominant influence on drainage in the area is the Owenboy River flowing east through Carrigaline and the Glounatouig Stream flowing east into Monkstown Creek which ultimately flow into the Lower Harbour (refer to Figure 2.1 *Location of Existing Outfalls and Proposed Outfall*). There are no streams or rivers crossing or adjacent to the development site.

The proposed development lies within Hydrometric Area 19 (Lee, Cork Harbour and Youghal Bay) as defined by the EPA. The hydrodynamics of the Lower Harbour which currently receives all the untreated waste water from this drainage scheme is dealt with in Section 3.3 *Water Quality*.

According to the Office of Public Works (OPW) National Flood Hazard Mapping – *Flood Report for the Carrigaline Area*, one flood event was recorded (November 2002) within a 1km radius. During this period the entire country received an exceptional amount of rainfall over a short period of time. One of the worst affected regions was the Carrigaline area. The locations closest to the proposed WWTP impacted by the heavy rainfall (recorded by the OPW) were Raffeen Bridge on the R610 and Coolmore Crossroads on the R613. Both of these are at lower elevations than the proposed WWTP site.

As described above (topography section) the site is situated on a south-facing gentle slope at an elevation of approximately 30m OD and is well drained. Surface water is expected to infiltrate the overburden and flow in a southerly direction in the water table to the Owenboy Estuary (which is the nearest water channel located approximately 1km south of the proposed WWTP site). No evidence of flooding has been reported at the site.

Hydrogeology

Hydrogeology looks at how water interacts with geological systems and the distribution and movement of groundwater in the soil and rocks (commonly in aquifers). Groundwater is often thought of as the hidden resource, yet it supplies around 30% of the country's water supply, both public and private.

The GSI identify two distinct hydrogeological environments in the Cork area. The Devonian cored anticlinal ridges and the synclinal valleys composed of carboniferous limestone and overlain by Quaternary deposits. The ridges are characterised by steep slopes, impermeable ground and 'flashy' runoff. The valleys are gently undulating, generally well drained and the rivers have a substantial baseflow. Potential recharge to these aquifers range from 450-750mm/year where the bulk of this recharge is expected to occur between late October and early March (GSI, 1994).

The major aquifers in the Cork Harbour area occur in both bedrock and overburden deposits. The main bedrock aquifers are intensely karstified limestones, coring the Cork-Middleton and Cloyne synclines which possess significant storage capacity and hydraulic conductivity. These limestones represent typical buried karst with a surface outcrop of only 5%. Effective porosity is conservatively estimated as 1% with the depth of karstification of at least 60-100m. Characteristic well yields are in the range of 3-20 litres per second. Intergranular aquifers overlie the limestone and are developed in sands and gravel infilling the buried valleys. Both of these aquifers are in hydraulic connection (Milenic & Allen, 2002).

In general the ORS represents a hydrogeological barrier on a regional scale. Locally, however, a certain amount of groundwater may be contained within the weathered zone to an approximate depth of 10m. Effective porosity is estimated as 0.1%. Furthermore, north-south fracture zones cutting the ORS may act as pathways for groundwater transfer between the two karst aquifers within the adjacent synclines (Milenic & Allen, 2002).

Aquifer Classification and Vulnerability

Rocks which store and transmit groundwater are known as bedrock aquifers. Different bedrock types have differing abilities to store and transmit water, depending on their permeability and fracture intensity. The Geological Survey of Ireland has classified all aquifers in Ireland into three main categories based on potential yield and extent:

- Regionally Important
- Locally Important
- Poor

Provisional information on the hydrogeological classification of the bedrock beneath the proposed WWTP site and pumping stations was obtained from the Geological Survey of Ireland (refer to Table 3.4.8 *Summary of GSI Bedrock and Aquifer Data*).

Table 3.4.8: Summary of GSI Bedrock and Aquifer Data

Location	Bedrock Geology	Aquifer Classification	Aquifer Vulnerability
WWTP Site	Cuskinny Member and Waulsortian Limestone	Ll & Lk	Reclassified as Extreme (GSI mapped as High)
Raffeen Pumping Station	Cuskinny Member	Ll	Extreme
Monkstown Pumping Station	Gyleen Formation	Ll	Extreme
Carrigaloe Pumping Station	Ballytrasna Formation	Ll	Extreme
West Beach Pumping Station	Cuskinny Member	Ll	Extreme
Marine Crossing	Ballytrasna Formation (assumed)	-	-

The Cuskinny Member (sandstone and mudstone) beneath the proposed new WWTP site is considered by the Geological Survey of Ireland to be a ***locally important bedrock aquifer (Ll)*** and the Waulsortian limestone beneath the proposed new WWTP site is considered by the Geological Survey of Ireland to be a ***locally important karst bedrock aquifer (Lk)***; both described below.

1. *(Ll) Locally Important Bedrock Aquifer, Moderately Productive only in Local Zones:* Aquifers with a limited and relatively poorly connected network of fractures, fissures and joints, giving a low fissure permeability which tends to decrease further with depth. A shallow zone of higher permeability may exist within the top few metres of more fractured/weathered rock, and higher permeability may also occur along fault zones. These zones may be able to provide larger 'locally important' supplies of water. In general, the lack of connection between the limited fissures results in relatively poor aquifer storage and flow paths that may only extend a few hundred metres. Due to the low permeability and poor storage capacity, the aquifer has a low 'recharge acceptance'. Some recharge in the upper, more fractured/weathered zone is likely to flow along the relatively short flow paths and rapidly discharge to streams, small springs and seeps. Groundwater discharge to streams ('baseflow') can significantly decrease in the drier summer months.

2. *(Lk) Locally Important Karstified Bedrock Aquifer:* Essentially it is similar to the Regionally Important Karstified Bedrock Aquifer (Rk), but with a smaller continuous area (<c.25 km^2). Although the properties imply that this aquifer can supply 'excellent' yields, the smaller size limits the amount of recharge available to meet abstractions.

There are further sub-categories based on the geology of the subsoil, the type of recharge (i.e. either point or diffuse) and the thickness of the unsaturated zone through which potential contaminants can move. The Geological Survey of Ireland uses a matrix comprising four groundwater vulnerability categories - extreme, high, moderate and low - for mapping purposes and in the assessment of risk to groundwater. The categories are based on the thickness of cover (overburden), which provides some attenuation for contaminants migrating toward the groundwater table from the surface or near sub-surface. A detailed description of the vulnerability categories can be found in the *Groundwater Protection Scheme* document (DELG/EPA/GSI, 1999) and on Table 3.4.9 *Vulnerability Mapping Guidelines* below.

Table 3.4.9: Vulnerability Mapping Guidelines (GSI, 1999)

Vulnerability Rating*	Hydrogeological Conditions				
	Subsoil Permeability (Type) & Thickness			Unsaturated Zone	Karst Features
	High Permeability (sand & gravel)	Moderate Permeability (e.g. sandy subsoil)	Low Permeability (e.g. clayey subsoil, clay, peat)	(Sand/gravel aquifers only)	(<30 m radius)
Extreme (E)	0 - 3.0 m	0 - 3.0 m	0 - 3.0 m	0 - 3.0m	-
High (H)	> 3.0 m	3.0 - 10.0 m	3.0 - 5.0 m	> 3.0 m	N/A
Moderate (M)	N/A	> 10 m	5.0 - 10.0 m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

* This system assumes unconfined hydraulic conditions which are not always present in nature.

Where the overburden is less than 3m thick or karst features are present (which is the case for this assessment – potential karst feature at the south eastern portion of the site), the Matrix Vulnerability Rating of the aquifer is considered extreme (i.e., the potential for contamination to reach the aquifer is extremely high). Where the overburden is greater than 10m thick and has a low permeability, the vulnerability is considered to be low.

The hydrogeological significance of the Quaternary deposits at the site is dependent on overburden permeability and thickness. An open quarry exists to the northeast of the site which suggests that groundwater at the site is likely to be encountered at a deep level. Vulnerability for the WWTP site is classified by the GSI as High. However, it should be noted that because of the potential for karst features at the eastern side of the proposed site, this area has been reclassified for the purposes of this EIS as extreme vulnerability.

A number of groundwater wells have been identified within a 3km radius of the proposed site (*Volume III, Appendix 4D Well Search conducted by the Geological Survey of Ireland, November 2007*). Local topography suggests that the groundwater flow direction is southerly towards the Owenboy River. No supply wells are located within 500m radius of the proposed development or hydraulically down gradient of the WWTP (i.e. from the WWTP towards the Owenboy River).

Typically across the Cork area the water table is generally within 10m of the surface except for the more elevated parts of the limestone aquifers and the annual fluctuation is less than 6m. The geophysical survey carried out at the WWTP site in November 2007 (following a wet summer) suggests an absence of groundwater 10-15m below ground level.

Groundwater Chemistry

According to the GSI total hardness of the groundwaters in the South Cork sandstones and sand and gravels (derived from non-calcareous strata) is typically less than 200mg/l (as $CaCO_3$). The hardness of the limestone and sand and gravel (where derived from limestones) waters usually range from 200-400mg/l (as $CaCO_3$). The harder and more mineralised groundwaters in the Cloyne Syncline and eastern part of the Cork Syncline is characteristic of areas where vertical recharge is prevented or reduced by an overlying cover of poorly permeable Quaternary deposits. The chloride levels in these aquifers are likely to be higher than inland aquifers because of their proximity to the coast. The groundwaters in these strata are generally of potable quality with the exception of small local areas where they have been contaminated by effluent from mainly organic wastes. Groundwaters in most of the synclines have been identified as vulnerable to pollution (GSI, 1994).

As part of the Water Framework Directive (WFD) the South Western River Basin District (SWRBD) group has categorised the groundwater body for the WWTP site (reference IESWG072) as '1b' (*probably at significant risk*). This is primarily attributed to diffuse pressures which include mobile chemicals and nutrients (resulting from existing industry and waste water treatment regimes).

Contaminated Land

Based on the site walk-over it is considered that the risk of encountering contaminated materials or soil is low.

3.4.4 Impact Assessment

This assessment focuses on predicted impacts in relation to bedrock geology, drift geology and hydrogeology. The assessment relates to impacts occurring both during the construction and operational phase.

(i) Construction Phase Impacts

Drift Geology & Topography

Development works proposed for the site will not radically change the existing topography in a local or regional context. It is intended that the slope afforded by the existing topography of the site and its surrounds will be used to advantage in the design of the WWTP to minimise pumping.

It is expected that much of the topsoil and a smaller percentage of the subsoil at the proposed development site will be removed to allow for construction of the WWTP and a new access road. The specimen design identifies that to optimise the use of the sloping nature of the site, the preliminary treatment and primary settlement stages would be located at the higher elevations on site and constructed for the most part below ground level where only the tops of the chamber walls would be visible. In addition the storm water settlement tanks, aeration tanks and secondary settlement tanks would be constructed in part below ground level, with only the top one metre of the side walls emerging above the finished ground levels.

Given the relatively small quantity which will be removed it is not considered to be a resource of any regional significance. It is expected that all of the excavated topsoil and the majority of the subsoil (where the maximum estimated volume of surplus material from the excavation of the site for the WWTP tankage is in the order of 10,000m^3) will be reused in landscaping throughout the site. A risk assessment will be carried out as to the suitability of this material in advance of these works. The impact on soils locally as a result of the development will not be significant (low to negligible impact).

The soil classifications in the Cork Lower Harbour area will not be impacted on. Construction activities have the potential to impact on soil quality of the local drift deposits. This could occur due to leakage or spillage of construction related materials e.g. oils and fuels on site. Potential impacts could result in the introduction of substances such as diesel range organics (DRO), mineral oils, polycyclic aromatic hydrocarbons (PAH), heavy metals etc.

Many substances used at construction sites, such as lubricants, fuels and oils, are harmful to the environment and can cause soil contamination. Soil contamination from re-fuelling of vehicles or inadequate storage of fuels could occur in the absence of appropriate mitigation measures. The significance of this impact would be moderate and long term in duration.

There is potential for construction activities to impact on soil erosion. Soils can be disturbed and eroded by vehicular activity. Winds and heavy precipitation can also impact on non-vegetated areas (e.g. stockpiles) resulting in soil disturbances, which can enter water bodies as runoff. The significance of this impact in the absence of appropriate mitigation measures would be slight to moderate and long term in duration.

The effects of soil stripping on water resources have the potential to cause leaching of contaminants into the groundwater. This could have a significant (*moderate*) negative impact on groundwater quality.

Marine Sediment

The marine crossing (pipeline route) traverses an area where the thickness of sediment is currently unknown. From the historical available information it suggests that marine sediment could be in the region of 20m deep in the channel and decreasing to shallow depths at the eastern side of the West Passage. It is envisaged that the pipelines will be laid by either:

- open cut techniques (laid below the surface of the sediment bed and backfilled to the original profile, pipes are likely be encased in concrete for protection) or
- tunnelled (where there would be less sediment disturbance).

Open cut methods are considered to have greater impact on marine sediment and are dealt with here as a worst case. The route of the proposed pipeline is limited in its extent and in the overall context will involve minimal *temporary* disturbance to marine sediments and is anticipated to have a *slight* negative impact.

Sediment dredging will be required for open cut pipeline installation. Sampling of these sediments will be carried out in consultation with the Marine Institute. Consultation will also take place with respect to the disposal plan for these materials. It is not anticipated that construction-related activities will result in a significant chemical impact to local natural sediments (i.e. a *negligible impact* is anticipated).

It will be the responsibility of the Contractor to ensure that there is minimal impact on the sediment for the length of the pipeline. In addition, a method statement for construction will be developed in advance in consultation with the National Parks and Wildlife Service (NPWS). A foreshore application will be required for the proposed structures on the foreshore from the DAFF.

Other potential works in the foreshore, which may involve marine sediment disturbance or removal, are the pipelines associated with emergency overflows and storm water overflows. It is anticipated that these works will involve minimal *temporary* disturbance to marine sediments and is anticipated to have *slight* negative impact. It is not anticipated that construction-related activities will result in a significant chemical impact to local natural sediments (i.e. a *negligible impact* is anticipated). It should be noted that construction of outfall facilities for waste water or storm water will require separate planning approval (Part 8, *Planning and Development Regulations*, 2001). Method statements will be generated in advance of any works in consultation with the NPWS and the DAFF.

Bedrock Geology

The depth to bedrock beneath the proposed waste water treatment site is expected to range between 8m below ground level in the in the south east corner of the site to 20m (refer to *Volume III, Appendix 4A*- Geophysical Survey). No blasting is anticipated to be required. It is expected construction of the site will not affect the bedrock.

The proposed collection system (series of piped routes) is generally routed along existing roads, road verges or other hard core areas therefore it is unlikely that the trench excavations will impact on the bedrock geology. According to GSI publicly available information a number of the proposed major pumping stations are located in areas where bedrock may be close to the surface (<3m). There is no proposal for blasting; however should bedrock be encountered there may be a need for rock breaking. It is expected that construction of the proposed WWTP, collection system and the marine crossing will not affect the bedrock in this area (*negligible impact*).

No sites or features designated or identified as being of geological interest will be affected by the WWTP or collection system (including the marine crossing). The geology in the locality is of low sensitivity and therefore predicted effects will have negligible or no significance to geology. In addition, consultations with the Geological Survey of Ireland addressed no concerns about potential impacts on the integrity of the geomorphological and geological heritage of the Cork Lower Harbour landscape.

Marine Bedrock Geology

The depth to bedrock below the marine sediment is currently unknown. As mentioned previously, historical information suggests that marine sediment could be in the region of 20m deep in the channel and decreasing to shallow depths at the eastern side of the West Passage. Should bedrock excavation be required as part of the construction phase, it is anticipated that this work will entail a permanent impact to the underlying strata. It is considered that open cut techniques will have a greater impact on the bedrock geology as the quantity of rock disturbed/excavated will be greater than that required for tunnelling. In the context of the proposed development, construction activities relating to the pipelines are not expected to have a significant impact (i.e. *negligible*) on both regional and local bedrock geology. The proposed works are not anticipated to significantly alter the quality of the marine geological landscape or geological environment.

Other potential works in the foreshore, which may involve bedrock removal, are the pipelines associated with emergency overflows and storm water overflows. It is anticipated that these works will involve minimal disturbance to bedrock geology and is anticipated to have *negligible* impact. The proposed works are not anticipated to significantly alter the quality of the marine geological landscape or geological environment. It should be noted that construction of outfall facilities for waste water or storm water will require separate planning approval (Part 8, *Planning and Development Regulations*, 2001).

Hydrology and Hydrogeology

Karst groundwater (the water in a karst aquifer) is a major water resource in many regions. Karst aquifers have specific hydraulic and hydrogeologic characteristics that render them highly vulnerable to pollution from human activities. Karst groundwater becomes polluted more easily and in shorter time periods than water in non-karstic aquifers. Thus, protection measures are required to preserve the quality and quantity of karst groundwater that specifically consider the vulnerability of the karst environment. In order to preserve karst groundwater, it will be necessary to control and eliminate sources of pollution. No groundwater discharges are proposed and the site is located in an area where saline or brackish water would be anticipated (hence a low value for drinking water supply). Arising from the karstified nature of the aquifer, additional precautionary measures will be implemented to ensure any accidents or spillages will not negatively impact on the groundwater quality.

The geophysical survey carried out at the WWTP site in November 2007 (following a wet summer) suggests an absence of groundwater 10-15m below ground level. It is not anticipated that any of the construction works will extend to this depth and therefore it is unlikely that direct contact with the water table will be made. At detailed design, the site investigation will identify the depth to the water table level. If the final excavation depths are within 3m of the water table, a risk assessment will be required by an experienced hydrogeologist.

During the construction phase, there is a possibility of a spillage of contaminants such as fuels and oils to exposed fractured rock excavation which in turn could negatively impact on the quality of the receiving water body (i.e. the potential exists for pollution of the groundwater in the area to occur). With an appropriate emergency response plan and staff training, mitigation measures can be put in place to minimise the possibility of groundwater pollution from the spillage of fuels and oils.

The excavation and construction activities will cause quantities of excavated materials to be reused on site or, only where deemed unsuitable, removed from site for disposal or recovery. It is not anticipated that these activities will have any adverse impacts on the groundwater quality or quantity in the vicinity of the proposed development. Overall, there are no anticipated significant impacts predicted from the construction of the proposed development from a hydrological/hydrogeological perspective.

(ii) Operational Phase Impacts

Topography, Drift & Bedrock Geology

The soil classification in the Cork Lower Harbour area will not be impacted on by the operational phase of the proposed development. Operational impacts are not considered relevant in the context of geological bedrock or topography due to the nature and scale of the proposed development. The impacts from the operational phase of the proposed development are considered to be negligible as the drift geology in the locality is of low sensitivity.

On a more regional basis, the operational phase of the proposed development should have a positive impact on soils. It is acknowledged that in the *Sludge Management Plan for County Cork*, agricultural land in the Cork Harbour tidal area is unsuitable for landspreading of the biosolids product as this area displays a nutrient surplus in terms of phosphorus. However, based on phosphorus balances undertaken for the *Sludge Management Plan for Cork County*, there is sufficient spare capacity in County Cork as a whole to facilitate the landspreading on agricultural land of all of the municipal waste water sludge produced in the county. Ultimately the contractor will be responsible for operating the WWTP and may therefore transport the biosolids further afield from Region 19 (Cork County has been subdivided into Regions 18-22 for the purposes of municipal waste water sludge treatment) for landspreading on suitable agricultural land. The most attractive option would be to produce a biosolids product for use in agriculture as in the waste hierarchy it is considered to be a recovery activity due to the nutrient benefits arising from same.

The sludge produced at the site is a valuable fertiliser due to the nitrogen and phosphorus content. The reuse of the material in agriculture will reduce the use of inorganic fertilisers. Also controls will be put in place to ensure the proper application of the sludge in accordance with best practice.

Marine Sediment

It is not expected that there will be any significant impact on the physical properties of the marine sediments during the operational phase.

Hydrology and Hydrogeology

The operational phase of the development is not expected to pose any significant risk to groundwater flow or the prevailing hydrological conditions in the locality. It is not anticipated that there will be any adverse impact on the prevailing groundwater quality as there will be no discharges from the proposed site to groundwater at this location.

However, a possibility exists that contamination of the groundwater may occur as a result of the accidental release of potential pollutants (e.g. waste water treatment chemicals) at the site or along the effluent pipelines. Any leakage has a high probability of percolating directly into the soil or rock strata below. If the rock is fissured the potential risk is higher as a direct pathway allows potential pollutants to reach the groundwater table below. All storage tanks will be bunded and areas of potential spillages will be drained to the waste water treatment facilities for containment and treatment. In the event of a leak along the effluent pipelines, it is likely that this could generate a localised contamination event. However, this scenario is considered to be unlikely to occur as it is proposed to utilise materials proven through extensive use in waste water infrastructural projects coupled with pressure testing and flow monitoring and telemetry systems. In the event of there being a significant variance in flow readings, remedial action will be implemented immediately to identify the source of, and repair the leak.

Without appropriate mitigation measures as detailed in Section 3.4.5 *Mitigation Measures*, the impact on the local groundwater quality could be *moderate* in the event of an accidental localised spill of untreated effluent or fuel/oil.

A public water supply will be available to the site and, as such, it is not intended to install boreholes to extract groundwater.

Marine

Impacts on groundwater in the marine environment are considered to be limited in significance as the treated waste water is more likely to be dispersed in the overlying coastal waters. In any event groundwater in the coastal environment is likely to be saline or brackish and as such not suitable for potable (drinking) requirements.

(iii) 'Do Nothing' Impact

If the proposed development does not proceed at this location, agricultural activities are likely to continue at the site. This, coupled with any future development activities in the area may alter the water quality in the existing environment. It is not anticipated that there would be any significant impacts on the soils, geology and the hydrogeological regime.

(iv) 'Worst Case Scenario' Impact

Where the mitigation measures outlined in Section 3.4.5 *Mitigation Measures* are not implemented correctly or fail, worst case impacts on the existing environment may include a significant deterioration in groundwater quality and the soil/sediment characteristics of the receiving environment, both during construction and operational phases of the proposed development. These impacts could be moderate in magnitude and long term in duration.

3.4.5 Mitigation Measures

Mitigation measures proposed in this section relate primarily to the preservation of the existing subterranean drainage regime, the protection of groundwater and also the re-use of excavated materials.

(i) Construction Phase

In advance of construction a drilling programme is recommended to verify the ground conditions under the site, the depth to bedrock, depth of water table and confirm the presence/absence of karstified rock (particularly at the south eastern corner of the site). If the final excavation depths are within 3m of the water table, a risk assessment (including any additional mitigation measures) will be required by an experienced hydrogeologist.

Where it is necessary to remove overburden or topsoil to facilitate construction, where possible and in the context of an agreed landscaping plan, any soils removed to allow for construction of development will be reused for the construction of landscaping features around the development site. These measures will ensure that any loss of existing topsoil or overburden resource is minimised. An assessment will be carried out as to the suitability of this material in advance of these works.

In the case where the Contractor is required to dispose of surplus or unsuitable excavated materials, this will be to an appropriately licensed landfill site or permitted recovery facility in order to comply with the *Waste Management Acts,* (1996-2005) and associated regulations. Strict control of erosion and sediment generation and other pollutants associated with the construction process will be implemented particularly where works will be taking place close to water bodies.

The effects of soil stripping and soil stockpiling on water resources will be minimised by the removal of topsoil during dry conditions, where possible reducing the possible effects of leaching to ground water. During initial construction land will be stripped in phases in order to limit the length of time the soil will be exposed to erosion.

The effects of soil erosion will be minimised by ensuring that all ground disturbances or excavations are completed and re-vegetated/covered as soon as practical. Soil erosion effects will be evaluated prior to commencement of the works to prevent silts and fine fractions becoming mobilised and from becoming mobilised and entering waterbodies. Fills or stockpiles which are likely to erode into nearby water-bodies, will be covered temporarily e.g. with polyethylene sheeting. Eroded sediments will be retained on site with erosion and sediment control structures such as sediment traps and silt fences. Where possible the land will only be stripped in dry weather to reduce nutrient loss, sustain soil condition and reduce the generation of silt-laden run-off. Care will be taken to ensure that the bank surfaces are stable to minimise erosion.

The main threat posed to soils and groundwater arising from the development is the potential for soil contamination from construction materials. For all activities involving the use of potential pollutants or hazardous materials, there will be a requirement to ensure that material such as concrete, fuels, lubricants and hydraulic fluids will be carefully handled and stored to avoid spillages. In most cases, good housekeeping (daily site clean-ups, use of disposal bins, etc.) on the project site, and the proper use, storage and disposal of these substances and their containers can prevent contamination. Potential pollutants will be adequately secured against vandalism and will be provided with proper containment. Any spillages will be immediately contained and contaminated soil removed from the site and properly disposed of.

Possible soil contamination from re-fuelling of vehicles will not occur, as this will be undertaken in specific designated areas with interceptors in place. In the event of hydrocarbon leakage from on-site plant, a supply of hydrocarbon absorbent material will be maintained locally and immediately applied to the affected area and will be appropriately disposed of.

Construction works will be engineered to ensure all current discharges will be maintained until the WWTP is capable of accepting flows.

The potential for spillages and the possibility for materials to enter the groundwater will be mitigated by proper construction management on site. Other measures which will be implemented include;

- An emergency response plan
- Training for on-site personnel

A method statement will be developed in consultation with the NPWS to help minimise any temporary impacts associated with the marine crossing and all pipeline construction. The DAFF will also be consulted on the proposed methodology, timing and duration of these works. Any areas subject to clearing as a result of construction will be returned to a stable grade. This will be carried out bearing in mind that backfilled and settled sediment materials will be arranged differently than the original configuration. Heavier particles will settle first as they descend from the water column most rapidly. The finest sediments (smallest, lightest particles) from the dredged material, will settle out last, blanketing the marine bed.

If applicable, analysis on the marine crossing footprint in advance of excavation/dredging works will be required to confirm the presence/absence of contaminants in the material likely to be excavated during the construction process. The results of this analysis will be interpreted to assess the required management of the excavated materials (in accordance with the *Waste Management Acts* (1996-2005) and associated regulations as amended).

The collection system will be designed using standard materials proven through extensive use in waste water infrastructural projects. All pipelines and chambers will be pressure tested to industry standard in order to ensure correct assembly and installation. In addition flow monitoring and telemetry systems will be installed to immediately identify any problems with the conveyance of waste water to the WWTP.

The Contractor will be required to prepare a Construction Environmental Management Plan (CEMP) in advance of any works being carried out at the site. This will identify all potential control measures to avoid impacts on the soils, geology and hydrogeology.

(ii) Operational Phase

As there are no foreseeable impacts on geology, no mitigation measures are recommended. The proposed development is therefore considered to have a *negligible* impact on the existing geological environment.

The potential for accidental spillages will be mitigated by proper management on site. Measures which will be implemented include:

- Establishment of bunded oil and chemical storage areas
- An emergency response plan

- Training for on-site personnel

3.4.6 Residual Impacts

According to EPA guidelines, Residual Impact is described as *'the degree of environmental change that will occur after the proposed mitigation measures have taken place.'* The mitigation strategy above recommends actions which can be taken to reduce or offset the scale, significance and duration of the impacts on the known and potential soils and geological resource. Many aspects of the soils and geological resources are non-renewable and once impacted upon cannot be replaced.

The purpose of this statement is to specify mitigation measures where appropriate to minimise the 'risk factor' to all aspects of soils and geological resources such as to minimise the potential for hydrocarbons to contaminate the ground, reduce the risk of erosion, etc. This 'risk factor' is reduced or offset by recommending the implementation of a mitigation strategy in each area of the study. On effective implementation of this mitigation strategy, the potential for impact will be lessened. As a result, when the recommended mitigation is implemented, it is considered that there will be no significant residual negative impacts on the soils or geological/hydrogeological environment.

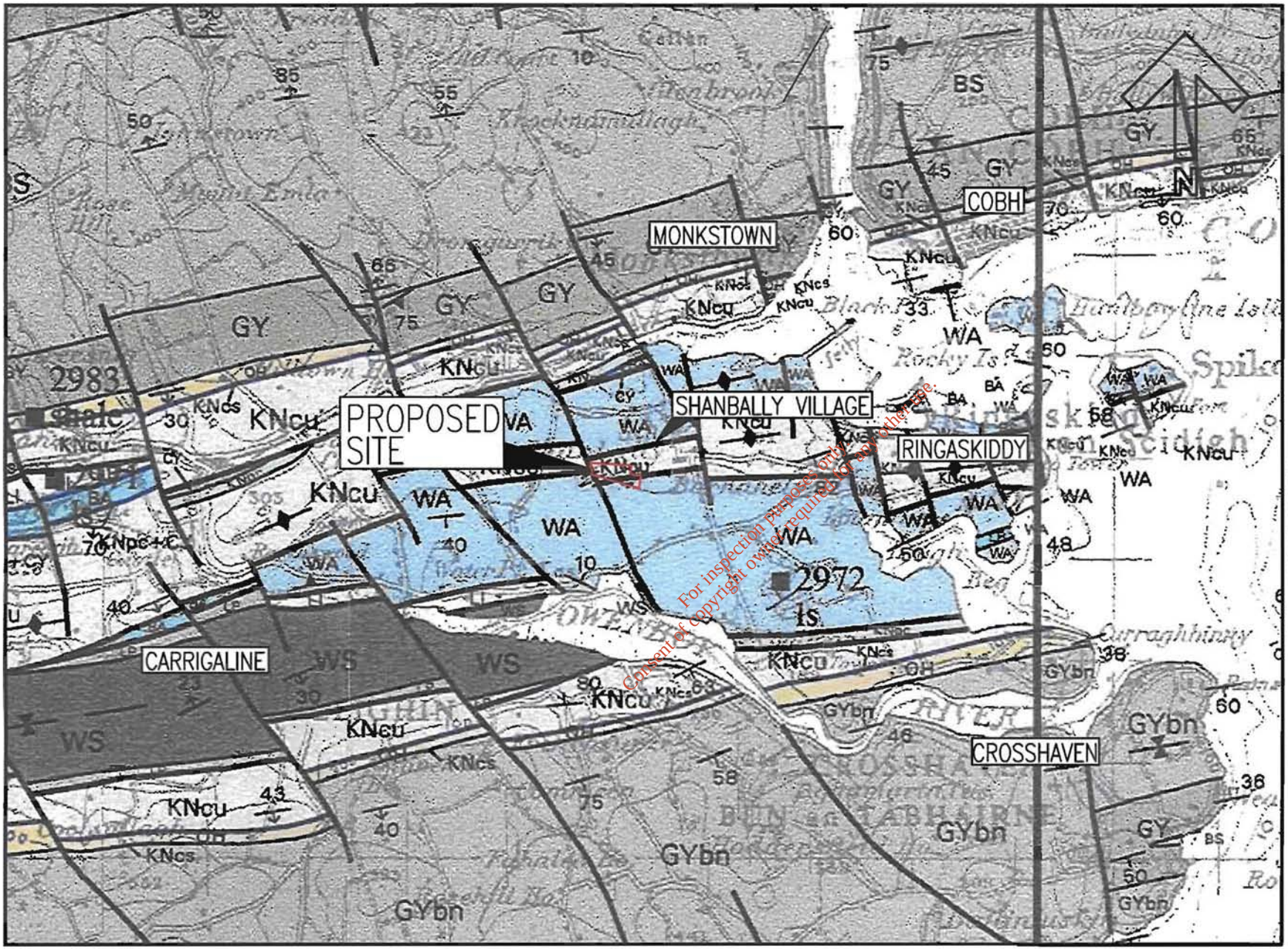

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FIGURE 3.4.1 LOCAL BEDROCK GEOLOGY

CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG141

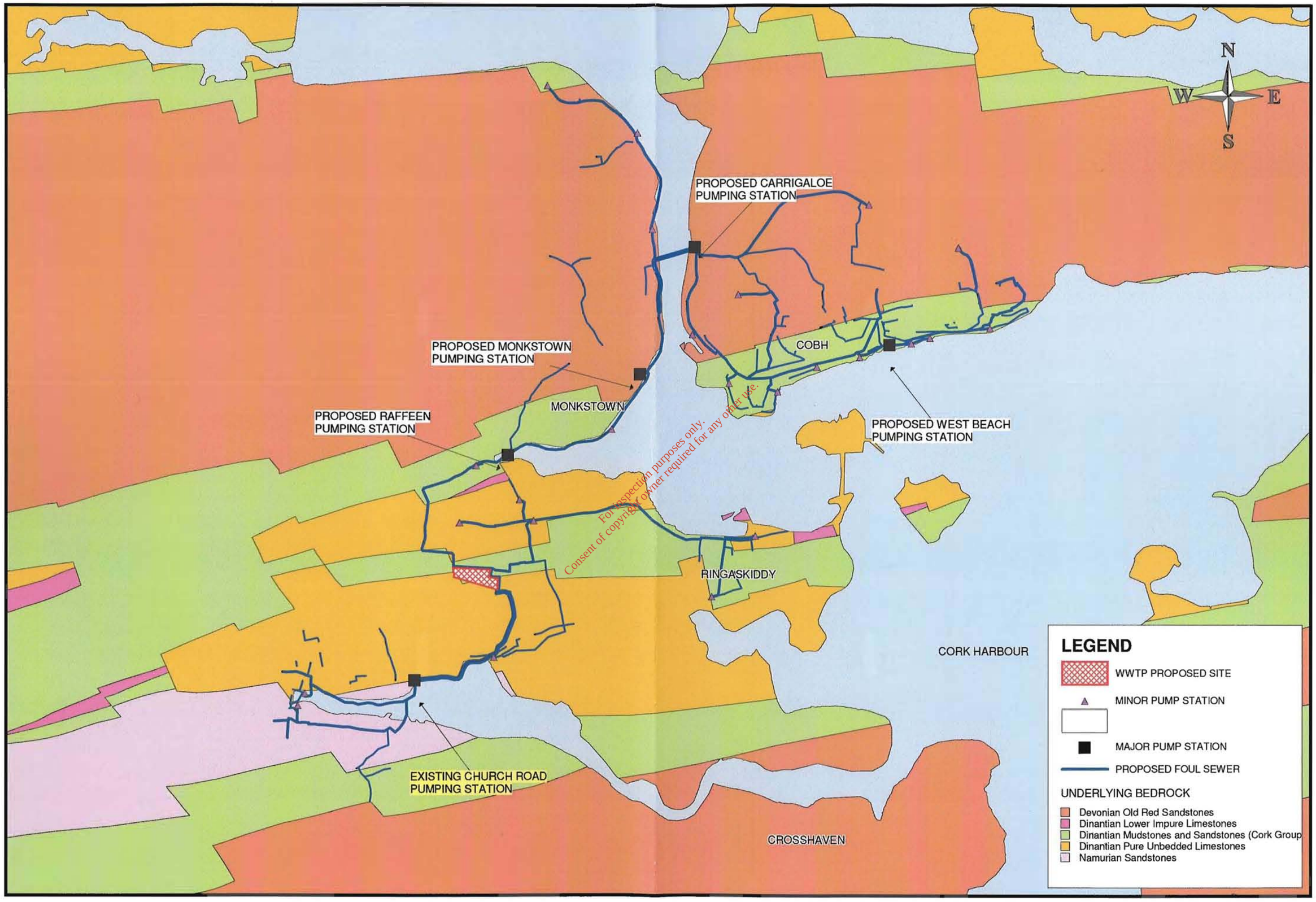

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FIGURE 3.4.2 - PROPOSED WWTP & COLLECTION SYSTEM with UNDERLYING BEDROCK

Extraction from GSI Geology of South Cork
Cork Harbour Main Drainage Scheme
Environmental Impact Statement
Job Nr. A5670
P:\Cork\DESIGN\acad\Mapinfo\23454I\Workspaces\bedrock.wor

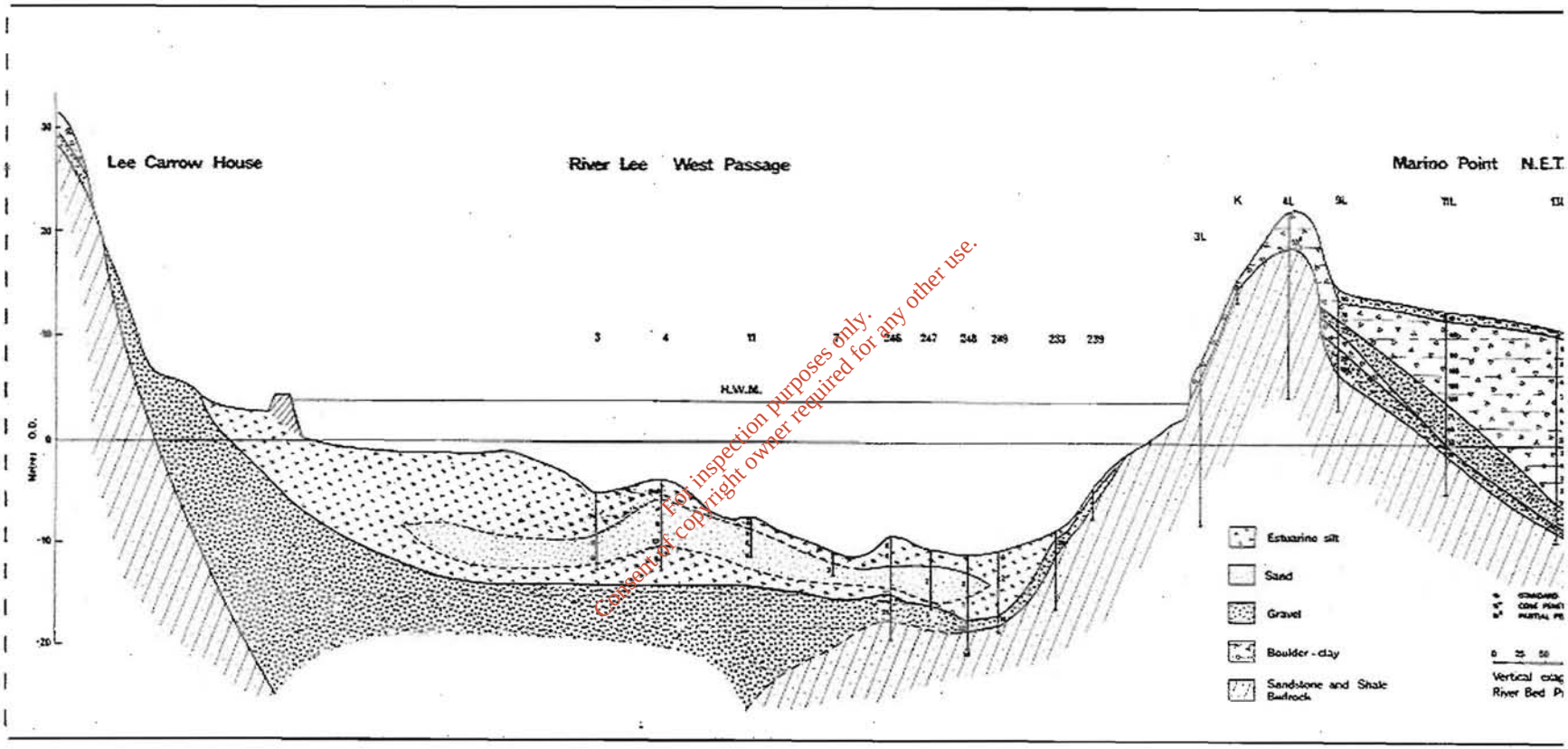

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FIGURE 3.4.3 MARINE CROSS SECTION (MARINO POINT TO LEE CARROW HOUSE).

CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG142

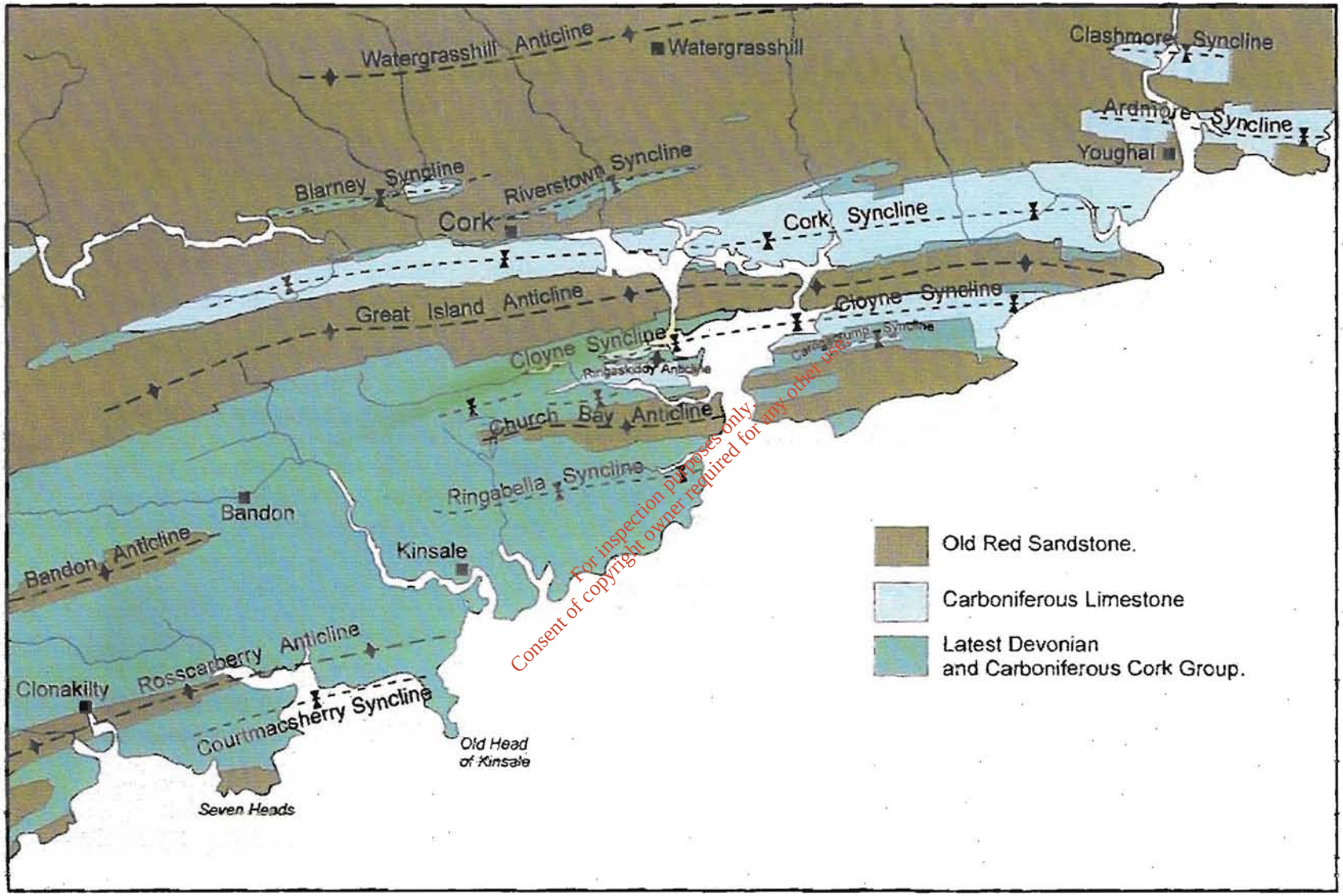

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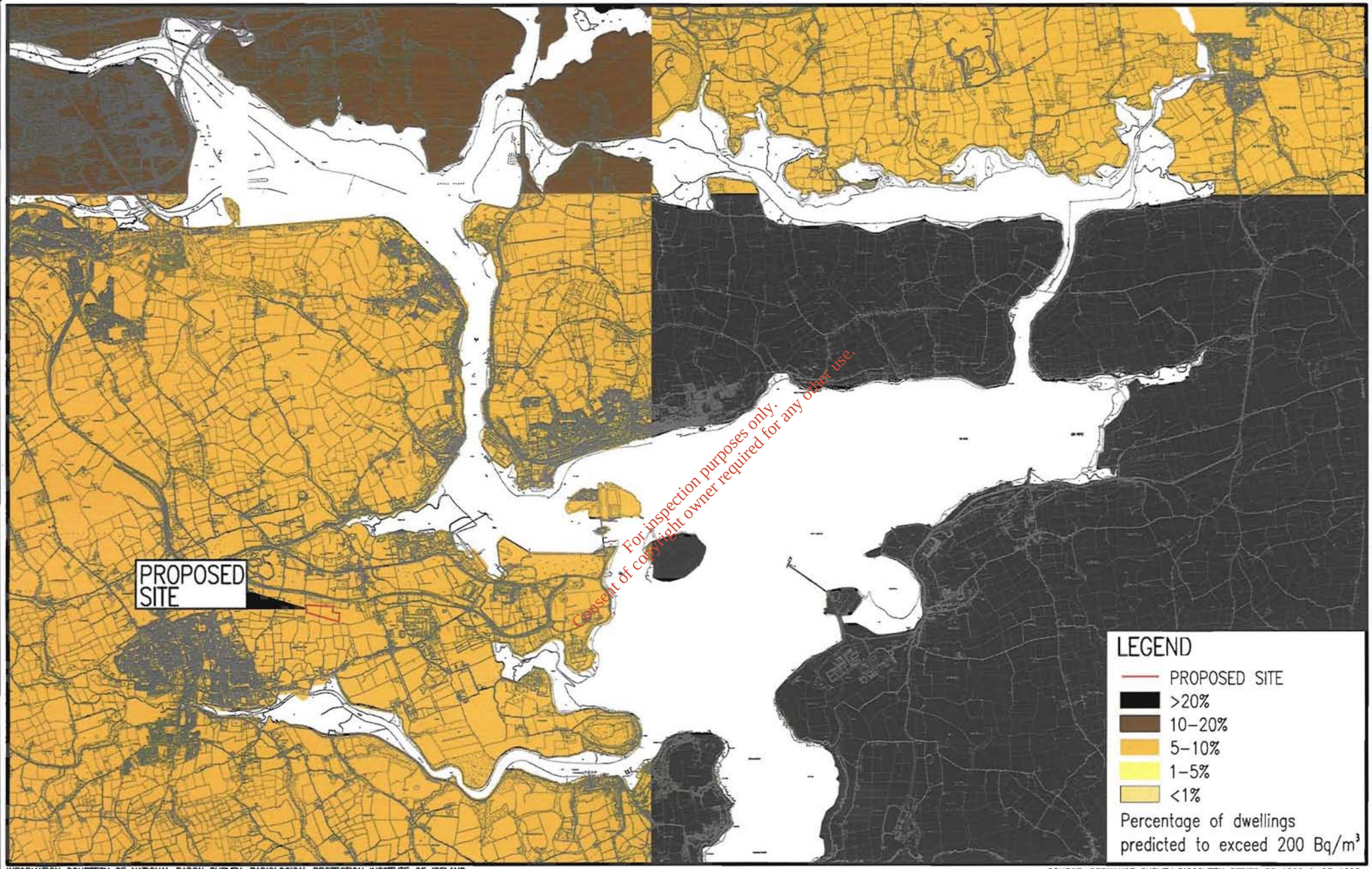
FIGURE 3.4.4 STRUCTURAL GEOLOGY

CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG143



INFORMATION COURTESY OF NATIONAL RADON SURVEY, RADIOLOGICAL PROTECTION INSTITUTE OF IRELAND

SOURCE: ORDNANCE SURVEY DISCOVERY SERIES OS 1806 & OS 1606

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FIGURE 3.4.5 RADON LEVELS IN CORK HARBOUR

CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG105

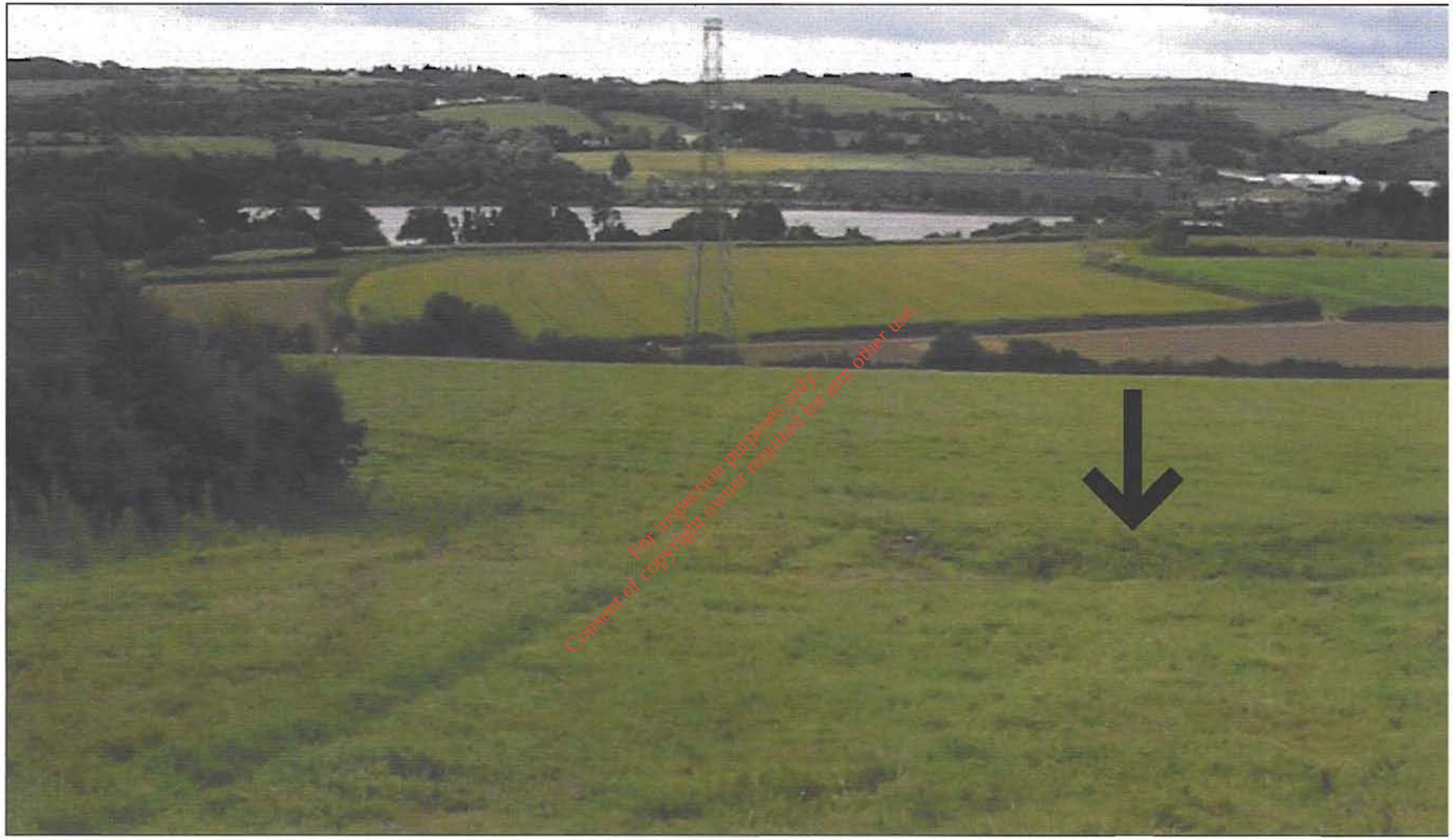

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PLATE 3.4.1 GROUND DEPRESSION
LOCATED NEAR THE EASTERN FIELD BOUNDARY

CORK HARBOUR MAIN DRAINAGE SCHEME
ENVIRONMENTAL IMPACT STATEMENT
JOB NR. 234541
DRG NR. 5670FG140

3.5 Material Assets

3.5.1 Introduction

Material assets comprise physical resources in the environment, which may be of human or natural origin. The objective of the assessment is to determine the impact of the proposed development on the material assets in the area and to ensure they are used in a sustainable manner with respect to the proposed development.

3.5.2 Methodology

MMP conducted a desk-based assessment of material assets in the vicinity of the proposed WWTP and the footprint of the collection system for the Cork Lower Harbour area. The required information on material assets was obtained from:

- The National Roads Authority
- Department of Environment, Heritage and Local Government
- An Bord Pleanála
- Bord Gáis
- Eircom
- Cork County Council
- Geological Survey of Ireland

The impact assessment for this section of the report is based on the *Guidelines on the Information to be contained in Environmental Impact Statements* and the *Advice Notes on Current Practice (in the Preparation of Environmental Impact Statements)* published by the Environmental Protection Agency (EPA) in March 2002 and September 2003 respectively. The criteria used include the quality, magnitude and duration of impacts.

Criteria for assessing impact quality, magnitude and duration are described in Tables 3.5.1, 3.5.2 and 3.5.3 respectively.

Table 3.5.1: Criteria for assessing the quality of impacts

Impact type	Criteria
Positive impact	A change is likely to improve the quality of the environment.
Neutral	No effect.
Negative impact	The change is likely to adversely affect the quality of the environment.

Table 3.5.2: Criteria for assessing impact magnitude

Impact Magnitude	Definition
No change	No discernible effect on human beings.
Imperceptible Impact	An impact capable of measurement but without noticeable consequences.
Slight Impact	An impact which causes noticeable changes in the character of the environment without affecting its sensitivities.
Moderate Impact	An impact that alters the character of the environment in a manner that is consistent with existing and emerging trends.
Significant Impact	An impact which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
Profound Impact	An impact which obliterates sensitive characteristics.

Table 3.5.3: Criteria for assessing impact duration

Temporary Impact	≤ 1 year
Short-term Impact	1 – 7 years
Medium-term Impact	7 – 15 years
Long-term Impact	15 – 60 years
Permanent Impact	≥ 60 years

3.5.3 Existing Environment

Material assets which may be affected by the proposed development are described under the following headings:

Assets of Human Origin:

- Towns, villages, settlements and residential clusters
- Recreational facilities
- Transport infrastructure
- Public utilities

Assets of Natural Origin:

- Natural Resources
- Natural Amenities
- Natural Heritage

Cultural Assets

- Archaeological and Built Heritage

Towns, villages, settlements and residential clusters

The towns and villages in the vicinity of the proposed development site are described in detail in Section 3.1 *Human Beings* and are listed below.

WWTP: The towns closest to the WWTP site include Shanbally, Carrigaline and Ringaskiddy. The village of Shanbally is located approximately 625m to the northeast. The nearest towns include Carrigaline, 1.06km southwest of the development site, and Ringaskiddy, which lies 2.24km to the east. Residential clusters exist along the LS472, L2490 and L6470 minor roads and along the N28 and R613. Planning permission has been granted for residential development at a site 134m east of the WWTP site.

Collection System: The towns nearby the proposed pipelines and pumping stations include Carrigaline, Shanbally, Ringaskiddy, Monkstown, Raffeen, Passage West and Cobh. The majority of the pipelines are proposed along existing roads and residential dwellings are present alongside these roads (see Figure 2.1 *Location of Existing Outfalls and Proposed Outfall*).

Recreational facilities

WWTP: Fernhill Golf and Country Club is located approximately 640m to the west of the proposed site. Facilities include an 18-hole golf course, sauna, steam room, swimming pool, gym and tennis court. Hibernian AFC sports grounds and clubhouse are located approximately 80m east of the site boundary and Shamrocks GAA sports grounds and clubhouse are located approximately 295m to the north east of the site.

Collection System: Cork Lower Harbour provides a location for water-based activities such as sailing, angling and fishing. Recreational facilities within the Harbour area include boat yards, mooring facilities and marinas for boats. The Royal Cork Yacht Club, based in Crosshaven, is the oldest yacht club in the world. Every second year it hosts Cork Week, a major sailing regatta of international significance. GAA clubs are present in Carrigaline, Passage West and Cobh. Marina facilities situated in the town of Crosshaven to the southeast; there are launching and mooring facilities in Ringaskiddy, Monkstown, Cobh, Aghada and Ballinacurra for smaller boats and jet skis. Recreational Walking is a popular activity e.g. Passage West to Monkstown/Raffeen Creek is a popular walking route in the locality. Cork Lower Harbour has a number of beaches utilised by locals and/or tourists visiting the area. These include Fountainstown, Myrtleville, Church Bay, Robert's Cove and Ringabella Bay on the western shores and White Bay on the eastern shore.

Transport Infrastructure

WWTP: Existing roads in the area surrounding the development site include the N28 National Primary Route 490m to the north; the R613 610m to the south; the R611 ca. 1.7km to the west and a number of minor roads to the east and west of the proposed site. Access to the WWTP site will be via the LS472 (Raffeen/Cogan's Rd.) minor road 405m west of the site. The LS472 is a local road with a speed limit of 80km/hr. The LS472 is a two-lane narrow country road with a narrow grass verge. The road has a tarred surface and there are no bridges or lay-bys on the road. The access road to the site is un-surfaced gravel and is in poor condition. It currently provides access to the Bord Gáis substation at the south west boundary of the WWTP site. It is proposed to widen/upgrade a section of the access road into the site. A 10m right of way has been acquired for this purpose.

Cork County Council is promoting the development of the Cork-Ringaskiddy Road Scheme. It is proposed to improve the existing N28 from the Bloomfield Interchange at Rochestown on to Ringaskiddy village. The improved road will have a greater capacity to cater for high traffic volumes (NRA, 2004). The preferred route will traverse lands 100m north of the WWTP site. Communications with the relevant road authorities indicate that it is not envisaged to provide direct access from the WWTP to the N28. This will result in the decommissioning of the northern section of the LS472 (Cogan's Rd.) and access to the site from the N28 will be from the south via the L2490 (Fernhill Rd.) to the junction with the LS472.

Collection System: The majority of the pipelines will be installed along existing roads. Figure 2.1 *Location of Existing Outfalls and Proposed Outfall* illustrates pipelines which will run along existing roads. Cross River Ferries Ltd. operate a car and passenger ferry between Carrigaloe and Glenbrook in Cork Harbour and the marine crossing for the pipeline is in close proximity to this ferry crossing.

Public Utilities

WWTP and Collection System: The public utility of most relevance to this EIS is the existing drainage network. The existing network for the Cork Lower Harbour area, which is primarily combined (waste water and storm water), can be divided into the following sewerage networks:

- Cobh and environs
- Monkstown / Passage West
- Carrigaline
- Ringaskiddy
- Crosshaven

There is an existing IDA marine outfall servicing industries in the Ringaskiddy area. This outfall extends eastwards terminating at Dognose Bank on the eastern side of the mouth of Cork Harbour. The location of the existing discharge point is shown in Figure 2.1 *Location of Existing Outfalls and Proposed Outfall.* Other public utilities include the water supply network, the electricity distribution network, gas network, telecommunication and broadband internet network.

Natural Resources

WWTP and Collection System: The site of the WWTP is a green-field site, used for agriculture at present. The lands surrounding the site are predominantly agricultural and form part of the metropolitan green belt between Cork City and Carrigaline. The proposed site is located on a south facing hill, at approximately 30m altitude (Malin Head Datum). The surrounding topography is undulating due to ridgelines which run from east to west. The development of a WWTP at the proposed site is consistent with the objectives of the *Carrigaline Electoral Area Local Area Plan* (2005) and adopted amendments (January 2007).

Rock types in the Cork area are sedimentary and were deposited during the later Devonian and Carboniferous Periods (370-310 million years ago). The bedrock underlying and surrounding the proposed location for the new WWTP site comprise Dinantian massive unbedded fine grained limestone (*Waulsortian Limestone Formation*); and Dinantian grey mudstone with subordinate sandstone (*Kinsale Formation* – Cuskinny Member which is a flaser-bedded sandstone and mudstone).

The proposed site is located in an anticlinal structure. Faults dissect the regional folds in the area close to the proposed site in a north/north-west to south/south-west direction. No outcrop is visible within the site. A geophysical survey (refer to *Volume III, Appendix 4A*) was carried out to determine the ground conditions, depth to rock, existence of karst features and reduce the risk of encountering difficult subsurface conditions. During this assessment an area of possible faulting/fracturing or karstification was identified in the SE corner of the site where strong lateral variations in the model resistivity values were recorded. It is possible that this variation represents the change in bedrock to Waulsortian limestone in the area. Refer to Section 3.4 *Soils, Geology and Hydrogeology* for a detailed assessment of soils, geology and hydrogeology.

Natural Amenities

WWTP and Collection System: Cork Harbour is the second largest natural Harbour in the world, in terms of navigational area. Cork Harbour provides excellent shelter for recreational and commercial boat traffic. The Harbour is a major asset to the Cork region and has significant potential with respect to marine leisure activities. Cork Harbour is made up of many islands and inlets which combine to make it an area of considerable natural beauty, with cliff faces and attractive sandy beaches.

Cork Harbour is a birdwatcher's dream. It is of major international importance due to the number of wintering migrants and for its international population of Redshank and is among the top five sites for wintering waterfowl in Ireland. There are at least 15 wintering species that have populations of national importance, including a nationally important colony of Common Tern which has been breeding here since 1970. Several of the species which occur regularly are listed in Annex I of the *EU Birds Directive (79/409/EEC)* and include Whooper Swan, Golden Plover and Bar-tailed Godwit. Cork Harbour in its entirety has therefore been designated as a Special Protection Area (SPA) for birds and a Ramsar site of international importance.

Currabinny Woods are largely deciduous woods and are sensational in autumn but make a pleasant walk at any time of year. It is situated in the south-eastern tip of the Ringaskiddy Peninsula which looks across the water to Crosshaven. The woods originally belonged to a private house, and there is a gazebo in the centre where the owners used to take tea. At the highest point in the woods there is a pre-historic burial cairn in rather bad condition, known locally as the Giants Cave. The forest trails here are unusual in that they were originally laid out for horse and carriage so that they are wide and airy, with none of the enclosed feeling that dense woodland can produce.

Owenboy River: The Owenboy estuary is designated as an area of visual/scenic importance. The river and estuary is a proposed Natural Heritage Area (pNHA), and includes a number of enclosed tidal inlets and areas of steeply wooded slopes. It is primarily of interest as a habitat for wildfowl and waders.

Scenic routes (views and prospects) are designated under the *Cork County Development Plan, 2003*. Views from scenic routes are to be preserved or improved. Scenic routes, which are situated in the general vicinity of the site are:

- Road between Carrigaline and Crosshaven (Item No. A56): The R612 road linking Carrigaline to Crosshaven has been identified in the *Cork County Development Plan* (2003) as a scenic route, the view from which is to be preserved or improved. This route extends along the Owenboy Estuary, with views of tidal inlets such as Drakes Pool and a number of steep wooded slopes. The road then rises towards Crosshaven, offering extended views of the Harbour. The route is popular with walkers who use the specially developed path (a former railway line) running alongside the route. The proposed development site is visible from this road.
- Road between Passage West and Ringaskiddy (Item No. A54): The road linking Passage West and Ringaskiddy has been identified in the *Cork County Development Plan* (2003) as a scenic route, the view from which is to be preserved or improved. This route extends from Passage West in the north, through a mixture of rural and urban areas, along the shoreline through Monkstown. The views available include the east and north of the Harbour. The latter section of this route (N28) extends from Raffeen Bridge through Shanbally and to Ringaskiddy through the industrial zone. The proposed development site is not visible from this route.

Scenic views and routes are detailed in Section 3.9 *Landscape and Visual Assessment*.

Natural Heritage

WWTP and Collection System: There are no conservation designations immediately adjacent to the WWTP site. However, several pNHAs and the Cork Harbour SPA occur in the vicinity. The pipeline along the northern shore of the Owenboy Estuary borders the Owenboy River pNHA and the proposed location for the Raffeen pumping station is adjacent to the Monkstown Creek pNHA. Section 3.2 *Terrestrial and Marine Ecology* describes the conservation sites, species and habitats of conservation importance in the area.

Archaeological and Built Heritage

WWTP: Section 3.8 *Cultural Heritage* details sites and structures of archaeological importance within the study area. Immediately outside the boundary of the WWTP site there are two recorded archaeological features (Recorded Monuments and Places or RMPs). Both are enclosures and likely to be ringforts.

Collection System: A total of 25 archaeological/architectural constraints were identified in relation to the pipelines and pumping stations and these include ring forts, holy wells, lime kilns, mill, graveyards and churches, souterrains and fulacht fia.

3.5.4 Impact Assessment

(i) Construction Phase Impacts

Towns, villages, settlements and residential clusters

WWTP and Collection System: The construction of the WWTP and ancillary works will have short-term negative impacts on the surrounding towns and villages in terms of increased noise, dust and construction traffic. However, these impacts will cease on completion of construction. A short-term positive impact for the surrounding towns will be an increase in revenue due to the sourcing of construction materials and also an increase in employment to the area.

Recreational Facilities

WWTP: Fernhill golf club, Hibernian AFC and Shamrock GAA sports grounds and clubhouses are all located within 1km of the site. Short-term impacts may include increased noise, dust, vibrations and increased traffic during the construction phase of the development.

Collection System: Foreshore and in-stream works may have temporary moderate-significant negative impacts on recreation, depending on the method of construction. An application will be made to the Department of Agriculture, Fisheries and Food (DAFF) for approval of this work and a schedule and method of works developed in consultation with the DAFF and other relevant bodies and stakeholders, including the Port Authority and Cross River Ferries Ltd.

Transport Infrastructure

WWTP: There will be an increase in traffic volumes associated with the construction phase of the development, which will have a short-term slight negative impact. Access to the site will be via the LS472 (Carrigaline Middle/Cogan's Road). Increased traffic volumes will be due to deliveries to site or disposal of surplus excavated material off-site by HGVs. Increased movements will also be generated by construction employees travelling to and from work. Impacts will include increased noise, vibration levels, visual impact, odour and dust impacts from HGVs.

Collection System: The routes of the pipelines are primarily concentrated along existing road infrastructure. The laying of pipes in these areas will result in slight temporary negative impacts due to traffic disruption. During the construction phase, the laying of pipelines along the shoreline and the marine crossing may have temporary moderate-significant negative impacts on river/Harbour traffic. The impacts will be temporary; however, the magnitude of the impacts will depend on the method of construction. An application will be made to the DAFF for approval of this work and a schedule and method of works developed in consultation with the DAFF and other relevant bodies and stakeholders, including the Port Authority and Cross River Ferries Ltd.

Public Utilities

WWTP: The proposed development will require a power source for most aspects of the facility and therefore the development will require connection to the electricity supply, provided by the ESB. A water supply will also be required. Impacts of the proposed development on public utilities are expected to be neutral.

Collection System: The pumping stations will require an electricity and water supply also and the impact associated with this will be neutral. The construction of a new collection system will have a long-term positive impact on the drainage network.

Natural Resources

WWTP: The construction of the WWTP will result in the permanent loss of 7.36ha of agricultural land. The land has been zoned for Utilities and Infrastructure and the impact is considered to be neutral.

Collection System: The pumping stations at Monkstown and Carrigaloe will not result in a loss of natural land resources. However, the stations at Raffeen and West Beach, Cobh will be located on reclaimed land at Raffeen and West Beach, Cobh and will result in a permanent loss of reclaimed land in these areas. Construction of the marine crossing will result in moderate to significant temporary impacts on the Harbour area in terms of disruption to Harbour traffic and recreational use. An application will be made to the DAFF for approval of this work and a schedule and method of works developed in consultation with the DAFF and other relevant stakeholders, including the Port Authority and Cross River Ferries Ltd.

Natural Amenities

WWTP: The construction of the WWTP will result in slight, negative impacts on the scenic route (A56) between Carrigaline and Crosshaven.

Collection System: The construction of the marine crossing will have moderate-significant temporary negative impacts on Cork Harbour. Impacts will include disruption to Harbour traffic.

Natural Heritage

WWTP: It is considered that construction of the WWTP will not result in any impacts on Natural Heritage.

Collection System: The Owenboy River and Monkstown Creek are pNHAs and during the construction of the collection system, temporary negative impacts may affect these pNHAs and Cork Harbour SPA. Birds are likely to avoid feeding in these areas due to increased noise and disturbance. Consultation with the National Parks and Wildlife Service (NPWS) will be required prior to construction, due to these areas being important for waterfowl.

Archaeological and Built Heritage

WWTP: Two archaeological features were identified at the boundary of the WWTP site. One of the features may be directly impacted during construction.

Collection System: 25 features of archaeological/architectural constraints were identified for the pipelines and pumping stations. The majority of the potential impacts are indirect, in that the Zone of Archaeological Potential may be impacted. Details are available in Section 3.8 *Cultural Heritage*.

(ii) Operational Phase Impacts

Towns, villages, settlements and residential clusters

WWTP and Collection System: A moderate long-term positive impact of the WWTP and collection system will be improved water quality in the Cork Harbour area thereby facilitating continued growth and development in the surrounding towns and villages. During the operational phase it is recommended that low level lighting is chosen for external lighting around the treatment plant. Locally directed on-site lighting will be provided for access and maintenance purposes and on the access roads and other locations, as required, for safety and security reasons. This will have imperceptible impacts on the surrounding towns and villages.

Recreational Facilities

WWTP: At present, discharge effluent entering the waters of Cork Harbour is untreated. Therefore, the operational phase of the WWTP will result in improved water quality entering Cork Harbour, thereby positively impacting on recreational facilities in the area.

Collection System: At present there are many waste water outfalls to the receiving waters at locations used for recreational activities (refer to Figure 2.1 *Location of Existing Outfalls and Proposed Outfall*). The construction of the proposed WWTP and associated pumping stations and rising mains will eliminate these outfalls resulting in a long-term positive impact on water quality and recreation. Where outfalls are to be retained, these shall operate only during storm conditions.

Transport Infrastructure

WWTP: During the operational phase of the development, there will be a slight negative impact on transport due to a slight increase in vehicular traffic entering and exiting the WWTP.

Collection System: Maintenance of the pumping stations will result in occasional additional traffic movements of light goods vehicles (LGVs) and this will have a neutral impact on traffic in the areas affected.

Public Utilities

WWTP and Collection System: The most significant positive impact of the WWTP and Collection System on public utilities will be the improvement in the waste water collection system. It is expected that the WWTP and Collection System will have a neutral impact on electricity and water supplies.

Natural Resources, Natural Amenities and Natural Heritage

WWTP and Collection System: The operation of the waste water collection and treatment plant will have a significantly positive impact on water quality in Cork Harbour. At present, untreated effluent is being discharged into Cork Harbour. The discharge of untreated effluent is a threat to this valuable resource and thus threatens the internationally important wetlands which form Cork Harbour SPA.

Archaeological and Built Heritage

WWTP and Collection System: The pumping station at West Beach, Cobh may have a slight negative visual impact on the cultural town of Cobh, however, sensitive design of this structure should mitigate for this impact.

(iii) 'Do Nothing' Impact

In the event that the proposed development does not proceed, water quality in Cork Harbour would expect to remain variable and eutrophic in parts. The effects of an increasing population coupled with increased housing demands in the Lower Harbour area would be an increase in the amount of untreated discharges entering the Harbour.

Impacts would include deterioration in water quality and this would affect:

- recreational activities due to poor water quality;
- revenue to the towns and villages in the area may decrease due to potentially reduced numbers of tourists;
- development in the Lower Harbour area would be inhibited due to a lack of appropriate drainage and waste water treatment infrastructure;
- conservation sites, including the internationally important Cork Harbour SPA

(iv) 'Worst Case Scenario' Impact

Where the mitigation measures are not implemented correctly, or fail, a potential exists for the WWTP to pose a safety risk, generating significant air quality impacts, uncontrolled effluent discharges or noise impacts. However, these situations are unlikely to occur on effective construction and operational management of the development and the implementation of the mitigation measures proposed in the appropriate sections of this statement.

3.5.5 Mitigation Measures

(i) Construction Phase

Towns, villages and residential clusters

WWTP and Collection System: A detailed Construction Environmental Management Plan (CEMP) will be developed for all construction activities to be carried out on the site of the WWTP and on the sites required for the laying of pipelines, sewers, marine crossing and pumping stations. This management plan will address activities likely to affect aspects of the environment e.g. noise, dust, odour, traffic, run-off, spillages, effluents etc. and will include environmental protection measures such as monitoring, protection barriers, operational procedures and contingency measures.

Recreational Facilities

WWTP: Dust abatement measures will be incorporated into the CEMP to mitigate against any potential air quality impacts on the nearby sports facilities.

Collection System: The construction of the marine crossing may result in temporary moderate-significant negative impacts on tourism and recreation. The impacts will be temporary; however, the magnitude of the impacts will depend on the method of construction. In order to mitigate for any negative impacts, a schedule and method of works will be agreed with the DAFF and other relevant bodies and stakeholders, including the Port Authority, local fishing interests (commercial and angling) and Cross River Ferries Ltd.

Transport Infrastructure

WWTP and Collection System: A Traffic Management Plan will be implemented to ensure the control of movements of materials, plant and labour to and from the site in order to minimise disruption to other road users and local residents. To minimise disruption to river traffic, a schedule and method of works agreed with the DAFF and other relevant bodies and stakeholders, including the Port Authority and Cross River Ferries Ltd.

Public Utilities

WWTP and Collection System: No mitigation measures are deemed necessary as no negative impacts associated with the proposed development are predicted.

Natural Resources and Natural Amenities

WWTP: In advance of construction a drilling programme is recommended to verify the ground conditions under the site, the depth to bedrock, depth of water table and confirm the presence/absence of karstified rock (particularly at the south eastern corner of the site).

WWTP and Collection System: An application will be made to the DAFF for approval of foreshore and marine work and a schedule and method of works developed with the DAFF and other relevant stakeholders, including the Port Authority, local fishing interests and Cross River Ferries Ltd. Mitigation measures described in Section 3.9 *Landscape and Visual Assessment* will be adhered to in order to mitigate for any negative visual impacts of the development.

Natural Heritage

WWTP: As no designated natural heritage areas are located directly adjacent to the proposed WWTP site no mitigation measures are deemed necessary.

Collection System: Prior to any works within or directly adjacent to pNHAs, consultation with the NPWS will be required and a programme and method of works developed.

Archaeological and Built Heritage

WWTP and Collection System: Mitigation measures for archaeological and architectural monuments and structures are addressed in Section 3.8 *Cultural Heritage* and will be adhered to.

(ii) Operational Phase

Towns, villages and residential clusters

WWTP: The Preliminary treatment at the WWTP must include for Septicity Control in addition to Screening and Grit Removal due to the length of the conveyance system. It is recommended that inlet channels and chambers be covered, vented and connected to an odour control system. The appointed contractor will be required to comply with the *Waste Water Treatment (Prevention of Odours and Noise) Regulations* (2005) *(S.I. No. 787 of 2005)*.

Collection System: It is essential that the pumping stations include for Standby power arrangements to prevent the overflow discharge of raw effluent to the Harbour. At a minimum an automated control operating system should be put in place to ensure that if a downstream pumping station fails to operate, the upstream pumping station will cease pumping.

Recreational Facilities, Natural Amenities and Natural Resources

WWTP and Collection System: The appointed contractor will be required to comply with the *Waste Water Treatment (Prevention of Odours and Noise) Regulation* (2005) *(S.I. No. 787 of 2005).* The pumping stations should include for Standby power arrangements to prevent the overflow discharge of raw effluent to the Harbour. At a minimum an automated control operating system should be put in place to ensure that if a downstream pumping station fails to operate, the upstream pumping station will cease pumping.

Transport Infrastructure, Natural Heritage, Archaeological and Built Heritage

As there are no significant impacts, no mitigation measures are proposed in relation to the above.

3.5.6 Residual impact

If the proposed mitigation measures are implemented, no significant negative residual impacts are expected to occur as a result of the proposed development.

3.6 Air Quality, Odour and Climate

3.6.1 Introduction

This chapter of the EIS describes the Air Quality, Odour and Climate in the existing environment along with the impacts and any mitigation measures proposed for the development.

Odour Monitoring Ireland Limited (OMI) was commissioned to conduct an assessment into likely impact on the air quality, odour and the climate associated with the proposed development. The specialist brief was to assess the current climate and air quality in the region and to predict the impacts of the proposed development on air quality in future years. Copies of the specialist reports are included in *Volume III Appendix 5A, B and C* of this statement.

3.6.2 Methodology

(i) Air Quality

A baseline air quality assessment has been carried out in the area (between the time periods July to August 2007) in the vicinity of the proposed WWTP development for benzene, toluene, ethyl benzene, p/o xylene (BTEX), nitrogen dioxides (NO_2), sulphur dioxide (SO_x), carbon monoxide (CO; EPA data), total depositional dust and particulate matter (PM_{10}), hydrogen sulphide (H_2S) and speciated volatile organic compounds (VOC's). In addition, a baseline speciated VOC survey was performed in the vicinity of five major pumping stations located along the drainage network (four proposed and one existing). These included Raffeen, West Beach, Monkstown, Church Road (existing) and Carrigaloe pumping stations. The purpose of this survey was to identify existing pollutant trends in the vicinity of the proposed development(s), and to assess the potential impact of the proposed development(s). This will establish sufficient spatial information in order to determine compliance with relevant ambient air quality legislation. Additionally, comparison with longer period limit values can be used to establish trends and are important in defining baseline air quality.

A total of twelve sample locations were chosen to represent the baseline air quality for named parameters in the vicinity of the proposed development(s). These locations are listed in Table 3.6.1 *Description of Air Monitoring Locations* and presented in Figure 3.6.1 *Overview of Monitoring Locations A1 to A7* and Figure 3.6.2 to 3.6.6 for pumping station locations.

Table 3.6.1: Description of Air Monitoring Locations

Reference	X Co-ordinates (Irish National Grid)	Y Co-ordinates (Irish National Grid)	Description of Monitoring
A1-WWTP	174861	63796	NO_2, SO_2, BTEX, PM_{10}, Total depositional dust, H_2S-Monitored using passive diffusion tubes, Partisol PM_{10} analyser, Jerome analyser and Bergerhoff gauges.
A2-WWTP	175341	63619	NO_2, SO_2, BTEX, Total depositional dust, H_2S-Monitored using passive diffusion tubes, Jerome analyser and Bergerhoff gauges.
A3-WWTP	175267	63938	NO_2, SO_2, BTEX, Total depositional dust, H_2S-Monitored using passive diffusion tubes, Jerome analyser and Bergerhoff gauges.
A4-WWTP	175071	63891	NO_2, SO_2, BTEX, Total depositional dust, H_2S-Monitored using passive diffusion tubes, Jerome analyser and Bergerhoff gauges.
A5-WWTP	174850	63999	NO_2, SO_2, BTEX, Total depositional dust, H_2S-Monitored using passive diffusion tubes, Jerome analyser and Bergerhoff gauges.
A6-WWTP	174907	63837	Speciated VOC's and H_2S-Monitored using pumped sorbent tube and Jerome analyser.
A7-WWTP	175257	63805	Speciated VOC's and H_2S-Monitored using pumped sorbent tube and Jerome analyser.
A8-Raffeen Pumping Station	175442	65188	Monitored using pumped active sorbent tube. Monitoring of H_2S using Jerome metre at 5 locations around the pumping station.
A9-West beach Pumping Station	179799	66426	Monitored using pumped active sorbent tube. Monitoring of H_2S using Jerome metre at 5 locations around the pumping station.
A10-Monksland Pumping Station	176977	66081	Monitored using pumped active sorbent tube. Monitoring of H_2S using Jerome metre at 5 locations around the pumping station.
A11-Carrigaloe Pumping Station	177607	67511	Monitored using pumped active sorbent tube. Monitoring of H_2S using Jerome metre at 5 locations around the pumping station.
A12-Church Rd Pumping Station (existing)	174405	62628	Monitored using pumped active sorbent tube. Monitoring of H_2S using Jerome metre at 5 locations around the pumping station.

The methodology for the description of the general air quality in the existing environment is also based on a desk based review of the relevant literature, with particular reference to the publication from the EPA (2007) *Air Quality in Ireland, 2006 – Key indicators of Ambient Air Quality.*

(ii) Odour

Dispersion Model: In order to obtain odour emission data for the site, library based odour data collected in accordance with EN13725:2003 European Standard on olfactometry was used to construct the basis of the dispersion modelling scenarios. Utilising the indicative design and site library odour emission data; dispersion-modelling techniques were used to establish maximum allowable odour emission rates from the proposed sites in order to limit any odour impact on the surrounding population.

Two odour emission scenarios were developed to take account of the specimen design of the Cork Harbour Main Drainage Scheme WWTP and pumping station operations with the implementation of odour mitigation strategies. These odour emission rates and specified source characteristics were input into AERMOD Prime in order to determine any overall odour impact from the proposed development.

The AERMOD model was developed through a formal collaboration between the American Meteorological Society (AMS) and U.S. Environmental Protection Agency (U.S. EPA). AERMOD is a Gaussian plume model and replaced the ISC3 model in demonstrating compliance with the National Ambient Air Quality Standards (Porter et al., 2003) AERMIC (USEPA and AMS working group) is emphasizing development of a platform that includes air turbulence structure, scaling, and concepts; treatment of both surface and elevated sources; and simple and complex terrain. The modelling platform system has three main components: AERMOD, which is the air dispersion model; AERMET, a meteorological data pre-processor; and AERMAP, a terrain data pre-processor (Cora and Hung, 2003). A full description of the model is included in *Volume III, Appendix 5B*.

Cork airport meteorological station Year 1993 to 1997 inclusive was used for the operation of AERMOD Prime. This allowed for the determination of the worst-case meteorological year for the determination of overall odour impact from the proposed Cork Harbour Main Drainage Scheme WWTP and each of the five pumping stations on the surrounding population.

Topography affects in the vicinity of the WWTP site were accounted for within the dispersion modelling assessment using a topography file. All significant deviations in terrain are examined in modelling computations through terrain incorporation using AERMAP software. All building wake effects within the propose WWTP and Pumping stations were accounted for in the modelling scenarios (i.e. building effects on point sources) as this can have a major effect on the odour plume dispersion at short distances.

- In the case of the proposed Cork Harbour Main Drainage Scheme WWTP, all significant odour sources (waste water handling and sludge handling operations) capable of generating offensive odours will be enclosed, sealed and negatively ventilated to an odour control system. Only the aeration tankage, secondary settlement tankage and storm water tankage within the proposed WWTP will be open to atmosphere. All other odour sources will be enclosed, sealed and abated using odour treatment system (two stages of treatment for biological treatment unit as first stage).
- For all pumping stations, an odour management system will be implemented to ensure that no uncontrolled release of fugitive odours occurs.